RESEARCH REVIEW

VLAG

2015-2020

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Contents

Preface

This peer review followed the new Strategy Evaluation Protocol of 2021, and was thus a qualitative assessment and not a quantitative performance evaluation.

The mandate of the International Peer Review Committee was to focus on recommendations for improvements, if possible.

This report summarises this qualitative assessment and the recommendations, mainly considering the following assessment criteria for the VLAG Graduate School and the four different Research Themes in relation to their aims and strategy:

- **research quality** (assessment period 2015-2020)
- **societal impact** (assessment period 2015-2020)
- **viability** (future-oriented)
- **research environment** (Open Science, PhD policy & training, academic culture, HR policy)

The Peer Review Committee visited Wageningen University and the VLAG Graduate School October 11-13 2021. Prior to the site visit, the Committee had received written material, notably the comprehensive self-assessment report of the VLAG Graduate School and the four Research Themes 2015-2020 produced by the VLAG Graduate School and the scientific personnel belonging to the four individual Research Themes. During the site visit, the interview sessions were informative and well-prepared. The committee especially valued the open atmosphere during all discussions.

The Peer Review Committee wishes to thank the VLAG Graduate School, notably Scientific Director Prof. Dr. Karin Schroën and the VLAG Graduate School administration team Vesna Prsic and Anouk Geelen for their eminent support to the Review process, as well as University of Wageningen for the excellent arrangements of the whole Review process and the site visit.

The Peer Review Committee hopes that the assessment and recommendations outlined in this report are considered as constructive, supportive suggestions that can help the VLAG Graduate School, the four Research Themes, and the VLAG community as a whole in their further development.

Prof. Dr. Anne S. Meyer, Chair of the Peer Review Committee

1. Executive summary

This review deals with the performance of the VLAG Graduate School and in particular that of the four Research Themes and focuses on identifying ways for further improvement.

The Review Committee has some general commendations:

- The Review Committee commends VLAG Graduate School's and WUR's strong commitment to PhD education and training.
- The Review Committee recognises the support and visionary outlook from Rector Magnificus Prof. Dr. Arthur P.J. Mol and the WUR Agrotechnology & Food Sciences management.
- The Review Committee would like to highlight the critical role that the VLAG Graduate School, incl. the Scientific Director Prof. Dr. Karin Schroën, play in creating a favourable environment for the PhD programme supporting doctoral training, research collaboration, and identity creation within the Biobased, Biomolecular, Chemical, Food and Nutrition Sciences at WUR.
- The Review Committee was pleased with the high quality of the facilities, space, and instrumentation.
- Scientific quality is high, societal relevance is clearly on the agenda, and viability is high.
- The Review Committee also commends the overall astounding recruitment of new PhD candidates and tenure track researchers (even during the pandemic).

General recommendations

Prior to the recommendations to the VLAG Graduate School and the recommendations per Research Theme, the Committee has some general recommendations regarding the tenure track system, Open Science and diversity, support to patenting, and the Research Themes.

The Tenure track system:

- The tenure track evaluation criteria appear too high. Consider lowering the quantitative tenure track evaluation criteria, especially with regard to quantitative requirements for PhD supervision, to enable broader and more strategic development of tenure trackers to secure a strong and balanced University.
- The tenure track evaluation criteria should in particular be more flexible with regard to the distribution between research, teaching, and administration to also foster individual developments that align with societal impact criteria and other forward-looking qualitative criteria such as Open Science stewardship etc.
- Support tenure trackers by considering the option of increasing the supervisory team for PhD candidates from 3 to 4.
- The Committee advises the tenure trackers to form a tenure track council to represent their interests in the tenure track framework. WUR and the VLAG Graduate School should provide formal and financial support and recognition for this council.

Open Science and diversity

- Enhance the awareness of Open Science. Create a long-term plan for the implementation of Open Science objectives to meet requirements from funding agencies and stakeholders.
- Build increased and more pro-active awareness around diversity to promote the establishment of a more balanced personnel structure at all levels.

Support for patent applications:

There seems to be limited centralised support for patent applications, with the financial burden of application and maintenance relying on external funding.

- WUR should take a more active role in this with central financial support for patents to ensure long-term viability and impact.

The Research Themes:

The Committee commends the formation and the structure of the 4 Research Themes that accommodate all 22 chair groups. The Themes 'cover the ground' well within the Biobased, Biomolecular, Chemical, Food and Nutrition Sciences. Each Theme (unit) provides a platform that enables collaboration across chair groups, as well as development of strong research visions and strategies for each Research Theme. The Committee advises to use the Research Theme structure to:

- Promote and intensify further interactions between groups and continue strong collaborative activities within the Themes.
- Review the recruitment plan of future tenure trackers to match the strategy of the Themes, i.e. going beyond individual chair group strategies.
- Plan tenure track recruitment on a career-long perspective to continue development of viable Themes and balanced chair groups within each Theme.
- Formulate clearer strategies and e.g. shared activity prioritization to formalise the societal impact activities.

Recommendations VLAG Graduate School

- Articulate VLAG Graduate School's main role better by formulating a clearer key principle regarding the focus on PhD education, e.g.
    - *'Educating researchers for a sustainable and healthy future' or*
    - *'Supporting scientific excellence through research training' ….or…*

With regard to the key question to the Committee regarding '*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 Committee recommends paying more attention to preparing some of the PhD candidates for jobs outside of academia, e.g. by emphasising courses in people management, patenting, entrepreneurship etc. in the course curriculum of the VLAG Graduate School.

Other comments and recommendations to VLAG Graduate School:

- The delays in PhD completions are undesirable and must not become the norm. The Committee recommends the following actions:
    - Analyse the reasons for the delays and make them transparent.
    - Initiate measures to ensure that the delays are brought down e.g. by aligning expectations better, or by helping PhD candidates with better time management both during the whole PhD study and during the Thesis writing process.

- Attend to the rights and obligations among the different PhD candidate contracts in order to ensure transparency and proper distribution of teaching obligations among the PhD candidates.
- Continue to support the PhD council's efforts in becoming an active player in increasing the VLAG community spirit. The VLAG Graduate School organization can support this by awarding a generous PhD council budget and by helping facilitate space to develop such activities.
- Consider better Alumni-tracking and generation of a VLAG Graduate School alumni network to support the societal and industrial network and broaden the career outlook for VLAG Graduate School PhD candidates, e.g. by arranging events for the alumni network.

Recommendations per Research Theme

Research Theme 1 Chemistry for Life Sciences and Biobased Economy

- Promote and intensify further interactions between the Chair groups in the Theme and continue to build strong collaborative activities within the Theme.
- Continue to focus on balancing fundamental research with disciplinary depth and applied research activities; the applied direction helps ensuring industry-funding, partnering, and PhD training for industrial employability.
- Implement more concerted actions for better outreach with potential societal impact.
- Continue the collaborative process in the Theme to create a true Wageningen Chemistry for Life Sciences and Biobased Economy Theme with high visibility.

Research Theme 2 Food Science and Technology

- Consider formulating an explicit strategy to clearly articulate what the Research Theme's leading position means. Identify the main contributing factors and what will be needed to continue strengthening the Theme in a context of increased competition worldwide.
- Formulate a strategy to clarify priorities in terms of cutting-edge equipment as well as skills to be internalised to realise the strategy of multiscale (temporal and special) exploration of food and dynamics along the food chain.
- Continue the interaction with Human Nutrition and Health, both with regard to digestion and physiology of food intake, and to better feature Global sustainability goals.
- Develop external interactions to better position food science and technology as a key player in terms of research to propose solutions for a global, circular bio-based economy.
- Open Science & Data Science. a) Focus on implementing FAIR (findable, accessible, interoperable, and reusable) data within the Theme in a context of Open Science. b) Find models for Open Science in relation to projects with industry collaboration, IP issues ('as open as possible, as closed as necessary'). c) Explore the possibilities opened by 'big data' to develop novel scientific approaches and understanding of the dynamics of the food system, from unit operations to sustainability.

Research Theme 3 Human Nutrition and Health

- Consider formulating a transparent and operational translation of the mission 'To improve global health and well-being through better nutrition' into action points in relation to specific science goals and actions, and recruitment.
- Consider some of the capacity building activities, e.g. the training of PhD candidates from developing countries, as societal impact activities as well as research.

- Formulate a strategy, e.g. prioritise specific research topics and/or identify a flagship to harness your uniqueness, in order to attain a higher success rate for highly prestigious grants.
- Make sure that the Open Science requirement is prioritised.

Research Theme 4 Biological Systems and Interactions

- Use the Theme to formulate a clear identity and emphasise the uniqueness of the Theme.
- The Theme could help strike a balance between fundamental and applied science, and to further deepen synergies that arise in the nexus between fundamental and applied research.
- The Theme might help to reduce workload and overhead by combining management, administrative or infrastructural tasks.
- The Theme could also help to profile the societal relevance of the groups even better. This could include a more explicitly formulated joint strategy for dissemination and valorisation, but also for instance a joint face to the public, e.g., website, spokesperson.
- The Mission and Strategy of the Theme should be used strategically when hiring new Chair leaders in current and upcoming vacancies.
- There appears to be a particularly large number of new tenure track PIs in this Theme. Ensure that the continued development of the younger tenure track staff includes attention to strategic priorities as well as scientific development (in accord with the general recommendations).

2. Introduction

2.1 Aim of the assessment

All publicly funded university research in the Netherlands is evaluated at regular intervals in compliance with a national strategy evaluation protocol (SEP 2021-2027), as agreed by the Universities of the Netherlands (VSNU), the Netherlands Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW). The evaluation process, which is applied at the research unit level, consists of an external peer review conducted every six years. Consistent with WUR terminology, this report uses the terms Research Theme or Theme (instead of research unit).

This research quality cycle aims to achieve three generic objectives:

- To assess a Research Theme in light of its own strategy and aims, including the sufficiency or appropriateness of the aims and strategy.
- To monitor and improve the quality of research conducted by the Research Theme.
- To contribute to fulfilling the duty of accountability towards government and society.

This assessment deals with the performance of the VLAG Graduate School and in particular that of the four Research Themes in the context of an (inter)national field of science and PhD training (retrospective) and focuses on identifying ways for further improvement (prospective).

The Committee sees the report as a form of peer advice. The attitude of the Committee during the interviews and in the writing of the report has been that of 'critical friend'. It seemed most relevant to the Committee to point out possible areas of improvement more than simply to confirm what is already going well.

2.2 The Review Committee

The Board of WUR appointed the following members of the International Peer Review Committee:

- Prof. Dr. Anne S. Meyer, Department of Biotechnology and Biomedicine/DTU Bioengineering, Technical University of Denmark, Denmark (Chair of the Committee).
- Prof. Dr. Olof Ramström, Chemistry Department, University of Massachusetts Lowell, USA and Department of Chemistry and Biomedical Sciences, Linnaeus University, Kalmar, Sweden.
- Dr. Catherine M.G.C. Renard, INRAE Provence-Alpes-Côte d´Azur Research Centre, Avignon, France.
- Prof. Dr. Christophe Matthys, Chronic Diseases and Metabolism, Nutrition, KU Leuven, Belgium.
- Prof. Dr. Nick Wierckx, Department of Microbial Catalysis, Institute of Bio- and Geosciences IBG-1, Forschungszentrum Jülich, Germany.
- Pamela González Dávila, Groningen Biomolecular Sciences and Biotechnology Institute, Faculty of Science and Engineering, University of Groningen, Netherlands (PhD candidate).

The Board of the University appointed Esther Poort of De Onderzoekerij as the Committee secretary. All members of the Review Committee signed a declaration form stating no conflict of interest and ensuring impartiality and confidentiality.

2.3 The assessment process

The research assessment as set out in the 'Strategy Evaluation Protocol 2021-2027' for public research organisations is based on three central criteria:

- Research quality: the quality of the Research Theme's research over the past six-year period, in light of its own aims and strategy.
- Societal relevance: the societal relevance of the Research Theme in terms of impact, public engagement and uptake of the research.
- Viability: the extent to which the Research Theme's goals for the coming six-year period remain scientifically and societally relevant.

In addition to these three main criteria, the following four specific aspects should be taken into account: Open Science, PhD candidate Policy and Training, Academic Culture and Human Resources Policy. The assessment is executed by an independent, international peer Review Committee, which is supported by an independent secretary.

As research within the graduate school takes place at the level of the Research Theme, the assessment criteria are assessed for each Research Theme.

At the level of the graduate school, the Committee is expected to give general findings and recommendations in light of the graduate schools' strategy and three main tasks: 1) doctoral education and training, 2) coherent research programme, 3) quality and progress of research.

The Executive Board of Wageningen University has formulated the following question for the Committees of each of the Wageningen graduate schools:

> *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 assessment is based on the following evidence:

- A narrative self-evaluation report describing the aims, strategy and performance of the graduate school and its Research Themes, both for the past six years and for the next six years.
- A site visit focused on discussions with both temporary and permanent academic staff.

The site visit took place 11-13 October 2021 and consisted of the following elements (programme in Annex A):

- Introduction to Wageningen University by the Rector Magnificus.
- Meeting with the director of the Graduate School, two members of VLAG Board, and two VLAG office staff.
- Sessions with all individual Research Themes (leaders and key staff).
- A meeting with PhD candidates and a meeting with Tenure Track candidates.
- Tours of the facilities.
- Writing time sessions.
- Feedback session by the Review Committee to present preliminary findings.

3. Structure, organisation and mission of the VLAG Graduate School

3.1 Introduction

The VLAG Graduate School is one of the six Graduate Schools at Wageningen University. The VLAG Graduate School forms an academic community for research and post-graduate education in the areas of biobased, biomolecular, food and nutrition sciences. It primarily provides a platform for high-quality post-graduate education and professional development of early-stage researchers, primarily PhD candidates, across the research areas.

The VLAG community consists of researchers from twenty-two Wageningen University chair groups. Since 2018, all research within the VLAG community is structured within four Research Themes that are subject to the current peer review, namely:

- Research Theme I: Chemistry for Life Sciences and Bio-based Economy.
- Research Theme II: Food Science & Technology.
- Research Theme III: Human Nutrition & Health.
- Research Theme IV: Biological Systems & Interactions.

The organisation of Research Themes was required to accommodate the newly introduced Strategy Evaluation Protocol 2021-2027, which dictates assessment of larger research units rather than individual chair groups.

3.2 Mission and strategy

The VLAG Graduate School's mission is to develop the careers of young researchers and to promote research collaboration within biobased, biomolecular, food and nutrition sciences. In essence, the VLAG Graduate School hosts a PhD programme and functions within the playing field defined by Wageningen University policies. The PhD programme policies are jointly defined and put into practice by the six graduate schools at Wageningen University that are united within the Wageningen Graduate Schools platform (WGS). These policies can be translated into three main tasks for the graduate schools:

1. Coordinate, develop and facilitate doctoral education and training.
2. Stimulate and coordinate the development of a coherent research programme within the mission of the graduate school.
3. Safeguard, monitor and stimulate the quality and progress of research by staff, postdocs, and PhD candidates.

3.3 Management and organisation

During the period under review the governance structure of VLAG Graduate School was simplified and there was a change in management:

- The formal decision-making authority is in the hands of the VLAG Board. The Board consists of one representative from each of the 4 Research Themes in the VLAG community, one member from a participating research institute, and a PhD Council representative.
- The Scientific Director provides guidance to day-to-day operations of the Graduate School.
- The VLAG Graduate School office staff currently includes an Executive Secretary, a programme coordinator, a PhD candidate advisor, three education coordinators and a secretary.

The Scientific Director, executive secretary, and programme coordinator participate in the Board meetings as advisors.

The VLAG Graduate School is an umbrella organization that also encompasses the VLAG PhD Council and the International Advisory Board (IAB). The council deals with issues related to the position of the PhD candidates and currently consists of 19 PhD candidates from different chair groups within the Research Themes within the VLAG Community. The chairperson of the PhD Council is also a member of the VLAG Board. IAB provides advice on strategic issues concerning the direction and quality of the research and educational programme and helps to identify opportunities for academic and professional alliances.

4. General findings and recommendations: VLAG Graduate School

4.1 General findings and recommendations

PhD policy and programme

As presented in the Wageningen University & Research (WUR) policies, the VLAG Graduate School secures the education and training of new generations of all-round scientists with high levels of competencies. The VLAG Graduate School is indeed the embodiment of WUR policies with regard to inclusivity, diversity, and equal opportunities. The Committee notes that the courses and overall training programme for PhD candidates organised by the VLAG Graduate School are in good shape with a rich curriculum.

Each Research Theme provides high-quality teachers, and the amount of PhD courses, teaching and training appears well-balanced across the four Themes, although with fair emphasis on courses from Research Theme II: Food Science & Technology and Research Theme III: Human Nutrition & Health. Of relevance to Research Themes I and IV, in particular, is to emphasize exposing PhD candidates to international developments in Chemistry through the new Wageningen University & Research Chemical Sciences (WUR-CS) initiative, as this initiative brings together chemistry groups of WUR and helps attract world-class speakers to Wageningen to give seminars.

It is recognised that the VLAG research director plays a critical role in creating a favourable 'community spirit' that provides connectedness across the four Research Themes by being involved in e.g. chair selection, tenure track decisions, and other decisions of research strategic character. Nevertheless, it is important to clarify VLAG Graduate School's main role as being a graduate school that supports the PhD education across the four Themes rather than being a research community. The VLAG Graduate School indeed helps shape scientific excellence through research training, and its main role in research education should be better clarified, e.g. by articulating its role in PhD education more explicitly in the description of its mission.

Considering the impressive size and the broad mission of the VLAG Community, the VLAG Graduate School (and WUR) regarding societal impact, there is a lack of relevant courses for PhD candidates seeking careers outside of academia. Current courses are mainly academically oriented. Considering the career perspectives of VLAG Graduate School graduates, more courses preparing PhD candidates for professional careers outside academia are recommended, e.g. within patenting, people-management, entrepreneurship, etc.

Furthermore, within most of the Research Themes, societal impact activities are mainly extra-curricular community communication activities. It is recommended that the VLAG Graduate School supports all Themes in formulating strategies for societal impact actions beyond community communication activities, e.g. by helping set up workshops across Themes.

An Alumni-network is recommended in order to provide better networking opportunities for PhD candidates and perhaps also young tenure trackers – e.g. by arranging contact-research days for the alumni or similar.

Guidance of the PhD candidates is formalised by the VLAG Graduate School, supporting the PhD study development with regular checkpoints. Still, significant delays in graduation occur. These delays are undesirable and unsatisfactory, and measures should be taken to identify the causes and prevent the

delays. Further, it is advised to help improve time-management both during and towards the end of the PhD studies, e.g. by imposing earlier deadlines for draft Thesis manuscripts etc.

Lastly, the rights and obligations of different PhD categories should be made more transparent.

Tenure track

Most new scientific staff members are appointed in the Tenure Track system, which sets clear criteria for successive career steps (Assistant Professor 2-1, Associate Professor 2-1, Personal Professor). The assessment criteria in the Tenure Track include quality of teaching, research, supervision of PhD candidates and Postdocs, funding acquisition, management, and team work competences. The Committee has several recommendations:

- The tenure track evaluation criteria appear too high. Consider lowering the quantitative tenure track evaluation criteria, especially with regard to quantitative requirements for supervision of PhD candidates, to enable broader and more strategic development of tenure trackers.
- The tenure track evaluation criteria should in particular be more flexible with regard to the distribution between research, teaching, and administration to also foster individual developments that align with societal impact criteria and other forward-looking qualitative criteria such as 'Open Science' stewardship, etc.
- Support tenure trackers by considering the option of increasing the PhD supervisory team from 3 to 4.
- The Committee advises the tenure trackers to form a tenure track council to represent their interests in the decision-making process for the tenure track framework. WUR and VLAG should provide formal and financial support and recognition for this council.
- Review the recruitment plan of future tenure trackers to match the strategy of the Themes, i.e. also going beyond individual chair group strategies.
- Plan tenure track recruitment on a career-long perspective to continue development of viable Themes and balanced units within each Theme. Each tenure track PI should be able to succeed on their own merit.

Open Science

The Committee noted a difference in the awareness of Open Science and FAIR data principles among the Themes. The Committee recommends to enhance the awareness of Open Science, and to create a long-term plan for the implementation of Open Science objectives to meet requirements from funding agencies and stakeholders.

Diversity

The Committee notes that all the Research Themes aspire to achieve an inclusive culture, with diversity aspects being part of the recruitment strategy. However, an explicit strategy regarding diversity appears to be lacking. The Committee recommends that the Themes as well as the VLAG Graduate School continue to build increased awareness of diversity in order to promote the establishment of a more balanced structure at all levels:

- Decide on a visible commitment to a gender plan policy: For instance, it should be clarified how the Themes and the whole VLAG community cover the EU Horizon requirements for a Gender Equality Plan (https://eige.europa.eu/gender-mainstreaming/toolkits/gear/what-gender-equality-plan-gep). It is also recommended to specify how diversity considerations are

considered in relation to recruitment and career development plans: e.g. statements such as 'we employ the best-qualified candidates in available positions, regardless of gender, ethnicity, religion, personal preferences, etc.'; and e.g. 'gender, ethnicity, religion, or personal preferences do not affect an individual's career development.'

- Consider initiating a point of coordination across the Themes and the VLAG Graduate School to establish and address awareness; within the next 5 years it is advised to develop guiding targets, e.g. by setting goals for e.g. extent of men/women and minority representations in committees and in leadership roles.

4.2 Recommendations to the VLAG Graduate school

At the level of the graduate school, the Committee was asked to give general recommendations in light of the graduate schools' strategy and three main tasks: 1) doctoral education and training, 2) coherent research programme, 3) quality and progress of research.

The VLAG community and the VLAG Graduate School would benefit from articulating the main role of the VLAG Graduate School more explicitly by formulating a clearer key principle regarding the focus on PhD education, e.g.

- *'Educating researchers for a sustainable and healthy future' or*
- *'Supporting scientific excellence through research training' ….or similar…*

With respect to the key question to the Committee regarding '*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 Committee recommends to pay more attention to preparing some of the PhD candidates to jobs outside of academia, e.g. by emphasizing courses in people management, patenting, entrepreneurship etc. in the course curriculum.

Other comments and recommendations to VLAG Graduate School:

- Analyse the reasons for the delays in completion of the PhD studies, and initiate measures to ensure that the delays are brought down e.g. by helping PhD candidates to adopt better time management during the PhD studies in general as well as during the Thesis writing process.
- Attend to the rights and obligations among the different PhD candidate contracts – to ensure transparency and a proper distribution of e.g. teaching obligations among PhD candidates.
- Continue to support the PhD council's efforts in becoming an active player in increasing the VLAG community spirit. The VLAG Graduate School can support this by awarding a generous PhD council budget and by helping facilitate space to develop such activities – However, the Committee recommends considering to reduce the PhD Council to a maximum of 8 members to help with the communication and effective dynamics of the PhD council.
- Consider better Alumni-tracking and generation of a VLAG-Graduate School-alumni-network to support the societal and industrial network and broaden the career outlook for VLAG Graduate School PhD candidates by generating contact meetings or arranging events with the alumni.

5 Assessment of the Research Themes

5.1 Research Theme I: Chemistry for Life Sciences and Bio-based Economy

The Research Theme comprises the chair groups of Biochemistry (BIC), Biophysics (BIP), Bionanotechnology (BNT), Bio-based Chemistry and Technology (BCT), Organic Chemistry (ORC), and Physical Chemistry and Soft Matter (PCC).

Already before the Theme was established, the chair groups had many discussions regarding their future strategy. From these discussions, some of the new research areas emerged, e.g., theoretical chemistry. The discussions during the site visit gave the impression that the chair groups were already working well together before the Research Theme organisation was established and that another clustering approach involving 11 Chemistry-related groups preceded the present grouping. The Theme was, to some extent, experienced as being of 'artificial' character with a relatively short history and the chair groups were not absolutely convinced of the long-term effects or benefits. Nevertheless, the faculty members - especially the younger PIs - were very optimistic about the Theme idea and discovered interfacial possibilities while working on the report.

During the review period (2015-2020), the Theme consisted of 33 academic staff members on average (excluding post-docs), with a marked increase in 2020 to 37. The number of postdocs ranged between 12 and 23 (on average 19) and the number of PhD candidates increased from 85 to 98. At the same time the budget was increased from 15.1 M€ to 18.4 M€, with a marked increase in primary funding (by 45%).

5.1.1 Aims and strategy

The overall aim of Theme I has been '*To improve the quality of life through successfully addressing fundamental and applied questions and societal challenges related to the chemistry of (bio)molecules'*.

The Theme divides its scientific challenges into three large areas of interest: a) synthetic approaches and catalysis, b) molecular Interactions, and c) development of advanced instruments and methodologies. The research of the Theme is driven by two societal challenges: a) environment and sustainability, and b) food and health.

The overall aim and the goals have been addressed through three strategic areas:

- Developing new in vivo/in situ biophysical and materials science methods, nanotechnologies, and scientific toolboxes.
- Integrating knowledge from experiments, modelling and theoretical chemistry in both fundamental research and process application.
- Strengthening new joint research avenues within the Theme, e.g., mechanobiology, and generating truly interdisciplinary science.

The three strategic areas are highly relevant with respect to the overall aim of the Theme. A training/educational top-level strategy statement is partly lacking, albeit part of the realisation steps.

A large number of supplementary PIs have been recruited (14 tenure trackers, up to 6 special professors). This has significantly strengthened the Theme with respect to widening the research activities, as well as integrating different chair group areas within joint research topics. Through the appointments of the special professors, the interactions with industry have been strengthened.

The Theme researchers have been very active in developing new state-of-the-art equipment. This is a significant and original strength of the Theme that warrants further emphasis.

The focus on Open science and technology is intriguing and of true benefit to the stakeholders. The Theme has been instrumental in promoting and guiding open access publishing and open data management. The Theme has maintained its attractiveness to students at different levels. In addition to providing a broad curriculum in the Theme areas, a new interdisciplinary master program has been established during the period. At the research level, the number of admitted PhD candidates has increased during the period, and a high number of postdoctoral fellows has been preserved. Outreach to the public has been emphasized through a wide variety of activities.

The interaction and collaboration with industry have been further emphasized, where the Theme researchers have used their expertise and resources to aid and assist surrounding industry.

5.1.2 Research quality

The Theme has been highly productive during the review period, with on average 241 refereed articles per year. Overall, peer-reviewed publications consistently exceed 1 refereed article per year per scientist. The bibliometric analysis reveals that these have been well received within the community with a high number of citations. Approximately 15% of the publications are in the top 10% and 1% in the top 1%. The field-weighted citation index (FWCI) is consistently >1 with an average of around 1.4. These metrics indicate the high productivity of the Theme researchers and some of the impact of the published work within the scientific literature.

The Theme has been highly successful in its publishing strategy, with a large number of publications in high-impact journals. The Theme researchers have been active in review/editorial boards/committees.

As expected, the research of the Theme is multifaceted and covers a wide range of topics from fundamental research to more applied development. For example, the ten given highlights in the self-evaluation document encompass structural biology, spectroscopy, biomaterials design and synthesis, inorganic synthesis, catalysis, eukaryotic evolution and cell polarity, asymmetric synthesis, click/conjugation chemistry, cryo-electron microscopy, synthesis and properties of organic/inorganic nanomaterials, microfabrication, soft robotics, nuclear magnetic resonance and imaging, as well as plant cell biophysics. Some of the highlighted publications result from collaborative efforts between chair groups, thus demonstrating the emphasis on interactions within the Theme. In addition, as indicated in the bibliometric analysis document, many of the Theme publications are results from national and international collaborations. The Theme has also been very successful in attracting high-profile personal research grants on a national and European level.

The quality of the highlighted publications is very high with respect to research topic, experimental standard, scientific and public interest, and research findings. The reported research is well justified, addresses fundamental questions, and displays scientific and societal relevance.

An analysis of the research of the different chair groups within the Theme gives a clear picture of excellence:

- Biobased Chemistry and Technology (BCT). Emphasis on catalysis and use of biobased resources as well as fabrication and applications of biobased materials. This research topic is well in line with societal needs, addressing fundamental issues and questions regarding sustainability.
- Biophysics (BIP). Focus on biophysics, including photosynthetic light harvesting, NMR/MRI, single-molecule biophysics, and biomolecular nanodynamics. This chair group studies the

physics of biological systems and addresses fundamental questions and challenges using advanced optical and magnetic resonance techniques. The research is of high importance, delineating biological processes and establishing new knowledge.

- Bionanotechnology (BNT). Focus on the study and development of micro- and nano systems with emphasis on NMR/MRI development and sensors/devices. Particular emphasis is placed on applications in the food and health areas. The research is of high interest in the fields of supramolecular chemistry, nanoscience and nanotechnology and combines advanced analytical and fabrication techniques with fundamental principles in chemistry and materials science.
- Organic Chemistry (ORC). Emphasis on the study of advanced organic reactivity with bearing on modern organic synthesis, nanotechnology and chemical biology. This chair group develops new, sustainable methods in synthesis and applies organic chemistry to surfaces, materials, and biological systems. This research is of high and general importance for a wide variety of fields with a special bearing on the Life Sciences.
- Biochemistry (BIC). Focus on cellular biochemistry using molecular genetics, proteomics, bioinformatics and spectroscopy approaches. Particular emphasis is placed on plant biochemistry and protein structure and function. This research is of high relevance for modern progress in plant and protein science.
- Physical Chemistry and soft matter (PCC). Studies on phenomena of soft matter at the nanoscale using chemical tools. Topics include self-assembly of (bio)polymers, self-consistent field theory, colloidal materials, multiphase materials, emergent systems, microscopy and spectroscopy. The research is of high importance and addresses fundamental questions and challenges within the area. The PIs are also involved in more application-oriented developments resting on the basic findings.

In all cases, the research activities address the overall aim of the Research Theme. The research is generally original and of high quality, with publications in reputable, high-quality general and specialised journals. The chair groups have strong collaborations within and outside of the Theme and generate high-quality knowledge bridging several areas.

Clearly, the chair groups and PIs of the Theme are very active in their respective fields, striving to address the overall Theme objective of improving the quality of life.

The analysis of the Theme shows that all chair groups are producing relevant, original, and collaborative research of high quality that meet the objectives of the Theme. The chair groups were already involved in many collaborations prior to Theme launch and had essentially learned to ‘get along with the other chair groups’ beforehand. Because of this, synergistic activities and effects due to the Theme clustering were present from the beginning, thereby facilitating meeting the Theme objectives. These effects can, for example, be seen in that the chair groups have secured joint funding in national and international competition, such as national Sector Plan grants. Nonetheless, the Theme has accelerated these effects further, with new initiatives of sharing resources, new, bridging cross-disciplinary tenure track recruitment, and shared PhD-candidates.

5.1.3 Societal relevance

The Theme activities are well in line with societal needs, answering questions of high relevance to understanding of matter as well as complex artificial and biological systems. The research findings and the many applications emanating from the Theme, are of benefit to a wide variety of stakeholders: peer researchers within and outside of the Netherlands, industry in different sectors, and the general public. The objective of serving the agricultural and food sector guarantees the short- and long-term impact in

these areas for the benefit of all. The pioneering advances in nanoscience and nanotechnology secure that WUR and the Netherlands as a whole will be at the forefront of this important, modern area.

The discussions indicated that the objective of increasing the societal impact is complex while being addressed from different angles. The activities are mostly initiated by individual PIs, although the general impression was that this element is not rewarded in tenure evaluations. Moreover, in response to a somewhat lacking WUR press office with respect to Chemistry, the Theme has established its own press officer to better accommodate the needs of the Theme.

The Theme greatly increased the percentage of open-access publications in the last evaluation period from 19% in 2015 to 70% in 2020. The Open Science goal of the Theme ensures that the majority of the research findings reach all potential stakeholders without limitations. This channel of information is of high importance, but may also deter immediate industry collaboration, where IPR is a critical factor for success.

The Theme self-evaluation report emphasizes the societal relevance of the activities. However, fundamental, open-ended, and boundary-free research does not immediately result in applications of high importance for long-term impact. This aspect would benefit from a more explicit analysis.

The Theme produces research and development of fundamental and applied nature and of high relevance to different stakeholders. More applied projects are common, with a high level of interaction with industry at different levels. A multitude of avenues have been followed to promote a higher societal impact, albeit mostly from individual PIs.

5.1.4 Viability

The Theme has several strengths that will guarantee success in the foreseeable future. This includes a strong, complementary, and multidisciplinary faculty that is well engaged in intramural and external collaborations. All chair groups are producing original, high-quality research, and the Theme has been enhanced by a number of new faculty members with complementary skills. The Theme develops new cutting-edge methodology and instrumentation and leads expertise centers that ensure excellence in research quality. The Theme is engaged in modern, fundamental, and interdisciplinary teaching activities at all levels, including outreach to the public.

Significant funding has been secured during the period. The direct funding has especially been improved, but a good level of research grants and contract research has been maintained. Inventions of the Theme, as shown in recent patent applications, will facilitate increased future funding for more applied research and development. The Theme instrumentation centers have also been made eligible for larger infrastructure grants, which will enable sustenance and further development of the facilities.

In response to the pandemic, the Theme proposes saving office space by continuing to work from home to some extent. This is a real, short-term possibility, but may result in less direct, informal contact between researchers on an everyday basis.

The Theme has recently become a specific scientific Theme within VLAG and is also part of 4TU. This will result in improving the visibility of the Theme and gives access to a larger research infrastructure.

Much of the quality of the Theme research depends on advanced instrumentation and facilities. This has to be maintained and continuously modernised and renewed in order to sustain the Theme excellence and productivity. At present, restrictions regarding equipment space constitutes an issue of increasing magnitude, limiting future progress, education, and collaboration. Measures should be put in place to guarantee that the instrumentation park required by the Theme is properly staffed and has adequate

space in the same location as the researchers. Furthermore, the Theme highlights complications regarding access to large equipment and infrastructure at WUR, hampering the research activities. Another obstacle is the fact that chair groups of the Theme are spread out over several buildings. In order to obtain consistent and seamless collaboration between the PIs, a common location with ample meeting opportunities is of high importance.

The Theme maintains a high degree of time-consuming experimental teaching for which it receives relatively low compensation from the university. This is a serious threat that needs to be addressed in order to sustain the high-quality education that is a hallmark of the Theme.

Another obstacle identified by the Theme researchers is that WUR showcasing of chemistry-related topics is somewhat side-lined and marginalised. WUR should make efforts to change the information structure to better accommodate the Theme news.

The Theme stands out as being robust while growing according to a continuous strategic plan and the joint initiatives of the groups. Some considerations for improved sustainability could be identified, especially regarding the educational burden, space limitations, and personnel growth. The high degree of costly, time-consuming experimental teaching is subject to non-sustainable compensation from the University. Equipment space is becoming a challenge, especially in relation to educational requirements, and the geographical spread of the groups is hampering a more seamless collaboration between the PIs.

Tenure track

The increase in tenure trackers over the last few years has strengthened the Theme but also comes out as a risk/threat regarding future financing. This is not unique to this Theme, as a similar situation was evident also within other Themes. The fate of and strategic plan for the many new tenure trackers are somewhat unclear at this point, with potential long-term consequences. The tenure tracker funding is (mostly) temporary, and the economic burden to the Theme could become strained if all tenure trackers were to be promoted. Therefore, the situation appears to be non-sustainable, and the tenure track plans need to be considered carefully to ensure that the financing model is valid in the long term.

Open Science

Open Science is of major importance to the Theme, which emphases open technologies, open science databases and schematics, open-source programming/coding, and open access publications. Clearly, the Theme is fostering open science principles at all levels and strives to increase its output to different stakeholders. Compared to other units and universities, the Theme can be regarded as being at the absolute forefront of open science and is likely to remain in that position in the future.

The Theme is actively embracing the open science concept and works actively to ensure the realisation of this objective. Not only are the Theme groups promoting and enabling open access publications, open data management, and open-source applications, etc., but they are also spearheading open science in terms of research applications with relevance to the public. This objective has been considerably strengthened by recent recruitments.

Human resource policy

Again, the central policies of WUR are followed by the Theme. As shown, a high level of diversity with respect to cultural and geographic background has been secured in the recruitment of new faculty during the last period.

The Theme reports on the pursuit of an active and inclusive human resource policy that supports various aspects of diversity. This was primarily resulting in the recruitment of tenure trackers of diverse cultural and geographical origins. Gender balance is a known issue, especially at the professor level.

Academic culture

All Theme members painted a bright picture concerning the academic culture within the chair groups and the Theme as a whole. The general atmosphere witnessed gave a very positive impression, with a high degree of collaborative alacrity and generosity.

5.1.5 Recommendations

The Committee notes that the Theme organisation is relatively new with a short window of opportunity to enhance new and already established collaborations between groups. We therefore recommend that VLAG, the chair groups, and all Theme researchers strive to make additional efforts to promote intra-Theme interactions and collaborations in order to foster an even better Theme identity and activity. The Committee also notes that lack of space and split locations between the groups is hampering the everyday activities within the Theme and recommends WUR to make efforts to solve the space issues.

The Committee notes that the strategy of the Theme has been in place for several years, already bearing fruit within the Theme. We can only recommend that this open and active collaborative spirit is further maintained and possibly enhanced.

The Committee notes that many societal impact-generating activities are taking place within the groups of the Theme, although being of a more individual, ad-hoc nature. We commend the Theme for taking the press relations into their own hands and recommend more concerted actions for better outreach. We also recommend a re-evaluation of the overall WUR tenure criteria to better align with the societal impact objective.

The Committee notes that the groups in the Theme are working well together for several years and produce high-quality, collaborative research and development. We recommend that this process is further emphasized in the future to create a true Wageningen Chemistry environment with high visibility. More intra-Theme activities and meeting points could be organised to facilitate the initiation of new collaborations and ideas.

The Committee notes the high societal relevance of the Theme and the many activities in place to promote the Theme expertise in relation to different stakeholders. We recommend a continuation of this process, while also guarding a strong element of scientific depth and open-ended fundamental research. A more concerted Theme approach to societal impact could be of value in addition to the already established communication strategy.

The Committee notes that the Theme is viable and maintains a rational approach with respect to funding. Space issues need to be addressed by WUR to enable sustained growth of the Theme. Allocations of funding by WUR for more costly, hands-on experimental training of undergraduate students should be revised to better reflect the actual costs. The Theme provides high-quality training using advanced instrumentation, which is becoming a hallmark of WUR. This needs to be further addressed by WUR to maintain a strong position and to attract future generations of students.

The picture is not entirely clear to the Committee, but we recommend restrained recruitment of future tenure trackers to better match the growth/size of the Theme. In principle, a healthy recruitment plan should come with a career-long perspective in order to maintain a viable economic unit. All recruited tenure trackers should have the possibility to succeed on their own record.

The Committee notes that Open Science is an ongoing and very active reality within the Theme. Our recommendation is to build on that excellence and maintain leadership in this important field.

The Committee notes that the overall academic culture within the Theme is healthy. Our recommendation is that the Theme members strive to maintain this atmosphere in their continuing growth and success.

5.2 Research Theme II: Food Science & Technology

The Research Theme "Food Science and Technology" comprises five chair groups: Food Chemistry (FCH), Physics and Physical Chemistry of Foods (FPH), Food Process Engineering (FPE), Food Microbiology (FHM), and Food Quality and Design (FQD). All chair groups are located in the same building (Axis) of Wageningen University.

As evidenced by their names, the chair groups, have a clear application focus and at the same time an equilibrium with more basic approaches to better understand complex systems in a multidisciplinary manner. Structured collaborations between these chairs have been in place for 25 years, growing from bilateral projects to a common program and integrated functioning. The long-standing existence of collaborations as well as the shared building (and a number of shared equipment) enables fluid exchanges and project building between the chair groups, with a process described as "self-organised".

During the review period (2015-2020) the Theme consisted of 42 academic staff members on average (excluding post-docs) with a marked increase in 2020 to 46. The number of post-docs increased from 17 to 27 and the number of PhD candidates increased from 132 to 182. At the same time the budget increased from 15.8 M€ to 22 M€, with a marked increase of primary funding (by > 50%), research grants (more than doubled) and a stable level of contract research.

The research work is built on two overall scientific disciplines, that are food process engineering and physicochemical characterisation. The research is broadly presented as 'Sustainability from food production to food quality' and 'Food during consumption and digestion'. This mission-oriented research entails the acquisition of specialised equipment, which appears to be coordinated within the Theme. The Theme has an abundant state-of-the-art parc of analytical (chemical and physicochemical) instruments and lab-scale processing equipment.

5.2.1 Aims and strategy

The overall aim of the Theme has been '*to be the leading unit of food science disciplines, by combining the joint expertise in all five disciplines with world class facilities into a centre that can work cross-disciplinarily to create novel mechanistic understanding and to invoke new principles to pro-actively enable our society to tackle the challenges of turning the world's harvests into safe, healthy and enjoyable foods for our changing populations, for decades to come.*

The Theme's ambition to have a leading role in food science and nursing a "Wageningen Food" trademark is well-founded and legitimate. The Theme is in a very strong position to bring together the multidisciplinary expertise needed to understand the complex phenomena occurring during and after food processing. It has built the necessary trust and smooth collaboration between chairs, as shown at all levels during the assessment, it has the required critical mass, and it has a very high level of resources. Furthermore, the Theme emphasizes the necessity of fostering disciplinary research in parallel to more applied development. Within the strong Wageningen environment, the Theme can easily have collaborations with researchers working on the primary production on the one hand and with Human nutrition on the other hand.

The presentation of the strategy was strongly focused on the scientific aspects. The scientific strategy has been built to take advantage of strong points of the Theme in food characterisation and processing, by a more concerted approach of multiscale dynamics from molecular to macroscopic scale, to answer the societal demand of the shift to more vegetal and personalised diets, and the new enabling technologies. Six research priorities have been identified for the next 6 years in continuity with the two overarching topics of 2015-2016 and in line with the transition to more plant-based food.

To target the new challenges in the field specific forward-looking research areas have been identified:

- Sustainability: multiscale dynamics in the food chain and mobility and growth of food-associated microorganisms in food matrices.
- Food during digestion: sensory perception and digestion. In this topic, the links with the Nutrition groups will need to be strengthened.
- Two topics at the intersection, namely multi-scale dynamics of novel plant-based food materials and novel food concepts based on new and synthetically produced sources.

The need for multiscale understanding is clearly presented and includes both plans to set up a new pilot plant and to acquire advanced microscopy equipment. The varied potentials of enabling technologies need to be approached in a structured manner and carefully integrated in the six topics.

On-going strong collaboration with industry partners will be needed and is expected to continue at a high level with Dutch government support. This support was demonstrated by the recent recruitment (2019 & 2020) of 6 tenure track positions, including some in obvious connection with Human nutrition and with Computer science.

The need for an integrated use of raw materials is acknowledged, but the non-food uses are barely hinted about, although the same set of skills and equipment apply for the large part to both. How much demand there is for the integrated skills of the 'Food Science and Technology' groups regarding these applications and how much potential synergies can be gained with other groups and universities are important questions.

Continued attention should also be paid to the evolution of the academic staff and the succession of chairs and group leaders, to ensure that new chairs and group leaders will pursue the dynamic of integration and collaboration built by the existing team.

The acquisition of high-level personal grants is an issue for applied sciences. However, some efforts, maybe with more coordination and support, should be pursued, also to enable recognition of the strength of food science in addressing complexity. The emphasis on multiscale understanding, in particular, could be a relevant angle.

5.2.2 Research quality

The Theme has been highly productive during the review period with on average 223 refereed articles each year. Overall, peer-reviewed publications consistently exceed 1 refereed article per year per scientist. The bibliometric analysis reveals that these have been well received within the community with a high number of citations. Approximately 15% of the publications are in the top 10% and 1% in the top 1%. The field-weighted citation index (FWCI) is consistently >1 with an average of around 1.4. However, the self-evaluation report does not indicate their repartition between food science and more disciplinary journals.

The overarching research topics from 2015 to 2020 were 'sustainability from primary production to food quality', and 'food during consumption and digestion'. These topics correspond to research challenges identified by the food science community. The research was conducted in major projects, mostly with national grants including industrial consortia and small groups of PhD candidates working in a coordinated effort. These two overarching topics were presented in a well-argued manner and illustrated by two narratives, which dovetailed with the presentations done during the site visit. During the site visit, the Theme made an attempt to actually present a small demonstration of research approaches and results with focused presentations illustrating collaborations between chairs, carefully highlighting the relation between state-of-the-art methodologies and societal relevance. These three

demonstrations concerned 'from molecule to microstructure and novel food properties', with presentations on isolation, surface properties and fibrillation of plant proteins, 'novel food concepts based on novel and synthetically produced sources', with presentations on protein structure construction and insect fractionation, and 'antibacterial chemicals' and UHPLC-cyclic ion mobility MS illustrating phytochemicals as antibacterials and the use of top protein analysis equipment to understand food digestion. These demonstrations as well as the narratives and the interviews demonstrated the integrated approach of the Theme and the force of the synergies between disciplinary strengths applied to common problems.

The Theme has an outstanding recognition in the food science community, and all indicators are outstanding in terms of publication level and growth. However, the Theme should consider pursuing the efforts to publish in top, multidisciplinary journals again with the aim of raising the profile of the group and more generally of food science. This could also be articulated in terms of productions of the PhD candidates and the academic staff, as a single high impact article would sometimes be more beneficial.

The Theme generates a lot of complex data and models. The strategy to make them accessible in a responsible and FAIR (Findable, Accessible, Interoperable and Reusable) manner is highly important notably considering the urgency of carrying out a major transition of the food system and the need to bring on board the stakeholders, beyond the existing strong partnership with the food industry leaders.

5.2.3 Societal relevance

The Theme has historically made a strong contribution to innovation in the food industry both through projects and by providing well-trained young researchers. A lot of energy is dedicated to smooth collaboration with industrial project partners in large consortia (precompetitive) within the framework of doctoral training. Although the career prospect of the PhD candidates after graduation was documented in the self-evaluation report, the network of graduated PhD candidates also plays a role in the relatively seamless collaboration with industry.

The Theme greatly increased the percentage of open-access publications in the last evaluation period from 10% in 2015 to 72% in 2020.

There is a fair level of interaction with stakeholders beyond the food industry (schools, government, press), however it is not clear whether this stems from a specific action of the Theme or individually of its members. With the current issues about the food system becoming prominent in the public discussion (ultra-processed foods, artificial meat, meat and dairy analogue etc.) efforts should probably be devoted to extend and structure this engagement in public debate. This has two corollaries, related to open science. One concerns making more transparent (within the limits due to collaborations with socio-economic partners) the data and models generated by the Theme. The second regards developing relations with a more diverse group of stakeholders (from SMEs and start-ups to citizens).

Sixteen patents are mentioned for the past 6 years. The self-evaluation report doesn't provide information on whether the patents were obtained with the industries or from own funds / grants, whether they have led to start-ups or licensing.

5.2.4 Viability

The Theme's goals for the next six years are societally and scientifically relevant. As an applied science, food science and technology will be at a key intersection between primary production and the consumer to ensure a smooth transition to a more sustainable, yet socially acceptable food system. This interface role means providing knowledge (data, models, technologies, etc.) for new near optimal pathways based on a strong science base. The responsibility to provide robust science-based evidence to answer this societal challenge is clearly enunciated in the strategy of the Theme ('*to provide mechanistic understanding on how to minimise environmental impact while ensuring sufficient, affordable, safe and tasteful food for the coming decades'*).

At the same time, the ambition of providing mechanistic understanding, and especially integrating multiple time and a spatial scales, is a major scientific challenge that will require cutting-edge skills and equipment. This is addressed in the ambition concerning both the understanding of raw materials and food structures, in a descriptive and active manner, and to tackle the food system itself. Relations with the Human nutrition Theme are in place to better understand food acceptance and physiology during digestion. Relations with more social sciences groups could be beneficial both to go beyond the purely physiological aspects of food preference and to better understand the relationships between the stakeholders of the food system. Reliance on prior pathways might be a tipping point and could be integrated in analyses of required future technologies or organisations.

Six new tenure track staff were recruited recently, contributing to the already mentioned increase in personnel of the Theme. This relatively large number of tenure trackers presents a potential financial viability challenge in the longer run. The increase in staff was explained as being funded on a permanent funding source from the government, however the long-term funding and the career tracks may have to be reviewed within the next period.

The perspective of a new building grouping all Theme operations at a pilot-scale will be a very important addition. It is highly timely, as there is a need to identify the optimal or near-optimal (while mild) processes needed for the next generation foods, from new raw materials, produced in a sustainable manner. This will require major innovations with integration of processes and knowledge, greatly facilitated by the scale-up potential. The priority 'novel food concepts' of the research strategy would greatly benefit from such an investment. It will give a focus for these efforts while also enabling them e.g. by advanced pilot equipment with in-line real-time data acquisition, production of sufficient volumes to assess acceptability, more realistic sustainability assessment (water, energy requirements), demonstration for industry and stimulation of innovation in SMEs. The disruption in the food system may also demand to work more with start-ups or SMEs and this may require a different way to collaborate, reaching higher technology readiness levels, such as may be done in a pilot plant. Specific communication tools as well as more 'open data' strategies may also be required.

An important point for getting full benefits from this major investment would be to also have increased capacities for data science, taking into account not only the characterization data of raw materials and products but also the in-line temporal signals from the processes. Currently the Theme relies on collaboration with other universities (University of Eindhoven) but some internal capacity building could be recommended.

The strategic vision for the third dimension of the research strategy, which is the advancement of enabling technology, will need to be strengthened in terms of concrete means, i.e. collaborations, internalisation of skills, etc.

5.2.5 Recommendations

The ambition of the Theme is to be identified as the world's leading research unit of food science discipline. Currently, the Theme is in a unique position by its exceptional concentration of expertise in food science. An explicit strategy needs to be formulated to articulate what this leading position means, what are the main contributing factors and what will be needed to strengthen it in a context of increased competition worldwide.

The research topics have clear scientific aims and are well aligned with the goals. The larger picture might need to be kept in mind to reach them, notably the interactions with research on production of animal-based raw materials for example with a clear return to these research groups on specification or tools to validate adequacy for food processing. The relations with the plant, animal, environmental and social science Themes which are mentioned in the documents will require a specific plan including means and strategy in adequacy with the central role envisioned by the Theme. Another point that will require attention concerns the global, circular bioeconomy, of which food is the linchpin. Many of the same expertises are needed and this broader point of view may entail an active and prioritised strategy to develop partnerships beyond the food environment.

A major focus of the future research strategy is multiscale (temporal and spatial) exploration of food and of dynamics along the food chain. This will require further investments in the tools (both conceptual and physical) needed for multiscale dynamics and multiscale understanding. A strategy needs to be formulated both to identify priorities in terms of cutting-edge equipment as well as skills to be internalised to use them.

Some attention should be devoted to data in the context of Open Science. The more immediate one concerns the application and implementation of the FAIR principles of the newly collected and already collected data generated by the Theme. This should notably be formulated keeping in mind the high level of projects with industry collaboration and the intellectual property issues ('as open as possible, as closed as necessary'). Second, attention should be devoted to the possibilities opened by "big data" to develop novel scientific approaches and understanding of the dynamics of the food system, from unit operations to sustainability.

The very good collaborations between the chair groups are currently self-organised, leading to strong synergies. A more formalised organization might be needed notably to ensure that any new chairs continue in this dynamic. Specific links with other Themes, notably to Human Nutrition and Health, would strengthen the food science Theme as well.

5.3 Research Theme III: Human Nutrition & Health

The Research Theme 'Human Nutrition and Health' is composed of five chairs groups: Sensory Science and Eating Behaviour (SSEB), Nutrition and Disease (NAD), Nutritional Biology (NB), Global Nutrition (GNU), and Nutrition, Metabolism and Genomics (NMG). These chair groups constitute a coherent research Theme grown over 50 years from a single chair by accretion and creation of new chair groups. They are located in the same building (Helix) and share a global budget.

It was clear from interviews that they constitute and consider themselves a single academic unit with a clearly overarching Theme, and function as such. Their facilities include the common human research infrastructure and an ongoing collaboration with a local hospital for access to patients, a kitchen and restaurant to study eating behaviour, as well as more classical laboratories for analysis of samples. The Theme also has structural collaboration with Low- or Middle--Income Countries. There is a well-structured internal governance including decision-making bodies for day-to-day management as well as weekly meetings for science-based discussions.

During the review period (2015-2020) the means of the Theme clearly show two phases, with a decrease up to 2017/2018, either in terms of permanent staff (from 35 to 31) or budget (from 15.6 to 13 M€ in 2017), and with an improving outlook for the last 2 years (2020: 41 academic staff, 14.9 M€). The same trends are visible for the number of PhD candidates (163 in 2020 from a low point of 124 in 2017), and post-docs.

5.3.1 Aims and strategy

The overarching mission of the Theme is to '*improve global health and well-being through better nutrition',* with a global approach from large interventions to understanding the physiological mechanisms behind food perception'. The strategy is clearly presented as delivering knowledge and interventions to improve nutrition (and potentially impacting the societal burden of diet-related diseases) for all. This strategy covers two main applications, in the European context, better health and less obesity for an aging population and in Low- and Middle-Income Countries adding the question of undernutrition and micronutrient deficiency. The current research Theme exists for more than 50 years and organically grew from one chair holder to currently five chair holders. The slow and organic growth emphasizes the interrelationship of the different research topics. The organic growth also indicates the flexibility of the Theme to adjust to the changing environment and society by taking up new societal dilemmas (e.g. sustainability issues). In relation to nutrition-responsiveness the Theme included recently as well a clinical Theme affiliated to a local hospital (Gelderse Vallei Ziekenhuis), allowing the Theme to cover a broad range of topics, namely from bench to bed and back, while working on prevention as well.

The strategy would gain by being more precisely described notably in terms of approaches to address the societal challenges as well as disciplinary approaches. This might allow the definition of a tighter focus for action which can be used by the different chair groups in the formulation of precise priorities and goals. Collective appropriation of theses priorities could in particular facilitate the formulation of proposals for the more prestigious grants based on a collective vision.

Another relevant point for the Theme's approaches to stand out in the view of the various funding bodies would be to make better use of the Wageningen brand and environment, for example by a more structured interaction with the food science groups. A wider environment including the researchers working on primary production will be necessary to advance on the link between nutrition and sustainability of the food system. The Theme is uniquely placed to contribute to the next food transition which will be a consequence of the necessary agricultural transition, and which must be approached holistically.

Collaboration with the private sector can be an asset but could be considered as a limitation at the same time, especially in a field like nutrition, where the public opinion is clearly against public-private partnerships in the context of research. The use of private-public partnerships can put pressure on researchers in two ways: i) IP-related issues and ii) consultancy-related issues. In the context of the IP-related issues, this can have an effect on the viability of the unit in the future (e.g., not having the possibility of exploiting your own research findings) or putting pressure to have specific findings that would lead to specific IP. Regarding the consultancy issue, some research could be considered as more result-driving than context/research-driven. Both aspects can have an effect on the quality of the work that is performed.

5.3.2 Research quality

The Theme has been highly productive during the review period with on average 226 refereed articles each year. Overall, peer-reviewed publications consistently exceed 1 refereed article per year per scientist. The quality and influence of scientific output is evidenced by a substantial proportion of articles in the top 1% section. The percentage of top 1% papers is around 3% during the last 6 years (excluding the publications co-authored by more than 100 authors). The field-weighted citation index (FWCI) is consistently >1 with an average of around 1.9. This indicates that the different chair groups are producing relevant, original but as well collaborative research of high quality that meets the standards of the Theme. The scientific output indicates the collaboration between the different chair groups, as the high number of top publications is only possible due to the different synergies between the different chair groups. The effect of top papers is also indicated by the secured funding in different competitive grant proposals. On top of that, the Theme has accelerated its activities in the field of nutrition by starting new initiatives both locally and worldwide.

The members of the Theme are well involved in public bodies, and they contribute to policy both in the Netherlands and with their partners in low- and middle--income countries. The Theme has gathered through the years a wealth of data and participate in massively co-authored papers aiming at decision-making bodies such as governments or the FAO. Beyond these specific papers, they also have a high level of highly cited papers.

Within the self-assessment document as well as in the interviews, the Theme presents itself as having a broad multi- and interdisciplinary approach and a large number of collaborations. However, the 6 narratives chosen for the self-assessment report highlight one major trend, which is instrumenting nutrition as a lifestyle factor in non-communicable diseases for science-based and efficient interventions. This can be operational either against obesity (including the role of food characteristics in energy intake) or malnutrition in Low- and Middle-Income Countries. The topics clearly correspond to major societal challenges, while projects are underpinned by methodological advances.

5.3.3 Societal relevance

As noted in the SWOT, nutrition *per se* has a high societal relevance and visibility. The Theme has tackled well-identified societal risks related to overnutrition and hidden hunger. The work in Low- and Middle-Income Countries is relevant to approach nutrition questions with a wider outlook, in particular in connection with the expected nutritional (and agronomic) transition to a more plant-based diet.

The Theme is active in different ways to have a societal impact. Different members are part of different consumer-related and governmental advisory bodies. Other members are active on social media and other parts of media. Direct confrontation with social influencers is not necessarily needed and

potentially not required as well, as the latter only stimulates the polarization of the nutrition field. The Theme works on broad topics that have wide societal and Global impact.

The Theme greatly increased the percentage of open-access publications in the last evaluation period from 26% in 2015 to 78% in 2020.

The use of MOOCs is an ideal way to reach out to several communities and is highly valued by different society members.

Part of the societal impact of the Theme is linked to its activities in Low- and Middle -Income Countries and includes the training of local nutrition scientists. Improving also the general level of understanding of nutrition by the health professionals is also a high-impact activity and can help create tools within an open science approach (including citizen's science).

5.3.4 Viability

The Theme underwent a reorganization in 2016 following financial difficulties (e.g. triggered by a grim financial outlook).

The Theme's goals for the next six years are societally and scientifically relevant, with a clear mission on 'To improve global health and well-being through better nutrition'. This overall mission allows to include research about unravelling the underlying mechanisms but as well understand how one can implement dietary advice on both individual and population level. At the population level, the Theme wants to include the sustainability aspects as well the relevancy of individual responses on dietary interventions while unravelling biological mechanisms of sensory sciences. All these topics are highly relevant in the context of the very broad and diverse field of nutrition. Further, the Theme is also focussing on the future development of dietary assessment methodologies, a key methodology under scrutiny. To stimulate integrated research the different staff members have weekly meetings which is contributing to the interactive academic culture.

To operationalise the mission the Theme will need to attract young talented researchers. The Theme seems to have a clear strategy towards the tenured track researchers that stimulates collaboration and integration of expertise and know-how. Although the increase in tenure trackers over the last few years has strengthened the different research groups (chair groups), this could be considered as a risk/threat. The strategic plan for all tenure trackers is somewhat unclear as hiring a high number of tenure trackers has potential long-term consequences. It seems that the recruitment plan should likely be revised to be more in line with the growth of the Theme and potentially related to the growth or absence of growth in research funding.

5.3.5 Recommendations

The traditional aims and strategy are clearly stipulated, however the link with the more clinical nutrition- related topics is somehow hidden. The Committee advises to strengthen these links. Similarly, the Committee advises to strengthen and clarify the link to more societal aspects such as sustainability.

It was not clear to the Committee how the Theme deals with the potential of the bio-informatics and relation with Theme IV (Biological Systems & Interactions) on the role of the gut microbiome (see also recommendations below regarding Open Science and Viability). The Committee advises to formulate a clear strategy on this.

Limited success in obtaining personal grants has been considered as a weakness of the Theme. Although the Theme is successful in publishing in top journals, potentially a different approach is needed to

obtain the highly competitive personal grants. The Committee advises to formulate a strategy, e.g. prioritise specific research topics to attain higher success rate with the highly prestigious grants. The Committee also advises considering a more integrated approach to developing funding options, including obtaining grants from a diversity of funding sources, which should be installed already at the PhD level. This would emphasize a more integrated collaboration between the chairs of the Theme but across Themes as well.

The Theme has existed for more than 50 years and has generated an enormous amount of data (from molecular insights to more public health-oriented aspects). Currently it seems that this enormous amount of data cannot be harvested. The Committee advises to prioritise Open Science requirements and formulate a strategy to operationalise the principles of Open Science especially in view of harvesting the fast increasing amount of available data.

To operationalise the Open Science principles, collaborations with other Themes like dynamical systems, signal processing and data analytics or specific forms of bio-informatics are needed.

Building a community or infrastructure that is beyond the ELEXIR Food and Nutrition Community, would assist in both playing the role of a Key Opinion Leader and accelerate the Open Science field. This investment is also a form of return of investments (former research projects will have post-hoc analyses).

The outreach and valorisation of different findings can be put under pressure due to the public-private partnerships that mainly attract the large enterprises.

The Committee advises to create awareness of the nutritional aspects among food-producing SMEs (in the Netherlands but as well relevant in LMIC countries).

The Theme has created an enormous capacity over the years in many LMIC countries, which is a potential source of knowledge. The HNH Theme highlights its role in global nutrition but it seems that the Theme is focusing on individual capacity building.

Considering the change in vision of development cooperation (see EU strategy), the Committee advises to collaborate with universities/research institutes in LMICs as this will potentially accelerate the capacity building and also will assist several LMIC-based universities to shift from a text-book education format to a research-based education format. Several opportunities are possible especially if combined with the use of MOOCs.

Currently it is unclear if all chair groups can obtain enough funding (e.g., molecular vs translational) to realise the described ambitions. In relation to the tenure track requirements, the Committee advises to guarantee that all chair groups can obtain sufficient funding to reach their targets. Blue sky ideas in the nutrition domain should be stimulated.

The Committee advises a restrained recruitment of future tenure trackers to better match the growth/size of the different research topics. A career-long perspective in order to maintain a viable economic unit could be recommended.

The inclusion of medical doctors as staff members in the Theme is a great asset. The Committee advises to ensure these staff members will require sufficient funding to stay motivated in the context of research. It is also a new field where the team still has to accelerate while there is already a lot of competition worldwide in the field of clinical nutrition, however sound scientific research is sometimes lacking in this domain.

5.4 Research Theme IV: Biological Systems & Interactions

The Research Theme consists of four VLAG-supported chair groups: Microbiology (MIB), Systems & Synthetic Biology (SSB), Bioprocess Engineering (BPE), and Toxicology (TOX).

The chair group Host-Microbe Interactomics is also a member of the Theme but is not subject to this VLAG evaluation because it is primarily associated to another graduate school (WIAS).

These groups were united in the Research Theme IV: Biological Systems & Interactions under the VLAG umbrella during the past evaluation period. The Theme is therefore relatively young, although the chair groups already had many successful previous interactions.

5.4.1 Aims and strategy

The overall aim of the Theme is *'to deepen our understanding of biological systems and their interactions, including their utilisation to solve societal challenges'*. The scientific focus is broadly divided into three lines:

- Microbiome research includes human, environmental, and toxicity aspects.
- Cell factory research to understand and engineer cells for applications such as chemical production, alternatives to animal testing, or risk assessment.
- Systems modelling research that takes an *in silico* approach to help understand, design, and predict the behaviour of biological systems.

These research lines run across the Theme chair groups, providing many synergies and interactions. This strategy has proven quite successful in the last period, and it can be expected to maintain a strong relevance and viability of the Theme, as the research lines are still very important in current research. The collaboration with the chair of Host-Microbe Interactomics and the establishment of the Wageningen Microbiome Center are also important developments that ensure the strong position of the Theme in this field. These developments should be supported by WUR, possibly by providing one joint research space.

There is a good mix of fundamental and application-oriented research in the Theme, and this mix is guarded carefully. Dutch funding is gravitating more and more towards application-oriented research and industry co-funding schemes in recent decades, but the chairs have been very successful in the attraction of major research grants for fundamental science including ERC grants and a Spinoza prize, that help to ensure financial stability and room for curiosity-driven research.

5.4.2 Research quality

The quality and scientific relevance of the Theme is excellent. The Theme has been highly productive during the review period with on average 223 refereed articles each year. The bibliometric analysis reveals that these have been well received within the community with a high number of citations. During the review period, 25% of the publications are in the top 10% and 4% in the top 1%. The field-weighted citation index (FWCI) is consistently >1 with an average of 2.2.

Overall, peer-reviewed publications consistently exceed 1 refereed article per year per scientist. This high output is topped by several publications in high-impact Nature/Science/Cell journals. Wageningen University, through the Theme chairs, has an outstanding international reputation around the Theme of Biological Systems & Interactions. Several central scientific topics of the Theme like microbial communities and CRISPR-Cas9 are hot and chairs within the Theme have been at the forefront of this

development. The groups are very well networked in the national and international scientific community.

The chairs within the Theme can thus be considered as highly respected in their field, which is also apparent from the scientific output and recognition of PIs within the Theme in the successful attraction of a number of prestigious research grants and prizes, including 2 Veni, a Vici, an ERC Consolidator and ERC Advanced grant, and the highly prestigious Spinoza prize (considered the Dutch Nobel prize in the Netherlands). These are clear signs of recognition of the scientific excellence of both senior and junior PIs in the Theme. They also provide a very solid funding basis for fundamental science for the years to come. Besides these personal grants, the research topic also operates in a significant number of national and international consortia, which is evidence of a large and active network of academic and commercial partners.

An analysis of the research gives a clear picture of the scientific contributions of the Theme to the field:

- The Microbiology group is by far the biggest group in the graduate school, with a scientific focus on microbial genetics, physiology, evolution and ecology. The scientific output can be applied in sectors such as health & food, bioproducts & energy, and the natural environment & sustainability.
- The Systems & Synthetic Biology group investigates basic cellular processes, genotype-phenotype relationships, and interactions among microbes and between microbes and their environment. This knowledge can be applied in a Synthetic Biology approach, with main focus on biotechnology, but also medical and environmental applications.
- The Bioprocess Engineering studies production systems and processes using a wide variety of organisms including bacteria, yeasts, microalgae, and cell cultures of higher eukaryotes, covering aspects such as physiological characterization, bioconversion and downstream processing.
- The Toxicology group focuses on understanding toxicology mechanisms and developing *in vitro-in silico* testing strategies. This enables rational and efficient risk analysis of toxicological processes related to human and environmental health.

5.4.3 Societal relevance

Societal impact is clearly demonstrated through collaboration with industry, contract research, patents, participation in advisory bodies, and outreach to the general public. With regard to industrial and commercial relevance, the Theme filed for 30 patents in the last evaluation period. Some of these patents are also being actively valorised. This occurs through licensing or selling to companies like Total, Corbion, or Editas, but also in the form of spin-off companies founded by Theme chair PIs. Interaction with industry is further intensified by direct bilateral contract research, collaboration in 3rd party funded consortia, the inclusion of several special professors on an industry endowment, and the involvement of PIs in scientific advisory boards of large multinational companies. The outreach of the Theme chairs also extends to policymakers through activities in advisory bodies and discussions in the domains of health, food, and biobased production, extending all the way to presentations in the Dutch and European parliaments. Educational outreach is also good with an active iGEM team and active representation at scientific conferences.

The level of engagement in societal outreach is also impressive, especially considering that some topics are controversial or not easily communicated. Theme members participated in a broad spectrum of dissemination platforms ranging from discussion podia, fairs, museum exhibits, social media, articles in newspapers and glossy magazines, and even some prime-time national television appearances in

programs that are viewed by millions of people. The Theme is clearly placed within society with both one-way communication and open discourse, helping to bring attention and acceptance to important and sometimes controversial issues. The Theme also greatly increased the percentage of open-access publications in the last evaluation period from 32% in 2015 to 82% in 2020, and the concepts of FAIR data sharing are also actively being applied and stewarded by Theme chairs. This comes with a significant financial burden; it would be good to develop measures to evaluate the extent to which this openness increases scientific and societal impact.

The Theme has a representative gender balance and a good mix of cultural backgrounds.

5.4.4 Viability

The strategies for scientific and societal impact of the Theme are well thought out and certainly have the potential to carry the group forward at the current high level for the next evaluation period. However, succession of chair holders can be a viability risk. Prof. Willem de Vos was succeeded by Prof. Thijs Ettema as head of the Microbiology chair group in 2019. This major change seems to have gone smoothly and has come with no apparent disruptions, rather, it provided a new scientific and financial input to the group.

A vacancy for the head of the chair of Systems and Synthetic biology was published during the evaluation process (Oct 2021), and the next period will further likely see a change in leadership of the Toxicology group. The RT is thus going through a period of rather uncertain future. This will certainly affect the future direction of research, and it will also occupy the minds of scientists in these chairs. It will be important to communicate the process of change to all levels of personnel, and especially to safeguard the mentoring of graduate students and early-career scientists in the transition period. The future strategy overall is sound, but the scientific direction will depend on the focus of future chair holders. It will be essential for the Theme groups to play an active role in the filling of current and upcoming vacancies. This can help safeguarding the stability of the scientific work and the viability of the long-term strategy. It can also be a great opportunity to break new scientific ground and stay up to date with current developments.

The Theme has seen significant growth in the number of PIs that are on a tenure track. Although the quality of these PIs is without question, the Theme should be careful of too much, too fast, growth. The tenure trackers have very high demands placed upon them in term of quantitative output. This runs the risk of gravitating from quality to quantity just to maintain the basic funding needed to support the groups.

5.4.5 Recommendations

The combination of Chairs into the Theme IV Biological Systems & Interactions is relatively recent. There were, and are, already many ‘natural’ interactions between the chairs, but the joint identity of the Theme could be strengthened. A more intensive combination of chairs in the Theme offers several strategic and communicative advantages and these could be expanded and exploited beyond the excellent scientific synergies that already exist:

- The Theme could help to profile the societal relevance of the groups even better. This could include a more explicitly formulated joint strategy for dissemination and valorisation, but also for instance a joint ‘face to the public’ (e.g., website, spokesperson).

- The Theme could help to strike a balance between fundamental and applied science and to further deepen synergies that arise between them. This could also help some sub-groups to reach critical mass by integrating more into the Theme as a whole.
- The Theme might help to reduce workload and overhead by combining management, administrative or infrastructural tasks.

The self-assessment lists many impressive accomplishments of societal relevance, but the aims are vague as to which grand challenges are focused on. We advise the Theme to define more clearly aims for societal relevance along with the UN Sustainable Development Goals.

Although the societal relevance of the Theme is clearly documented and very significant, there seems to be no clear *strategy* concerning societal relevance. Currently, the Theme mainly relies on *ad hoc* activities of PIs that have a reputation that lends them credibility, and a network that provides dissemination and valorisation opportunities. This seems to work well; it would be good to formalise this strategy. Such formalisation could also be a step on the way to better recognition of societal relevance activities of individuals by WUR, especially for the PIs that are on a tenure track.

The Theme, and individual chairs, should have a clear long-term strategy to make sure there is room for all tenure trackers. Not just financially and physically (lab and office space), but also scientifically, to avoid internal competition for second/third party funding and to safeguard the current positive atmosphere of collaboration. A 'full house' of senior research staff could also make the succession of retiring chair holders more difficult, as high-profile candidates will want to have room to bring in their own group leaders and associated research topics.

There seems to be limited centralised support for patent applications, with the financial burden of application and maintenance relying on external funding. WUR should play a more active role in this with central financial support for patents to ensure long-term viability and impact.

Appendix A - Programme of the site visit

Sunday 10 October

Time	Part
18:00	Preparatory meeting committee

Monday 11 October

Time	Part
09.00 - 09.30	Welcome to Peer Review Committee members and introductory presentation by WU Rector Magnificus, Dean of Research, AFSG director Also present: VLAG Research Theme representatives, VLAG Scientific Director, VLAG Office
09.30 - 10.00	Assessment Committee Q&A with Rector Magnificus, Dean of Research, AFSG director
10.00 - 12.00	Peer Review Committee preparatory meeting
12.00 - 13.00	Lunch with VLAG management (possibility to clarify)
13.00 - 14.30	Interview VLAG Research Theme I - Chemistry for Life Sciences and Bio-based Economy
14.30 - 15.50	Tours along facilities (HELIX) e.g. including pitches from PhD candidates in the labs
16.00 - 17.30	Interview VLAG Research Theme IV - Biological Systems & Interactions
17.30 - 18.00	Assessment Committee wraps up first day and prepares second day

Tuesday 12 October

Time	Part
09.00 - 10.00	VLAG Graduate School presentation by Prof. Karin Schroen, followed by interview
10.00 - 11.00	Writing time
11.00 - 12.30	Interview VLAG Research Theme II - Food Science & Technology
12.30 - 13.30	*Lunch with members of VLAG PhD Council*
13.30 - 14.30	VLAG PhD Council presentation, followed by interview
14.30 - 15.30	Tours along facilities (AXIS) e.g. including PhD pitches in the labs
15.45 - 17.15	Interview VLAG Research Theme III - Human Nutrition & Health
17.15 - 17.45	Writing time & Committee wraps up second day and prepares third day

Wednesday 13 October

Time	Part
08.30 - 10.00	Writing time, Committee prepares presentation
10.00 - 11.00	Interview Tenure Track candidates
11.00 - 12.00	Writing time, Committee prepares presentation
12.00 - 13.00	*Lunch with VLAG Scientific Director (possibility to clarify various issues)*
13.00 - 14.30	Writing time, Committee prepares presentation
14.30 - 15.15	DEBRIEFING: Presentation of preliminary findings by Assessment Committee Chair attended by Dean of Research, AFSG director, VLAG Board, VLAG Research Theme representatives, PhD council (whole VLAG community welcome)

Appendix B- Quantitative data

B.1 RT I: Chemistry for Life Sciences and Bio-based Economy

Table 1 Scientific staff

	2015		2016		2017		2018		2019		2020	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Professor[1]	11	2.9	11	3.0	11	3.0	10	2.9	12	3.4	12	3.5
Associate prof[1]	7	2.4	11	3.5	11	4.0	11	3.5	11	2.7	8	2.5
Assistant prof[1]	12	4.0	10	3.2	10	3.6	12	4.1	13	4.0	17	5.1
Post-docs[2]	23	14.2	12	7.6	13	7.5	23	14.6	21	12.9	21	11.6
Total staff	**53**	**23.5**	**44**	**17.3**	**45**	**18.1**	**56**	**25.0**	**57**	**23.0**	**58**	**22.7**
PhD candidates [3]	85	-	83	-	84	-	86	-	90	-	98	-
Total research staff	**138**	**-**	**127**	**-**	**129**	**-**	**142**	**-**	**147**	**-**	**156**	**-**

[1] Professor, Assistant Professor and Associated Professor: Research Capacity = 40% of the appointment
[2] Post-doc: Research Capacity amounts to 90% of the appointment (if not otherwise specified)
[3] PhD candidates: number of PhD candidates (both internal and external)

Table 2 Funding

	2015		2016		2017		2018		2019		2020	
Funding /%	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*
Direct funding	8,654	57	9,369	62	9,423	64	10,572	65	11.595	66	12,544	68
Research grants	2,448	16	2,071	14	2,466	17	2,929	18	2,874	16	2,508	14
Contract research	3,982	26	3,572	24	2,893	20	2,742	17	2,992	17	3,351	18
Total funding	**15,084**		**15,011**		**14,783**		**16,188**		**17,461**		**18,403**	
Expenditure:	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*
Personnel costs	8,995	59	8,791	58	9,053	61	9,677	61	10,103	63	11,134	64
Other costs	6,188	41	6,454	42	5,713	39	6,087	39	6,001	37	6,141	36
Total expenditure	**15,164**		**15,244**		**14,766**		**15,764**		**16,105**		**17,275**	

B.2 RT II: Food Science & Technology

Table 1 Scientific staff

	2015		2016		2017		2018		2019		2020	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Professor[1]	17	4.4	17	4.9	16	4.7	16	4.8	15	5.1	15	5.1
Associate prof[1]	9	2.2	11	3.1	12	4.2	12	4.3	12	4.1	13	4.2
Assistant prof[1]	17	5.3	14	4.4	12	4.1	12	4.1	14	4.6	18	5.4
Post-docs[2]	17	9.7	12	4.1	10	5.7	17	8.3	22	10.7	27	13.3
Total staff	**60**	**21.6**	**54**	**16.5**	**50**	**18.7**	**57**	**21.5**	**63**	**24.4**	**73**	**28.0**
PhD candidates [3]	132	-	132	-	138	-	158	-	171	-	182	
Total research staff	**192**	**-**	**186**	**-**	**188**	**-**	**215**	**-**	**234**	**-**	**255**	

[1] Professor, Assistant Professor and Associated Professor: Research Capacity = 40% of the appointment
[2] Post-doc: Research Capacity amounts to 90% of the appointment (if not otherwise specified)
[3] PhD candidates: number of PhD candidates (both internal and external)

Table 2 Funding

	2015		2016		2017		2018		2019		2020	
Funding /%	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*
Direct funding	9,794	62	11,001	71	11,489	66	12,660	64	14,549	67	15,277	70
Research grants	733	5	829	5	1,158	7	1,112	6	1,728	8	1,585	7
Contract research	5,329	35	3,678	24	4,890	28	6,109	31	5,518	25	5,105	23
Total funding	**15,856**		**15,507**		**17,537**		**19,881**		**21,795**		**21,967**	
Expenditure:												
Personnel costs	8,891	55	8,782	55	9,513	55	10,401	57	12,044	60	12,480	61
Other costs	7,186	45	7,163	45	7,715	45	7,844	42	7,980	40	7,962	39
Total expenditure	**16,077**		**15,945**		**17,288**		**18,245**		**20,024**		**20,443**	

B.3 RT III: Human Nutrition & Health

Table 1 Scientific staff

	2015		2016		2017		2018		2019		2020	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Professor[1]	12	2.6	11	3.4	10	3.4	11	3.4	12	3.8	15	4.4
Associate prof[1]	8	1.4	7	1.9	5	1.4	4	1.2	9	2.9	10	3.3
Assistant prof[1]	15	4.4	16	5.8	17	5.8	16	5.4	14	4.4	16	5.0
Post-docs[2]	15	7.5	12	7.8	11	4.9	15	7.5	15	9.1	17	11.1
Total staff	**50**	**15.8**	**46**	**18.9**	**43**	**15.4**	**46**	**17.6**	**50**	**20.2**	**58**	**23.8**
PhD candidates [3]	89		82		81		83		96		105	
Total research staff	**139**		**128**		**128**		**129**		**146**		**163**	

[1] Professor, Assistant Professor and Associated Professor: Research Capacity = 40% of the appointment
[2] Post-doc: Research Capacity amounts to 90% of the appointment (if not otherwise specified)
[3] PhD candidates: number of PhD candidates (both internal and external)

Table 2 Funding

	2015		2016		2017		2018		2019		2020	
Funding /%	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*
Direct funding	6,981	45	6,757	49	6,816	52	8,384	57	9,107	55	8,616	58
Research grants	831	5	750	5	837	6	956	6	1,215	7	761	5
Contract research	7,833	50	6,350	46	5,394	41	5,411	37	6,188	37	5,505	37
Total funding	**15,645**		**13,858**		**13,047**		**14,750**		**16,510**		**14,882**	
Expenditure:												
Personnel costs	8,860	57	8,100	58	7,859	53	7,653	61	8,871	61	9,729	64
Other costs	6,782	43	5,912	42	6,906	47	4,941	39	5,658	39	5,470	36
Total expenditure	**15,642**		**14,011**		**14,765**		**12,594**		**14,529**		**15,199**	

B.4 RT IV Biological Systems & Interactions

Table 1 Scientific staff

	2015		2016		2017		2018		2019		2020	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Professor[1]	16	3.2	17	3.3	16	3.4	15	3.6	18	4.2	19	5.0
Associate prof[1]	17	2.0	8	2.8	11	3.9	11	4.3	11	4.0	10	3.3
Assistant prof[1]	13	5.6	12	3.9	12	3.3	10	4.0	10	3.5	10	3.4
Post-docs[2]	22	15.0	21	12.9	20	10.2	17	13.0	21	11.5	27	18.6
Total staff	**58**	**25.9**	**58**	**22.9**	**59**	**20.8**	**53**	**24.8**	**60**	**23.2**	**66**	**30.3**
PhD candidates [3]	156		155		149		163		161		167	
Total research staff	**214**		**213**		**205**		**216**		**221**		**233**	

[1] Professor, Assistant Professor and Associated Professor: Research Capacity = 40% of the appointment
[2] Post-doc: Research Capacity amounts to 90% of the appointment (if not otherwise specified)
[3] PhD candidates: number of PhD candidates (both internal and external)
(!) Special professors included in the 'professors' category

Table 2 Funding

	2015		2016		2017		2018		2019		2020	
Funding /%	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*	*k€*	*%*
Direct funding	6,989	41	7,565	45	7,311	44	8,330	48	8,660	48	10,108	50
Research grants	1,978	12	2,519	15	2,284	14	3,276	19	4,018	22	4,555	23
Contract research	7,993	47	6,714	40	6,885	42	5,877	34	5,510	30	5,516	27
Total funding	**16,960**		**16,798**		**16,479**		**17,484**		**18,389**		**20,180**	
Expenditure:												
Personnel costs	9,017	53	8,952	54	8,922	54	9,251	56	10,178	57	11,599	61
Other costs	7,883	47	7,771	46	7,544	46	7,402	44	7,686	43	7,458	39
	16,900		**16,723**		**16,466**		**16,653**		**17,863**		**19,057**	