Publications of the Academy of Finland 3/11

Plant Science in Finland 2005–2009

Evaluation Report

Academy of Finland
Research funding and expertise

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Evaluation Report

Evaluation Panel

Dorothea Bartels, Chair
Neil Baker
Thomas Boller
Maarten Koornneef
Julio Salinas
Alison M. Smith
Eva Sundberg

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Description

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Abstract

This report presents the findings of an international panel convened to evaluate plant science related research in Finland. The panel members were Professors Dorothea Bartels (chair), Neil Baker, Thomas Boller, Maarteen Koornneef, Julio Salinas, Alison M. Smith and Eva Sundberg.

Evaluation covers 12 plant science units and the years 2005 – 2009. The assessment is based on the interviews and on background material provided by each unit. In the evaluation process the panel considered research quality, research environment including infrastructure and funding and training of young researchers.

The review panel observed an overall high standard of plant science research in Finland. The research achievements and the quality of the publications have contributed to very good scientific reputations of the researchers with some being internationally recognized leaders in their fields. The quality of research and research output is heterogeneous across the different units. Smaller units should actively seek scientific co-operation to form larger units with common research topics. In general, the research environment of all units allows a good research performance. The collaboration on infrastructures needs to be strengthened for optimal usage of available infrastructure and for defining future needs. Serious deficiencies were observed in bioinformatics infrastructure and in advanced modelling approaches. The tenure track system has to be implemented at the unit level and international and nation-wide recruitments should be encouraged at all levels, including postgraduate students, postdoctoral researchers and faculty staff. Doctoral training has benefited from doctoral programme/graduate school system. The challenge now is to reduce the time required for PhD studies by matching the required publications to PhD study schemes.

It has to be emphasized that it is essential to continue to strengthen basic research to keep a leading role and to stay competitive internationally. Quality and visibility of research can be increased by stronger collaboration and networking on priority-defined research projects and on exploitation of infrastructure. Funding agencies need to continue to fund basic research at a high level. This has to be on a competitive basis with well-defined priorities.

Key words	plant science, research policy, research funding, research quality, research environment, doctoral training	
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Tiivistelmä	Raportti esittelee kansainvälisen arviointipaneelin tekemän Suomen kasvibiologian tutkimuksen arvioinnin. Paneelin jäseninä olivat professorit Dorothea Bartels (pj.), Neil Baker, Thomas Boller, Maarteen Koornneef, Julio Salinas, Alison M. Smith ja Eva Sundberg. Arvioinnin kohteena oli kaksitoista suomalaista kasvibiologian tutkimusyksikköä kattaen vuodet 2005–2009. Arviointiraportti perustuu paneelin tekemiin haastatteluihin sekä yksiköiltä saatuun taustamateriaaliin. Paneelin tuli kiinnittää huomiota alan tutkimuksen laatuun, tutkimusympäristöihin (ml. infrastruktuurit), rahoitukseen ja tutkijankoulutukseen. Arviointipaneeli toteaa raportissaan, että Suomen kasvibiologian tutkimus on kokonaisuudessaan korkeatasoista. Tutkimustulokset ja julkaisujen laatu ovat entisestään lisänneet alan tutkijoiden hyvää tieteellistä mainetta ja jotkut tutkijoista ovat yltäneet oman alansa kansainvälisiksi huipuiksi. Tutkimuksen laatu ja tulokset vaihtelevat kuitenkin eri yksiköiden kesken. Pienempien yksiköiden tulisikin aktiivisesti tehdä tieteellistä yhteistyötä ja muodostaa suurempia yksiköitä yhteisten tutkimusaiheiden ympärille. Yleisesti ottaen kaikkien arvioitujen yksiköiden tutkimusympäristöt mahdollistavat hyvien tutkimustulosten toteutumisen. Tutkimusinfrastruktuuriyhteistyötä tulisi kuitenkin lisätä olemassa olevan infrastruktuurin käytön optimoimiseksi ja tulevien infrastruktuuritarpeiden kartoittamiseksi. Arviointipaneelin mukaan erityisesti bioinformatiikan infrastruktuureissa ja kehittyneessä mallinnuksessa on vakavia puutteita. Paneeli toteaa myös, että opetus- ja tutkimushenkilöstön vakinaistamispolku on otettava käyttöön yksikkötasolla ja suosittaa, että kaikilla tasoilla lisätään jatko-opiskelijoiden, tutkijatohtoreiden ja opetushenkilöstön rekrytointia sekä kansallisesti että kansainvälisesti. Paneelin mukaan tohtoriohjelmat ja tutkijakoulujärjestelmä ovat parantaneet alan tutkijankoulutusta. Jatkuvana haasteena on kuitenkin tohtorinkoulutukseen ja väitöskirjatyöhön käytetyn ajan lyhentäminen sovittamalla vaadittujen julkaisujen määrä koulutusohjelmien puitteisiin. Arviointipaneeli korostaa, että alan perustutkimusta täytyy edelleen vahvistaa, jos Suomi haluaa säilyttää nykyisen asemansa ja kansainvälisen kilpailukykynsä kasvibiologian tutkimuksessa. Tutkimuksen laatua ja näkyvyyttä voidaan lisätä paremman yhteistyön kautta sekä muodostamalla verkostoja tärkeiden tutkimushankkeiden ja infrastruktuurien ympärille. Lisäksi rahoittajaorganisaatioiden on jatkettava korkeatasoisen perustutkimuksen tukemista kilpailuun perustuen ja selkeästi määritellyillä prioriteettialoilla.	
Asiasanat	kasvibiologia, tutkimuspolitiikka, tutkimusrahoitus, tutkimuksen laatu, tutkimusympäristö, tohtorikoulutus	
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Preface

Plant science represents one of the core fields of the Research Council for Biosciences and Environment of the Academy of Finland. As one of the tasks of the Academy is to conduct evaluations to assess the scientific level of research and researcher training in Finland, the Council decided in year 2009 to launch an international evaluation on plant science. In the context of the evaluation, plant science is defined as to cover all basic research in the fields of plant biology, plant molecular biology, plant physiology and plant technology on the molecular, cellular or individual level. Applied research is included in the evaluation insofar as it involves clear basic research aims.

The goal set for the international evaluation by the Steering Group was to assess research quality, research environment (including infrastructure and funding) and training of young researchers. The evaluation was expected to provide assessments as well as recommendations for the future both at the unit level and with regards of the research system of the Finnish plant science. Unit assessments were made from nine university units and three units from three government research organizations.

A fundamental principle in science is the independent review process. Through the review process, it is possible to obtain scientific assessments, including constructive criticism. The Academy of Finland values highly the independent work of the international expert panels appointed for evaluations.

Assessments and recommendations both at the level of the research system as well as at the unit level should be taken as scientific advice on how to further improve and strengthen the research lines and research environments for the future.

The international evaluation panel for the plant science was chaired by Professor Dorothea Bartels. On behalf of the Steering Group, I would like to take this opportunity to thank all panel members for their willingness to take on the task, and their professional and solid work throughout the evaluation process.

Helsinki, May 2011

Mari Walls, Chair of the Steering Group

Summary

The Research Council for Biosciences and Environment of the Academy of Finland decided to commission an international evaluation of plant science in Finland. The evaluation covered plant science in four universities (University of Helsinki, University of Eastern Finland, University of Oulu and University of Turku) and three government research organisations (MTT Agrifood Research Finland, the Finnish Forest Research Institute Metla, and VTT Technical Research Centre of Finland). In some units, only a fraction of the work is devoted to plant science.

The evaluation was performed by an international expert panel with Professor Dorothea Bartels (University of Bonn) as Chair and Professors Neil Baker (University of Essex), Thomas Boller (University of Basel), Maarteen Kornneef (Max Planck Institute for Plant Breeding Research), Julio Salinas (Centro de Investigaciones Biológicas-CSIC; CIB, CSIC), Alison M. Smith (John Innes Centre) and Eva Sundberg (SLU, Swedish University of Agricultural Sciences) as panel members. In the evaluation process, the panel paid attention to research quality, research environment including infrastructure and funding and training of young researchers. The evaluation was based on pre-collected assessment material and additional information received during unit interviews. The evaluation was expected to provide assessments and recommendations at unit level and for the research system of Finnish plant science in terms of future development.

The evaluation panel observed an overall high standard of plant science research in Finland. The research achievements and the quality of the publications have contributed to a very good scientific reputation of the researchers, with some being internationally recognised leaders in their fields. There seems to be a relationship between the critical mass of scientists and students and the quality of research. All units have steadily published their research findings in refereed international journals, they have been able to attract considerable external funding and they have actively been training young researchers over the evaluation period 2005–2009.

Even though Finland has high-quality research groups, the quality of research and the research output is heterogeneous across the different units. The research in the smaller units is often on the descriptive level rather than addressing functional analysis and causal relations. Finnish plant science research would benefit from smaller units actively seeking scientific cooperation to form larger units with common research topics. It is important to encourage and facilitate a multi-level "systems" approach for a better understanding of the interaction and dependence of the biological system. National efforts should integrate research in, for example, ecophysiology, the effects of climate change and forest-related research questions. Also, the excellent skills present in some molecular biology units should be utilised in the mentioned topics to further strengthen Finnish plant science.

To maintain the good quality of Finnish plant science research, sufficient funding opportunities need to be made available for basic research. The panel suggests discussions between the research community and research funding agencies on the

most appropriate ways to ensure the highest quality of research and to encourage networking and strategic planning of research. Multi-group and multi-institution grants might be suitable instruments to foster coherent research strategies and collaboration between research groups competing in the current funding system.

In general, the research environment of all units allows for good research performance. The quality of the infrastructure in terms of experimental equipment, plant growth facilities and experimental field stations is very good and in several cases excellent. The panel recommends strengthening the collaboration on infrastructures to optimise the usage of available infrastructure and to define future needs in order to maintain the high quality. A more cost-effective research system should include the funding for permanent qualified personnel. This implies the necessity for a long-term strategy on a coordinated level.

Modern plant science requires not only sophisticated instrumentation but also adequate data analysis. Serious deficiencies were observed in bioinformatics infrastructure and in advanced modelling approaches. A lack of such infrastructure is likely to prevent optimal development of systems- and genomics-based approaches in Finnish plant science research. Funding bodies need to consider modifying their funding programmes so that the necessary bioinformatics infrastructure can be implemented.

Increased transparency and predictability of research careers has been supported at the science-policy level in Finland. Future challenges include how to implement the tenure track system at unit level and how to secure funding for it. Another challenge for Finnish plant science is to decrease the in-house recruiting of research staff. The panel acknowledges that in-house recruiting has been very successful in some cases, but it may potentially lead to a lack of innovation and creativity and make Finnish plant science internationally less competitive and attractive. International and nationwide recruitment should be encouraged at all levels, including postgraduate students, postdoctoral researchers and faculty staff.

The most detrimental phenomenon in Finnish doctoral training is the time it takes to complete PhD studies. Support systems such as doctoral programmes and graduate schools exist, and they ensure that in most cases students have a study and research plan and that their progress is assessed at strategic intervals. The key reason for long PhD study times seems to be the requirement for a large number of published papers and first authorships. This is too ambitious to be compatible with the goal of a four-year-funded PhD study time. The demand for published papers and unpublished manuscripts should be harmonised with the length of the funding period in Finnish doctoral programmes.

The quality and expertise of Finnish plant science is important in developing an attractive educational platform that trains high-quality, competitive plant scientists who will be able to lead plant science research in the future and who will be involved in social and political decision-making. It has to be emphasised that it is essential to further strengthen basic research to keep a leading role in plant science and to stay competitive. The quality and visibility of research can be increased by stronger collaboration and networking on priority-defined research projects and on infrastructure utilisation. Funding agencies need to continue to fund basic research at a high level, on a competitive basis and with well-defined priorities.

1 Introduction

Background of the evaluation

Evaluations of disciplines and individual fields of research are important research and science policy development tools to provide feedback to the scientific community and to funding agencies. The aim of evaluation is to inspire discussion and debate and help researchers and funding organizations to identify potential problems and areas of development. The Research Council for Biosciences and Environment of the Academy of Finland decided to commission an international evaluation of the Plant Science in Finland. The Steering Group for the evaluations defined plant science to "cover all basic research in the field of plant biology, plant molecular biology, plant physiology and plant technology on the molecular, cellular or individual level. Applied research is included in the evaluation insofar as it involves clear basic research aims. Plant research that is clearly focused on population biology, population genetics, evolution research or systematics does not come under this evaluation but will be assessed in connection with an upcoming evaluation of ecology and evolution biology. Neither does the evaluation cover any agricultural and forestry research that is purely applied in nature."[1]

The Academy of Finland established a review committee on Plant Sciences in Finland consisting of seven plant scientists from outside Finland. The review panel convened from February 13–18, 2011 and had the opportunity to interview representatives from Finnish plant science research units. This assessment is based on the interviews and on background material provided by each unit. Plant science was evaluated from four universities (University of Helsinki, University of Eastern Finland, University of Oulu, University of Turku) and from three government research organizations (MTT Agrifood Research Finland, Metla the Finnish Forest Research Institute, VTT Technical Research Center of Finland). For some units only a fraction of the employment time is devoted to plant sciences. The panel considered research quality, research environment including infrastructure and funding and training of young researchers in the evaluation process.

The expectation of the evaluation outcome was to provide assessments and recommendation to unit level and to the research system of Finnish plant science. The term 'unit' refers to the department of a university or an independent research institute or relevant part of it assessed in the evaluation. System level, on the other hand, is the organization of individual units in relation to and as embedded to the Finnish research and innovation system.

Finnish Research and Innovation system

Finland has a national consensus that a prospering society has its roots in well functioning entity comprising the producers and users of new information, knowledge and know-how. The cornerstones of the national research and innovation

[1] Term of Reference for Finnish Plant Science Evaluation

system are top-quality education from first level to higher education, research and product development and knowledge-intensive business and industry. An underlining and supporting policy process is an integral part of the system. In general there is a move from narrow science and technology policy towards a broad-based research and innovation policy, also incorporating issues of education, research policy, technology policy, entrepreneurship, and elements from various other policies into a more coherent entity.

The highest-level of science governance takes place at the Parliament and at the national Government. The key ministries are the Ministry of Education and Culture and the Ministry of Employment and the Economy. Other ministries have a minor but still important role via sectoral research and governmental research organizations. The Ministry of Education and Culture handles matters relating to education, science policy, universities and polytechnics, and the Academy of Finland. The Ministry of Employment and the Economy takes care of matters relating to innovation and technology policy and of entrepreneurship, and Tekes, the Finnish Funding Agency for Technology and Innovation.

The major research funding (competitive funding) agencies are the Academy of Finland and Tekes. Almost half of the government research funding is channeled through these two organizations. The Academy of Finland funding goes primarily to scientific research at universities and research institutes. The total volume of funding comes to € 300 million annually. The Academy has the responsibilities of decision-making, development and monitoring of Finnish doctoral programmes. Tekes annually finances some 1 500 business research and development projects, and almost 600 public research projects at universities, research institutes and polytechnics. In 2009 from the total of € 579 million, research funding for universities, research institutes and polytechnics was € 236 million.

The operational level is composed of education and research and development performing organizations like polytechnics and universities, research organizations and R&D oriented enterprises. The Finnish higher education and research system has a degree of heterogeneity with 27 polytechnics, 16 universities[2], 18 governmental and 11 other research organizations.

Finland is one of the most research intensive countries in the world. In total Finnish R&D employs some 79 500 people, R&D funding is € 6,9 billion which equals to 3,9% of GDP. Private sectors proposition of R&D funding is ca. 70% when higher education and other public funding is ca. 20 and 10%, respectively. Governmental research expenditure was € 2.05 billion in 2010 and the estimated funding for basic research is € 1.1 billion.

Embedding of plant science inside the Finnish Research System

In plant science evaluation, a total of 12 research units were assessed (Table 1). The units are from four universities and from three government research organizations.

Universities promote basic research and scientific education and provide higher education based on research. In carrying out their mission, universities must interact

[2] There are 16 universities in the Ministry of Education and Culture sector. National Defence College operates within the Ministry of Defense sector.

Table 1. Units in the international evaluation of Finnish plant science.

University	Faculty or equivalent	Department or equivalent	Former	Acromyn
University of Eastern Finland	Faculty of Science and Forests	Dept. of Biology	Univ. Joensuu, Dept. Biology	UE_Biology
University of Eastern Finland	Faculty of Science and Forests	Dept. of Biosciences	Univ. Kuopio, Dept. Biosciences	UE_Biosci
University of Eastern Finland	Faculty of Science and Forests	Dept. of Environmental Science	Univ. Kuopio, Dept. Environmental Science	UE_Environ
University of Eastern Finland	Faculty of Science and Forests	School of Forest Sciences	Univ. Joensuu, Faculty of Forest Sciences	UE_Forest
University of Helsinki	Faculty of Agriculture and Forestry	Dept. of Agricultural Science	Univ. Helsinki, Dept. Applied Biology	UH_Agri
University of Helsinki	Faculty of Agriculture and Forestry	Dept. of Forest Sciences	Univ. Helsinki, Dept. Forest Ecology	UH_Forest
University of Helsinki	Faculty of Biological and Environmental Sciences	Dept. of Biosciences		UH_Biosci
University of Oulu	Faculty of Science	Dept. of Biology		UO_Biology
University of Turku	Faculty of Mathematics and Natural Sciences	Dept. of Biochemistry and Food Chemistry	Univ. Turku, Dept. of Biology	UT_Biochem
Finnish Forest Research Institute, Metla				Metla
MTT Agrifood Research Finland				MTT
VTT Technical Research Centre of Finland	Biotechnology Cluster	Medical Biotechnology Knowledge Centre		VTT

with the surrounding society and strengthen the impact of research findings on society. Under the new Universities Act that came into force 1.1.2010, the universities, which have units involved in the plant science evaluation, are independent corporations under public law. Their operations are built on the freedom of education and research and university autonomy.

Research performed in sectoral research organizations aims to provide, produce and transfer knowledge to support strategic decision making and presents a valuable societal resource. Besides the applied oriented research and development functions, all public research organizations have sectoral and organizational specific functions. Their functions are partly based on law and some organizations have tasks in public authority, supervision and service. Two of the governmental research organizations in this evaluation, Finnish Forest Research Institute, Metla and MTT Agrifood Research Finland, function within the administrative sector of the Ministry of Agriculture and Forestry. VTT Technical Research Centre of Finland is within the sector for Ministry of Employment and the Economy.

During the evaluation period the Finnish university system started to undergo a reformation. This, and university-level changes in organizations, were reflected in organizational status of the units in the evaluation. In this evaluation report, units are named according to their current organizational name and status (Table 1).

Doctoral training

The Finnish education system is composed of a nine-year basic education, upper secondary education, and higher education, provided by universities and polytechnics. The mission of universities is to conduct scientific research and provide graduate and post graduate education. Universities award bachelor's, master's, licentiate and doctoral degrees.

In order to pursue the highest university degree, a doctoral degree, a student has to be accepted as a doctoral student by a university at the faculty level. During the application process, a student must present a study plan and a research plan for the doctoral dissertation. Doctoral studies include, in addition to conducting research to be reported in the thesis, high-level studies worth 60 study points equaling one year's work. In order to increase the number of doctoral degrees, and to support and to shorten completion times, a graduate school system was established in Finland 1995, and has ever since gradually expanded. On 1 January 2008, the Ministry of Education delegated the decision-making and responsibility for the development and monitoring of doctoral programmes (former graduate schools) to the Academy of Finland.

Doctoral programmes provide systematic, high-level and supervised researcher training for a fixed period. They ensure the supply of a sufficient number of high-level researchers and experts to meet the needs of universities, business and industry, and society at large. The four-year doctoral programme positions are intended for full-time work on a doctoral dissertation, and doctoral candidates are generally hired to positions for the entire four-year term. In addition, doctoral programmes receive funding (operational grants) to arrange systematic and high-level education and establishing systematic cooperation, both on a national, international and sectoral level.

The Ministry of Education and Culture allocates the doctoral programme positions to universities in accordance with the Academy's decisions, and the operating grants are awarded to universities by the Academy. In addition to student positions funded by the Ministry, doctoral programmes usually accept students with equal rights who are funded from sources other than from the Ministry to take part in doctoral training programmes (matching fund students).

Doctoral programmes are typically organized as a national network organization, with different universities and research organizations with coordination offices allocated to hosting universities. There are currently 112 Doctoral programmes in Finland from which 85% are national networks and 15% local programmes. Currently 1 600 doctoral programme positions are funded by Ministry of Education and Culture. In addition, doctoral programmes have ca. 4 800 matching funds -students. The percentage of international students is ca. 16%. In this evaluation, units reported that 14 doctoral programmes or graduate schools at a local or Nordic level provide training for their students (Table 2). Annually ca. 1 500 doctoral degrees are awarded in Finland.

Table 2. List of Finnish doctoral programmes or graduate schools providing training for doctoral students in the units.*

Applied Bioscience – Bioengineering, Food & Nutrition, Environment
Arctic Graduate School
Biological Interactions Graduate School
Doctoral Program in Integrated Catchment and Water Resources Management
Finnish Graduate School for Environmental Science and Technology
Graduate School in Biotechnology and Molecular Biology
Graduate School in Forest Sciences
Graduate School in Pharmaceutical Research
Nordic Graduate School CBACCI
Northern Environmental Research Network Graduate Programme of the Thule Institute of the University of Oulu
Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change
Finnish Graduate School of Plant Biology
Viikki Doctoral Programme in Molecular Biosciences
VTT Graduate School

* These programmes were mentioned in the units' answers to Question 4.3 Organisation of doctoral training. The role of graduate schools and other research training and supervision. Describe aims, practices and arrangements of doctoral training at the unit.

The next step in the evolution of Finnish doctoral training is the establishment of graduate schools at the university level. At the moment, being a student in a doctoral programme or in a graduate school is not a prerequisite to be accepted as a doctoral student in a university. It is expected that in the future all doctoral students will be members of a graduate school at the university level, whether or not they are participating in a doctoral programme at a national level. [3]

[3] References for Introduction chapter: ERAWATCH, National profiles, Finland (http://cordis.europa.eu/erawatch); Finnish science and technology information service Research.fi ; web pages provided by Ministry of Education and Culture (www.minedu.fi) and the Academy of Finland (www.aka.fi)

2 Profile of plant science in Finland

For the evaluation of plant science in Finland, units collected data on their resources, research profiles, organization of research and researcher education and on the outcomes of unit performance. Data-sets complied by the units were used as assessment material. The complete set of evaluation forms are provided in Appendix 3. Summary tables of research inputs in the field of plant science are provided in Appendix 5.

In addition to the pre-collected assessment material, the evaluation panel received additional information during unit hearings.

Research fields

Units were asked to provide information of their research profile by nominating subfields of their research focus. The focus of Finnish plant science research interest is in stress and adaptation (estimated 27%), followed by plant environment interactions (14%) and biotechnology (14%). A substantial amount of research (17%) was in the field "other" that was not pre-categorized in the data-collecting forms. Plant science research has a minor role in the larger research portfolio of organizations. The mean percentage of plant science in departments' research was 17,5%, with the maximum being 78% for the Department for Agricultural Sciences in the University of Helsinki and the minimum of 1,9% for the Finnish Forest Research Institute, Metla (share of annual funding). (Figure 1)

Subfield "other" represents the following fields: Applications in management science and forest ecosystem dynamics, Applied genetics, Astrobiology, Bioinformatics, Biotechnology (gmo safety), Genomicas and genetics, including modeling, Metabolism, Mycology, Non-plant related microbiological research (together with plant-related work); Snow ecology and geophysics, Plant chemistry, Plant-pathogen interactions, Secondary metabolites, Soft fruits.

A more detailed breakdown into research subfields on a unit level is presented in Figure 2 with additional data given in Table 3. More information on the units' research profiles is presented in individual unit assessment reports.

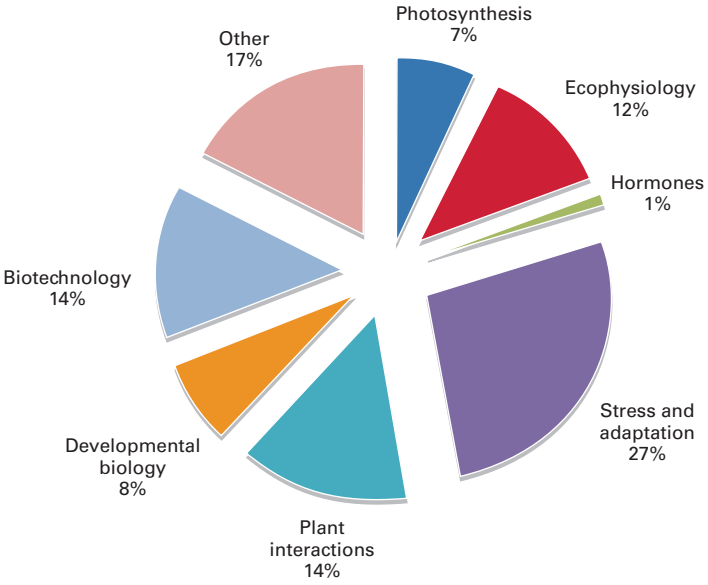

Figure 1a. Plant science subfields in Finland in relation to staff (%).

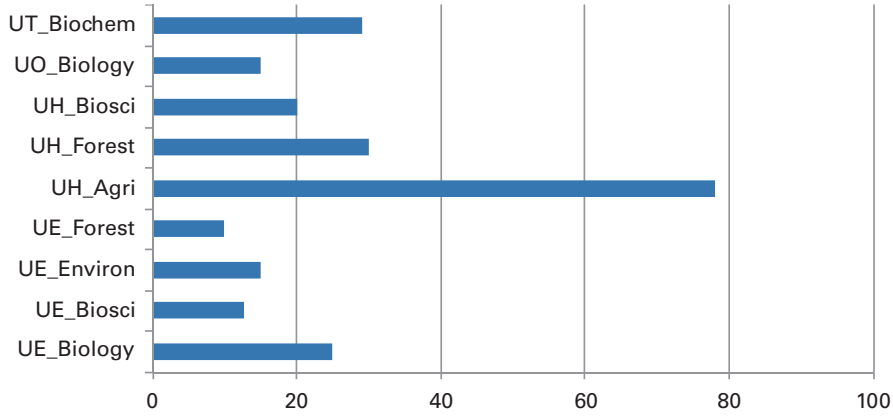

Figure 1b. Percentage of plant science in the university department's research.

Table 3. Unit's research profile.

	UE_Biology	UE_Biosci	UE_Environ	UE_Forest	UH_Agri	UH_Forest	UH_Biosci	UO_Biology	UT_Biochem	Metla	MTT	VTT
RESEARCH PROFILE, %												
Percentage of Plant Science in department's research												
in relation to staff		9,3										13
in relation to funding		15,9								1,9		
not specified or average value calculated from staff and funding	25	12,6	15	10	78	30	20	15	29	1,9	53	13
In relation to staff												
Photosynthesis	0	0	0	2,5	0	25	5	0	50	0	0	0
Ecophysiology	20	0	10	2,5	0	45	5	25	5	27	0	0
Hormones	0	0	0	0	2	0	10	0	0	0	0	0
Stress and adaptation	60	35	50	30	3	25	35	0	31	33	12	0
Plant interactions	10	0	40	0	34	5	15	35	4	23	0	0
Developmental biology	0	0		0	33	0	20	25	1	6	0	0
Biotechnology	0	15	0	0	9	0	5	15	6	11	0	100
Other	10	50	0	65	19	0	5	0	3	0	48	0
In relation to funding												
Photosynthesis	0	0	0	2,5	0	25	5	0	50	0	0	0
Ecophysiology	20	0	14	2,5	0	45	5	13	5	37	0	0
Hormones	0	0	0	0	1	0	10	0	0	0	0	0
Stress and adaptation	60	17	43	30	7	25	30	0	31	37	12	0
Plant interactions	10	0	43	0	44	5	10	40	4	13	0	0
Developmental biology	0	0	0	0	22	0	25	32	1	1	0	0
Biotechnology	0	0	0	0	10	0	10	15	6	12	0	100
Other	10	83	0	65	16	0	5	0	3	0	48	0
Other, please specify	1)	2)		3)	4)		5)		6)		7)	

1) Plant chemistry
2) Biotechnology (gmo safety); soft fruits; secondary metabolites
3) Applications in management science and forest ecosystem dynamics
4) Moteabolism; plant-pathogen interactions, bioinformatics
5) Non-plant related microbiological research (together with plant-related work); Snow ecology and geophysics, including modelling
6) Astrobiology, mycology
7) Genomicas and genetics; applied genetics

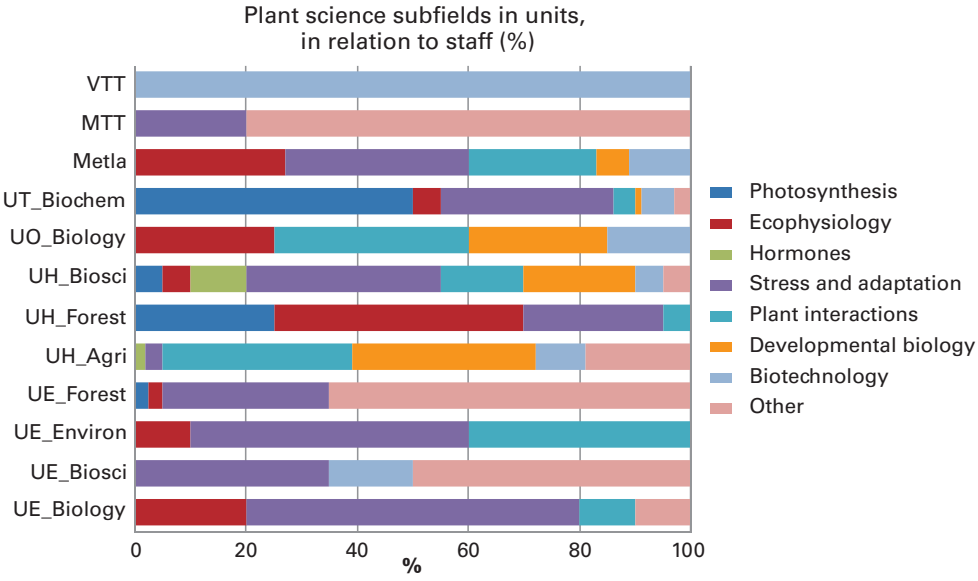

Figure 2. Unit's research profile in the context of the evaluation.

Research inputs and outputs

Finnish plant science community received a total of € 75 109 000 funding during the evaluation years 2005–2009. From this, core funding represented 36% and external funding 64%. The most important external funding agency was the Academy of Finland with a share of € 26 940 800 for the period from 2005 to 2009, equalling 34% of the funds available for plant science in Finland (Figure 3). A more detailed breakdown of the funding is presented in Table 4.

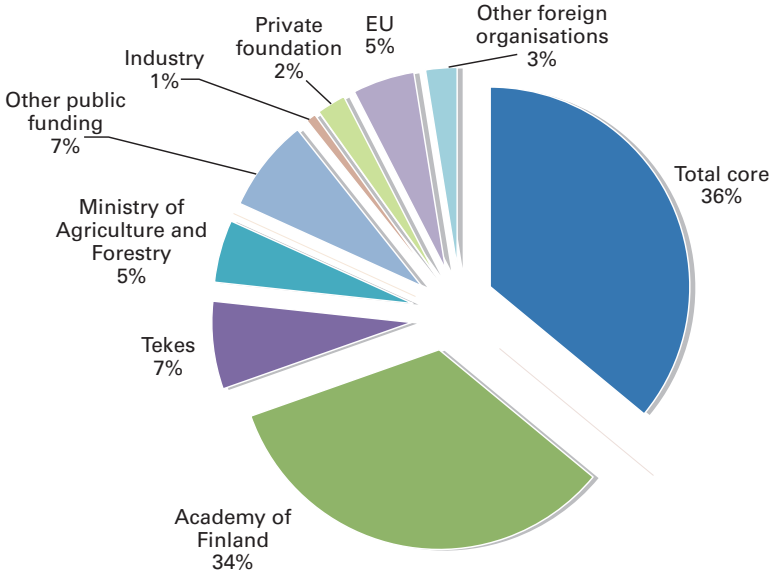

Figure 3. Share funding by source.

Table 4a. Main research inputs by unit 2005–2009.

	UE_Biology	UE_Biosci	UE_Environ	UE_Forest	UH_Agri	UH_Forest	UH_Biosci	UO_Biology	UT_Biochem	Metla	MTT	VTT
INPUTS, total 2005–2009												
Research staff in FTE												
Professors	10,0	3,0	7,4	0,5	11,4	5,8	14,9	11,3	5,7	1,4	5,0	1,3
Other senior researchers	12,0	4,5	2,5	1,5	10,0	12,1	29,9	16,2	11,5	17,2	23,6	24,1
Post-doc researchers	9,0	5,5	33,0	0,9	35,3	13,8	75,1	2,5	26,5	9,2	16,3	3,7
Doctoral students	23,0	27,3	56,5	13,9	111,6	36,5	116,6	38,2	50,3	7,5	17,7	5,7
Visiting researchers and research students	4,2	0,5	8,5	0,0	0,1	3,8	9,3	0,0	0,8	0,6	4,3	4,8
Other research staff	0,0	9,0	0,0	0,0	3,5	0,0	16,7	0,0	11,8	3,8	0,4	7,0
Other staff (incl. technical, admin.)	17,1	8,9	3,0	10,5	76,7	3,9	41,6	10,5	15,3	32,2	41,1	35,3
Research staff, total	58,2	49,8	107,9	16,8	171,9	71,9	262,4	68,2	106,6	39,7	67,3	46,5
Doctoral students/Senior staff (Profs+Other seniors)	1,0	3,6	5,7	6,9	5,2	2,0	2,6	1,4	2,9	0,4	0,6	0,2
Funding, € 1,000												
Total core	1 634,7	868,0	1 482,6	1 155,6	4 325,0	1 297,0	4 359,0	1 620,0	1 441,0	2 308,4	2 938,5	3 512,0
External												
Academy of Finland	1 582,8	287,0	1 336,4	441,0	3 008,0	1 701,0	7 129,0	1 361,0	4 279,0	2 209,3	1 403,9	425,0
Tekes	135,0	1,0	140,0	0,0	1 634,0	34,0	1 605,0	96,0	0,0	82,5	160,0	1 431,0
Ministry of Agriculture and Forestry	0,0	0,0	0,0	0,0	2 271,0	0,0	40,0	0,0	266,0	0,0	669,0	547,0
Ministry of the Environment	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other public funding	13,3	1 144,0	200,0	0,0	1 279,0	272,0	1 980,0	525,0	104,0	95,6	16,0	12,0
Industry	0,0	28,0	0,0	0,0	118,0	0,0	50,0	10,0	25,0	0,0	89,0	272,0
Private foundation	0,0	202,0	461,0	13,0	86,0	24,0	210,0	312,0	376,0	34,4	33,0	0,0
EU	518,7	506,0	372,8	0,0	40,0	156,0	0,0	248,0	520,0	0,0	390,0	1 001,0
Other foreign organisations	0,0	1,0	85,0	0,0	300,0	15,0	176,0	190,0	238,0	0,0	164,0	731,0
Total external	2 249,8	2 169,0	2 595,2	454,0	8 737,0	2 203,0	11 190,0	2 742,0	5 809,0	2 421,8	3 178,9	4 419,0
Total	3 884,5	3 037,0	4 077,8	1 609,6	13 061,0	3 499,0	15 550,0	4 362,0	7 250,0	4 730,2	6 117,4	7 931,0

Table 4b. Main research outputs by unit 2005–2009.

	UE_Biology	UE_Biosci	UE_Environ	UE_Forest	UH_Agri	UH_Forest	UH_Biosci	UO_Biology	UT_Biochem	Metla	MTT	VTT
OUTPUTS, total 2005–2009												
Researcher education												
Doctoral degrees	13,0	7,0	12,0	4,0	21,0	9,0	17,0	6,0	16,0	7,0	1,0	3,0
Average age when PhD completed	35,3	31,9	36,0	30,8	34,3	37,1	33,6	37,0	31,8	35,3	30,0	39,3
Completed post-doc periods	4,0	2,0	6,0	6,0	12,0	5,0	20,0	2,0	12,0	5,0	3,0	2,0
Science communication												
Articles in refereed international journals	94,0	42,0	93,0	28,0	108,0	119,0	115,0	65,0	112,0	78,0	44,0	45,0
Articles in refereed international edited volumes and conference proceeding	8,0	9,0	0,0	1,0	11,0	3,0	9,0	37,0	28,0	6,0	6,0	11,0
Articles in refereed Finnish scientic journals	0,0	0,0	0,0	0,0	1,0	0,0	5,0	0,0	0,0	0,0	0,0	2,0
Articles in refereed Finnish edited volumes and conference proceeding	0,0	1,0	2,0	0,0	5,0	0,0	1,0	0,0	1,0	3,0	7,0	0,0
Scientific monographs published abroad	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	6,0
Scientific monographs published in Finland	3,0	7,0	15,0	0,0	0,0	7,0	0,0	0,0	0,0	0,0	1,0	6,0
Other scientific publications	2,0	1,0	3,0	0,0	7,0	87,0	17,0	4,0	5,0	6,0	70,0	76,0
Patents	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,0
Computer programs and algorithms	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	0,0
Visiting/invited international lecturers	0,0	0,0	0,0	0,0	0,0	2,0	42,0	15,0	0,0	0,0	36,0	45,0
Radio and television programmes and journals popularising science	13,0	1,0	0,0	0,0	56,0	14,0	20,0	7,0	37,0	26,0	19,0	31,0
Other outputs	30,0	1,0	0,0	1,0	2,0	1,0	0,0	0,0	13,0	1,0	1,0	44,0

The structure of the Finnish plant science community as presented in percentage of staff categories shows that doctoral students formed the majority of the active research staff with a share of 47%. Post-docs were the next biggest category with 22% share of the research force. Senior researchers, professors 7% and senior scientists 16%, represented a total of 23% of plant science active research staff during years 2005–2009. (Figure 4).

The average number of doctoral students per senior researcher was 2.1. A total of 116 doctoral graduates completed their studies at the average age of 34.4 years during years 2005–2009. (Table 4).

Finnish plant science publishing activity was 1.03 publications per research FTE in refereed scientific journals and refereed edited volumes and conference proceeding. A total of 1100 refereed scientific papers were published during years 2005–2006. A vast majority, 97%, was published in international publication series (Table 4). Bibliographic analyses of Finnish scientific publication indicate that Finland produces ca. 0.6% of global scientific publications. Finnish plant scientists' share of world production of plant science publications during years 2005–2007 was 0.6%. The United States produced 19.4% and, as Nordic comparison points, Sweden, Denmark and Norway produced 1.2, 0.6 and 0.4%, respectively, of plant science publications. If number of publication were normalized to population, Sweden, Finland, Denmark and Norway had a better production than the United States.

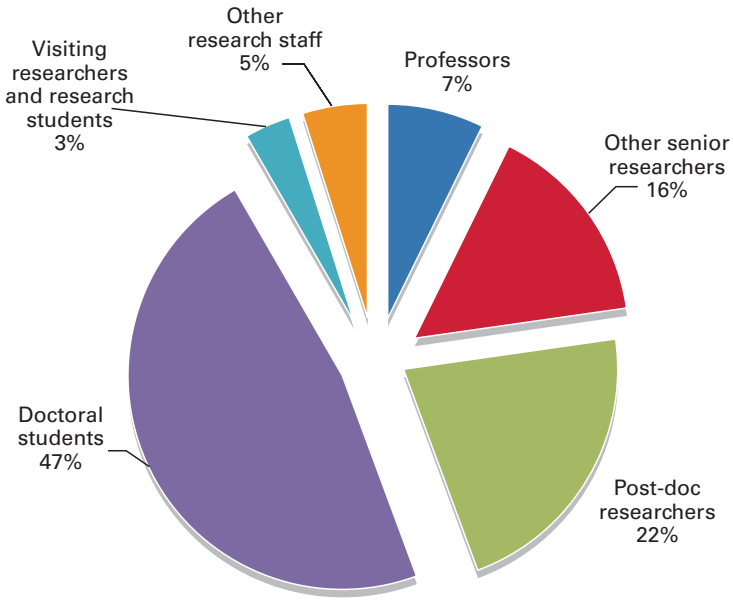

Figure 4. Research active staff in Finnish plant science community 2005–2006.

Publication growth rate indicated a slow-down in Finnish plant science publications when compared between countries and by comparing publications between years 1995–1997 and 2005–2007. Publication data covering a longer time period 1982–2008 does show, after an increase to millennium, an annual fluctuation with a slightly decreasing trend.[4]

More data on research inputs and outputs are presented in Table 4.

Mobility of researchers

Finnish plants scientists are almost entirely publishing in international journals since less than 3% of refereed scientific publications were published via refereed Finnish scientific publications. This implies that Finnish Plant Science seeks international visibility. The ways of doing science internationally have changed drastically with the onset of eScience. Still the most commonly used quantitative indicator is visits researchers pay to each other's organizations. Visits to and from the units are presented in Figure 5. A more qualitative analysis of units and of researcher education is presented in respective assessments.

The career choices of doctoral graduates and post-docs indicated that most of them continue doing science after completion of doctoral or post-doctoral studies (Figure 6).

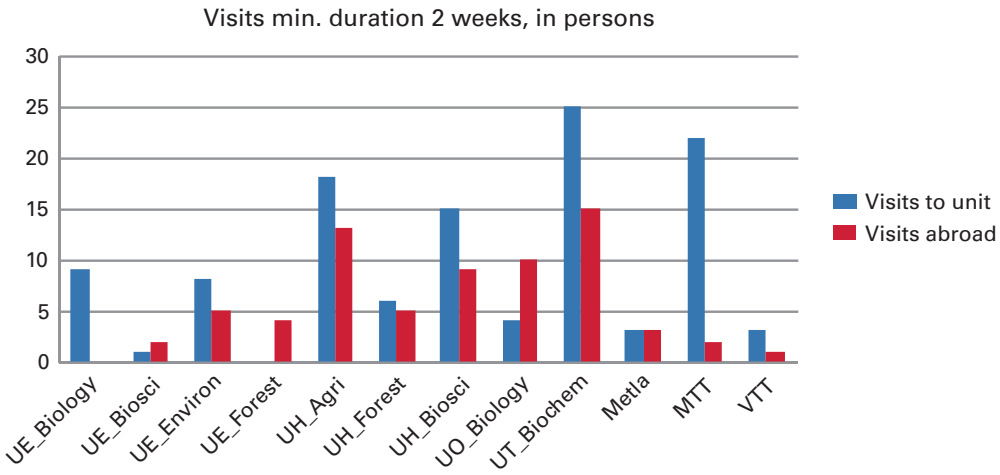

Figure 5. Visits to the units and from the units in persons during 2005–2009. Minimum duration of the visit was two weeks.

[4] Bibliographic data Thomson Reuters Science Citation Index Expanded, Vetenskapsrådet 2009

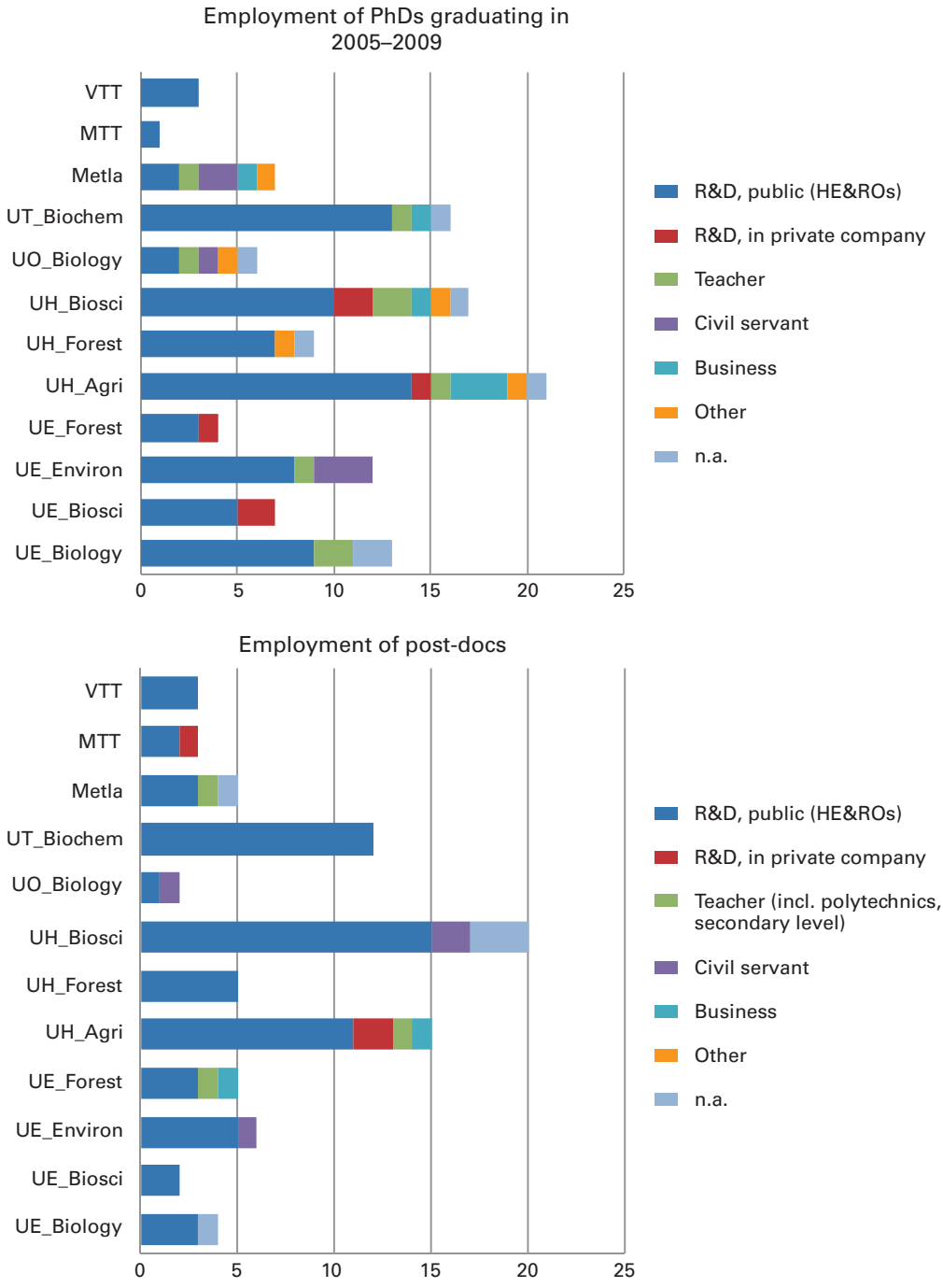

Figure 6. Current employment of doctoral graduates and post-docs. Reported employments were grouped according to best judgement. Thus this information should be considered as an indicative one.

3 Unit assesment

University of Eastern Finland, Department of Biology

Three groups contribute to research in the Department covering the areas of environmental plant stress, ecophysiology and phytochemical and metabolic responses to environmental change. Major stresses investigated are increasing temperatures, ozone and UV radiation. Analyses of plant secondary compounds are also a major interest, together with molecular and chemical analyses of defence mechanisms in plants.

Scientific quality of research

The unit undertakes a wide range of activities that have resulted in a large quantity of good quality publications. A strength of the unit are the facilities which allow plants to be grown in controlled environment chambers, open-air field plots and natural field sites. The majority of research is conducted under environmental conditions relevant to future climate changes. Considerable efforts have been made to examine the interactive effects of different environmental stresses, for example elevated ozone or UV-B radiation exposure together with elevated temperatures. An impressive range of physiological, biochemical and molecular biological approaches have been employed. However, the majority of the research has been descriptive and has lacked critical examination of mechanisms involved in driving the observed environmentally-induced changes.

Research environment and organization of research

The unit does not have a well defined research strategy. Many of the research projects appear to result from opportunistic situations and are not the consequence of strategic long term planning. Leadership of the individual research groups has been successful, but the unit would benefit from an improved overall level of leadership which is required to develop a more logical strategic plan for the successful development of long term environmental research. There is a need for more detailed future planning and development of key focuses based on important issues emerging from current and future data sets. The facilities for field studies and metabolite analyses are important assets. The unit is well resourced for equipment, facilities and technical support, however with better strategic planning there is potential to better exploit this infrastructure to improve the level of research outcome. The members of the unit have good collaborations with other groups within Finland and internationally. The activities of the unit involve a range of interdisciplinary approaches that have been important in underpinning their research programmes.

Research education

The unit successfully recruits and trains an appropriate number of graduate students.

Interaction between research and society

The unit makes contributions to the development of management plans for maintaining sustainable forests in the face of climate change. A good awareness was demonstrated of the requirement for environmental plant biologists to communicate their research to society in general. The unit is involved in a range of activities with local communities and industry.

Recommendations

- Unit leadership needs to be improved to ensure better strategic planning.
- Identification of core future research activities should be made to reduce the diversity of current research activities and ensure that key future research issues become the major focus.
- Better strategic planning is needed to ensure that future research programmes are developed which will allow resources to be utilised to provide understanding of the mechanisms involved in the response to environmental change.
- High priority should be given to obtaining funding to maintain and operate the field facilities in the future.

University of Eastern Finland, Department of Biosciences

Research in this unit is in two unrelated areas: metal tolerance, using the Arabidopsis relative Noccaea, and disease and compositional aspects of berries. Metal tolerance is the major focus and is basic research. The berry research is more applied and is largely driven by the availability of funds from the local region and end-user demand.

Scientific quality of research

For the metal tolerance area, *Noccaea* is good and relevant model species. The unit has good links to other groups internationally. In the last five years, the unit has identified genes and proteins that may be related to metal tolerance using proteomics and transcriptomics. Unfortunately most of the candidate genes and proteins examined so far have no clear links to metal tolerance. The unit has recently employed deep sequencing of the transcriptomes of *Noccaea* accessions to identify further candidate genes and examine whether differential gene expression is related to different patterns of methylation. This approach is potentially powerful, but the unit cannot analyse the data fully because it has limited bioinformatics expertise. It has no publications so far in the field of DNA methylation. In general, the research in metal tolerance is at a crossroad. Previous approaches have not yielded major new insights so far. The group is to be congratulated on trying new approaches. It is very important that the deep-sequencing approach does not stall: high-level bioinformatics expertise and improved resources and collaborations will be necessary to permit full use of the data.

The research on berries is largely centred on the problem of downy mildew disease in arctic bramble. The disease is a major barrier to commercial cultivation of this crop, for which there is a high demand in Finland. The unit has been very successful in attracting funding from the regional agencies. It has set up a culture system for study of downy mildew, and is attempting to set up a robust system for field studies. Other work on berries described in the submitted paperwork has largely

been discontinued. The unit pioneered analysis of phenolics in native berries, but this work is now being done by groups elsewhere in Finland. Work on the health-promoting properties of berries has moved to animal and clinical research groups.

The general productivity of the unit has been high. The numerical output of publications is good, and many are the results of international collaborations. However, the output consists largely of small papers in low-impact journals. This publication profile is driven to some extent by the requirement that students must publish four papers for their PhD theses. Overall, the output is of national rather than international quality.

Research environment and organization of research

The unit has strong expertise in biochemistry, is well-connected to chemists and biochemists, and is well equipped for metabolomic and proteomic analyses but it does not always utilize the full potential. The unit lacks capacity in bioinformatics and has not developed networks to overcome this problem.

The unit does not seem to have strong and focused research strategies. It is regrettable that there is only limited access to bioinformatics expertise. The unit does not appear to be involved in decision-making at the University level, which could be detrimental to its future development. It would also benefit from strong connections to highly relevant international developments in *Noccaea* genomics that will have a major impact on its research. The unit plans to discover effectors associated with resistance of arctic bramble to downy mildew, but it is not clear how this information will be exploited to provide solutions to the disease problem.

The unit is engaging in some projects that do not appear to fit with its main themes, for example the University-funded initiative on the clonal birch experiment. Although the unit has skills that could be valuable in this research, there is a danger that that the project will lead to loss of focus without delivering high-impact outputs.

Research education

The unit is able to recruit well-qualified PhD students from within the University, reflecting the strength of the University in biochemistry and chemistry. However, training in bioinformatics is lacking at all levels. There is only limited recruitment from outside the University, so the student population may be rather "inbred". Considering its size, the unit trains a large number of students. Many are jointly supervised by researchers from different disciplines, giving valuable breadth to their education. The students are easily able to find work after completion of their training. The Faculty requirement for four publications before submission of a PhD thesis is seen as detrimental to the PhD programme. It encourages research leading to small descriptive papers rather than more in-depth, higher-impact publications. There are relatively few opportunities to recruit post-doctoral workers.

Interaction between research and society

The research on berries has a very good public profile and strong links to growers and end-users, facilitating regional funding and promoting the profile of the University and of plant science.

Recommendations

- The unit should define focused objectives for the next five years. It should consider which topics to pursue, and which to discontinue, and develop strategies for funding the priority areas.
- The unit needs an adequate bioinformatics capacity, as a matter of urgency.
- If research on downy mildew of arctic bramble is to continue, efforts should be made to find support and collaborations for underpinning science, and to identify how this work will be exploited in future.
- The unit would benefit from a more pro-active approach and a higher profile within the University. It should seek to participate in University and Faculty decisions that influence its future.
- The unit should consider a wider recruitment policy for PhD students, to ensure diversity of outlook and approach. It could provide extra training in biochemistry and chemistry for outside students who may lack adequate skills in these areas but have otherwise excellent qualifications.
- Quality and impact of publications should be major considerations. The unit should also push strongly for bioinformatics training at all levels in the University. It should consider recruiting students and postdocs who have these skills, even if this means extra training in biochemistry and molecular biology.
- If berry research is to continue, the unit is strongly encouraged to keep up its good work in public and end-user engagement. Every effort should be made to persuade regional and industrial funders of the importance and benefits of the "research" element of the work.

University of Eastern Finland, Department of Environmental Science

This unit consists of two groups working in distinct but related areas of ecophysiology: the effects of ozone, UVB and other climate-change-related environmental variables on boreal vegetation and ecosystems, and the emission of volatile organic compounds (VOCs) by plants, particularly in relation to signalling, herbivory and climate. The unit forms part of the large Environmental Science Department at Kuopio, the main activities of which relate to environmental health. The unit relies heavily for its work on plant growth and open-field research facilities at the University research garden.

Scientific quality of research

The topics studied by the unit are of undoubted importance from both a fundamental science and a strategic perspective. Deeper understanding of the effects of elevated ozone, UVB, carbon dioxide and temperature on natural vegetation will contribute to plans for mitigation and amelioration of the impact of climate change. Little is known about the interactions of VOC emissions with the biotic and abiotic environment, but it is increasingly apparent that they may be of great ecological importance.

The unit has made significant contributions in both areas, resulting in a good output of papers in international journals in the last five years. However, many of the papers are largely descriptive. Relatively few provide important conceptual or mechanistic insights. There is good evidence that the research on VOCs is internationally appreciated: for example there are collaborations with experts at the

Max-Planck Institute in Jena and with US researchers, a significant fraction of the publications have international authors, and important funding has come from EU programmes. There is less evidence that the research on the effects of climatic variables on boreal vegetation has received major international recognition.

The unit has developed important facilities for studying environmental stress effects in natural vegetation, and makes extensive use of environmental science and chemistry facilities available in the University of Eastern Finland. However, the unit is isolated from other aspects of research in plant biology. Because of this, it is not capitalizing on some of its interesting discoveries by exploring their implications at a cellular, metabolic, genetic or molecular level. Such investigations could potentially enhance the impact of the unit's research.

Research environment and organization of research

The unit exhibits strategic thinking in its use of local facilities and expertise in atmospheric science, geochemistry, and chemistry. However, although the need to engage with molecular biologists and other plant scientists is acknowledged, there are no plans for how this will be achieved. The future plans for the unit as a whole showed relatively little vision and creativity. It was not clear whether opportunities for integration and synergy between the two research themes of the unit have been fully explored.

Multidisciplinary networking with environmental scientists and chemists at a local level appears to be excellent. Research on VOCs has good connections to international collaborators, although it is not clear whether these contacts are part of a planned strategy or opportunistic. Research on the effects of climatic variables on boreal vegetation is poorly connected with other relevant research in plant biology.

The unit has developed excellent resources for field experiments on plant-environment interactions. These include expensive and scarce facilities for open-field elevation of ozone and carbon dioxide, and sharing of a high-specification proton transfer mass spectrometer with local atmospheric researchers. However, aspects of the infrastructure and experimental approach could be improved. First, it is not clear that the monitoring and feedback controls in the ozone, UVB and carbon-dioxide enrichment facilities are of the highest international standard. Second, the basis for deciding the levels of enrichment in carbon dioxide, ozone and UVB were not clear. Third, better links to predictive modelling would allow integration of the effects of different environmental variables on plant performance. Fourth, there are threats to the research garden from urban encroachment and from its possible sale by the University. The unit appeared to have no firm strategy for influencing University decisions. In the event of loss of the garden, it is not clear how the unit's research could be continued.

Research education

The unit has trained significant numbers of PhD students over the reporting period, and provides an international MSc course. It is increasingly difficult to attract Finnish students: no Finnish students have taken the MSc course so far. However, the international students on the course are seen as a suitable source of future PhD students. The Faculty requires PhD students to produce four papers in order to submit a PhD thesis, two of which must be first-author. Although this is a relatively

demanding requirement there is some flexibility and the policy is not considered to have an adverse effect on student training or publication impact.

Interaction between research and society

The unit provides training in ecophysiology to international MSc students. Its research is relevant to understanding the impacts of GM crops expressing Bt, and to environmental impact monitoring. Although the research results are important for understanding and responding to the effects of climate change, there is little attempt to engage and influence policy-makers and the wider public in these respects.

Recommendations

- A far greater degree of engagement with molecular, cellular, genetic and metabolic plant biology would be desirable. The unit should seek collaborations in these areas.
- The unit should develop much stronger and more ambitious objectives for its future research, and use these as a basis for planning collaborations and applications for resources.
- The unit should consider forming links with modelling experts to exploit its data fully.
- Loss of the research garden would be a severe problem for the unit's research. The unit should seek to influence University decisions on this matter, making use of its good record in publication, discovery and training. It should also seek support from other users of the facility, who can attest to the importance and scarcity of such facilities on an international scale. The unit should make contingency plans in case the research garden is lost.
- Every effort should be made to ensure that the open-air enrichment facilities in the research garden conform to the highest standards of monitoring and control.
- It would be valuable to know why these important research areas do not attract Finnish students to unit's international MSc course. Reasons may include perceived lack of job opportunities and lack of appropriate undergraduate teaching. Investigation of this problem would enable development of strategies to encourage application from Finnish students.

University of Eastern Finland, School of Forest Sciences

This is one of four units of the University of Eastern Finland that does research in the area of plant science. The main focus of the School of Forest Sciences, located at Joensuu, is the sustainable management of forest ecosystems. Plant science research in the sense of this evaluation is a mere side activity, covering aspects of stress physiology and nutrient uptake of woody plants. Furthermore, physiological performance (e.g. ecophysiology of photosynthesis, respiration) are studied experimentally for modelling purposes.

Scientific quality of research

Plant science research in this unit is not a major activity. According to the self-assessment of the unit, its head, Prof. Seppo Kellomäki, invests only 10% of his working time in plant science research. The main research lines are ecophysiology of

trees with regard to climate change and tree nutrition, with specific emphasis on boron. With respect to ecophysiology, the unit has developed a model which incorporates different parameters relevant to forests' ecosystems. The boron work has potential, but it would profit from a more dedicated inclusion of current knowledge, derived from model species, about mechanisms of boron transport and allocation. The publications are solid but descriptive and the impact is therefore quite low.

The research topics of the unit are potentially interesting and relevant to forest management, but execution of the research could be improved by a better understanding of fundamental mechanisms and underlying processes.

Research environment and organization of research

It is unclear how strategic priorities in plant science research are set since the main research focus of the unit is sustainable management of forest ecosystems. As plant biology appears to make up only 10% of the research effort of some unit members, leadership in this area does not appear to have priority. The unit is well connected to the Finnish Forest Research Institute Metla and participates in several EU projects, but should consider widening the scope of its collaborations. The potential of interdisciplinary approaches could be utilized more. The infrastructure to do the research in the chosen areas is in place and functioning. A strength of the unit is its association with large forest research units that focus on forest management and sustainability, while the small size of the unit and the limited allocation of time to plant science is a weakness.

Research education

The unit organizes the Graduate School in Forest Science. This demonstrates leadership and is a platform for collaboration and networking on a national scale.

Interaction between research and society

The unit is in dialogue with some end-users of the research results and participates in the discussion about the political consequences of this type of research. Interactions in different directions are ongoing.

Recommendations

- Basic plant science, with a focus on tree physiology, should be strengthened.
- More analytical, physiological and molecular approaches are required. This would also lead to higher impact publications.
- More detailed modelling should be applied in the ecophysiological studies.
- The unit should make an effort to continue the national Graduate School in Forestry.

University of Helsinki, Department of Agricultural Science

The Department of Agricultural Science at the Agricultural Faculty of the University of Helsinki is one of the larger and stronger plant science groups in Finland. They cover a wide range of topics from developmental biology in Gerbera and Fragaria to plant–pathogen (mainly virus and bacterial pathogens) interactions and lignin biochemistry.

The research focuses on a number of plant species, which are described as second generation plant models. This allows an effective translation from basic research to applications. These new models benefit from the recent advances in technology such as Next Generation Sequencing, which is now well embedded into the ongoing research of the unit.

Scientific quality of research

The unit produces a large number of papers, including several in very high ranking journals. The strategic choice to work on the next generation models is a good one, especially when combined with state of the art genomic technologies.

The diversity of the research in the different groups is a potential weakness, although the unit made a convincing case that there are biological links, e.g. between the work on Gerbera and Fragaria and between earlier research on secondary metabolites and spruce lignin biology. Another example is the use of virus induced silencing as a tool. The strength of the unit is the quality of their research and also the collegial interactions. A potential danger is a lack of focus with so many species and topics being studied, although the diverse needs for teaching and the history of the groups justify diversity. The panel would only encourage the extension of the pathogen work to Physcomitrella, if a specific host pathogen interaction can be examined. The future of research on heterologous proteins was also questioned.

Research environment and organization of research

The group has a relatively flat organization and operates in a collegial way within the unit but also within the University of Helsinki, as demonstrated by coordination of teaching and research with the Department of Biosciences, and further evidenced by a Centre of Excellence in research -status for some of the PIs. Together a group of 100 plant scientists work at the Helsinki University Viikki campus. The unit is well embedded in national and international networks. The unit would benefit from a stronger common leadership and strategy.

No deficiencies are observed in the possibilities to do the research, because when additional expertise is needed, it can be found in the Helsinki/Finnish research environment.

The expertise of the group might benefit from new initiatives and collaborations with groups outside of Viikki campus e.g. in multidisciplinary tree projects. In general there is an excellent infrastructure with free information flow and use of facilities within Viikki campus. The overall research environment of the University of Helsinki appears very beneficial to the unit.

Research education

The unit has had no problems in recruiting good candidates for their PhD program, both by internal and national recruitments. However, some concern was expressed on the background knowledge in chemistry and physics among MSc students that are a major supply for PhD positions. This might be solved with training courses or by making chemistry compulsory for the study of biology.

Interaction between research and society

The work on crop plants is effective for translational research and thereby

dissemination to end-users. The involvement of the unit in the GMO discussion involving good interactions with various stakeholders, is a good example of an outreach activity.

Recommendations

- The strength of the unit is the quality of the research and it has been recognized as the Centre of Excellence in research -status, which was a guarantee for part of the stable funding over a number of years. New resources must be found when the excellence programme ends. Plans should be made.
- The relatively flat structure might lead to the absence of coordinated initiatives e.g. at the level of preparing new research applications, which will be relevant when the excellent status expires. The unit is therefore recommended to improve the leadership and propose common strategies at the unit level.
- The expertise of the unit can stimulate coordinated new initiatives and collaborations with other groups e.g. in multidisciplinary tree projects.

University of Helsinki, Department of Forest Sciences

The Department of Forest Sciences is part of the Faculty of Agriculture and Forestry. Seven groups contribute to plant research in the Department. The activities of these groups focus on energy fluxes between the forest biosphere and atmosphere, biological mechanisms of tree and forest productivity and the relationships between climate change and forests.

Scientific quality of research

The unit has demonstrated a range of research activities of international quality which have resulted in a large number of good quality publications. A major strength is the holistic approaches that are adopted to solve complex problems. The research combines theoretical modelling with field and laboratory studies to examine issues from the subcellular to canopy-atmosphere interactions and which frequently involve both temporal and spatial considerations. The unit has a well planned and executed research strategy which has produced structured research programmes yielding important outputs. The individual research groups are well integrated and constitute a coherent research unit. The unit is exceptionally well positioned to make cutting edge contributions to understand how future climate changes will impact on forest productivity. A clear policy exists to ensure relevant research findings are appropriately introduced into future programmes for forest management. The unit's research effectiveness and international profile could be further enhanced by a greater application of biochemical and molecular biological approaches to many of the research problems being studied.

Research environment and organization of research

The unit has strong leadership that has produced focused research strategies. These have been well planned and implemented. An excellent collegiate atmosphere has been developed and has resulted in many synergistic interactions between groups. The unit has a high quality infrastructure, particularly notable are the excellent field facilities and instrumentation. It is essential that the unit ensures that strategies are in

place to maintain and enhance these facilities in future to remain internationally competitive. The interdisciplinary nature of much of the unit's research has enhanced the exploitation of this good infrastructure. The long term collaborations developed with members of the Department of Physics have been particularly impressive, as evidenced by the publication output. The unit has extensive national and international research collaborations that will assure continuous research productivity. The unit is also involved in a range of educational networks associated with Masters and Graduate School programmes.

Research education

The unit makes considerable contributions to Masters and Graduate teaching. A key feature is the interdisciplinary nature of much of the training. Good quality graduate students are recruited and trained. However, the unit should endeavour to obtain funding for an increased intake in order to better exploit the excellent research facilities available. In particular, recruitment of students with backgrounds in biochemistry and molecular biology would be beneficial in enhancing the range of experimental approaches applied in the research programmes. The unit also is involved in a range of graduate educational programmes at the Nordic-Baltic, European and International levels.

Interaction between research and society

The unit's inputs into this activity are exceptional and could set an example for other units. A major focus is the effect of climate change on forest productivity. Considerable efforts have been made to implement a wide range of societal impacts at local, national and international levels. A high awareness of the requirement to interest different sections of society to future forest problems has been demonstrated.

Recommendations

- In some cases the unit's international reputation could be enhanced by encouraging staff to publish their work in higher profile journals.
- Inclusion of biochemical and molecular biological approaches to some research projects would add an important dimension to the unit's research profile.
- Contingency planning for the maintenance and improvement of field facilities and instrumentation is essential to ensure future international competitiveness.

University of Helsinki, Department of Biosciences

The Department of Biosciences is a very large substructure of the University of Helsinki, and its research and teaching is divided into six Divisions: Plant Biology, Ecology and Evolutionary Biology, Biochemistry, Physiology, Genetics and General Microbiology. This evaluation covers plant research conducted in Plant Biology, Genetics, General Microbiology and in the Department of Environmental Sciences.

Scientific quality of research

Plant research in this unit has a very strong international standing, maintained by a continuous stream of high-caliber publications during the last five years. The main strength is in the areas of developmental biology and biotic and abiotic stress using

Arabidopsis as a genetic model plant. Research also involves the model tree species poplar, including a contribution to the full-genome sequence of poplar, and the ecophysiology of northern trees, particularly with regard to cold and UV stress. The unit has had the status of a Centre of Excellence in research in two consecutive periods (2000-2005 and 2006-2011). Thus, it is undoubtedly a major contributor to Finnish plant science.

While many of the individual scientists in this unit have been very successful in the past and will most likely continue to be so in the future, there seems to be a certain lack of team spirit. Surprisingly, a proposal of the unit to join forces in a new major research area of molecular approaches to improve cultivation of the birch tree, was not even presented in the submissions of the unit, and surfaced only in response to the questions with respect to strategic plans. A broadly based, common strategic research plan would add strength and coherence to the unit's efforts. Overall, the main strength of the unit is the originality and excellence of the research strategies of the individual PIs. This strength should be used to increase the leverage of the entire unit by developing a coordinated common research strategy.

Research environment and organization of research

Taken individually, most groups of this unit have well-focused research plans, which position them strategically at the forefront of their respective fields. They make good use of the infrastructure on the Viikki campus, and they are well embedded in national and international networks. Some groups in this unit were particularly successful in the ERA-Net programs, which have been put into place to promote international collaborations from "bottom-up" based on excellence in basic science. At the individual level, there are strong interdisciplinary links on campus to chemistry and bioinformatics. The unit as a whole, however, perceives it as a weakness that there is a lack of bioinformatics infrastructure. This apparent contradiction could be solved, if the individual groups joined forces to develop a common bioinformatics strategy.

A disadvantage of the unit as a whole is the spatial and organizational fragmentation. The unit proposes the creation of a "Viikki Plant Science Center" (ViPS) with a single building housing such a Center. The unit would further benefit from the formation of a "Virtual Plant Science Center", which should define a common research platform and prioritizes infrastructural needs.

Research education

In 2007 the unit has successfully established the Finnish Graduate School for Plant Biology, an overarching national enterprise with international visibility. This is a strength not only of the unit itself, but a major contribution to Finnish plant science in general. It is strongly recommended to further promote and support this doctoral programme.

Interaction between research and society

The unit has been very active in its outreach activities, particularly with respect to new legislation on GMO crops that is currently being debated in the parliament. Prominent members of the unit take part in the corresponding discussions in the media and explain state-of-the-art plant science to the public. These outreach activities should be actively encouraged.

Recommendations

- This unit profited over the last ten years by the high profile of its Arabidopsis research. In the foreseeable future, with the rapid development of molecular tools, it will be important for plant scientists to consider new model plants that are important in agriculture and forestry, such as potato, barley, poplar and birch. It is recommended to identify one or two second generation model systems that should serve as focal points and will allow translational biology from basic research to application in the future.
- A "Viikki Plant Science Center" should be established to further enhance the unit's international status. It is important for staff to collaborate and define and promote common research strategies.
- Plant sciences on the Viikki campus are fragmented and belong to different organizational units. However, based on a "bottom-up" approach, the PIs in this field have already established a Plant Biology Club to organize common seminars and annual retreats. This informal organization should now lead to the creation of a "Virtual Plant Science Center" to develop research strategies, to set priorities for recruitment of new faculty members, and realize a "Viikki Plant Science Center", i.e. a new building for all plant scientists on campus, ideally with its own leadership and organizational structure.
- It appears that PIs in the unit apply for considerable amounts of research funding, of which a large proportion is not awarded. It is recommended that an in-house planning or peer review system for grant submissions is established to reduce the number of submissions and improve the success rate.

University of Oulu, Department of Biology

Plant science at the University of Oulu has recently been re-organized as one of the three main areas of the Department of Biology under the name of "Functional Biology and Biotechnology of Plants". This unit carries out basic research in developmental biology and biotechnology, in biotic interactions and in ecophysiology related to abiotic stress.

Scientific quality of research

The unit has a very diverse research portfolio including zygotic pine embryogenesis, new chemicals from pine endophytes, biosynthesis of polyketides in *Hypericum*, and regulation of anthocyanin synthesis in bilberry (*Vaccinium myrtillus*). There is a steady flow of solid publications, but as the unit itself recognizes, there are too few publications in the top journals. This may be due, in part by the diversity of the research subjects and by the requirement for PhD students to publish four papers for their thesis, which is an incentive to split up research results into "minimum publishable units". The unit recognizes this problem and plans to publish their most important discoveries in the form of major comprehensive publications in the future.

Currently, there seems to be a somewhat opportunistic, albeit quite successful approach to the research subjects in this unit. For example, the discovery of a bacterial endophyte in pine tissue culture that contributed to browning led to an interesting new research topic, bioactive compounds from endophytes, which culminated in the successful application for an EU grant.

Overall, there is a lack of research focus in this unit, even at the level of the individual PIs, many of whom lead two different, unlinked research projects with different experimental systems. Again, this may be due, in part, to the requirement for PhD students to have distinct projects. However, this causes considerable fragmentation and hinders the development of a focused research strategy.

As the northernmost academic plant science research group in Europe, the unit has the opportunity to focus on northern plant species in their natural environment, making it unique. Several individual research groups work on two Nordic key species, pine (*Pinus sylvestris*) and bilberry (*Vaccinium myrtillus*). The unit has formed and coordinated a Nordic wild berry project 2007–2009. In plant science, there is currently a demand for second generation models species after Arabidopsis, rice and poplar. The unit should consider a research strategy with a focus on one of the two Nordic species in order to profit from its unique geographical location.

Research environment and organization of research

The unit is well organized and shows clear leadership. Its equipment is excellent, but some of its laboratory space is old and unpractical. A renovation should receive high priority. The unit has well-established national and international networks, as demonstrated by the frequent visits of scientists and students from abroad. Within the University of Oulu, the unit has interdisciplinary links, particularly with chemistry and ecology.

The Department of Biology has recently established a service laboratory ("BioSer") for next-generation sequencing and laboratory automation services, with first class equipment. This is an opportunity for the unit to add genomic approaches to its research projects. It will be essential to get sufficient support for technical staff to run this facility and to continually update the hardware. This is an excellent service facility which of course has to function as a service platform on the University level and not at the unit level, otherwise it will be too expensive for the unit and the service platform will be under-used.

Research education

The PhD students of the unit appear to be very motivated. They praise the accessibility of their supervisors and the team spirit in the unit. As in several other units, the time to obtain a PhD degree takes too long compared to the average duration of a PhD elsewhere in Europe. A PhD period of seven to eight years is considered normal, in part because the requirement of four research papers appears to be quite rigid.

Interaction between research and society

The unit contributes to the education of teachers and in the popularization of science. A highlight was the Nordic wild berry project, which emphasized the transfer of scientific approaches from the laboratory bench to the consumer.

Recommendations

- The unit has a large diversity of small projects, but a considerable lack of focus. The number of plant models should be reduced and focus should be on the two important northern species, pine and bilberry, to exploit the unique geographic location of the unit.

- The unit should consider promoting one of these species as a second generation model plant after Arabidopsis. This will promote the visibility of the unit and will serve as a platform to increase synergies and collaborations within the unit.
- The unit is part of the Department of Biology, which has recently invested considerably in a new platform of next-generation sequencing and laboratory automation services (BioSer). This is an ideal time to start, in a joint effort, gene expression analysis and genomics of a new model plant.
- The unit should find ways to promote the publication of major research findings in the form of comprehensive publications in top journals.

University of Turku, Department of Biochemistry and Food Chemistry

This is a large unit consisting of two professors, two university lecturers and two university teachers with budget funding. In addition, there are six other researcher positions supported by competetive funding. Research is focused on different aspects of photosynthesis in both higher plants and cyanobacteria. Other research activities include plant and cyanobacterial stress signaling, plant-microbe interaction and solar fuels. During the evaluation period, the unit was part of the Department of Biology. Since 2010, it belongs to the Department of Biochemistry and Food Chemistry.

Scientific quality of research

The unit is producing very good science with high international impact. The quality of research has been recognised by the Centre of Excellence in research -status. The high number of articles published in journals relevant to the field attest to its quality and visibility. The capacity to get external funding is another indicator of the strength of the unit. The research is vigorously active. The combination of fundamental and applied investigations has a positive impact on the research activities. This unit is well aware of how to best exploit research opportunities and has been able to establish well-defined and coherent research structures. As a consequence, the research is well focused, innovative and challenging. The unit has a clear vision of future research plans and possibilities.

Research environment and organization of research

The unit is now a member of the Department of Biochemistry and Food Chemistry which provides a strong interdisciplinary research environment. Excellent resources and facilities are available to develop their programmes, and parts of their developed infrastructure are also available for the use of the wider scientific community within the University and Finland. The unit has identified the needs and it has taken the appropriate actions to achieve them. There is strong and visionary leadership. The research organization is excellent with well-defined strategies based on long term planning that stimulate collaborative interactions. The unit has an extensive national and international networking which is reflected in their collaborations inside Finland and their active participation in EU programmes. The unit has a high degree of effective interdisciplinarity, which is recognized as essential to attain the scientific goals.

Research education and careers

The unit is efficient in recruiting and training PhD students from both Finland and abroad. Students actively participate in the Finnish Graduate School for Plant Biology, of which Prof. Aro is vice-director, as well as in other national graduate schools and different EU Marie Curie networks. The unit shows a good awareness of graduate students needs and provides a good scientific education. The unit appears to be able to cope with the constraints related to the traditional Finnish doctoral training as they are trying to limit the PhD study period to 4–5 years.

Interaction between research and society

The unit has taken into serious consideration the need of communicating the results of its work to the society. The members are actively contributing time and expertise to a wide range of dissemination activities in Finland, including TV shows, radio programs, public lectures and print media. In addition, they participate in a number of international panels and forums which discuss the impact and acceptance of the future technologies by the society.

Recommendations

- This is an excellent unit that should maintain its strategy, which results in very high quality research.
- However, the unit still could try to improve their international visibility by publishing in top-quality journals.
- The unit is located in two separate buildings located 400 m apart from each other. Unifying the groups in one building would improve the capacity of the infrastructure and increase the research potential of the unit.
- The Finnish Graduate School for Plant Biology is an appropriate instrument for collaboration and interaction among PhD students with similar research interests, this should be maintained in the future.
- The panel encourages the unit to use their capacities and possibilities of communication to disseminate research on alternative fuels.

Finnish Forest Research Institute, Metla

The plant biology researchers at the Finnish Forest Research Institute Metla, which constitutes 2% of the Metla organization, study the impacts of climate change as well as of biotic and abiotic stress on forest trees. They also study the relationship between forest tree species and symbiotic mycorrhizal fungi, especially during abiotic stress and embryogenesis.

Scientific quality of research

The research programmes of the unit are diverse in scientific questions addressed and species examined despite the relatively small size of the unit. The unit members span a wide range of disciplines, providing a solid platform for interdisciplinary research. The productivity is good, and the journals selected for publication are respectable. However, the science is rather descriptive and does not provide an integrated view of many issues addressed. Although the unit maintains an international research quality

and has established good local networks and international contacts, the unit has not succeeded in creating the level of international visibility required for providing a solid funding infrastructure, e.g. EU-funded networks.

Research environment and organization of research

A focused research strategy with specific objectives is missing.

Metla is organised into 20 disciplines and around 10 programmes spanning several of the disciplines and the unit participates in a number of these. The programs and therefore the unit use Metla's field experimental research stations at several locations in Finland and collaborate with universities in the vicinity of the research stations. The panel recognises the importance of the collaborations between unit members and different plant biology research groups at Finnish universities. However, there is concern that such activities dilute the interactions between the unit members, which may be one of the reasons why a common research strategy has not been formulated. A weak leadership at unit level may also contribute to a lack of critical group sizes and few common strategies. The long-term field experiments provide the unit with excellent means to run research projects aiming at understanding fundamental questions related to the research subjects. The unit has access to advanced walk-in growth chambers. Metla has a unique root laboratory facility allowing for short-term experiments on plant responses to environmental stresses. Laboratories are equipped for biochemical and molecular experiments. However, due to financial issues, Metla can no longer provide the unit with some of the necessary equipment and this has resulted in scientists having to find other international sites to perform some of their key experiments. The general budget cuts of Metla may also result in a reduction of support staff. The scientific research environment provides excellent opportunities for interactions with Metla researchers in other disciplines, such as forest genetics, forest breeding and forest biology, although it was not apparent how well this potential is utilized.

Research education

The number of PhD students in the unit is adequate considering that Metla is a research institute. The unit has the capacity to provide high quality research education with its interdisciplinary competence and relevant associations with Finnish universities and graduate schools.

Interaction between research and society

The research subject of the unit is highly relevant to end-users and society in general. The unit frequently delivers information to decision makers. Because the unit constitutes only 2% of Metla, and the unit did not make a clear presentation of their interactions with the geneticists and breeders, it is difficult to estimate how much of the research is disseminated to the end-users. The unit interacts with schools and participates in outreach activities including the Forestry days.

Recommendations

- The research and the international recognition of the unit would benefit from development of a more focused and coherent strategy with mutually agreed scientific objectives. The strategy should be based on the strengths of Metla.

- Leadership must be improved to produce a better integration of the research groups.
- Research objective-based interactions with international institutions should be increased. This would result in better international recognition.
- The unit would benefit from a focus on common systems and environmental parameters.
- The unit has the potential for expansion, as the research subject area is important for Finland.

MTT Agrifood Research Finland

The Plant Genomics group at MTT, which is the main agricultural institution in Finland, is located both at the Viikki campus in Helsinki and in the Jokioinen laboratory of MTT at 135 km from Viikki and headed by Prof Schulman. The group studies mechanisms of genome dynamics and identifies, via genetic and genomic technologies, genes that underlie important agricultural traits and create tools for plant breeders. The main emphasis of research of this moderately sized unit has been on the study of Retrotransposons (RTE's) in cereals.

Scientific quality of research

The Plant Genomics group is productive with a strong emphasis on barley and other cereals as well as on marker development in other crops.

Research environment and organization of research

The focus and expertise of the group on RTE's have resulted in them being embedded and linked to relevant international genome projects dealing with cereals, especially barley. In this field Dr Schulman is one of the leaders of European cereal genomics and is part of an impressive scientific network.

Innovative research directions have been often based on RTEs in the context of relevant biology in evolutionary ecology and stress biology.

The focus on cereal genomics involves state-of-the-art technologies, including next generation sequencing. The strategic choices are excellent and very visible. Suitable collaborations are set up where needed and are effective. The genomic infrastructure is well organized and synergy with other groups working on genomics is apparent.

Choices between applied aspects and basic research might sometimes be a problem, although Dr Schulman appears to deal with these choices very well.

Research education

The number of PhD students is relatively low, in contrast to the scientific productivity and in comparison with Finnish university groups. It is expected that the unit can provide good supervision of PhD students at both national and international level, even when the mission of MTT is application oriented.

Interaction between research and society

Many projects are relevant for modern plant breeding. Some more involvement in outreach activities could be useful. For example, the unit's research on genomic

plasticity could be explained to the general public as it can put the dynamics of natural genomes in the context of the discussion on GMO issues. MTT should recognize plant genomic expertise as a central subject for communication.

Recommendations

- The unit should maintain the present focus, which may need more bioinformatics and phenotyping support in the near future.
- The present funding structure issues may not allow the group to embark on large genome projects on their own and therefore their strategic planning should continue to focus on their specialties, e.g. abiotic stress and development of marker systems based on RTE.

VTT Technical Research Centre of Finland

The plant biotechnology group of VTT aims at developing technology, which applies knowledge of plant metabolism for the production of complex small molecules especially in plant cell cultures. Their emphasis is on alkaloids, terpenes and secondary metabolites (especially phenolic compounds) in berries.

Their expertise in plant cell fermentor technology and metabolism makes the unit an attractive partner for collaborations with industry and applied projects within EU programs.

Scientific quality of research

The unique expertise of the group together with their international connections has produced a good publication track record, which includes papers in high ranking journals. This is despite the fact that IP issues and confidentially in contract research may delay or even preclude publication of results.

Research environment and organization of research

The unit is well embedded in the infrastructure of VTT, which allows opportunities to perform specialized research in other VTT units. This infrastructure also strongly supports international collaborations as demonstrated by the involvement in several EU projects. The leadership of Dr Oksman has been important in this. The new head of the unit apparently provided an excellent continuity of the ongoing program, which requires setting up new projects after previous projects expire.

Research education

The number of PhD students in the unit is limited, partially because this is not always compatible with the mission (applied and confidential research) of the group. When PhD students are employed attention is given to ensuring that the data obtained by the student can be made public. However, more applied research might be attractive to some students as this might result in potential positions in industry on completion of studies.

Interaction between research and society

The involvement of the group in setting up a spin off company (Solucel) together with their collaborators from the VIB in Belgium shows successful dissemination of knowledge.

The patents obtained by the unit are another indicator that the unit pursues application of their technology. The relevance of their research on berry metabolites is important because of the economic and health aspects. In addition, the unit is active in European plant research politics (EPSO).

Recommendations

The excellent infrastructure together with the focused research topics have led to the strength of the unit. The panel sees no need to change this in the coming years and recommends to continue high level research utilizing appropriate funding opportunities.

4 Overall assessment of plant science in Finland

Status of research

The review panel observed an overall high standard of plant science research. There are a number of scientists that are internationally leading in their field. All units have steadily published their research findings in refereed international journals, all units were able to attract considerable external funding and have actively been training young researchers during the evaluation period 2005–2009. Individual scientists have the freedom to define their research projects, which is highly appreciated and leads to creativity necessary for high quality research. It was sensed that most units have a working atmosphere which fosters collegiality. Nevertheless a trend of declining citation impact was seen in the last few years, as indicated by the Academy of Finland. This fact raises the question how this declining trend can be reversed.

Even though Finland has internationally high quality research groups, it was observed that quality of research and research output is heterogenous across the different units. The strongest units are those from the University of Helsinki, the University of Turku, MTT, and VTT. The University of Oulu is relatively good but not as convincing as the units mentioned above, and a lower level of scientific strengths was observed for the units from the University of Eastern Finland and the Finnish Forest Research Institute Metla (details are provided in the reports on each unit). The University of Eastern Finland has a special situation as it has recently been formed by merging the University of Joensuu and the University of Kuopio, but the campuses of the two universities are geographically separated. Overall, it appears that there is a relationship between the critical mass of scientists and students and the quality of research. Exceptions are the VTT and MTT units, but they are embedded in large research institutions.

The research of the smaller units is often on the descriptive level rather than addressing functional analysis and causal relations. Consideration needs to be given to strengthening these small groups. The less effective units have to re-think their research strategies and the organization of their research. To achieve this goal it is advised to seek appropriate scientific interactions and to make larger units with common research objectives. Larger units offer the advantages that administrative burdens fall on a lower proportion of staff and that strategic plans can be developed and supported by a group of scientists which is an advantage in the decision making processes. Another issue is that some staff from less effective units will benefit from training in innovative, modern research areas, and therefore scientists should be given the opportunity and be encouraged to spend some time in a different, inspiring research environment to develop fresh ideas and new research approaches.

An attempt to form a larger, effective unit was the formation of the University of Eastern Finland. The panel noted tension and uncertainty among plant scientists from both Kuopio and Joensuu over future changes, like moving Kuopio scientists to Joensuu and over a possible loss of an experimental research garden at Kuopio. A lack of leadership in plant science at the University of Eastern Finland was identified as a

serious problem, as apparently nobody is taking the initiative to devise joint scientific strategies. A stronger interaction between the campuses will allow the development of common research resources. For example the expertise in biochemistry and proteomics at the Kuopio campus could be utilized by the ecologically oriented groups at Joensuu. As part of improving intercampus interaction shared planning needs to be implemented to identify opportunities for strengthening plant sciences in the future.

Finnish plant research includes areas of special interest to Finland, such as research on forestry, on effects of climate change, on biology of plants adapted to growth in Northern areas and climates, and on natural compounds from Finnish plant species. Research projects on these subjects are conducted in several units. Some of the research on large, complex and important issues for Finland seems to be isolated and often descriptive. There is a major interest in forest research, which has a large critical mass of scientists with excellent knowledge in several areas and with very good infrastructure in multiple locations. There are unique experimental sites due to specific geographical locations, and good links exist to the forest industry. However, overall the forestry research does not appear to be coherently organized to exploit its full potential. It is recommended that in particular the experimental stations should be optimized to maximize the scientific output. This implies that the leadership and management structures have to be discussed and reorganized to become a strong visible entity.

Global climate change is another general research topic which is studied by several units. To strengthen this research area more networking and higher level of interdisciplinary research are required. It is important to encourage and facilitate multi-level "systems" approach for forestry and climate change-related research. This should lead to a better understanding of the interaction and dependence of the biological system. Some broader and more in-depth approaches are in place in some institutions but there is unexploited potential to integrate excellent research in molecular biology, physiology and ecology. Incentives should be put in place for isolated groups to align themselves with the research activities of larger units. The unique experimental sites should be better utilized as resources for national and international collaborations.

Research in ecophysiology is present in a number of places and some of it is of good quality. The panel acknowledges that research is often being carried out on very difficult and poorly understood systems. However, in several cases this research area lacks international visibility due to the lack of a broad perspective and a long term vision. More consideration should be given to identifying the most important parameters that influence ecosystems in relation to climate change. Research in this area should be improved by integrating different approaches and by using advanced modeling to interrogate and extrapolate datasets derived from these approaches.

Recommendations

- Sufficient funding opportunities need to be available for basic research in plant science.
- Large viable research units should be created with common research goals.
- National efforts should be made to integrate research in e.g. ecophysiology, effects of climate changes and forest related research questions.

- Efforts should also be made to utilize the excellent skills present at some units in molecular biology in several of the above mentioned topics.

Research environment and infrastructures

Although heterogenous, the research environment of all units allows a good research performance. Overall, the quality of the infrastructure in terms of experimental equipment, plant growth facilities and experimental field stations is very good and in several cases excellent. Large differences were evident between the units. The Academy of Finland provides routes for funding large pieces of equipment, but apparently not the human and informatic resources required to support the equipment and to utilize the potential of the equipment in an optimal way to exploit emerging data. The panel recommends that experimental field stations should be organized to allow optimal scientific and economical use. Both sophisticated experimental equipment and field stations require welltrained technical staff to allow appropriate applications, to ensure continuity of function and to prevent loss of technical expertise. Some units were concerned that technical knowledge of the use of large instruments is often disappearing and requires re-training of personnel. Responsibility for such equipment is frequently left to post-docs or Ph.D. students who have a restricted contract and can only dedicate a small proportion of their time to this task. This is not an efficient use of facilities. Institutions, together with funding bodies, need to be aware that long term expert support staff is required for the efficient running and maintenance of large equipment and experimental stations. Institutions and researchers have to formulate plans to reallocate personnel to optimize the future infrastructure use. The panel recommends that discussions need to be held to consider how to improve the possibilities to effectively share facilities between research institutes and universities in order to optimize their use. Collaboration needs to be improved for the use of large experimental facilities to avoid duplications and to ensure access to all units who need to use this equipment on a service basis (i.e. services have to be paid by the users). Except for some local collaboration, the panel did not observe any major collaborations in relation to use of large, expensive infrastructure facilities. It is necessary to strengthen collaborations on infrastructures within the Finnish research community to produce a more cost-effective research system. Long-term plans need to be developed to provide for optimal usage of the available infrastructure and to identify plans for future needs in order to maintain the high quality infrastructure.

Modern plant science requires not only sophisticated instrumentation, but also adequate data analysis using bioinformatics and modelling approaches. In several units serious deficiencies were observed in bioinformatics infrastructure and advanced modeling approaches. A lack of such infrastructure is likely to prevent optimal development of systems and genomics-based approaches in Finnish plant research. Funding bodies need to consider modification of their funding programmes so that the necessary bioinformatics infrastructure can be implemented. This will require funding to recruit specifically trained personnel and training courses for existing staff and for PhD students.

Recommendations

- A long-term strategy should be developed for optimal use and further improvement and maintenance of infrastructure.
- Collaboration on large equipment needs to be better organized to ensure more effective usage, maintenance and acquisition of new technological developments in the future.
- Use of international facilities for fast developing technologies, such a sequencing, is also encouraged.
- Infrastructure and training for bioinformatics and modeling need to be considerably strengthened.

Recruitment and funding

Several of the units appear to have recruited temporary as well as permanent staff from their own training schools or undergraduates. This could be due to a deliberate policy of a unit or because suitable applicants from elsewhere cannot be attracted. The in-house recruitment has been successful in some cases, as high quality researchers were hired due to the very good research standards in the unit. The panel is concerned about such in-house recruitment because this could potentially lead to a lack of innovation and creativity. In-house recruitment may limit the future development of units and makes Finnish plant science less competitive on the international level.

In some units efforts have been made to establish the internationally well accepted tenure-track system for hiring staff at the professor level. However, this has not been consistently implemented. The panel considers the tenure-track system as an appropriate appointment procedure. Guidelines at national science policy level exist since a four-stage research career model has been drafted by the Ministry of Education and Culture. The future challenges are to implement tenure-track system at unit level and to secure funding for it. The Academy of Finland, other research funding agencies and research institutions, together with the Ministry of Education and Culture, should define strategic measures for both implementation and funding of the tenure-track system in order to promote the transparency and predictability of a research career.

All units are very active in recruiting Ph.D. students but there seems to be a general lack of postdoctoral fellows. The panel recommends that funding strategies have to be modified, so that post-docs can be recruited on a competitive basis and that Ph.D. students as well as young scientists from abroad will be able to pursue a scientific career in Finland.

The strong units are well adapted to the Finnish funding system. To increase funding opportunities for high impact research, the panel suggests a discussion between scientists and the Academy of Finland to decide whether a one-grant-per-researcher rule is the most appropriate way to ensure the highest quality research and to encourage networking and strategic planning. Other funding models, which limit the number of applications per unit, but allow multi-group and multi-institution grants, may foster coherent research strategies and collaborations between research groups, which currently submit individual applications on closely related topics and

compete in the current funding system. This funding policy should reduce the level of competition between research groups that should be collaborating, and would potentially allow successful groups to hold more than one grant. Consideration should be given to strategic targeting of funding to the best groups, or to alliances of groups with strong, common objectives. This will require good cooperation between research units and funding agencies, such as Academy of Finland and Tekes.

Recommendations

- International and nation-wide recruitments are encouraged at all levels, postgraduate students, postdoctoral researchers and faculty staff.
- Tenure-track system should be implemented at university level.
- A competitive postdoc recruitment system should be put in place. Special funds for Finnish postdocs to return to Finland from abroad should be available to support mobility and innovative research.
- New funding models should be considered, to promote strategic planning and collaboration and to promote the highest quality research.

Summary

Generally, the review panel was impressed with the quality of the Plant Sciences research and education. The research achievements and the quality of the publications have contributed to very good scientific reputations of the researchers. This quality and expertise is important in developing an attractive educational platform, which trains high quality, competitive plant scientists who will be able to lead plant science research in the future. It has to be emphasized that it is essential to further strengthen basic research to keep a leading role and to stay competitive. Quality and visibility of research can be increased by stronger collaboration and networking on priority-defined research projects and on exploitation of infrastructure. Funding agencies need to continue to fund basic research at a high level. This has to be on a competitive basis with well-defined priorities.

5 Doctoral training

General observations

The review panel had the opportunity to discuss doctoral training with representative PhD students from the Universities of Eastern Finland, Helsinki, Oulu and Turku. The students who talked with the evaluation panel were selected by the students themselves.

All plant science units are able to attract students, but in different ways. Several units, in particular Universities of Helsinki and Turku, recruited PhD students also from abroad, others mainly from Finland. Some institutions have a high level of recruitment from their own undergraduate population. PhD students are responsible for a large proportion of the research carried out in the units. The students appeared to be content and felt well integrated in the respective research teams. All students identified themselves with their universities and convinced the review panel by their good standard of knowledge and training. In particular, the students from Turku University showed strong enthusiasm for their research and impressed the committee with their dedication to research.

Overall, the students seemed to be satisfied with the contents of the courses they were taught. Most, if not all students, are given the possibility to attend national and international conferences. In general, the students appeared to be more mature compared to average European or American PhD students.

Organization of education

The period for completion of PhD studies is too long (5–9 years) and far above the average time taken in Europe, although the length varies greatly between units and research groups. Consequently, the average age of graduating PhD-students is relatively high (the average age at the Plant Science units varies between 30 and 39 years), making their situation quite different compared to other newly graduated PhD students in Europe. The major reasons for the long study time appear to be historical, with a traditional requirement for a large number of published papers and first authorships, making the research-grant funded period (generally four years) too short to meet these far too ambitious goals. In some cases, limited supervision also appears to play a role in the long completion period. The fact that the funding periods of research-projects does not match the time needed for the completion of the PhD studies forces many students into teaching, to periods of work outside of the university, and to making personal grant applications.

Most units appear to have a functional program ensuring that students produce research and study plans and that progress assessments are performed at strategic intervals. These include appropriate follow-up mechanisms that ensure students have up-to-date study and research plans in place. Recently, several units with very pro-active follow-up systems appear to have been able to reduce the length of PhD studies to a period that is commensurate with the funding period of the studentship.

A core doctoral programme (former graduate school) system has been established with sound and diverse curricula, including courses in transferable skills. Two national doctoral programmes, the Finnish Graduate School in Plant Biology and the Finnish Graduate School in Forest Science appear to be available to all plant science units. These programmes are important in forming a platform bridging the plant science units at the distantly located Finnish universities. In addition, a large number of more local graduate schools are available, especially at the larger universities, giving the students ample possibilities to find courses/training in subject areas of importance for their specific PhD projects. However, units at smaller universities generally do not have the same access to graduate school activities. The Doctoral programmes and graduate schools are important for several reasons, including the increased awareness of organized supervision, follow-up systems, and national collaborations. A potential weakness is the rather large number of graduate schools providing education for PhD students in plant science. The implementation of national graduate school systems focused on specific topics, such as Plant Biology and Forest Science, should be further encouraged and made easily accessible to all units.

Mobility

The majority of the PhD students continued their studies at the same university where they obtained their Master's degree, revealing that the mobility within Finland is fairly limited. The reasons for this could be institutional, as many units may try to keep students whom they taught as Master students, or personal, as many students have a family. Most students recruited from basic education at other universities are international students. In contrast, suitable mechanisms to promote short-term mobility during PhD studies are in place at most of the units, and the doctoral programmes play an important role in promoting the mobility within Finland.

Future prospects and careers

It appears that national post-doc programs are underdeveloped in the Finnish funding system.

The requirement for a large number of published papers in PhD thesis may in some case disadvantage PhD students seeking to do postdoctoral research outside Finland, because high-quality publications are generally more important than the quantity of publications in the international recruitment market for post-docs. Furthermore, because newly graduated PhD-students are relatively old and many have established a family, they often consider it socially and economically impossible to apply for international post-doc positions.

As a consequence, the investments made in PhD-education are not fully utilized in an economically sustainable development of competitive Finnish Plant Science.

Recommendations

- Reduce the length of PhD studies to match the research-grant funding period by adjusting to reasonable output expectations. The demand for published papers and unpublished manuscript should be harmonized with the length of the funding period in Finnish doctoral programmes.
- These publication demands should also be adjusted so that the PhD education system favours high scientific quality.
- Improve the quality of PhD training by implementing programs for improved supervision and follow-ups where such measures have not already been taken.
- Before entering a PhD-study program, a student should have secured funding for the whole study period.
- The university teaching budget should cover payments for the teaching performed by the PhD students.
- The teaching undertaken by PhD-students should not be compulsory. Students should have the right to decline offers to teach.
- All PhD students should be either full or associate members of a graduate school.
- Continuous support should be given to topic-based national doctoral programmes in order to encourage national collaborations.
- The plant science community should aim to build a national information system of the PhD courses offered; the use of the web would be ideal for this.
- The plant science community should create incentives to encourage more mobility of students between institutions.
- Graduate schools should also be used to encourage and support international visits.
- Funding for post-doc positions should be increased to improve career prospects after completion of PhD studies. Ideally some post-doc fellowships should be earmarked for positions outside of Finland.
- Family situation should be considered in the level of post-doc funding when going abroad.
- Competitive measures to facilitate return of post-docs to Finland should be considered.

Appendix 1. Panelist CV

(approved by panelists with exception of DB)

Dorothea Bartels

Dorothea Bartels is a C4 professor of Institute of Molecular Physiology and Biotechnology of Plants and the Vice Dean of the Faculty of Science at University of Bonn. She received her Ph.D. from the Institute of Botany, University of Hannover in 1979. She was nominated as a senior research scientist at the Max-Planck-Institut für Züchtungsforschung in 1986 to investigate at molecular level the problem of desiccation in plant. Dorothea Bartels started research on molecular mechanism of drought stress and cold stress in barley and model plants after habilitation to University of Hannover. She was appointed as Professor of Botany (C3) in 1997, Professor of Botany (C4) in 2003 at the University of Bonn. She became Vice Dean of the Faculty of Science at the same university in 2005. In 2001, she received a professorship in Ecology and Physiology of Plants at Vrije Universiteit Amsterdam, was appointed an EMBO member and gave the Theodor Bücher Lecture at the FEBS meeting in Lisbon.

Over the last 15 years Professor Bartels has made significant contributions by studying regulatory pathways controlling dehydration in the resurrection plant *Craterostigma*, she has discovered several regulatory molecules involved in osmotic stress and she was among the first to demonstrate a role for PLD in osmotic stress signaling.

Professor Bartels has since 2004 served as Editor in Chief of *Planta*.

Neil Baker

Neil Baker is a Professor of Biology at the University of Essex. He received his PhD in 1974 from University of Liverpool. His PhD studies focused on biochemical and physiological aspects of the development of chloroplasts in cocoa leaves. He was a Harkness Fellow at the University of California, San Diego (1974–1976) whereafter he joined the University of Essex as Lecturer in Biology and was promoted to Professor of Biology in 1987. Professor Baker was a Fullbright Fellow in University of California Los Angeles (1981–1982) and a visiting Professor at Université Paris-Sud (1993). He is currently Director of Graduate Research and the Head of Plant Productivity and Sustainable Agriculture Research Group in the Department of Biological Sciences at the University of Essex.

Professor Baker's main research interests are factors determining the efficiency of light utilisation in photosynthesis and the effects of environmental stress on photosynthesis. He is also interested in applications of chlorophyll fluorescence spectroscopy and imaging to study photosynthesis, and herbicide penetration and action in plants. He has published over 150 peer reviewed papers.

Professor Baker is an Associate Editor of Photosynthesis Research (since 2005) and Plant, Cell and Environment (since 2001). He is also a Monitoring Editor of Plant Physiology (since 1998) and member of the Editorial Advisory Board of the Journal of Experimental Botany (since 1993).

Thomas Boller

Thomas Boller is the Department Head of Department of Environmental Sciences at University of Basel, Switzerland. His thesis, 1977, described for the first time a vacuolar transport system, the arginine permease of the yeast vacuole, and was awarded Medal of Excellence by Swiss Federal Institute of Technology, ETH Zürich. Working at Michigan State University on plant vacuoles, he provided evidence that this organelle is equivalent to of the animal lysosome. Then Thomas Boller became interested in ethylene biosynthesis and discovered the key enzyme, ACC synthase, and cloned the ACC oxidase.

Thomas Boller returned to Switzerland in 1979 to join Botanical Institute of the University of Basel and became interested in chitinase and beta-1,3-glucanase as important defensive enzymes of the plant, acting in combination to destroy attacking fungi. Boller became professor in 1986 at University of Basel. From 1987–2003 Boller was a part time group-leader in Friedrich Miescher Institute where research interest focused on chemical sense of plants and particularly in the perception and transduction of elicitor signals in plants. The work on innate immunity is continuing at the Botanical institute as is work on carbohydrate metabolism, sugar sensing and synthesis and function of trehalose in plants.

Professor Boller's research interests range from ethylene biosynthesis, plant-microbe interactions to innate immunity in plants. He is currently heading a team interested in the physiology and diversity of ectomycorrhizal fungi and their impact for forest biodiversity.

Maarten Koornneef

Maarten Koornneef works as Director at the Max Planck Institute for Plant Breeding Research and has a part-time professorship of Plant Genetics at Wageningen University, the Netherlands. He graduated as PhD from the Wageningen Agricultural University in 1982 and has been working at the Laboratory of Genetics at Wageningen University, as assistant professor from 1976–1987 and associate professor from 1987–1992. From 1992 he held a Personal chair in plant genetics at this Laboratory. In 2004 he was nominated Head of the Department of Plant Breeding and Genetics at Max Planck Institute for Plant Breeding, and in 2008 as Honorary Professor at the Institute for Botany, University of Cologne.

Professor Koornneef has served as a Member of advisory and editorial boards of various journals in the field of plant science and was elected member of the Netherlands, European and USA Academies of Science.

Professor Koornneef' s research interests are physiological and molecular genetics of Arabidopsis with emphasis on the genetics of plant adaptation traits using natural variation.

Julio Salinas

Julio Salinas is professor at the Plant Molecular Biology Laboratory and the Head for the Depart of Environmental Biology of the Centro de Investigaciones Biológicas-CSIC (CIB, CSIC) in Madrid. He received his Ph.D in 1983 from The Complutense University, Madrid and worked as postdoctoral researcher at Institut Jacques Monod, France, years 1983–1986. After returning to Spain, he was Scientist in 1986–2006 at INIA – Instituto Nacional de Tecnologia Agraria y Alimentaria. Dr Salinas was Visiting Scientist at The Rockefeller University, USA during years 1989–1991, and has been serving as Research Professor since 2006 at CIB, CSIC, Madrid.

Professor Salinas is serving as Member of Molecular and Cellular Biology Commission at the National Evaluation Agency of Spain (ANEP) and as Spanish expert to FP7 People Programme Committee. He has a long history in refereeing scientific journals and evaluation grants nationally and internationally.

Professor Salinas has more than 20 years of experience in studying the molecular mechanisms that control plant response to abiotic stresses, mainly to low temperature. His research interests are molecular biology of plant responses to abiotic stress, biotechnology of abiotic stresses and using plants as biofactories.

Alison M. Smith

Alison Smith is Head of Department of Metabolic Biology and a Project leader at John Innes Centre. Smith received her Ph.D. in Plant Sciences from the University of Cambridge in 1978. She was a post-doctoral researcher at the Universities of Dusseldorf, Leeds and East Anglia (UK), until 1982. She joined the staff of the John Innes Centre in 1982. She has an honorary Chair in the School of Biological Sciences, University of East Anglia.

Professor Smith is a Handling Editor for The Plant Journal and member of the editorial board for Plant, Cell and Environment, Encyclopedia of Life Sciences (Plants) and Current Opinion in Plant Biology.

Her research interest is primary metabolism in plants, particularly the metabolism of sucrose and starch. Specific areas of research are starch metabolism in leaves, starch synthesis and degradation in storage organs and sucrose metabolism in non-photosynthetic cells.

Eva Sundberg

Eva Sundberg is professor in Plant Physiology at SLU, Swedish University of Agricultural Sciences. She received her PhD in Plant Breeding at SLU in 1991, worked as a Post-doc in Molecular Biology at John Innes Centre, UK during years 1992–1993. She worked as Assistant Professor and as Associate Professor in Plant Physiology at Uppsala University during years 1993–1998 and 1998–2002, respectively. In 2003, she was nominated as Professor in Plant Physiology at SLU where she currently is Head of Department (since 2007).

Eva Sundberg has served as Vice member for FORMAS board (2007–2009) and is currently a Member of Beijer lab board (since 2007). She is reviewer for a number of main scientific journals in the field of Plant science and of national as well as international grant proposals.

Professor Sundberg's group is studying organ development in Arabidopsis and moss. Her specific research interest is the role of local auxin biosynthesis in organ development (fruits, leaves, archegonia, antheridia, rhizoids) in the flowering plant model species Arabidopsis thaliana and in the moss Physcomitrella patens.

Appendix 2.
Plant science[1] in Finland 2005–2009

D1. Terms of reference for the evaluation panel

1 Background and purpose

The Research Council for Biosciences and Environment decided on 9 June 2009 that Finnish Plant Science will be evaluated with respect to the international level. The evaluation combines an external assessment by an international evaluation panel with an internal self-assessment exercise.

This document sets out the standard Terms of Reference applicable to the panel. The content of this document is relevant to the panel members as well as to the units being assessed. The document should be read in conjunction with the Guidance for Units, which will be used by the units being assessed when preparing their evaluation documents. The term 'unit' here refers to the department or institute involved in the evaluation.

2 Definition of the field to be evaluated

The evaluation covers all basic research in the field of plant biology, plant molecular biology, plant physiology and plant technology on the molecular, cellular or individual level. Applied research is included in the evaluation insofar as it involves clear basic research aims. Plant research that is clearly focused on population biology, population genetics, evolution research or systematics does not come under this evaluation but will be assessed in connection with an upcoming evaluation of ecology and evolution biology. Neither does the evaluation cover any agricultural and forestry research that is purely applied in nature.

3 Organisation

The Research Council for Biosciences and Environment of the Academy of Finland approved the general agenda for the evaluation of the research field in January 2010. The Council also appointed a Steering Group to lead and support the execution of the evaluation.

The members of the Steering Group are:
Professor *Mari Walls*, Academy of Finland, Research Council for Biosciences and Environment, Chair
Professor *Marina Heinonen*, Academy of Finland, Research Council for Biosciences and Environment
Councellor *Annu Jylhä-Pyykönen*, Ministry of Education
Professor *Kai Lindström,* Academy of Finland, Research Council for Biosciences and Environment
Councellor *Elina Nikkola*, Ministry of Agriculture and Forestry

[1] See definition

4 International evaluation panel

An international group of independent high-level experts will carry out the evaluation. All departments, independent research institutes and research stations will be evaluated by the evaluation panel.

The Academy of Finland has invited six renowned scientists as evaluators:
Professor *Dorothea Bartels*, University of Bonn, Germany, Chair of the Panel
Professor *Neil Baker*, University of Essex, UK
Professor *Thomas Boller*, University of Basel, Switzerland
Professor *Maarten Koornneef*, Max Planck Institute for Plant Breeding, Germany
Professor *Alison Smith*, John Innes Centre, UK
Professor *Eva Sundberg*, Swedish University of Agricultural Sciences, Sweden

5 Objectives of the evaluation

The purpose of this exercise is to evaluate Finnish Plant Science and research education. The evaluation covers the period 2005–2009, on which the recommendations to be provided for the future will be based.

The objectives of the evaluation are:
- To form a general picture of the focus, *scientific quality and strategies* of Finnish Plant Science and research education
- To assess the organisation, *strengths and weaknesses* of the research field and research units
- To make *suggestions and recommendations* concerning the needs for development, focus and emphasis of the units and whole research field

The basic unit to be assessed by the panel is a department of a university or an independent research institute or relevant part of it.

6 Evaluation criteria and recommendations

The evaluation panel is asked to give:
- a written statement on the quality of the research, strategies, achieved results, scientific contribution and doctoral training
- a written statement on the quality and efficiency of the research environment and organisation
- a written statement on the research system as a whole, focus, synergies, cooperation
- written feedback on the interaction between research and society, and its impact.

The main emphasis is on the scientific evaluation. The panel should ensure that the evaluation takes into account all relevant material available.

The panel is also asked to give recommendations for the future of the field (Section 6.5).

6.1 Scientific quality of the research

The panel's main task is to evaluate the quality of Finnish Plant Science internationally. The quality statement is based on evaluation *documents* submitted by the units. Panel members will have the opportunity to complete this information during *presentations* and *interviews* in Finland.

The quality statement must reflect the work of all the research staff listed in a unit.

Important issues to be considered:

- How do the *quality* and productivity of Finnish Plant Science and research education compare with international standards?
- Does Plant Science in Finland today focus upon *innovative*, challenging and successful research lines, themes and problems (strategy)?
- Which fields of research are strong and which are weak?
- What are the differences between strong and weak fields?
- Strengths and weaknesses, needs for improvement?

6.2 Research environment and organisation in its immediate vicinity

The evaluation deals with the prevailing research practices, research environments and collaborative networks. Does the research environment and organisation promote the quality of research and research education?

Important issues to be considered:

- How innovative and successful are the research *strategies* of the units?
- Balance between research and other duties?
- Relationship between senior and junior researchers?
- Role of national and international *networks* (universities, research centres, enterprises)?
- What is the role of *interdisciplinarity* in the units, and within the whole field? Do the units have relevant research infrastructures?
- Strengths and weaknesses, needs for improvement?

6.3 Research system

On the basis of the assessment of the units, the panel may also evaluate how appropriate the prevailing research system is.

- Does the research system focus upon innovative and successful research lines?
- Does the panel see any synergy benefits in the Finnish Plant research system?
- What kind of action and cooperation could promote them? (e.g. common strategies, cooperation, new division of labour, researcher mobility, better use of infrastructure, critical mass)
- Strengths, weaknesses, needs for improvement?

6.4 Interaction between research and society

The evaluation panel is asked to give feedback on the interaction between research and society and the impacts of research on society (e.g. environmental, technological, economic). The feedback is to be based on the evaluation documents as well as interviews and discussions. The panel should especially consider other activities such as expert tasks, popularised works, patenting, technology transfer and cooperation with other sectors of society.

The panel should pay special attention to the societal contribution of each unit, and to the relevance of its research on a national and international level. The questions to be asked are

- How actively and efficiently does the unit communicate its points and findings to various stakeholders and to society at large?
- How fruitful is the cooperation between the unit and the communities that ultimately apply the results of the research?
- How can the societal impact of Finnish Plant Science be improved?

6.5 The panel's recommendations for the future

The panel is asked to provide recommendations for the future development of the research field. Recommendations should focus both on the units and the research field as a whole.

Key issues to be addressed are:

- What kinds of means does the panel recommend in order to improve and strengthen research performance at various levels?
- What opportunities do the units and the research field as a whole have and what challenges do they face?
- How can the units and the research field meet these challenges and utilise the opportunities?
- How can the quality and societal impacts of research be improved?
- Better use for infrastructures, needs for new infrastructures?
- What kind of research funding programme could best promote the quality of Plant Science in Finland?

7 Tasks, responsibilities and working arrangements of the panel

Panel members will set responsibilities within the group together with the Expert Secretary. The Evaluation Office will provide all evaluation documents and background information dealing with the Finnish research system. The evaluation material consists of evaluation documents, the units' presentations, interviews and discussions.

For full description of the evaluation documents please see the submission form and related instructions, which will be used by the units assessed in preparing their evaluation documents together with these Terms of Reference.

7.1 Desk research

Desk research will be carried out before the panel's visit to Finland. The material includes

- facts on research staff and funding
- list of publications
- lists of key publications of senior staff
- collection of key publications
- list of doctoral theses
- lists of visits and collaborations
- self-assessment exercise of the unit

The Steering Group suggests that panel members perform a preliminary assessment of each research unit prior to any discussions with research staff. The evaluation panel may supplement their views during the visit to Finland.

7.2 Presentations and discussions

Each research unit is given an opportunity to give a presentation dealing with the focal points of the unit's research.

A sample of researchers will be interviewed during the site visit, e.g. heads of units (research), senior staff, professors, postdoctoral researchers, and visiting foreign scholars. The evaluation panel will also discuss research education with graduate students.

The specific timetable and instructions will be provided by the Evaluation Office.

7.3 Confidentiality

Panel members undertake not to make use of and not to divulge to third parties any non-public facts, information, knowledge, documents or other matters communicated to them or brought to their attention in the performance of the evaluation. The evaluation and the ratings are only for official use and they are confidential until the final summary evaluation report is published.

7.4 Evaluation report and publicity

The evaluation report including the main recommendations is based on the evaluation criteria defined by the Steering Group of the evaluation. The report will be written and edited by the panel members with the assistance of the Expert Secretary. The evaluation report is confidential and only for official use until publication.

Prior to final editing and publishing, the units of assessment are given an opportunity to review the report to correct any factual errors. The evaluation report will be published in the Academy of Finland Publications Series in both printed and electronic form (www.aka.fi/publications).

7.5 Impartiality

Evaluation is subject to the impartiality rules common to the field of evaluation. A panel member will be disqualified if his/her impartiality is endangered or if he/she feels that he/she has a conflict of interest with a research group included in the evaluation.

If you find that you may be unable to evaluate a research group, please notify the Academy and the other panel members of this as soon as possible. Clarification of potential conflicts of interest must preferably be carried out during the first panel meeting.

8 Schedule

Dec	2009	Communication to the field
Jan	2010	Appointment of Steering Group
Jan	2010	Appointment of evaluation panel
Mar	2010	The launch seminar
Apr-Aug	2010	Preparation and delivery of evaluation documents
Feb	2011	Interviews and discussions with units to be assessed
Feb-Apr	2011	Preparation of report
Sep	2011	Publishing and releasing the report
	2011	Dissemination of information on results
	2012	Follow-up of implementation of recommendations made

9 Coordination of Evaluation

The evaluation team working mainly at the Academy of Finland coordinates the evaluation process. Director Laura Raaska, Senior Adviser Timo Kolu and Project Secretary form the evaluation team together with the Expert Secretary Reetta Kettunen. The Expert Secretary will assist the panel on site visits and in preparing and editing the evaluation report. The duties of the evaluation team are to compile the evaluation documents, organise the site visits in practice and provide administrative support.

10 Funds

The evaluation is funded by the Academy of Finland. The Academy of Finland will pay an expert fee to the panel members. All travel expenses related to the panel's visits and accommodation in Finland will be covered or reimbursed by the Academy of Finland.

Appendix 3.
Submission forms and guidance (D2, D3)

D2 – Submission Form (Please read instructions carefully)

Plant science[1] in Finland 2005–2009

General information

Organisation	
Faculty or equivalent	
Department or equivalent	
Address	
Phone	
Website	http://
Head of Department	
Phone	
Email	
Contact person for evaluation	
Phone	
Email	

Percentage of Plant Science in your department's research
(in proportion to staff or funding):

%

Please give the information requested below only in relation to the Plant Science part of your research.

The submission form shall be submitted by 28 May 2010 in four (4) paper copies and one copy in electronic format (PDF). Please send all appendix files (Excel) to the following address:

Email: kasvi@aka.fi

Timo Kolu
Academy of Finland, POB 99
00501 Helsinki

More information:

Senior Adviser Timo Kolu
Email: Timo.Kolu@aka.fi
Tel. 09-774 88 341 or 040-719 6834

Director Laura Raaska
Email: Laura.Raaska@aka.fi
Tel. 09-774 88 336

[1] This evaluation covers all basic research in the field of plant biology, plant molecular biology, plant physiology and plant technology on the molecular, cellular or individual level. See Terms of Reference for the Evaluation Panel.

PART 1. RESOURCES AND RESEARCH OUTPUT WITH REGARD TO PLANT SCIENCE

1 Staff

1.1 Staff in 2005–2009 (**Appendix 1.1**)

1.2 Research active staff in 2005–2009 (**Appendix 1.2**)

2 Funding

2.1 Unit's core and external research funding in 2005–2009 (**Appendix 2.1**)

3 Unit's research profile and scientific output

3.1 Unit's research profile in the context of the evaluation (in relation to staff and funding)

Research field	(%) staff	(%) funding
Photosynthesis		
Eco physiology		
Hormones		
Stress and adaptation		
Plant interactions		
Developmental biology		
Biotechnology		
Other (please specify):		
Total	100%	100%

Comments:

3.2 Description of the unit's research profile (max. 3 pages). Describe the unit's research orientation, strategy and main results during the period under evaluation (see Guidance).

3.3 List of publications and other output in 2005–2009 (**Appendix 3.3**)

3.4 Number of scientific publications and other outputs in 2005–2009 (**Appendix 3.4**)

3.5 Lists of senior researchers' key publications (See 1.2) (**Appendix 3.5**)

3.6 List and copies of the unit's key publications in 2005–2009 (**Appendix 3.6**) (Append copies of publications, maximum *number of publications = number of senior researchers* but a minimum of *five* publications)

3.7 Describe the unit's practices on i) open access to scientific publications; and ii) promoting the reuse of research data. Does the Unit have a data policy on open access to and reuse of research data? (max. 1 page).

4 Researcher training

4.1 Doctoral thesis supervision in 2005–2009

Name (family name, given name	Year of birth	Gender (f/m)	Topic of dissertation	Supervisor (family name, given name)

4.2a Completed doctoral degrees in 2005–2009 (in order of completion, per year)

Name (family name, given name	Year of birth	Gender (f/m)	Year of degree	Organisation

4.2b Completed postdoc periods in 2005–2009 (minimum 1 year)

Name (family name, given name	Year of birth	Gender (f/m)	Home organisation	Duration (months)

4.3 Organisation of doctoral training. The role of graduate schools and other research training and supervision. Describe aims, practices and arrangements of doctoral training at the unit (max. 2 pages).

4.4a Present employment of PhDs who graduated in 2005–2009

Name	Year of dissertation	Present employment (job description, organisation)

4.4b Present employment of postdocs.[2]

Name	Present employment (job description, organisation)

5 Unit's collaboration contacts

5.1 Visits abroad during 2005–2009 (minimum duration of visit: two weeks)

Name	Target organisation	Country	Topic of the visit	Duration (months)

5.2 Visits to the unit in 2005–2009 (minimum duration of visit: two weeks)

Name	Home organisation	Country	Topic of the visit	Duration (months)

5.3 Short but particularly important visits 2005–2009

Name	Home organisation	Country	Topic of the visit

5.4 Most important collaborators in Finland and abroad 2005–2009

Name	Organisation	Country

[2] Having post doc period between 2005–2009

5.5 Describe the most important outcomes of the visits and collaboration contacts (max. 1 page)

6 Other scientific and societal activities

6.1 Invited presentations at international scientific conferences in 2005–2009

Name	Topic of presentation	Name and time of the conference

6.2 Memberships on editorial boards of international scientific journals in 2005–2009

Name	Journal	Task	Period

6.3 Prizes awarded to researchers, honours and scientific positions of trust in 2005–2009

Name	Prize, position etc.

6.4 Other significant tasks of no primarily academic nature 2005–2009

Name	Task	Period

PART 2. UNIT'S SELF-ASSESSMENT

7 Unit's self-assessment

7.1 The unit's research strategy for 2010–2015 (priority areas in research, development measures; max 1 page).

7.2 Will there be organisational changes (the new Universities Act, organisational changes) in 2010 that have an impact on your research? Describe the changes and their potential impact (max. 1 page).

7.3 SWOT – Evaluation of the unit's present scientific strengths and weaknesses, and future external opportunities and threats (in relation to the evaluation criteria: quality, research environment, plant science, societal impacts; max. 2 pages).

7.4 Infrastructures (including research stations; max. 2 pages).

Describe a) any infrastructures that the unit possesses that are unique or of major importance; and b) other infrastructures important for the unit's research. Give a brief analysis of the access policy to existing infrastructures and a foresight of the need for new infrastructures.

7.5a The societal impact of the unit's activities. Describe an example of a situation where you have successfully promoted the societal effectiveness of your unit's research (max. 1 page).

7.5b Contact information and impacts of the most important users/collaborators in relation to societal needs?

7.6 Assess the academic and societal need for doctoral training within the unit's research fields. Describe the unit's role in doctoral and postdoctoral training (max. 1 page).

7.7 The role of the Academy of Finland and other funding bodies in promoting the scientific and societal impact of research (max. 2 pages).

D3- Guidance for units on completing the submission form
(please read carefully)

All the data deals with Ecology and evolution biology[1]. The evaluation covers the period from the beginning of 2006 through to the end of 2010. All data and information deals with this period unless otherwise stated in the submission form or these instructions.

General information

Percentage of Ecology and evolution biology in your department (or equivalent). Ecology and evolution biology calculated as a percentage of research funding or staff in 2010.

1 Staff

1.1 Number of staff

Indicate information on the *staff* in full time equivalents (FTE). *Full time equivalent* refers to annual full-time work including paid holidays and other statutory days off. Other holidays, leaves of absence or similar shall be deducted from the calculated working time.

One person-workday is 8 hours 15 minutes and one person workweek 41 hours 15 minutes effective working time (lunch hours included, 1 hour/day). If the person's working time is less than the norms of normal office hours, the amount of person-work is calculated using the working-time norm as divider.

If the person has duties other than research, only the working time used for research work is to be included.

Research active staff includes persons who plan, produce and publish new knowledge, theories and methods, and products and processes based on them, and lead research projects.

Persons under the following titles shall always be listed under **research active staff**:

- Academy Professor (in Finnish: akatemiaprofessori)
- Academy Research Fellow (akatemiatutkija)
- Assistant (assistentti);
- Chief Research Scientist (johtava tutkija;)
- Clinical Teacher (kliininen opettaja, apulaisopettaja;)
- Doctoral Assistant (tohtoriassistentti)
- Group Leader (ryhmänjohtaja)
- Head of Research (tutkimuspäällikkö)
- Laboratory Director (laboratorionjohtaja)
- Postdoctoral Research Fellow (tutkijatohtori)
- Professor (professori)

[1] See Terms of Reference

- Research Professor (tutkimusprofessori)
- Research Director (tutkimusjohtaja)
- Research Lecturer (tutkijalehtori)
- Senior Curators (yli-intendentti)
- Senior Researcher (vanhempi tutkija)
- Specialist Researcher (erikoistutkija)
- University Lecturer (yliopistonlehtori)

Staff categories

1 Professor

Professors at university or research professors at research institutes.

2 Other Senior researcher

A senior researcher is a person who plans and leads research projects. A senior researcher at a university is e.g. a professor or adjunct professor (dosentti) who supervises doctoral dissertations. Below senior researcher refers to a professor or other senior researcher.

3 Postdoctoral researchers;

A postdoctoral researcher is a person who has earned his/her doctoral degree no more than five years ago and does not yet have the competence required for a senior researcher.

4 Doctoral students (category: Doctoral students) belonging to either of the following groups:

- Persons with at least an MA or MSc (or equivalent) degree who have been employed by the university as full-time researchers or assistant researchers to do doctoral studies for a period of no less than six months.
- Persons with at least an MA or MSc (or equivalent) degree who, for a period of no less than six months, have fulfilled the following two criteria: they a) have been affiliated with the unit as full-time researchers or assistant researchers to do doctoral studies and b) have been receiving research funding from some other source than another university or research institute.

These groups include e.g. doctoral students employed by graduate schools.

Doctoral students who do not fulfil either of the above criteria, i.e. who have not been employed by the university and have not been receiving other funding, can also be included in the research active staff for the period they are not holding a post at another university or research institute. The unit can decide case by case whether to include these doctoral students.

5 Visiting researchers and research students

A visitor is a foreign person who is doing research or completing his/her doctoral studies in the unit.

6 Other research active staff

Researchers and research students who are not included in the categories above.

7 Technical personnel

Technical personnel refer to persons working under the supervision of research active staff to carry out projects but who are not involved in the theoretical planning, publishing or other related activities.

8 Administrative personnel

Administrative personnel refer to persons who take care of administrative tasks related to the research, such as financial and personnel administration or other office duties, but who are not normally involved with the technical implementation of the projects.

1.2 List of research active staff in 2006–2010

List all research active staff and their tasks in 2006–2010. 'Task' here refers to the actual job or position that person has (e.g. head of unit, research professor). 'Task category' refers to categories in Table 1.1. Please use abbreviations, e.g. MA, MSc, PhD, for academic degrees.

If the person's duties have changed during the period under review (e.g. from doctoral student to postdoctoral researcher), indicate both tasks performed by the person and the period according to the format.

2 Funding

2.1 *Core funding* for scientific research refers to the unit's budget funding and any other funding for research allocated by the parent organisation. The funding covers both the salary costs with indirect employee costs and the operating costs, which include consumption costs and investment costs for research activities.

Use of research funding received from *external sources*, indicated per year. Academy of Finland Research Fellowships should also be included and counted. Salaries should be calculated as 1.33 * gross salary.

Work for societal impacts may have additional funding besides research funding. This kind of additional funding is not included in Table 2.1.

3 Unit's research profile and scientific output

3.1 Estimate of the unit's research orientation according to fields of research related to this evaluation.

3.2 The aim of this question is to survey how the research carried out in the unit *has impacted on the field of Ecology and evolution biology.* Describe the research strategy and orientation of scientific publishing, the most important research results, approaches, the role of interdisciplinarity etc. If it is reasonable, you may also describe the unit's research strategy from 2000 to the present. (See also Question 7.1).

3.3 List of publications and other outcomes in the order indicated in the summary table, by type of outcome. Regarding each outcome, indicate the name of the author/

authors, title/publication etc. and the type of outcome. This table can also be submitted in rtf format.

At the end of the publication data, give the citation index of the publications. Indicate this citation index as the last information by using the abbreviation CI = number of citations.

Example:
Ala-Honkola O, Uddstrom A, Pauli B D, et al. Strong inbreeding depression in male behaviour in a poeciliid fish. Journal of Evolutionary Biology, 22 (7), 1396-1406 (2009). CI=7
References to books should give the names of all editors, place of publication and publisher, and publication year.

3.4 In the summary table, calculate the number of each type of outcome in the list during the period under review.

3.5 Each professor and senior researcher shall list five of his/her key publications during 2006–2010 indicated in order of quality.

3.6 In the interests of readability, please do not make the font size smaller when copying publications. The copies of publications shall be two-sided. The minimum number of publications is five. The maximum number of publications = number of senior researchers.

4 Doctoral training

4.2 If at least half of a doctoral dissertation has been supervised and done at a research institute, the research institute can also list the doctoral dissertation as its own outcome. In this case, also indicate the university where the doctoral dissertation was *presented for approval* in the last column of the table (Supervisor). Please indicate the supervisors' *share* of the supervision if the dissertation has more than one supervisor.

4.3 Indicate only degree-awarding organisations.

4.6a–4.6b In addition to the name of the organisation, indicate the type of organisation (university, research institute, business company, state, municipality or other).

5 Unit's collaboration contacts

5.1–5.2 List the visits per year. List the visits of each year in alphabetical order by country. The minimum duration of a visit to be indicated is two weeks. Under the item 'Topic of visit', indicate clearly the objective of the visit: for example, with regard to a post-doc period, describe the content objectives related to the visit.

5.3 You may describe shorter visits (duration less than two weeks) that have been of particular importance to the unit or the field of Ecology and evolution biology.

5.4 Under item 5.4, 'collaborator' refers to a person or a research team with whom cooperation has either generated or is expected to generate within the next three (3) years one of the outcomes indicated under item 3.4.

5.5 Describe here e.g. key joint publications, researcher training, adoption and use of new technologies or new approaches.

6 Other scientific or societal activities

6.1 Plenary or other invited presentations

6.2 Indicate the task, e.g. chief editor, editor. Please, don't include referee tasks.

6.3 Prizes awarded to researchers, honours and scientific positions of trust

6.4 Other significant activities, e.g. memberships on committees and scientific advisory boards of business companies or other similar tasks of no primarily academic (scientific) nature

7 Unit's self-assessment

Self-assessment is an important part of the evaluation. Please answer carefully.

7.1 Describe the unit's research programme for the next few years, the key research objectives and the means to achieve these objectives. What is the role of basic and applied research?

7.3 In addition to present strengths and weaknesses it is also important to assess future opportunities and threats in a broader perspective. Ecology and evolution biology system level issues (e.g. university and science policy options, future funding opportunities, facilities etc.) should be included in future prospects.

7.4 Is there a need for new knowledge or facilities, is the present level of funding sufficient for attaining the objectives? What is the role of research stations?

7.5a Describe here how the unit's research activities and cooperation with other actors in society have promoted the activities of other societal actors. Describe for instance how the activities have contributed to production and use of new services and products, drafting of new regulations and norms, environmental risk management or similar.

7.5b User/collaborator's name, address, email and telephone number. Also describe what kind of cooperation you have with this user/collaborator to promote societal impacts.

Appendix 4. Evaluation process

International Plant Biology evaluation
Week schedule
February 13 - 18, 2011

Time	13.2. Sunday	14.2. Monday	15.2. Tuesday	16.2. Wednesday	17.2. Thursday	18.2. Friday
8:30		8:30 - 11:30 UH_Agri	8:30 - 11:30 UH_Biosci	8:30-11:00 Metla	8:30-11:00 UH_Forest	8:30-11:00 UE_Forest
9:00						
9:30						
10:00						
10:30						
11:00				11:00-12:30 Students: Univ. Turku	11:00-12:30 Students: U. E-Finland	Break
11:30		Lunch	Lunch			11:30-14:00 UT_Biochem
12:00						
12:30		12:30 - 15:00 UE_Biosci	12:30 - 15:00 UE_Environ	Lunch	Lunch	
13:00						
13:30				13:30-16:00 UE_Biology	13:30-16:00 UO_Biology	
14:00						Report drafting and late lunch
14:30						
15:00		15:00-17:30 MTT	15:00-17:30 VTT			
15:30						
16:00				16:00-17:30 Students: Univ. Oulu	16:00-17:30 Students: Univ. Helsinki	
16:30						
17:00	17:00 Introductory meeting: hotel meeting room	17:30 - 21:30 Report drafting and Dinner	17:30 - 21:30 Report drafting and Dinner	17:30 - 21:30 Report drafting and Dinner	17:30 - 21:30 Report drafting and Dinner	
17:30						
18:00						
18:30						
19:00	19:00 Dinner hosted by Academy of Finland					
19:30						
20:00					20:00 Dinner hosted by Academy	
20:30						
21:00						

Abbreviations:

MTT	MTT Agrifood Research Finland
Metla	The Finnish Forest Research Institute, Metla
UE_Biology	University of Eastern Finland, Faculty of Science and Forests, Department of Biology
UE_Biosci	University of Eastern Finland, Faculty of Science and Forests, Department of Biosciences
UE_Environ	University of Eastern Finland, Faculty of Science and Forests, Department of Environmental Science
UE_Forest	University of Eastern Finland, Faculty of Science and Forests, School of Forest Sciences
UH_Agri	University of Helsinki, Faculty of Agriculture and Forestry, Department of Agricultural Science
UH_Biosci	University of Helsinki, Faculty of Biological and Environmental Sciences, Department of Biosciences
UH_Forest	University of Helsinki, Faculty of Agriculture and Forestry, Department of Forest Sciences
UO_Biology	University of Oulu, Faculty of Science, Department of Biology
UT_Biochem	University of Turku, Faculty of Mathematics and Natural Sciences, Department of Biochemistry and Food Chemistry
VTT	VTT Technical Research Centre of Finland, Biotechnology cluster, Medical biotechnology knowledge

Appendix 5.
Research staff and funding

a. Staff in total by Unit 2005–2009; Staff in FTE

Organisation	Department	2005	2006	2007	2008	2009	Total FTE
University of Eastern Finland	Biology	13,5	14,4	14,4	13,5	19,5	75,3
	Bioscience	15,0	12,3	10,5	9,7	11,3	58,7
	Environmental science	22,0	21,5	21,8	23,1	22,5	110,9
	Forestry	5,4	5,5	5,8	5,8	4,8	27,3
University of Helsinki	Agricultural sciences	54,7	51,1	48,5	46,8	47,5	248,6
	Forestry	15,7	17,2	15,2	13,2	14,5	75,7
	Biosciences	53,7	59,1	61,7	65,8	63,8	304,0
University of Oulu	Biology	12,4	14,8	16,0	17,1	18,3	78,7
University of Turku	Biochemistry	20,5	21,4	24,4	25,0	30,6	122,0
Metla		11,9	13,2	15,5	16,4	15,0	71,9
MTT		21,0	23,0	21,6	20,6	22,3	108,4
VTT		19,5	17,6	14,3	15,8	14,6	81,7
Total		265,2	271,2	269,6	272,8	284,6	1363,1

b. Research active staff by Unit 2005–2009; Reseach staff in FTE

Organisation	Department	2005	2006	2007	2008	2009	Total FTE
University of Eastern Finland	Biology	10,1	11,0	11,0	10,1	16,0	58,2
	Bioscience	11,9	10,6	8,7	8,4	10,3	49,8
	Environmental science	21,4	20,9	21,2	22,5	21,9	107,9
	Forestry	3,3	3,4	3,7	3,7	2,7	16,8
University of Helsinki	Agricultural sciences	36,7	33,9	33,4	32,9	35,0	171,9
	Forestry	14,9	16,4	14,5	12,4	13,8	71,9
	Biosciences	48,8	50,1	52,5	56,7	54,4	262,4
University of Oulu	Biology	10,9	12,6	13,7	14,9	16,1	68,2
University of Turku	Biochemistry	17,7	18,6	21,6	22,2	26,4	106,7
Metla		6,8	6,7	8,3	9,8	8,2	39,7
MTT		11,5	13,5	14,1	13,1	15,2	67,3
VTT		11,6	10,6	7,8	8,2	8,3	46,5
Total		205,5	208,2	210,5	214,8	228,3	1067,2

c. Doctoral students/Senior staff by Unit 2005–2009

Organisation	Department	2005	2006	2007	2008	2009	Total FTE
University of Eastern Finland	Biology	1,3	1,3	1,0	0,4	1,4	1,0
	Bioscience	6,0	5,4	4,2	2,9	1,5	3,6
	Environmental science	7,4	6,3	5,8	5,8	3,7	5,7
	Forestry	7,1	7,5	7,5	7,5	5,0	6,9
University of Helsinki	Agricultural sciences	6,0	6,5	4,8	4,4	4,9	5,2
	Forestry	2,0	1,8	2,1	2,3	2,1	2,0
	Biosciences	3,1	2,8	2,6	2,9	2,0	2,6
University of Oulu	Biology	0,8	1,1	1,2	1,7	2,2	1,4
University of Turku	Biochemistry	2,3	3,8	3,8	3,1	2,2	2,9
Metla		0,4	0,3	0,4	0,1	0,9	0,4
MTT		0,5	0,7	0,7	0,6	0,6	0,6
VTT		0,4	0,1	0,0	0,2	0,5	0,2

d. Core funding, total 2005–2009

Organisation	Department	2005	2006	2007	2008	2009	Total
University of Eastern Finland	Biology	264,9	258,2	333,2	370,6	407,8	1635,0
	Bioscience	133,0	137,0	191,0	198,0	209,0	868,0
	Environmental science	289,5	290,5	291,5	342,5	268,7	1482,6
	Forestry	196,2	220,7	246,2	246,2	246,2	1156,0
University of Helsinki	Agricultural sciences	812,0	820,0	871,0	922,0	899,0	4325,0
	Forestry	188,0	232,0	308,0	339,0	229,0	1297,0
	Biosciences	796,0	859,0	843,0	875,0	987,0	4359,0
University of Oulu	Biology	296,0	354,0	369,0	291,0	310,0	1620,0
University of Turku	Biochemistry	180,0	190,0	190,0	420,0	461,0	1441,0
Metla		564,7	444,3	418,6	391,1	489,8	2308,0
MTT		597,5	522,8	512,3	592,8	713,0	2938,5
VTT		661,0	817,0	777,0	550,0	707,0	3512,0
Total		4978,8	5145,5	5350,9	5538,2	5927,5	26941,8

e. External funding 2005–2009

Organisation	Department	2005	2006	2007	2008	2009	Total
University of Eastern Finland	Biology	264,8	375,4	293,6	312,2	1003,8	2249,8
	Bioscience	300,0	292,0	382,0	497,0	698,0	2169,0
	Environmental science	535,1	605,2	630,6	351,8	472,5	2595,2
	Forestry	219,0	133,0	62,0	20,0	20,0	454,0
University of Helsinki	Agricultural sciences	1709,0	1786,0	1942,0	1695,0	1604,0	8737,0
	Forestry	429,0	523,0	368,0	343,0	541,0	2203,0
	Biosciences	1247,0	2241,0	2517,0	2853,0	2332,0	11190,0
University of Oulu	Biology	145,0	310,0	539,0	913,0	835,0	2742,0
University of Turku	Biochemistry	942,0	977,0	1037,0	1270,0	1582,0	5809,0
Metla		167,9	630,2	524,0	634,2	465,5	2422,0
MTT		480,8	703,7	571,8	820,4	602,2	3178,9
VTT		1092,0	907,0	912,0	582,0	926,0	4419,0
Total		7531,7	9483,5	9779,0	10291,5	11081,9	48168,7

f. Academy of Finland funding 2005–2009

Organisation	Department	2005	2006	2007	2008	2009	Total
University of Eastern Finland	Biology	264,8	375,4	293,6	278,9	370,1	1582,8
	Bioscience	0,0	0,0	0,0	110,0	177,0	287,0
	Environmental science	227,3	245,7	366,3	193,8	303,5	1336,4
	Forestry	217,0	124,0	60,0	20,0	20,0	441,0
University of Helsinki	Agricultural sciences	517,0	435,0	602,0	651,0	803,0	3008,0
	Forestry	258,0	471,0	294,0	318,0	361,0	1701,0
	Biosciences	780,0	1218,0	1569,0	1984,0	1577,0	7129,0
University of Oulu	Biology	63,0	84,0	317,0	479,0	418,0	1361,0
University of Turku	Biochemistry	697,0	780,0	848,0	822,0	1132,0	4279,0
Metla		156,0	557,4	445,7	596,1	454,1	2209,0
MTT		182,1	219,4	295,3	340,8	366,4	1403,9
VTT		0,0	0,0	39,0	186,0	200,0	425,0
Total		3362,1	4509,9	5129,8	5979,5	6182,1	25163,4

This evaluation report presents the findings of an international panel convened to evaluate plant science related research in Finland. The evaluation covers twelve plant science units and the years 2005–2009. The assessment is based on interviews and the background material provided by each unit.

In the evaluation, the panel considered the research quality, the research environment including infrastructure and the funding and training of young researchers. The report also includes proposals for future development of research in the field.

ACADEMY OF FINLAND

Hakaniemenranta 6 • PO Box 131, 00531 Helsinki
Tel. +358 9 774 881 • Fax +358 9 7748 8299
www.aka.fi/eng • viestinta@aka.fi