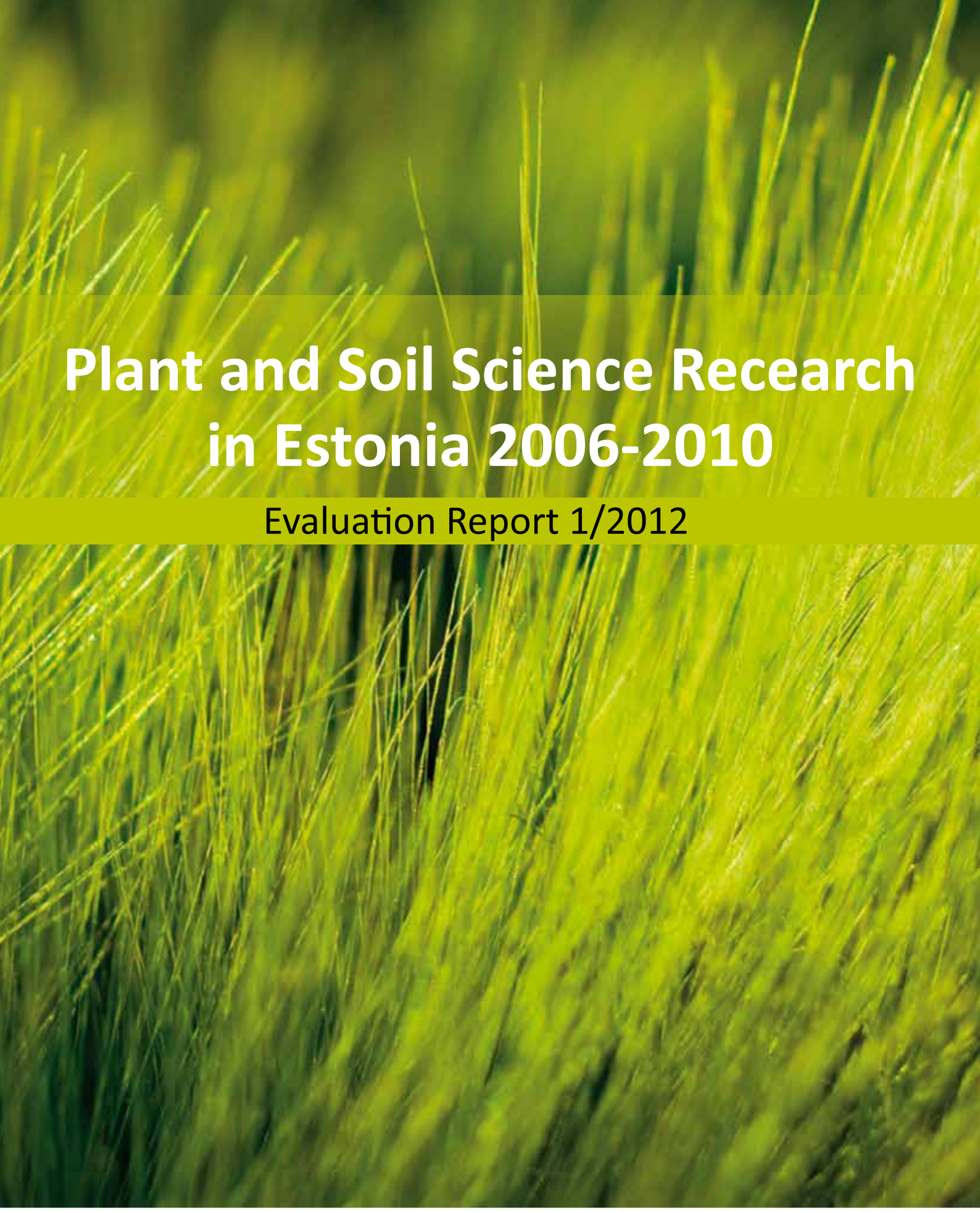

Plant and Soil Science Recearch in Estonia 2006-2010

Evaluation Report 1/2012

Eesti Teadusagentuur
Estonian Research Council

Evaluation Report 1/2012

PLANT AND SOIL SCIENCE RECEARCH IN ESTONIA 2006-2010

Evaluation Panel:

Professor Roland von Bothmer (chair)
Dr Jesper Rasmussen
Professor Paul Struik
Professor Felix Fäckers
Professor Nicholas M Holden

ISBN 978-9949-9266-0-2

Edited by: Viktor Muuli, Madis Saluveer
Page layout: AS Ajakirjade Kirjastus
ISBN (print): 978-9949-9266-0-2
ISBN (pdf): 978-9949-9266-1-9

Table of Contents

Table of Contents 1
1. Preface 3
2. Executive summary 4
3. Introduction 7
3.1. Background and objectives 7
3.2. Estonian R&D system 8
3.3. Agriculture in Estonia 10
4. Plant and soil science research in Estonia 11
5. Unit Assessments 13
5.1 Estonian University of Life Sciences (EULS) 13
5.1.1. Scientific quality of research 13
5.1.2. Research environment and organization of research 15
5.1.3. PhD education 16
5.1.4. Interaction between research and society 17
5.1.5. Recommendations 18
5.2. Estonian Research Institute of Agriculture (ERIA) 19
5.2.1. Scientific quality of research 19
5.2.2. Research environment and organization of research 20
5.2.3. PhD education 22
5.2.4. Interaction between research and society 22
5.2.5. Recommendations 23
5.3. Jõgeva Plant Breeding Institute (JPBI) 24
5.3.1. Scientific quality of research 24
5.3.2. Research environment and organization of research 26
5.3.3. PhD education 27
5.3.4. Interaction between research and society 28
5.3.5 Recommendations 29
5.4. Tallinn University of Technology (TuT) 31
5.4.1. Scientific quality of research 31
5.4.2. Research environment and organization of research 32
5.4.3. PhD education 34
5.4.4. Interaction between research and society 35
5.4.5. Recommendations 36
5.5. University of Tartu (UT) 37
5.5.1. Scientific quality of research 37
5.5.2. Research environment and organization of research 39
5.5.3. PhD education 40
5.5.4. Interaction between research and society 41
5.5.5. Recommendations 42
5.6. BiotaP LLC 44
5.6.1. Scientific quality of research 44
5.6.2. Research environment and organization of research 44
5.6.3. PhD education 45
5.6.4. Interaction between research and society 45
5.6.5. Recommendations 45

6. Overall assessment of plant and soil science in Estonia 46
6.1. Status and quality of research 46
6.2. Research environment and organisation 46
6.3. PhD education 47
6.4. Interaction between research and society 47
7. Recommendations 49
8. Appendices 52
8.1. Appendix 1. Directive of the Minister of Education and research No 595 (14.07.2011): Approval of theme, participants, personnel and detailed organisation of the 2011 evaluation of agricultural sciences (changed at 15.10.2011). 52
8.2. Appendix 2. Terms of Reference for the Evaluation Panel and the Steering Committee 56
8.3. Appendix 3. Panel Members 63
8.4. Appendix 4. Self-assessment Form 66
8.5. Appendix 5. Data provided by the Estonian Research Information System ETIS 70

1. Preface

The Estonian Ministry of Education and Research commissioned in 2010 an international evaluation of agricultural research in Estonia. In the context of the evaluation, agricultural research was defined as plant and soil sciences. The evaluation was carried out in cooperation with the Estonian Ministry of Agriculture, Estonian Research Council, Estonian Academy of Sciences and Estonian Chamber of Agriculture and Commerce.

The goal set for the international evaluation by the Steering Committee was to assess the research quality, the significance of agricultural research to Estonian society and training of young researchers. The evaluation was expected to provide assessments as well as recommendations for the future both at the institutional level and with regards of the research system of the Estonian plant and soil sciences. The institutional assessments involved three public universities, two state research and development institutes and a private company.

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 Steering Committee values highly the independent work of the international expert panel.

Assessments and recommendations both at the level of the research system as well as at the institutional 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 expert panel for evaluating the plant and soil sciences was chaired by Professor Roland von Bothmer from the Swedish University of Agricultural Sciences. On behalf of the Steering Committee 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.

Ülo Mander, Chairman of the Steering Committee

Tartu, February 2012

2. Executive summary

Background
The Estonian Ministry of Agriculture and Ministry of Education and Research commissioned an international evaluation of agricultural research with a specific focus on "Plant and Soil Science" covering basic and applied research in Estonia. The evaluation was performed by an international expert panel including Professor *Roland von Bothmer* (chairman, Swedish University of Agricultural Sciences), Dr. *Jesper Rasmussen* (University of Copenhagen), Professor *Paul Struik* (Wageningen University), Professor *Felix Wäckers* (Lancaster University and Biobest Belgium) and Professor *Nicholas M. Holden* (University College Dublin). The panel convened from November 19–26, 2011. The assessment was based on site visits and interviews with management, research staff and PhD students and on self-assessment reports and background material.

Objectives
The evaluation was performed in order to provide information to the scientific community, research institutes, universities, funding organisations, authorities and other stakeholders on the status of Estonian plant and soil research in an international context. The results will serve as an input for strategy development, policy decisions and measures pertaining to agricultural plant production and related fields.

Units of Assessments (UoAs)
The Estonian University of Life Sciences (EULS) in Tartu is the fourth largest Estonian university and the only one with a clear focus on agricultural sciences.
The *Estonian Research Institute of Agriculture* (ERIA) is a state institute specialising in applied research related to crop cultivation.
Jõgeva Plant Breeding Institute (JPBI) is a state institution for breeding of field crops and vegetables, applied research, and agrotechnological studies.
Tallinn University of Technology (TuT), Departments of Gene Technology and Chemistry (Tallinn campus) and Soil Biology (Tartu College), were included in the assessment.
University of Tartu (UT) is the largest university in Estonia mainly devoted to basic research and highly ranked in earlier evaluations. Some departments are marginally involved in agricultural research.
BiotaP is a private company that was established as a spin-off from TuT. The company specialises in environmental and microbial metagenomics.

Assessment of plant and soil research in Estonia
Status and quality of research. The evaluation panel identified shortcomings in the performance of all UoAs apart from EULS. The quality of individual research in the universities was of very high standard, but the lack of stakeholder interaction and social justification for their research activities was well below international norms. The research being conducted by the research institutes (ERIA and JPBI) was of variable standard, much lacked proper peer review and both institutes had a poor peer-review publication record. They scored much higher using indicators for applied research.

Research environment and organisation. The three universities provide high quality research environments and excellent physical infrastructure and equipment. In some cases there is poor strategic and human resource management. The institutes have some serious deficits, such as poor internal structures and variable quality of laboratory resources. A clear mandate and proper external oversight for both institutes are necessary. Mobility between groups is relatively limited and institutional governance with respect to strategic management of research in an area such as "plant and soil science" is almost impossible for all UoAs.

PhD education. The standard of PhD education is generally good. The on-site supervision is of good quality but for off-site PhDs the supervision from the universities falls short. To maximise benefit to agricultural research, the universities should ensure that there is a value-added benefit to each student's research programme.

On-site PhD students do not see themselves as being part of "agriculture". Internationally, research in plant and soil sciences is commonly linked to environmental research themes. Research relating agriculture and environment, and multi-disciplinary research activity were not apparent for most of the UoAs. The main shortcoming of the PhD education is the very limited expectation, ambition and worldview of the students involved. The PhD students interviewed showed little ambition, very little flexibility, and had no expectations beyond working in the same group in the future. This is not consistent with European expectations for doctoral students.

Interaction between research and society. Compared to international norms the interaction between the research reviewed and society is weak. There is no formal system in place for stakeholders to influence the strategic planning and activity of the UoAs. The research institutes (ERIA and JPBI) have developed from an applied focus towards some basic research. A clear mandate to underpin their activities and financial stability were lacking. The biggest problem for the agricultural sector in Estonia is the lack of a functioning advisory service that can combine production, economic and environmental advice in a holistic package for farmers.

Recommendations

Value for society

- The government needs to define a clear policy framework for agriculture and environment in Estonia.
- Much closer co-operation is required between agricultural and environmental stakeholders, not least at a ministry level.
- The involvement of stakeholders in setting the research agenda and using the beneficial results must be developed.
- Researchers must be educated to understand that there should be an objective driving why research is undertaken.
- The current system of funding should be reviewed to remove non-beneficial competition.
- There is almost no industrial funding in the sector. This needs to be changed.
- Individuals and research groups need training to better understand IP, its management, worth and exploitation.
- All UoAs need to develop strategic plans to maintain their infrastructure and to collectively plan for the future in a coherent manner.
- Better coordination of research activity across the sector is needed.

"Basic" vs. "applied" research

- There is a learned value judgment that places greater value on basic research than applied research. The over-riding role of this distinction should be weakened.
- The apparent belief that applied research does not require the same rigor and is not subject to the same peer-review is wrong and should be eradicated.
- Research funding should have clearly defined programmes that focus on basic research, translational research and applied research.
- Universities should encourage their agriculturally focused research groups to move towards "applied" research activity while retaining their core strengths and values in high quality "basic" research.

- The agricultural research institutes (ERIA and JPBI) should be encouraged to develop "basic" research in a planned manner in collaboration with the universities.

Development of "Research Programmes"

- Agricultural research that is strategy led rather than based on *ad hoc* projects should be developed.
- Research funding should be used to answer specific questions, developed by stakeholders rather than using an open topic based approach.
- Funding should be linked to national economic benefit / interest.
- There should be a coherent policy to reduce research fragmentation.

Research institutes

- Both ERIA and JPBI should be given a clear mandate defining their activity and research functions.
- The research institutes should be offered reasonable core funding.
- A Board of Trustees should be appointed for each institute.
- Researchers should have working and funding conditions that negate the need for "moonlighting". All activity should be defined and limited by the institute's mandate.
- Academic and non-academic indicators should be developed for continuous assessment of performance.

The PhD education system

- An Agricultural Doctoral School should be formed. All PhD students should recognize and engage with the agricultural significance of their research.
- All PhD students should reach basic EU standards concerning:
  research excellence, creativity, attractive institutional environment, critical mass, interdisciplinary research options, exposure to industry and other relevant work sectors, international networking, and mobility.
- Consideration should be given to developing Professional Doctorates suitable for applied research in agriculture.
- Skills training should be upgraded, particularly with a view to making PhD graduates suitable for employment in industry.

Researcher mobility within Estonian research

- Encourage greater consideration of the option for job flexibility.
- Encourage consideration of non-academic, non-public sector careers after graduating.

3. Introduction

3.1. Background and objectives

Evaluations of disciplines and research fields are an important research and science policy tool in order to provide information to the research community and research funding organisations. The results of these evaluations serve as an input for preparing the research policy decisions and measures pertaining to the plant production science and related fields, for the further development of the field and for the preparation of development plans.

The Estonian Ministry of Agriculture and Ministry of Education and Research decided to commission an international evaluation of the Plant Cultivation Research in Estonia (Appendix 1). The Steering Group for the evaluations defined Plant Cultivation Research as "Plant and Soil Science" and to cover basic and applied research in the field of plant biochemistry, plant genetics and plant physiology (all in agricultural context), agricultural ecology, plant production, horticulture, crop protection, phytopathology (including entomology, mycology and phytoparasitology), plant breeding, soil science and agrochemistry (Appendix 2).

The evaluation was performed by an international expert panel including Professor Roland von Bothmer (chairman, Swedish University of Agricultural Science), Dr. Jesper Rasmussen (University of Copenhagen), Professor Paul Struik (Wageningen University), Professor Felix Wäckers (Lancaster University and Biobest Belgium) and Dr. Nicholas Holden (University College Dublin) (Appendix 3). The panel convened from November 19–26, 2011 and this assessment is based on site visits and interviews with management, research staff and PhD students from institutions being evaluated and on self-assessment reports and background material provided by each institution. The set of self-assessment forms and general data are provided in Appendices 4 and 5. In addition to the pre-collected assessment material, the evaluation panel received additional information during unit hearings.

The evaluation covered plant and soil sciences research in Estonian University of Life Sciences, Tallinn University of Technology, Estonian Research Institute of Agriculture, Jõgeva Plant Breeding Institute, University of Tartu and BiotaP LLC. In some institutions, only a minor part of its activities is devoted to plant and soil science. The panel considered research quality, research environment including infrastructure and funding, training of young researchers and research impact in the evaluation process. The expectation of the evaluation outcome is to provide assessments and recommendations to the institution level and to the research system of Estonian plant and soil science as well as to other Estonian authorities, e g Ministry of Agriculture.

3.2. Estonian R&D system

Estonia is a leading country in the European Union in terms of annual growth of R&D expenditures (over 20% in 2000-2009). In total, Estonian R&D employs 4,300 people; R&D funding is about € 200 million (in 2009) which equals to 1.4% of GDP. The main financing body for research is Ministry of Education and Research. Its funding (€ 60 million in 2009) goes primarily to scientific research at universities and research institutes. Private sector's proportion of R&D funding in Estonia was ~45% in 2009.

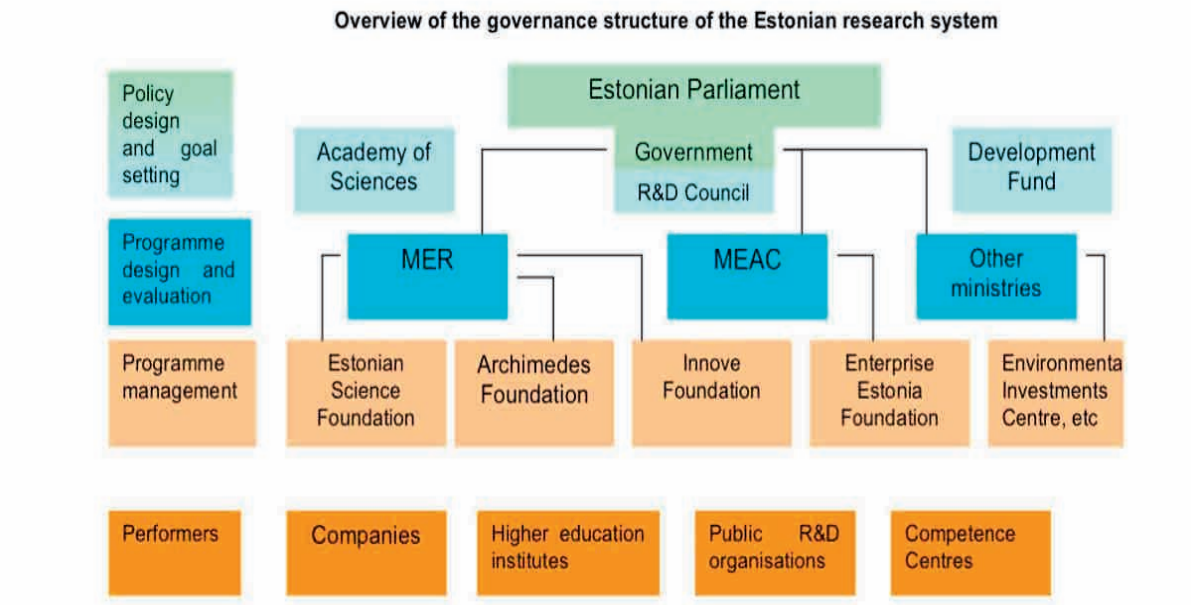

Figure 1. Overview of the governance structure of the Estonian research system.

The *Organisation of Research and Development Act* sets the structure and functioning of the Estonian R&D system as follows:

Policy and decision makers are the Parliament (*Riigikogu*) and Government of the Republic. The Government establishes national R&D plans, submits them to Parliament, approves national R&D programmes, ensures cooperation between ministries and enacts legislation. The Research and Development Council provides consultation to the Government on the matters of R&D. The Estonian Development Fund organises foresight activities in Estonia, required for assuring sustainable economic development. Estonian Academy of Sciences provides independent and highly professional scientific expertise and science-policy advice.

Programme design and evaluation. Policy preparation and managing organisations are the ministries. The key ministries are the Ministry of Education and Research (MER) advised by the Research Policy Committee, and the Ministry of Economic Affairs and Communication (MEAC) advised by the Innovation Policy Committee. These two ministries are responsible for nearly all research funding streams and horizontal policies. Other ministries play a minor, but still important, role by providing support to sectorial research and governmental research organisations. For example, the Ministry of Agriculture has three thematic R&D programs with appropriations also to plant and soil science.

Programme management. Main financing and supporting organisations of research are the MER (advised by the Estonian Research Council), Estonian Science Foundation and Archimedes

Foundation. The development and innovation activities are supported mainly by MEAC through Enterprise Estonia.

R&D performing organisations are universities and other public and private R&D institutions. There are 18 R&D institutions in Estonia that passed the regular research evaluation in 2010. Six of them are public universities, largest of which is the University of Tartu which accounts for more than 50% of Estonian research papers and citations and educates ~60% of new PhD-s. The largest state research organizations are Estonian Biocentre, Tartu Observatory, Estonian Literary Museum and the Institute of Estonian Language. There are also some public independent R&D institutions that perform high level research, i.e. the National Institute of Chemical Physics and Biophysics. Today nearly all basic research is conducted in the public sector; the private sector focuses mainly on product development and innovation.

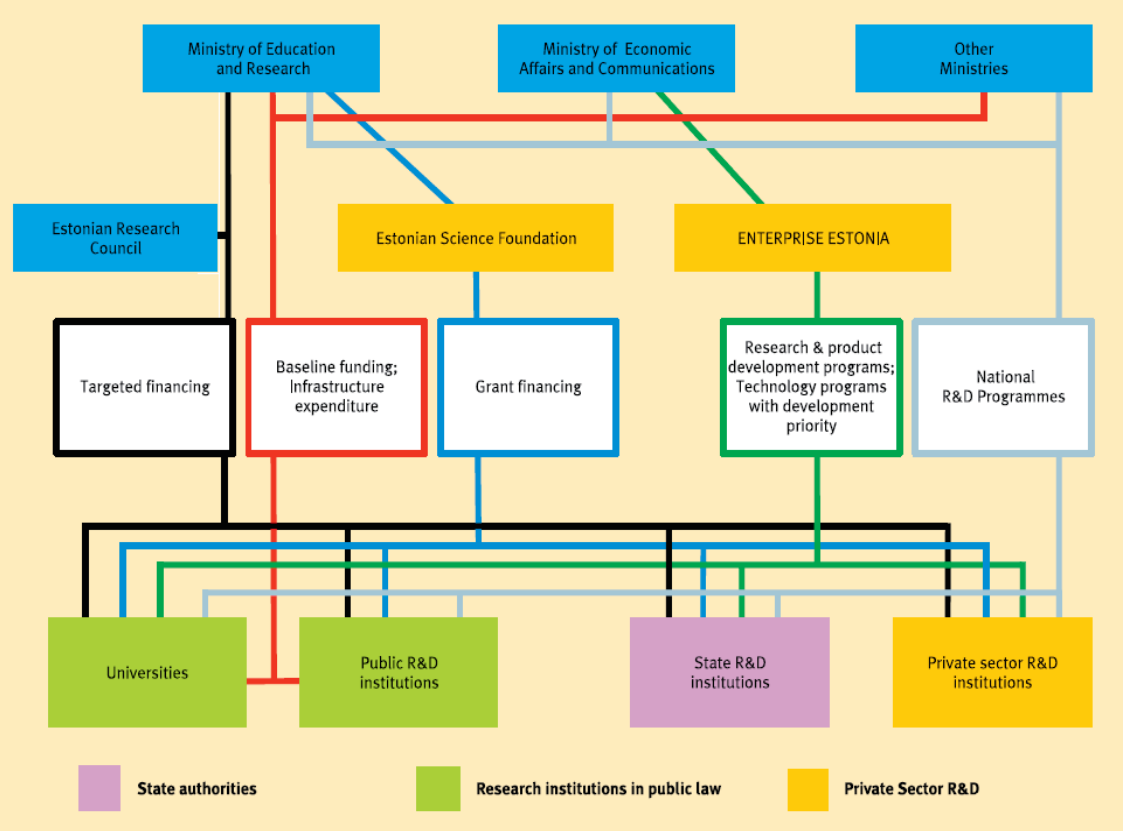

Figure 2. Estonian R&D funding system.

The biggest regular public funding stream for R&D institutions is **targeted financing** (€ 23 million in 2011) financed by MER. The Estonian Science Foundation allocates about € 8.3 million in 2011 in relatively small grants to curiosity driven research. Various national R&D programmes provide support for research in specific research areas.

A general remark

According to Estonian legislation, only universities are entitled to carry out and examine doctoral studies. Research institutes and private R&D companies do not have this right. The students must have a supervisor from a university department and can have a co-supervisor from other institutions and can perform their research outside the universities. Therefore, all the PhD students who have been enlisted at the universities can be divided into two distinct categories: PhD students who do their research on-site in the universities (including PhD students from abroad), and PhD students who work and do their research off-site in the research institutes.

3.3. Agriculture in Estonia

The area of Estonia is 4 523 000 ha, utilized agricultural area contributed to 932 000 ha of which the total arable land was 800 000 ha in 2009[1]. The share of utilized agricultural area accounted for 21% of the total area. Total arable area in Estonia occupied 567 000 ha in 2009, cereals were grown on 316 000 ha, forage crops on 151 000 ha, industrial crops on 83 000 ha and potatoes, vegetables and legumes on the total of 17 000 ha (Fig. 3). The share of cereals has increased regularly during last decade. The amount of produced cereals and oilseed is enough to cover Estonian needs; however, production of potatoes, vegetables, fruit and berries produced in Estonia does not cover the consumption of the population (Fig. 4). Organic farming has developed actively over the past years, since 2004 the area of organically farmed land has more than doubled (in total 103 000 ha in 2009). Most part of the organically farmed land is annual and perennial grasslands (64 100 ha in 2009).

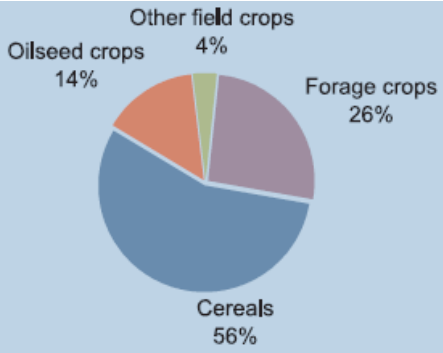

Figure 3. Structure of field crops in Estonia in 2009.

There were 234 700 bovine animals (incl. 96 700 dairy cows), 365 100 pigs, 80 400 sheep and goats and ca 1 800 000 poultry in Estonia in 2009. When compared to the year 2000 the number of bovine animals has decreased by 18 000, dairy cows by 34 000, poultry by 574 000, but the number of pigs has increased by 65 000.

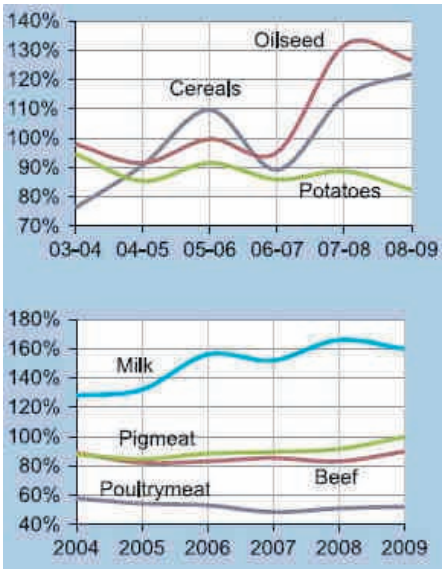

Figure 4. Level of self-supply of agricultural products in Estonia.

Major structural changes initiated in the agricultural sector after regaining independence have also occurred over the past decade: the number of agricultural holdings has decreased rapidly. There were ca 55 700 agricultural holdings utilizing agricultural land in Estonia in 2001, which have decreased to 23 300 in 2007. The decrease has mainly occurred at the expense of smaller holdings up to 5 ha from ca 31 000 in 2001 to 8 300 in 2007. The number of larger holdings of over 50 ha has increased from ca 2 000 in 2001 to 2 600 in 2007.

Economic accounts for agriculture (at basic prices of the corresponding year, million euros)	2003	2009
Total output	**421**	**570**
Crop production output	165	227
incl grass feeds	38	52
incl oilseed rape	18	40
incl wheet	16	36
Livestock production output	211	281
incl milk	104	133
incl pigs	56	73
incl cattle	15	34
Other production output	45	63

Table 1. Economic accounts for agriculture in Estonia.

The total economic output of agriculture in Estonia was 570 million euros in 2009 (1.5% of GDP). 49% of total agricultural output is livestock production, 40% crop production and 11% other production (Table 1).

[1] All data and figures in this section from: L. Rooma, M. Aamisepp, A. Laansalu, E. Matveev: Agriculture and Rural Life, 2010, 95pp.

4. Plant and soil science research in Estonia

For the evaluation of plant and soil sciences research in Estonia, five research institutions which have received earlier public funding were asked to participate by the Minister of Education and Research: Estonian Research Institute of Agriculture, Estonian University of Life Sciences, Jõgeva Plant Breeding Institute, Tallinn University of Technology and University of Tartu. One private company – BiotaP LLC – expressed additionally its wish to participate. All the institutions provided data on their research resources, organization, staff education and on the outcome of their performance via the Estonian research information system ETIS. In addition to that information, they also submitted a self-assessment report. The set of evaluation forms are provided in Appendices 4 and 5.

Estonian Research Institute of Agriculture (ERIA) is a state research institute under the jurisdiction of the Ministry of Agriculture. The research of ERIA is conducted in the area of plant and soil science.

Estonian University of Life Sciences (EULS) is the only agricultural university in Estonia and under jurisdiction of the Ministry of Education and Research. Approximately 20% of their research is conducted in area of plant and soil sciences and it is the only university in Estonia focus on agriculture (incl. plant and soil science).

Jõgeva Plant Breeding Institute (JPBI) is a state research institute under the jurisdiction of the Ministry of Agriculture. All research is conducted in area of plant science particularly with plant breeding and applied plant sciences.

Tallinn University of Technology (TUT) is the only technical university in Estonia and under the jurisdiction of the Ministry of Education and Research. Only 3% of their research is conducted in area of plant and soil science.

University of Tartu (UT) is the only classical university in Estonia and under the jurisdiction of the Ministry of Education and Research. Plant and soil sciences research is not the main focus of any of the research projects. Still, some of the research fields are of relevance for plant and soil sciences.

BiotaP LLC (BiotaP) is a private R&D company, and a spin off entity from the TUT with the aim to develop and commercialize a novel technological platform for testing the environmental status, based on the microbiological metagenomic testing of soils.

Institution [1]	Percentage of plant and soil science [2]	Research profile within plant and soil science[3]	Total financing (mln euros)	Persons involved in projects		Output		
				Total	Research staff	Publicat-ions (total) [4]	Articles and/or mono-graphs [5]	Patents[6]
TUT	3%	1 - 30% 2 - 45% 3 - 25%	4,3	76	35	155	60	13
ERIA	100%	1 - 15% 2 - 70% 3 - 15%	4,2	50	43	347	15	12
UT [7]	N/A	1 - 30% 2 - 30% 3 - 40%	4,4	106	62	86	58	0
EULS	21%	1 - 20% 2 - 68% 3 - 12%	9,0	163	78	1 134	260	33
JPBI	100%	1 - 10% 2 - 90% 3 - 0%	2,2	25	18	325	10	19
BiotaP	60%	1 - 0% 2 - 50% 3 - 50%	0,9	6	0	1	1	2

Table 2. General characterisation of institutions. Information bases on ETIS data provided by institutions and covers the period 2006-2010 and only plant and soil science research. Explanations in table:

[1] – Name of the institution. See abbreviations in the text above.

[2] – Percentage that plant and soil science research represents in the research carried out in the institution. Calculations are based on the proportions of research financing (data from institution's self-assessment reports).

[3] – Research profile within plant and soil science (percentage of subfields, data from institution's self-assessment reports):

1 – Plant biochemistry, genetics and physiology (in agricultural context).

2 – Agroecology, phytotechnics, horticulture, crop protection and phytopathology (incl. entomology, mycology, plant parasitology), plant breeding.

3 – Soil science, agrochemistry.

[4] – Includes selected ETIS publications (all ETIS categories) considered relevant for the evaluation by institutions.

[5] – Includes scholarly articles indexed by Thomson Reuters Web of Science and/or published in journals indexed by ERIH (European Reference Index of the Humanities) categories INT1 and INT2 (ETIS category 1.1) and high-level peer-reviewed research monographs (ETIS category 2.1).

[6] – Includes patents and patent applications, plant variety certificates and plant variety certificate applications.

[7] – Agricultural research is not the only or main focus of any of the UT projects given in their report. All of the projects have outcome related to wide areas of landscape ecology, botany, insect ecology, and plant physiology. Still, all of them have results which are more or less related to some of the fields of plant cultivation and plant protection. The UT data in this table reflect overall volume of projects and persons involved and do not reflect the share of plant and soil science inside those data.

N/A - Information not available.

5. Unit Assessments

5.1 Estonian University of Life Sciences (EULS)

The Estonian University of Life Sciences is the fourth largest Estonian university and the only one with a clear focus on agricultural sciences. Around a quarter of the 396 academic staff / 961 total staff work on activities related to plant science and there is an Institute of Agriculture and Environmental Sciences that attracts 74% of the research funding of the University. It is one of the few organisations reviewed that had made progress towards integrating agricultural and environmental sciences at the institutional level allowing more effective approaches to study agricultural issues. The University has recently been reorganized by reducing the number of departments in the Institute of Agriculture and Environmental Sciences to 11 and further consolidation is being discussed. Competence in environmental economics and soil ecosystems were identified as obvious gaps.

The departments evaluated were Plant Physiology, Horticulture, Field Crops and Grassland Husbandry, Soil Science and Agrochemistry, Plant Protection.

5.1.1. Scientific quality of research

Science indicators

Over the evaluation period 422 peer-reviewed papers of which 257 were class 1.1, were published, mainly in the areas of crop production and plant science. The work was of high quality by international standards. The output quantity was low compared with international norms, with 78 research staff publishing 5.4 peer reviewed papers each (3.3 SEI listed) over the 5 year period. In comparison with other Estonian institutions in the field, however, the volume of output is high. The output of other publications (conferences, books, etc.) was high compared with other organisations reviewed and certainly meets international norms. The output of SEI listed publications has almost doubled over the last five years and the strategic plan should help to further improve outputs in terms of quantity and quality.

While EULS has an IP management strategy in place, the concept of IP seems to be restricted to patents and licenses only, and there does not seem to be a wider view of IP and its management. Over the assessment period there were 33 patent applications/patents granted ranging from new fruit and berry varieties to soil water measurement techniques (together with ERIA). At the research group level there was an understanding that obtaining a patent should not be a goal in itself (due to cost and restrictions on dissemination), but there was little understanding of the idea that research outputs could have social and economic benefits managed in other ways, even as simply as through know-how.

There have been a number of non-academic deliverables from EULS over the review period including new fruit and berry varieties in collaboration with JPBI, UT and TuT, reporting on agri-environment measures and landscape management for the Ministry of Agriculture and development of a pollen beetle control strategy for oil seed rape. Continued development of this type of output is to be encouraged. The Competence Centre for Knowledge-based Health Goods and Natural Products should make a significant contribution in this regard.

Overall the research at EULS includes some innovative elements but much of the research tends to follow from existing international research. For the EULS to become a leading international university and to make a greater national contribution, it will have to focus on some truly novel ideas and concepts to which the existing expertise and methodology could be applied. There is awareness among PhD students that innovativeness is essential to increase international impact and there is some basic understanding of what constitutes innovative research and how to achieve this. This topic should be covered explicitly during PhD training.

Multi-disciplinarity

Internal collaboration between research groups is an explicit element of the EULS strategy and is facilitated by the joint focus of research groups on crop production. Internal collaboration is also expressed in joint research projects between groups, departments and organisations. The multi-disciplinary nature of these collaborations is however limited in many cases. True integration of natural and social sciences is a challenging but necessary step in the further development of the agricultural sciences of EULS.

There is scope for much more innovative thinking to address agricultural and environmental problems. There is room to further exploit synergies in expertise by further stimulating collaboration across departments within interdisciplinary projects. Links between the ENVIRON and the other institutes on topics such as early detection of crop stress, crop protection, or soil contaminants and emissions are currently weak. The topic of landscape management for optimization of ecosystem services, currently addressed at the Department of Plant Protection, also offers excellent opportunities for interdisciplinary research, including contributions from Soil Science (but the lack of a soil ecology group is a glaring omission for EULS).

EULS has an excellent record of national collaboration with other universities and institutions. Interaction with stakeholders was also more developed than that of other universities. Joint research projects with UT and TuT offer opportunities to link basic research to agricultural applications. There is a great opportunity for the Soil Science and Agrochemistry groups to link up with complementary groups at TuT and UT. The close collaboration with JPBI on plant breeding, and impact on pollination/parasitoids for different varieties should be strengthened, but collaborations with ERIA are limited and there is an urgent need to remedy this situation. A number of PhD students registered at EULS work at both JPBI and ERIA. The opportunities to strengthen collaboration through these PhD projects are insufficiently realized.

The University is well established in networks of international academic partners through the active participation in a range of EU and other international research projects. The international standard of the research and international standing of the researchers are important assets making EULS an attractive partner for international collaboration. The university has also managed to attract increasing numbers of international students. PhD students are actively encouraged to spend relatively long periods at universities abroad. These placements at times involve work that is not directly linked to the PhD research project of the student. These external visits could be chosen more strategically to optimize benefits to the PhD student and to the University. Care should be taken to ensure that the university's networks result in proper collaboration rather than less productive interactions.

5.1.2. Research environment and organization of research

Management

The university has a clear mission and strategic plan. There are annual meetings to set short and long term goals and to develop action plans. The aim of linking basic research to applications in agricultural production and environmental protection is unique in Estonia and should be fully supported. EULS has had mixed success in achieving these linkages but direct involvement of key stakeholders from the ministries of agriculture and the environment and other commercial stakeholders should ensure greater integration of agricultural and environmental research in the future. Strategies include optimization of financing, building international relationships and gap filling by networking and partnership. The current gaps in environmental economics and soil science urgently need filling within EULS if it is to achieve linkage between basic and applied research. The current reliance on academic indicators for assessing strengths and weaknesses (e.g. critical mass, project funding, PhD numbers, publications) should be complemented by a range of robust non=academic indicators to properly take the applied end of the research scale into account and to include the need for stakeholder interaction. While departments are aware of the University strategy, and participate in its formulation, the implementation at group level is varied with some being more active and focused by the strategy than others.

There is a hierarchical personnel structure at EULS, but researchers have reasonable freedom to develop their own research ideas. There were many young researchers and they did not seem too concerned about the five-year funding research appointment cycle, probably because their high output ensures continued funding. PhD students are stimulated to work independently, and there is sufficient support available for on-site students, but the supervision of off-site students fell far behind international norms for good practice. As it is EULS that awards PhD degrees for these students, it is up to the university to ensure high standards of supervision for off-site students, even if this requires fundamental changes to work practices for all involved.

Institutional environment

In Estonia the EULS is one of two universities reviewed that had a clear applied and technology mandate (TuT being the other one), and it is unique in its focus on agriculture. Among the institutions evaluated it was the only one that had spanned from basic research to application in any meaningful way. There is limited overlap between the research groups at EULS and the other organisations, and where it does exist, collaborative projects have been managed with clear task differentiation between partners. There appeared to be some overlap on the landscape management / biodiversity /photosynthesis with UT and on pesticide testing with both JPBI and ERIA. However, while ERIA mainly focuses on efficacy trials, the EULS studies primarily addressed non-target effects.

Both research staff and PhD students gave the impression of being highly motivated and committed to their research. This included the foreign European students that volunteered that they were better served at EULS than in their home countries. No major frustrations with EULS were apparent during the site visits.

The building stock at EULS was a mixture of new and old buildings and is in the process of being renovated (note, remote centres were not visited). While the buildings are perhaps not as good as those of the other universities visited, they are comparable with European norms and do not represent any disadvantage for research. The on-going investment in world class equipment for

biological and chemical analysis will enable cutting-edge research to continue into the foreseeable future. Investment in future maintenance of this infrastructure is essential.

5.1.3. PhD education

Doctoral training

PhD students registered at EULS fall into two distinct categories: those that are doing their research on-site (including foreign PhD students) and those that work off-site (mainly at JPBI and ERIA).

On-site PhD students are embedded within research groups and their departments and are part of the team. They are engaged and feel that they have influence. Weekly meetings, their work place in the department, attending seminars and having an input to projects ensures that these students are happy, motivated and productive. While PhD supervision is informal and with a single supervisor, the students have about of the fastest completion rate of all groups reviewed. Plans are discussed at the start of the project. Progress is evaluated every year by an evaluation committee from the department and, where necessary, (international) co-supervisors are appointed. All involved aim for PhD students to be working fully independently from the onset of their studies.

There was an obvious and acknowledged problem with off-site PhD supervision for students working mainly at JPBI, but also at ERIA. Off-site students did not feel part of the university system, they had insufficient supervision, did not get the support they needed and there was no obvious policy to properly manage the needs of off-site students. Their course work was insufficiently tailored to their research and training needs. These shortcomings contributed to extreme delays in PhD completion (but the main cause was working full-time while trying to complete the degree). The problem was sometimes exacerbated by changing of procedures and standards during the PhD, which further aggravated the problems. Improving off-site student supervision requires urgent action. The supervisor, local supervisor and student need to develop a realistic plan for the completion of the thesis. The role of the local supervisor requires special attention. The plan should include setting of training and research targets, as well as a timeline that takes account of daily workload. Progress should be discussed at regular (monthly) meetings.

Mandatory training courses are available in a range of topics including statistics and scientific writing. Students thought these useful along with a range of optional courses. While PhD students were exposed to, and work together with stakeholders (e.g. farmers or ministries), they had little understanding of the true potential of stakeholder interaction to maximise the societal benefit of their research. To further improve the training outcomes of PhD students' international placements, advance planning and integration of the placement into the research work plan for the student should be implemented. Efforts should be made to select a research group that can provide the student with the opportunity to do research relevant to the PhD project.

PhD completion rate is around 75% and the time it takes to complete at EULS is well below the national average, but still above the four year standard. It is important to try to bring this figure down, perhaps by ensuring that the semester abroad contributes to the PhD thesis, that the PhD thesis is sufficiently funded and any other research activity contributes to the publications for the thesis, that thesis chapters are published papers and close monitoring by the supervisor and committee of the progress against planned targets. It is not possible to offer prescriptions to solve the problems for off-site PhD project duration, but it is a matter of urgency that the university management addresses this issue.

A final issue with PhD students is that they often work within the system, frequently having done their MSc in the same group, which limits the breadth of their experience and their world view. This is somewhat addressed by the international placement, but when interviewed it was apparent that most students see their future as a direct continuation of their current work and they had very little understanding of the role of research in modern European societies. There was some interest in finding a post-doctoral position abroad, but this was nearly always with the objective of increasing chances for an academic job in Estonia. Few can imagine a career in a public service and even less in the private sector. There was a notable exception being a PhD student, who by his own initiative sought contact with the company "Click and Grow" where he got the position as R&D director. He won an Innovation award in 2010 and was the only PhD student who the evaluation team met who had any interest in or experience of using his skills beyond his immediate research team.

5.1.4. Interaction between research and society

Value to society

EULS actively engages with ministries, an advisory system, agricultural companies, farmers unions, and the private sector at the university management level. This interaction with the whole stakeholder chain was far better developed at EULS for the plant and soil domain of agriculture than of any other organization reviewed. It created knowledge chains linking basic and applied research to end-users, started to support the transfer and application of academic knowledge to stakeholders and had the potential to become instrumental in facilitating the development of knowledge and technology transfer. There are however still shortcomings with the management and implementation of stakeholder interactions.

Most stakeholders have input through regular contacts with researchers, among other activities at field days and training days organized by the institute. A concrete example where farmer input has given rise to a successful research project is the project developing a pollen beetle control strategy in oil seed rape. However, there seemed to be a lack of formalised structures for such input which means that some research groups are working in isolation from their stakeholders while other groups interact in an *ad hoc* way. With the way research is structured in EULS it is very important that communication with stakeholders can be managed at individual, group and institutional levels. The Ministry of Agriculture has an input through funding programmes and direct discussion with individuals, but such interaction with the Ministry of Environment was much less clear. This should be improved.

The university's objective is to provide solutions "from farm to fork". This requires active collaboration with various stakeholders along the food chain. This dissemination is currently realized by direct engagement with researchers or through contact between the researchers and the advisory system. The latter contacts are through training, field days and by a few researchers working as advisors. The most common interaction seems to be by producers calling researchers directly for free advice. While this is positive, it does deny researchers optimum use of their time, and it is not an equitable manner of distributing knowledge from the university. It appears that the advisory system is haphazardly organized. Nevertheless, the EULS should be in the position to actively lobby for the Estonian advisory system to be improved, thereby also ensuring a more effective dissemination of its results.

The Institute of Agricultural and Environmental Sciences has on several occasions been a key knowledge provider for the Ministry of Agriculture and the Ministry of Environment. Academics have been involved in the development of National Strategic plans and have participated in working

groups on climate change, gene technology and agri-environment measures. A two-way interaction at state level is required to maximise the benefit of EULS to the development of agriculture in Estonia.

Overall, it appears that EULS research is having a definable impact on the Estonian Society in various ways through state interaction, development of specific management options (e.g. blueberry production on cutaway peat lands) and knowledge provision. Compared with the other universities working in the agricultural plant and soil sciences domains EULS is a leader in providing value to society, but is perhaps only around a European average for such a university and would fall well behind the equivalent impact that a "land grant" university in the USA has on its society. Quite moderate management adjustments and significant researcher education in this area would greatly increase the contribution with relatively little additional effort and should be considered as a course of action.

Relevance to "plant and soil science" in Agriculture

Agriculture (and for some groups environment) is the primary focus of the plant and soil research at EULS. The policy of developing farm-to-fork research is strengthening relevance of all the research being conducted at EULS.

5.1.5. Recommendations

In the area of research and its focus:

- Continue to strengthen the links between research groups internally, nationally and internationally. Some obvious links such as those with soil science at TuT are not being properly exploited.
- While the strong investments in the Centre of Excellence (ENVIRON) raises the profile of the University and opens up opportunities for collaboration, this should not be done at the expense of other more applied research groups.
- Two-way communications with stakeholders should be formalised to ensure research activity is focused on those questions of importance nationally and internationally.

Doctoral studies:

- The current problems for off-site PhD students need urgent attention and a rapid solution that works for everyone.
- Further integrate the international placement requirement with the PhD research in order to maximise its value and to strengthen international collaboration.
- Stimulate PhD exposure to a wider range of career opportunities
- Encourage (inter)national industry driven PhD programmes
- Provide some innovation / commercialisation training for all PhD students

Stakeholder interaction:

- Improve dissemination of results by lobbying for improvements to the advisory system.
- Increase involvement of growers by doing more "on-farm research".
- Create structured and planned two-way communications with stakeholders at all levels of society.

5.2. Estonian Research Institute of Agriculture (ERIA)

ERIA is a research institute under the Ministry of Agriculture, which is mainly specialised in applied research related to crop cultivation. It consists of four Departments: Plant Sciences, Agricultural Engineering and Technology, Plant Biotechnology and Agricultural products with a total of 43 researchers during the five-year period, on average about 32 researchers working per year.

5.2.1. Scientific quality of research

Science indicators

Researchers at ERIA produced it total 347 publications over the evaluation period which makes nearly 8 publications per researcher which is a low number compared with international norms. The number of high-ranking scientific publications was extremely low (15 publications for the institute in the entire evaluation period or about 0.3 publications per researcher).

At the moment there are significant differences among departments in their ability to produce high-ranked scientific publications but even the best department produced less than one high ranking publication per researcher on a yearly basis, which is low as compared to international standards.

The main priority in terms of publishing has previously been given to articles targeted to local farmers but in 2007, a new strategy was implemented to increase the number of scientific publications, and in the end of the evaluation period the Institute contributed to 6-7 high-ranking scientific articles per year. However, only 9 articles from 15 had ERIA researchers as first author, and some departments made little contribution to the scientific publication strategy.

Besides publications the institute also delivers web-based decision support (DDS) for integrated pest management and databases with information about agricultural machinery. The DDS is in Estonian and it has not been evaluated.

There has been no tradition for IP protection at the Institute but during the end of the evaluation period the number of patent applications has increased. A total of 12 patent applications have been submitted during the evaluation period and 2 patents have been awarded.

The research has innovative elements and is seems closely linked to farmers' needs even if there is no formal record about this. The institute is active in organizing national conferences and field days for farmers and advisors.

The main weakness of the institute is the extremely low number of scientific publications. The main reason for this is that there previously has been no tradition for scientific publication and that the Institute is just in the beginning of a transition period. There is, however, no doubt that the research quality has to be further improved. This is crucial for the long term survival of the institute. Without scientific publications, the Institute will lose creditability and opportunities to participate in projects with national and international partners. It also will become increasingly difficult to attract qualified researchers. The Institute already has lost some opportunities due to the exclusion from the targeted funding programmes and it has already experienced some difficulties in recruiting qualified researchers.

The interviews revealed that some researchers at the institute have the opinion that scientific writing is not a part of their project obligations, which means that it more or less becomes a private issue. This attitude is detrimental and there is a need to make the causes transparent in order to change the attitude. However, the Department of Plant Biotechnology EVIKA is moving into modern molecular methods and researchers are becoming more positive to scientific publishing.

Multi-disciplinarity

Many topics covered by the Institute are not directly linked to scientific disciplines and researchers often cover several topics, which are not closely linked to a specific discipline. For example, all aspects related to crop protection are covered by only two researchers even though Estonia is working on implementation of an EU directive about sustainable use of pesticides, which includes development and introduction of integrated pest management and alternative approaches and techniques in order to reduce the use of pesticides.

There exists internal and national collaboration and the Institute is participating in EU funded projects. The most important national partner is Estonian University of Life Sciences, which also may be considered a competitor because the university also covers applied research issues and has close links to the agricultural sector. However, there is still a great potential in developing internal cooperation between departments.

The degree of multi-disciplinarity is varying within the Institute with the Department of Plant Biotechnology EVIKA and Department of Plant Sciences representing the extremes, which the latter as a true multi-disciplinary group.

The level of international collaboration was close to non-existent at the beginning of the period due to a narrow focus on Estonian agriculture. However, later during the review period international collaboration has been initiated as part of a new strategy to strengthen the international linkages.

Overall, the scientific quality is varying among departments but the general level of outputs falls short of international norms. The outputs in Estonian language are difficult to evaluate and discussing the quality and relevance with stakeholders gave no clear picture.

5.2.2. Research environment and organization of research

Management

Strategic planning of the Institute was mainly driven by the Institute's struggle for improving the scientific quality and funding. Key components in the strategic plan are to offer knowledge based solutions to the Estonian agricultural sector, to develop facilities and to increase the research quality. However, one of the main challenges, the scientific output, is only vaguely addressed in the strategic documents, which mainly address the needs of the main funder (MoA). The strategy is mainly to hire young scientists and enrol them in a Doctoral programme. This strategy, however, requires a continuous expansion of funding and there seems to be little reflection about how shortage of funding will influence the strategy. The strategy includes no considerations about how the Institute will develop a unique scientific profile.

The board of the Institute did not meet during 2011, which clearly shows a lack of strategic thinking and stakeholder involvement.

The institute has very low core funding (about 15%), which goes to management and infrastructure. Departments are 100% self-financing, which makes it difficult for the Institute and the departments to manoeuvre.

Lack of investments is a serious problem. Project-based financing results in lack of continuity and makes hiring young staff almost impossible even if high quality scientists are most needed. It was noted that it was difficult to attract qualified researchers and that the education level of new candidates from Estonian University of Life Sciences was low.

There does not seem to be a clear vision about the opportunities in changing the publication strategy, and there is no clear strategy to improve the performance of the researchers who are not enrolled in a doctoral programme. To some extent this is associated with the nature of the research system, which is based on project funding. The interviews gave the impression that the Institute seems to perceive the goal about scientific publishing as an additional burden instead of an opportunity to develop and improve applied science in new and international directions.

The institute appears in general not to be an active and strong player relative to funding bodies and policy makers, which means that it is under pressure. It also seems to have difficulties in competing with the Estonian University of Life Sciences within certain areas. Furthermore, it seems to have difficulties in developing a clear scientific profile.

Institutional environment

The strong emphasis on applied aspects to plant cultivation and the close contact to farmers contribute to the uniqueness of the Institute. There is, however, some overlap with JPBI and, to a smaller extent, with the Estonian University of Life Sciences.

The Institute is under pressure because it has difficulties to adapt to the new and more science based criteria for research and because the researchers have the feeling that their work is little recognized in the scientific community. The interviews showed that the researchers' motivation and commitment were certainly influenced by this fact. The researchers also gave the impression that the Ministry of Agriculture only has vague ideas about the modernization goals that have to be achieved.

The Institute is struggling with the aftermaths of the restructuring where laboratories, human resources and field trial equipment were moved to the newly founded Agricultural Research Centre (ARC). The Institute was supposed to buy services from the ARC but this arrangement does not work properly and the Institute is now trying to build up new facilities, which is questionable in terms of efficient use of scarce resources. Data flow between ARC and ERIA is very poor and there are a number of bottlenecks in the cooperation.

All in all the contentedness is far from optimal due to unclear goals and strategies, poor recognition and suboptimal infrastructure. However, the interviews showed that the staff is very active (applications and implementation) and researchers appreciated the friendly atmosphere within the departments and the absence of internal bureaucracy.

ERIA's English web-page (http://www.eria.ee/index.php?page=3) has not been updated for years within a number of subjects, which inhibits international collaboration. Lists of publications and projects have not been updated for years.

5.2.3. PhD education

PhD students receive qualified supervision from the researchers through informal exchange of experiences and ideas in a friendly atmosphere. The students are satisfied with the help they get and they consider it as a privilege to carry out PhD research at the Institute. The university supervisors play a relatively insignificant role in supervision, which is not considered problematic by the students.

In order to improve the scientific quality of research, there are efforts to hire 2-3 young researchers per year under the condition that they are enrolled in a doctoral programme. This means that PhD students only can use about 50% of their time on their PhD projects because they also have a number of obligations to the Institute. In consequence, the average duration of a PhD study is about 6-7 years. Students are encouraged to study one semester abroad, and they were contented with their study conditions.

The collegial atmosphere within the research groups that facilitates some aspects of learning but the relatively weak scientific educational level among researchers may impede other aspects such as scientific thinking. It is obvious, that many researchers do not incorporate scientific publication in the early stages of project planning, which is required in order to be able to produce scientific publications from applied research projects. This attitude is partly triggered by the evaluation criteria for applied research proposals but has the consequence that much of the work conducted is not subject to proper independent peer-review.

5.2.4. Interaction between research and society

Farmers certainly have some influence on research priorities through informal contacts to researchers and through participation in research programme committees. The state interaction is through personal contacts and research programme committee meetings but it is difficult to evaluate the quality of the interactions.

Dissemination is through articles, web-based decision support systems and databases, conferences, field days and personal contacts between farmers and researchers. To a certain extent researchers act as advisors but this dissemination is informal and difficult to evaluate and there are significant differences between departments and groups. It is highly dependent on the individual researcher.

The impact of research on society is difficult to evaluate due to the fact that one of the key value components of applied agricultural research is reflected in farmers' practices and ability to adapt to new contexts. One crucial key element in applied research is that knowledge and other outputs are disseminated to the end users. The created knowledge should be transparent and available for the end users. To achieve this, a well-functioning advisory system has to be in place, which can create a two-way link between applied researchers and farmers. This is apparently a weak point in the knowledge dissemination, which most likely reduces the value of the research for the society.

ERIA works to establish an innovation centre, which may strengthen links between the Institute and the sector.

Relevance to "plant and soil science" in agriculture

The Institute is exclusively focused on agriculture and it is obvious that the researchers are aiming to develop the agricultural sector. The applied approach to agricultural research is important to evolve the Estonian agriculture, which justifies the existence of the Institute.

5.2.5. Recommendations

- The value of the Institute's research for the Estonian agriculture justifies that targeted efforts are made to strengthen the Institute.
- A reorganization of the Institute under the Ministry of Agriculture and the Agricultural Research Centre (ARC) should be considered.

Scientific quality of research

- The output of high ranking scientific publications has to be significantly improved because this is a main weakness of the Institute.
- Recruiting young researchers and enrolling them in a doctoral programme should be stopped and main emphasis should be on the education of students that are enrolled in a doctoral school.
- There should be a strong encouragement in the whole research environment to improve the scientific quality.
- There should be targeted resources for scientific publishing, training programmes of existing researchers, and enhanced collaboration between researchers with and without experience in scientific writing.
- It should be clearly recognized that a new publication strategy has implications for funding, planning and implementation of research projects.
- Recruitment strategies for talented researchers should be elaborated.
- A review process for the Institute's total performance based on other than high-ranked scientific publications should be set in place.

Management

- Management should be strengthened in order to cope with the external pressure and stakeholders should be actively involved in strategic planning. The management should clearly address the low scientific performance.
- Web page should be updated.
- Problems with data flow and practical cooperation between ERIA and ARC should be solved.

Doctoral training

- Performing other tasks than PhD research and training by PhD students should be strongly limited (< 20%).
- The duration of PhD study should not exceed 5 years.

Interactions between research and society

- The Ministry of Agriculture should formulate a clear vision for the Institute.
- The board of the Institute should play an active role in strategic planning.
- Stakeholder involvement should be strengthened.
- Interactions with the advisory system(s) should be elaborated.

5.3. Jõgeva Plant Breeding Institute (JPBI)

Plant breeding at Jõgeva was founded in 1920 as an institution dealing with breeding of field crops and agrotechnology studies of field crops in Estonia. Today, the Jõgeva Plant Breeding Institute is the state research and development institution under the supervision of Estonian Ministry of Agriculture dealing with plant breeding and applied plant sciences.

Institute structure is defined by seven departments: Department of Cereal breeding; Department of Forage crops breeding; Department of Potato breeding; Department of Vegetable breeding; Laboratory of Biochemistry and resistance; Gene Bank and Department of Technical service.

JPBI has 105 employees, among whom 24 are academic researchers. The research activities cover applied studies of plant breeding, preservation of genetic resources, quality of plant production, plant protection, bioenergy, organic production, seed production and product development.

The main areas include practical breeding of agricultural and horticultural crops (winter rye, winter and spring wheat, barley, oats, field pea, potato, vegetables, forage grasses and legumes), applied research on agro technical aspects and seed production of agricultural crops and on genetics and heritability of valuable traits, selection and description of genetic resources. The official Estonian gene bank for seed propagated crops belongs to the institute and together with other units constitutes the Estonian National Program for Conservation of Plant Genetic Resources.

Commercial activities of JPBI include maintenance breeding, production of breeder's seed, production and marketing of certified seed and representation of varieties of foreign breeding companies, and collection of royalties according to intellectual property rights based on the Plant Variety Protection Act. Since 1920 JPBI has bred all together 285 varieties from 56 different crops. Several varieties bred at JPBI are cultivated in other Baltic and Scandinavian countries.

5.3.1. Scientific quality of research

Science indicators

Publications
The institute with an academic staff of 25 persons has a publication record of 10 publications in high-ranked (1.1 journals), which over 5 years (2006-2010) makes 2 per evaluated year. That is low for an institution with 25 academic staff making a contribution of 0.08 higher-ranked publications per person per year. The publications here are not in the highest-ranked journals. For other peer reviewed paper (1.2 and 1.3) the result is 0.38 publications per person per year.
Other types of publications are considerably better represented, altogether 277 over the evaluated period which gives 2.26 papers per person per year, mainly as popular articles in Estonian for domestic purposes. On top of that pamphlets and reports are provided. It clearly shows the role of JPBI as applied and not a purely academic institution.

IP protection
As a plant breeding institute the mandate of JPBI is to produce new cultivars of crops and to claim plant breeders' right. On the Estonian variety list for 2010, 66 varieties of field and vegetable crops bred at JPBI are reported. Over the period (2006-2010) the Institute has produced seven new cultivars, which have got variety protection. Two new varieties are released without variety protection and eight new varieties are in progress of registration for variety protection. The JPBI has agreements with foreign companies for marketing their varieties. The varieties of forage crops bred at JPBI cover >98 % of the Estonian market and for turnip rape likewise > 90%. For other crops the market shares are lower, but still considerable, e.g. winter wheat 32% and winter rye 38%.
One patent together with the Estonian Research Institute of Agriculture in Saku is reported.

Physical deliverables (variety, machine, design, process, system)
The varieties bred at JPBI are sold as certificate seed on the Estonian market and JPBI varieties are also marketed in Finland, Norway, Latvia and Lithuania.
The Estonian gene bank for seed propagated crops at JPBI provides material for research, pre-breeding and breeding efforts in Estonia and for other countries

Innovative nature of research
The plant breeding process in JPBI is implemented mainly through traditional breeding methods. Newer technologies like marker-assisted breeding and other biotechnological methods would considerably strengthen the breeding efforts and should be more widely applied.

Multi-disciplinarity

Internal collaboration
The evaluation panel observed that most scientists work in isolation. The organization of the work at the Institute where one scientist more or less alone has the responsibility for one crop with everything from long term planning to routine fieldwork is not optimal. Although the review committee accepts that this is mainly due to the funding system, it also concludes that the structure is a considerable hindrance for broader collaborations and development of new ideas internally and prevents the development of strong multidisciplinary research groups, where new ideas and new technologies could be incubated.

National collaboration
The national collaboration between JPBI and other organisations in the country seems well developed. There are strong links to the Universities, particularly with the Estonian Life Science University (with several groups and projects). With Tallinn University of Technology one major project was mentioned from both sides, but with TuT the collaboration could improve by developing more joint projects. The staff expressed a desire for more intense and organized collaboration with the universities in order to increase the efficiency of research and breeding as well as for the development of the own professional skills.
Particularly through the Estonian National Program of Plant Genetic Resources there are good links and collaborations with other partners, viz. the EVIKA group in ERIA, Polli Horticultural Research Station, and the Department of Gene Technology in TuT.

International collaboration
There is a broad commercial collaboration with foreign companies, e.g. Boreal in Finland, Nickerson in UK and SW Seed in Sweden and most researchers seem to have good international contact networks, particularly with neighbouring countries. Testing of foreign varieties is carried out at large scale. There is a generally positive opinion about the collaboration with the Nordic countries.

Contacts and collaborations with other countries should be strengthened. The staff requested more collaboration with universities in other countries.
The gene bank is working internationally and is represented in several international fora.

5.3.2. Research environment and organization of research

Management

Strategic plan and overall management
JPBI has a strategic plan, developed in consultation with research staff and stakeholders. This strategic plan is approved by the Board. The Board, consisting of 19 members (representatives from the government, stakeholders, own researchers and from other research units), is supposed to meet 4 times yearly, but in reality it has met only twice/year. The Board mainly deals with short-term decisions, next year's planning and yearly reports, etc. It does not seem to be active in long term strategic planning and major decision-making. The internal strategy and research direction is updated regularly and when needed by the institute management. The staff seems to have little influence on the overall strategy. At lower levels there is strategic planning for each project or each crop breeding programme.

Human resource management
There seems to be a strict hierarchical structure in the Institute. Although there is some collaboration among research groups, especially in the more recent research projects, the review committee formed the view that broader collaborations among staff members are desirable. The overall major problem is the frustration in the staff for the conflict of at the same time being an efficient, practical and commercial plant breeder with the goal to produce new varieties and to be a researcher with the objective to produce good scientific results aimed for international high-ranking journals. The situation is even more complicated since several of the breeders are registered as PhD students at a university department. The staff feels that they have little support from the Institute management.

External oversight
The MoA as well as farmers' associations and other stakeholders have obviously a fairly good insight in the breeding activities in JPBI. The MoA should formulate a more precise mandate for the Institute.

Efficiency
Breeding is a long-term undertaking and its output can be measured by the number of released varieties and the share of own varieties in the domestic and foreign markets. The efficiency of the gene bank can be measured in the number of accessions maintained, production of freely available data of evaluation and other parameters and by providing the breeders with suitable material. In both respects JPBI seems to fulfil the norm in an international comparison. The broad portfolio of breeding projects in a large number of crops is a hindrance for a higher efficiency in the breeding. The utilization of gene bank material could be improved.

Institutional environment

Uniqueness / overlap
The mandate for JPBI is clear – it is a public plant breeding institution with the primary aim to provide the Estonian farmers with high standard, novel plant seed material. The gene bank at Jõgeva has the mandate to preserve domestic material of seed propagated field and horticultural crops. In

both respects, the JPBI is unique: no other Estonian unit has a similar mandate from the Ministry of Agriculture. In projects related to plant breeding and gene banking there is a fair collaboration, and seemingly no overlap, with other Estonian institutions.
JPBI also has other types of projects, e.g. use of site specific weather data and irrigation management in potatoes, and development of soya been production for valuable protein products. Funding is also received for testing of organic fertilizers and pesticides, which is not directly linked to the plant breeding activity. Here is an obvious overlap and competition for funding with particularly the Estonian Research Institute for Agricultural in Saku, a situation, which does not promote collaboration or optimal use of resources.

Perception of motivation and commitment
The breeders are highly motivated and interested in their work.

Contentedness / frustration
Like most other units of the present evaluation JPBI claims financial problems. In contrast to several of the other units JPBI has a commercial part with income from royalties (4% of the budget) and seed sales (37%). This makes JPBI somewhat better off than other institutions. The rest of the budget is through project funding. However, based on the earlier negative evaluation JPBI has been cut off the targeted Estonian funds. In order to keep the staff employed the Institute has expanded into new areas.
The largest frustration among staff is the difficulty to combine efficiency in practical breeding with high-level research and scientific publication. It is even more complicated since several persons of the staff are registered as PhD Students.

Infrastructure
The JPBI has 14 older buildings, most of them renovated and the space seems sufficient for the requested work but inefficient and labour intensive. It is not practical that scientists and project leaders are spread over different buildings. This seems to be one major obstacle for better collaborations between groups. A concentration on the JPBI campus would bring facilities together and improve collaboration. Another major constraint is the lack of modern laboratory facilities for molecular work to support the breeding process.
The demographic structure for JPBI is rather alarming with a high average age of around 50 years and few younger employees.

5.3.3. PhD education

Doctoral training

PhD supervision
A major constraint for the Estonian institutes, in comparison to the universities, is that they have no right to confer a PhD degree. It makes the question of supervision complicated. The senior scientists of the Institutes can at best be co-supervisors. Six persons are registered as PhD in JPBI (one person has recently graduated), and all of them expressed frustration over the lack of supervision. There should be better support from the own department and clearer regulations from the university (today it is mainly lack of regulations). The students get most help and support from colleagues and in informal discussions. This is clearly an unsatisfactory situation.
One scientist (the director) is co-supervisor for a PhD project at Tallinn Technical University.

PhD training
The students are mainly lacking the technical training and are mostly left on their own for project development. There is an obvious difficulty with supervision and lack of communication between institute and university how the situation can be solved. All courses are given on university campus and abroad. It seems rather *ad hoc* which courses the JPBI PhD students have a possibility to follow.

PhD duration
There are no figures for the PhD duration for the PhD students at JPBI, but based on their situation and age it is concluded that it is far too long.

International experience
All students, through their roles as plant breeders, have substantial international experience, taking part in conferences and visits to other institutions. Some have worked for periods abroad.

Co-working while doing PhD
All students are working full time as breeders and are supposed to make their PhD at spare time, which is an unacceptable situation for them.

Expectation and ambition
The PhD students expressed the wishes to the evaluation panel to finish their studies as soon as possible and after that to continue as successful plant breeders in JPBI. There are few incentives for applying for work in other places in Estonia or abroad.

5.3.4. Interaction between research and society

Value to society

Stakeholder input to research
There is obvious feedback from stakeholders to JPBI, mainly concerning the performance of released varieties, but also with suggestions of breeding goals and particular traits.

Dissemination to stakeholders
JPBI organizes yearly 7-8 field days and 5-6 information days for farmers with in total about 1000 participants every year. The Institute takes part in local open conferences and exhibitions in the country. The staff has some direct advisory tasks to farmers, not going through the official advisory system and the review committee observed some hesitation to work with the official advisory system. An interesting initiative is the participatory projects with farmers and organizations. Generally the dissemination of knowledge, results and material seems good.

State interaction
JPBI has a mandate from the Ministry of Agriculture for the breeding, and there is a dialogue with authorities. The panel has the impression that there should be a clearer and more focused directive (terms of reference?) from the government and more continuous dialogue about strategy and goals.
The gene bank has a close link to the government through the Estonian National Program for PGR. The general strategy and goals are formulated together with the Ministry of Agriculture.

Impact of research on society
The breeding activities of JPBI have since long been beneficial to Estonia. A great number of new varieties in many crops have been produced. The know-how of cultivation of the new crops is disseminated to farmers.

Relevance to "plant and soil science" in Agriculture
JPBI is entirely working with applied research and development in the field and the work has thus a high relevance to plant and soil sciences.

5.3.5 Recommendations

Major strategic considerations
Practical plant breeding is highly competitive and dominated by businesses in most of Europe. Large, multinational enterprises and smaller, regional, private companies compete for market share, and both operate in the Estonian market. JPBI, as a public breeding entity, has managed to compete well in the domestic market in Estonia, certainly for specific crops such as wheat and forage grasses. However, future competition may be even tougher so both the Government and the directorate of JPBI should carefully evaluate the present situation and make a strategic plan for future development in order to meet these new challenges.

- The mandate from the Government for the future tasks for JBPI should be clarified, preferably focussing on the plant breeding and gene bank activities.

- The portfolio of JPBI is quite broad with breeding programmes in many species. While much of this activity is of scientific interest and may be of value to society, the breeding activities for minor crops aimed at the domestic market is not likely to be commercially viable. A decision has to be taken regarding the societal value of this broad portfolio and its economic implication with regard to whether such activities need to be subsidised in the national interest or not.

- JPBI should receive a “fair” amount of core funding for the operations in plant breeding, not covered by commercial interests or project grants.

- JPBI has recently expanded its activities into new areas, e. g. testing of organic fertilizers and pesticides as a means of maintaining funding. This has caused non-productive competition with other institutions, diverts human and infrastructure resources from its main areas of expertise, therefore JPBI should concentrate on core activities and seek collaboration with other institutions.

Management and infrastructure
- A Board should be assigned with very clear tasks to take long term strategic and economical decisions and to be responsible towards the owner (Government). It is recommended that the board should not be too big and contain at least one member representing the Government as well as 1-2 foreign members, well experienced in international plant breeding business and company management.

- The Board and leadership of JPBI should consider internal reorganization in order to increase operational efficiency. Individual breeders seem to work in isolation. A reorganization will promote internal collaboration and a more efficient use of the competent breeding staff.

- The present separation of breeders and researchers in different buildings on the campus is unfortunate. The planned new building should considerably enhance efficiency and promote collaboration. The infrastructure plan should be realized as soon as possible.

Scientific improvement

- Plant breeding is an advanced science containing many components of basic as well as applied research. JPBI, as a public institution mainly devoted to applied science, should also in the future take an active part in research and improve its international publication record.

- All breeders should be trained in the latest developments of applied statistics.

- The collaboration with Estonian and foreign universities should be improved.

PhD students

- The leadership should create a scientific working environment in which it is possible to do a high quality PhD of international standard within a normal time frame. This will improve moral and help facilitate positive developments in the practical breeding operations.

5.4. Tallinn University of Technology (TuT)

The research groups at TuT that were evaluated were (Tallinn campus) Gene Technology (29 people under one Professor), Chemistry (17 people under 1 professor) and (Tartu College) Soil Biology (9 people under 1 professor). In total the review considered somewhere between 35 and 50 researchers depending on the counting used. In previous consultation with the chairman of the evaluation committee, it was decided to have no formal meetings with the Chemistry group, as they had almost no research directly related to agriculture.

5.4.1. Scientific quality of research

Science indicators

Overall the peer-reviewed journal publication output from the TuT groups reviewed was satisfactory in terms of quality but small in number compared to international standards. The number of researchers is somewhere between 35 and 55, and over the review period they published 60 papers in class 1.1 journals that they considered to be related to plant and soil science, which is lower than might be expected for a group of this size. For groups at the cutting edge of modern biological research with such resources to deploy this is a barely adequate output. Very few of these papers were clearly relevant to agriculture and the sub-speciality “plant and soil science”.

The other publications from the groups (95 declared) represent a good range of scientific dissemination but relatively poor communication to other potentially interested groups. The overall publication output for a group of researchers of this size was small compared to international norms.

The “Intellectual Property” (IP) policy of TuT is “… to encourage creativity and inventiveness in its faculty, staff and students… The outcomes of research at TuT are commercialized through patenting, licensing or by founding new companies.” When discussing these issues with the researchers and PhD groups on the main campus in Tallinn and at Tartu College there was no demonstration of clear understanding of the need for and potential of IP protection related to their research.

The alternative outcome of physical deliverables (such as plant varieties, machines, instruments, processes or systems) indicated a limited range of outputs that reflect the primarily “basic” research focus of TuT. International norms for technical universities would be for more deliverables in this category reflecting stakeholder requirements and the technology / engineering focus of the university.

An overall assessment of the innovative nature of the research being conducted at TuT suggests that there is a tendency to follow research trends and agendas set elsewhere rather than being an innovative trend leader

Multi-disciplinarity

Within the groups reviewed there was strong internal collaboration at the group level but little evidence of internal collaboration between groups, even on the same site. The Soil Biology group at Tartu College was particularly isolated and seemed to have almost no internal collaboration with agriculture-oriented groups.

The level of national collaboration associated with the groups at TuT seemed very good. All were involved in joint projects with other institutions in Estonia. Details of some of the joint publications noted in the self-assessment were not found elsewhere so it is difficult to evaluate the true strength of these collaborations. There was a tendency for greater collaboration with other universities than the research institutes, and the Estonian Agricultural Research Centre was also regarded as an important collaborator during the site visit (but it is not part of this review so its role in Estonian Plant and Soil Science research cannot be established).

While collaboration was good, it was rarely associated with the deployment to create truly multi-disciplinary projects, rather it focused on accessing specific technical resources and focused knowledge within the same disciplinary area. This probably reflects the funding and scientific ethos in the universities in general more than a culture of intentional institutional isolation.

The level of international collaboration was high in all groups. Most researchers had experienced a placement in a laboratory abroad and there were joint publications arising from these linkages. This should however be placed in the context that the more junior researchers reported that mobility was for training courses or not necessarily directly related to on-going research (particularly for PhD students, despite the fact that several PhD students were involved in joint research activities with partners abroad. The contribution to EU research programmes was relatively small given the high quality of infrastructure, specialist facilities and scientific reputation in the groups.

Overall, the scientific quality of the research groups is high, with interesting research being conducted, but the level of outputs falls somewhat short of international norms and there is a tendency to work in disciplinary-isolated groups that are trend followers.

5.4.2. Research environment and organization of research

Management

Strategic planning was driven by the university's planning, based on a principle of scientific excellence. While the university plan encouraged synergy ("…the mission of the university is to create synergy between engineering, technology, exact, natural, health and social sciences that promotes societal development…"), a response to this strategy at institute, department and group level was not obvious during the site visits. Nearly all the research discussed was single-discipline, basic research with no attempt (or comprehension of the need) to place within a broader framework of technological applications. At the group level the emergence of drivers such a food prices and EU environmental legislation was noted but there was no evidence that these had been integrated into strategic thinking at the institute, department or group scale.

From the point-of-view of agricultural science, and plant and soil sciences specifically, the internal organisation of the Soil Biology Group being associated with a remote campus specialising in building technology appeared to make no strategic sense to those in the university and was never clearly explained to the review group. This appears to be a significant deficit in the institutional management related to agricultural research that might be delivered by TuT. It was noted by senior leaders that there were perhaps too many sub-projects being pursued by the groups resulting in a lack of focus on specific issues and problems (disease resistance was an example given). This perhaps reflects the strategic focus on wining projects associated with scientific excellence at the expense of strategic purpose.

From the research point of view the human resource management policy to favour PhD students over other students at the university (as described during the introductory session) is perhaps advantageous for research, but is probably not long-term sustainable. Furthermore, there is a relatively small PhD student population (26 including the Chemistry group that did not engage with the site visit as they do not really do agriculturally related research), which is not consistent with international norms for 30 possible supervisors (professors, associate professors and researchers). However, the committee acknowledges that there were also PhD students not included in the reporting. The conditions for some PhD students, particularly at Tartu College were far from ideal because their PhD studies were managed on top of daily work, and possibly were not even related to daily work (similar to the research institutes), rather than being the main focus of their time.

At the individual researcher level there appeared to be no clear human resource management or policy. Few researchers expressed goals other than to retain employment within the 5-year cycle. There seemed to be little guidance or support beyond informal networks for career development and little consideration of flexibility or the range of options that proper scientific education should offer. There was very little expression of ambition. That being said, the researchers were clearly happy to be working in a modern environment with good equipment and had a clear focus on project completion and renewal.

The isolation of the researchers at Tartu College both institutionally and academically did not seem to arise from any clear strategic plan and should be addressed in the future.

The degree of external oversight of the groups was unclear and could not be properly established during the site visits. The formal structures of university review, peer review while competing for project funding, peer review publication, PhD examination, annual staff reviews and the 5 year recruitment cycle were effective in ensuring that the minimum standard of research and conduct were at or above international norms, but there seemed to be no formal external communications to facilitate strategic planning. For a technical university of this kind, a steering group at the department or institute level would be expected. There was little apparent direct stakeholder interaction or external academic oversight of strategic policy for the groups reviewed.

A strategic plan at the group, departmental and institute level, combined with external oversight might be useful to direct the research more towards socially significant research (while maintaining the quality ethos so valuable to the groups), to ensure a greater efficiency from the groups (i.e. more outputs per unit input) and to develop long-term contributions to research that go beyond answering short-term questions. A long-term perspective is missing.

Institutional environment

The groups at TuT were fairly distinct from other groups in Estonia. There was very little overlap with other groups. This ensured that each group had a clear focus on its activity, but there was a distinct lack of inter-disciplinary thinking and planning, and the Soil Biology group was more “isolated” than is desirable for optimum contribution to agricultural (or environmental) research in Estonia.

The motivation and commitment of all the researchers interviewed was exemplary and exceeded international norms. Despite workload issues for the PhD students and a lack of tenure track at lower grades, all researchers were unequivocally committed to their work and driven by an innate curiosity that was exceptional. Great care should be taken to preserve this culture in TuT as it is one of its most valuable assets. While the researchers were very committed, a sense of frustration could also be detected during the site visits. This arose due to uncertainty about their future careers, a lack

of autonomy, and probably (although not acknowledged by the researchers themselves) by a lack of long term strategic planning to give their work a framework and focus.

The quality of the laboratory infrastructure and the equipment available is at or above international norms (note, details of chemical analysis facilities, central to plant and soil science, were not made available but presumably are present with the Chemistry Group). There is no reason to believe that physical infrastructure is in any way limiting these groups. A potential problem for the future is the lack of availability of service personnel noted in the assessment documents. It is essential that the resource investment during the review period be followed up by a sustained maintenance plan to ensure that maximum benefit is derived.

5.4.3. PhD education

Doctoral training

The quality of PhD supervision for those students based on site was very high, particularly on the Tallinn campus in the Gene Technology group. The use of weekly lab group meetings, formal seminars, annual reviews, clear goals for success (3 peer-reviewed papers (class 1.1)) and one-to-one interaction with supervisor(s) was excellent. The only issue of major concern was the additional workload that students faced (which was greater than for other universities visited). It was not possible to formulate a view of the supervision of off-site PhD students as this was not discussed.

The training that PhD students received was student specific, but all students had to do courses in writing, research management and statistics. Following the interview sessions it remained difficult to ascertain how useful these courses were, but they were clearly operating at the level of international norms. Access to courses throughout Estonia and beyond was a distinct advantage and should be encouraged and maintained. The role of National Doctoral Schools was not raised by the PhD students interviewed, and did not feature in the thinking of the researchers either. A lack of critical thinking by the students also seemed to require attention, as there seemed to be a very significant reliance on supervisor judgement throughout the PhD study period. In the other Estonian universities visited there seemed to be a more rapid shift to independent thinking by the PhD students.

The opportunity for international experience for all PhD students was excellent and most had availed of the chances provided. The focus of international visits was additional training and presentation at conferences. There is some scope to increase formal collaboration through PhD placements but other international activity for PhD students is at the level of international norms. The integration of visiting PhD students into the laboratories was, however, poor, and such activity might be beneficial for future development and widening the worldview of the PhD students working in the laboratories.

The PhD duration, at around 7 years was too long and a cause of some frustration for the PhD students currently enrolled. Furthermore, the very small number of PhDs being completed (6 declared during the review period) suggests that the management of PhDs by these groups, while excellent from the personal points-of-view, is lacking from the institutional point-of-view. It was not possible to formulate a view of the duration for off-site PhD students, but there is no reason to believe it would be / is any different to that for on-site student.

The culture of co-working while doing a PhD is perhaps a necessary part of doing a PhD at TuT. At Tartu College all the PhD candidates were working full time so the PhD was fitted in around this

work. At the Tallinn campus of TuT all the PhD students were reliant on additional employment to varying degrees, but beyond the level of a small part-time job or a few teaching hours for extra income.
Such a situation is not consistent with international norms and was not found in the other universities reviewed. The strategic and operational management should be reviewed to evaluate whether a more efficient use of PhD student time could be beneficial and allow a shorter completion time for students.
Overall the expectations and ambitions of the PhD students were very limited. Nearly all of them had restricted their career plans to academic research and had little knowledge of alternatives. They gave the impression that the idea of working beyond an university, institute or perhaps for the government was a completely new idea to them. In addition, despite international travel, the worldview of TuT PhD students was very limited. This situation is directly contradictory to European policy for modern universities.

5.4.4. Interaction between research and society

Value to society

There appeared to be very little stakeholder input to the research being conducted by the groups reviewed at TuT. In the Gene Technology group there was a complete lack of comprehension among researchers of the concept of stakeholders having a say in setting the research agenda and there was no direct line of communication to permit such an interaction. The only stakeholder input to the research was through the committees / commissions / groups that specify research themes associated with annual project funding completions. During the review process it was impossible to assess the significance of this input to the research at TuT but from the agricultural stakeholder point-of-view this input seemed very small. For a technology university this level of interaction is far below international norms.

In terms of dissemination of research findings to stakeholders, this was almost non-existent. In the case of the Gene Technology group there seemed to be a belief that stakeholders could not possibly comprehend what they are doing (perhaps this raises the need for better scientific communications training?) and there was no comprehension of why such activity should take place. There was a muted belief that any dissemination could occur through collaborative partners.

The Soil Biology group was much better at dissemination, including TV appearances, popular press articles, a commercial interaction (peripheral to agriculture) and providing feedback to farmers who had permitted sampling on their land. There was a clear contrast here and little chance for one group to learn from another due to the academic isolation and the geographical separation of the groups working in agriculture related fields. In addition there seemed to be no formal channels for agricultural advisors to obtain, understand and use the research findings from TuT. For a technology university this level of stakeholder interaction is far below international norms.

Other than competing for funding from various state programmes, the interaction of the research groups with Ministries seems to be limited. This probably reflects the lack of agricultural or environmental focus of most of the research. Little influence with Ministries was claimed or described during the site visits, but the self-assessment indicates that the Gene Technology group had a significant role to play helping formulate GMO policy in Estonia. For a technology university this level of interaction is far below international norms.

Overall it was only possible to see a very small tangible impact of the research being conducted at TuT on the wider society of Estonia or beyond.

Relevance to "plant and soil science" in agriculture

Overall the focus was largely on “basic” biological science and there was little consideration of agriculture, its needs or those of wider society. There was some research in areas of importance to plant and soil science (e.g. powdery mildew) but this was the exception rather than the rule and the research groups were happy to admit this.

5.4.5. Recommendations

- Make a strategic decision whether TuT wishes to contribute to agricultural research in Estonia in general and plant and soil research in particular
    - If TuT does want to make a contribution:
        - Institute, department and group strategic planning is required to develop a meaningful contribution to the field
        - TuT should develop a multi-disciplinary area within agriculture in which it plans to be a leader and research trend setter
        - Develop a two way interaction with agricultural stakeholders
        - The Soil Biology group, as the only one offering any activity in the “applied” science domain should be closely integrated with the other groups in the university.
    - IF TuT does not wish to make a contribution:
        - The Soil Biology group should be encouraged to transfer to EULS (where it would belong were such a decision to be made) as its position and role at Tartu College are currently artificial and underproductive.
- Develop two-way stakeholder communications (needed regardless of decision above).
- Develop a PhD working plan that will:
    - Encourage at least 80% commitment to PhD
    - Increase number of PhDs completing
    - Completion within 4.5 years
    - Encourage critical thinking
    - Include IP and “innovation” training
    - Adherence to EU norms for doctoral training (research excellence; creativity; attractive institutional environment; critical mass; interdisciplinary research options; exposure to industry and other relevant work sectors; international networking; mobility), some of which are in place, other ones are lacking
    - Perhaps consider creating an “agriculture” doctoral school with EULS and TU?
- Increase publication outputs to international norms (while maintaining the current focus on class 1.1 papers and aiming for at least 2 other publication outputs per 1.1 paper)
- Close the gap between “basic” and “applied” research. This has been started at EULS and looks to be very successful. A technology university should not encourage this divide and has the necessary attributes and skills to offer systems-based research that is currently lacking. The biology groups of TuT should not be allowed to ignore the institutional strategic plan.
- Develop a policy to encourage thinking of the university in terms of its long-term tangible benefits to society rather than as an isolated entity that need not justify its existence.

5.5. University of Tartu (UT)

UT is a university with about 18,000 students, 3500 staff (of which 1700+ academic staff). It considers itself to be of relative high quality and has been highly ranked by external evaluators. Education is entirely in Estonian language until the BSc level, although it is possible to offer parallel programmes in Estonian and English. In the MSc and PhD programmes part of the teaching is done in English. Many of the best scientists in Estonia are working in UT. There is an open attitude towards change at least at the highest level of management. Most of the funding is grant based (and thus individual), the rector controls only about 1 MEuro per year. Research funding is about 43 ME per year, per individual research that is about 25% of the average for the EU. Currently UT delivers about 100 PhD graduates, but with an incidental peak of 160 in 2010. Facilities are generally very good thanks to the use of structural funds from the EU. The University produces about 2500 publications per year of which almost 1000 were ISI WoS. Given the number of research staff and the internal criteria for output that is on the low side. It is a national requirement that PhD students spend 1 semester (4.5-5 months) abroad working on a topic which is not necessarily linked to their own field of research. The evaluation team visited the Institute of Ecology and Earth Sciences, the Institute of Technology (including the laboratories of Biophysics and Plant physiology) and the Institute of Molecular and Cell Biology (including the laboratories of Plant Biology and Environmental Technology). The Institute of Ecology and Earth Sciences (including the Departments of Botany, Geography and Zoology) is active in the fields of botany, agrochemistry, soil sciences and geography, landscape ecology, plant ecology, soil biology, entomology, greenhouse gas emissions from abandoned peat reclamation areas, plant protection, plant uptake of contaminants and nutrient flows in water sheds. The laboratory of Biophysics and Plant physiology has an active programme on biochemical and biophysical processes in plants relevant to photosynthesis and the resulting metabolic processes and on stress tolerance. Also the laboratory of Plant Biology and Environmental Technology focuses on cell and plant metabolism. The evaluation team had the impression that the work of the Institute of Ecology and Earth Sciences was basic and useful, of high quality, but that it had limited view on functionality of the biodiversity. In their self-assessment some groups stress that their research is not agricultural in nature, whereas other ones do claim a direct link. The Institute of Technology and the Institute of Molecular and Cell Biology did world-class research on photosynthesis and plant stress, but this research was not embedded in an agriculture–oriented research strategy.

5.5.1. Scientific quality of research

Science indicators

Peer-reviewed journal publications

The relevant research field of the University of Tartu has produced 51 publications in the category 1.1. Many of these publications are world class and the group should be complimented for its publication strategy. It is difficult to assess the absolute level of productivity as scientists participating in the evaluation are working in fields other than agriculture as well. However the number of publications is relatively low when weighed against the volume of research input, although the number of ISI WoS publications seems to be comparable to the overall average number of publications per year per FTE of the whole university. The output per unit of research time lies somewhat below the standard elsewhere in Europe (about 2 ISI publications per researcher per year in addition to proceeding papers and other outputs).

Other publications
Also here the productivity in terms of output of other publications per staff member is difficult to assess in absolute terms. The impression is that the other research outputs in terms of papers were somewhat below the European standard.

The university claims that the standard output is 3 publications for a 5-year period, meaning that the output for the plant and soil sciences of UT should be about 90 publications (categories 1.1. and 1.2). The sum of the categories 1.1 and 1.2 is 62, which rises to 81 if category 3 publications are also included. The number of papers in other fields is unknown.

IP protection
All IP goes to the university. It is trusted for the leader to manage IP. The individual researchers do not seem to have an idea about how IP licensing is managed and there seems to be very little action going on. There is very little spin-off of the research.
However, there are state programmes for trying to get universities to stimulate economic development, but the researchers the evaluation committee has spoken to seem to think that the linking of their basic research should be managed at the UT level and is not their problem.

Physical deliverables (variety, machine, design, process, system)
Several groups have been active in designing their own processes, systems of measurements or equipment. Especially the unique and award-winning photosynthesis equipment developed by the Laboratory of Biophysics and Plant physiology should be mentioned.

Innovative nature of research
Researchers claimed that it is difficult to get funding for new research ideas, as projects are assessed on the basis of previous publications. Therefore, there is a strong tendency to keep doing things in which the individual researcher has a proven track record. There is also no innovation at programme level as the funding is very much individual based. Although the current funding system has its merits, it does not enhance innovation and certainly no innovation linked to industry partners.

Multi-disciplinarity

Internal collaboration
In most, if not all, departments there is very little internal collaboration, groups function as isolated units. The main reason is that the strategy is determined at group level, not so much at department level. Some departments have intergroup meetings including strategic discussions.

National collaboration
The general statement was that it is easy to collaborate with local governments and institutions but the MoA is usually difficult to interact with as it is rather late in communicating deadlines, etc. There are active collaborations with other universities as well as research stations in place and these seem to function well. The collaboration with SMEs is generally lacking and this hampers relevant innovation.

International collaboration
Although the evaluation team has spotted some participation in EU programmes, structural, international collaboration was generally lacking. There was also a complaint that EU funding involved much more politics and given the absence of politics in the national funding system this was considered an undesirable situation. Estonian researchers will have to learn to play that international game very soon.

5.5.2. Research environment and organization of research

At the individual level of the researchers and the PhDs there is a stimulating atmosphere with a lot of academic freedom. Due to the low rate of rejection it is easy to realize ideas and get funding to follow one's own interest. It is the strong impression of the evaluation team that the groups visited are well endowed with modern research facilities and equipment. The equipment available is at the level of the best groups in the world and should be considered as a very valuable asset allowing maximum performance in the near future. The organization of the research is less optimal. There is a general lack of programming of research at the level of the department and at the level of the institution, let alone at the national level. This makes the research fragmented and reduces its impact.

Management

Strategic plan

The central management has a clear strategy. That is not true for the management at the department level. The strategy there is very individual and fragmented and given the structure of the funding there is a tendency to continue in what you are good at. Individual groups have too many stakeholders to link with stakeholders in an effective way. In many cases we recorded disinterest in the ideas of stakeholders for research.

Many researchers feel that the grant system is working well and is functional. The system provides them with more freedom for the individual Estonian researcher than for example common within EU research programmes. This "framed freedom" is considered pleasant. However, with good ideas and good track record one can continue forever, the system does not stimulate entering new paths or innovation. Given the increase in student numbers there is a need and willingness to branch out, but there is not an urgency felt to diversify or change. Therefore, at the individual team level there is a general lack of dynamics and (pro-active) initiative.

Senior management considers the funding of the research too fragmented and they want to get a better control. Currently distribution is a per head count basis. They want to see this move to a research quality basis. There is going to be a change to the funding scheme so that a wider range of things can be studied and internal management can bring efficiency without losing funds due to head count loss. In contrast, the researchers of the Institute of Technology had the opinion that there is an umbrella missing but that that was not their fault or problem.

The quality gap between UT and industry is huge and there is no sense of opportunity for industrial contact and interaction. University people do not see themselves closing this gap.

Human resource management

There is a high level of interest in each other's activities and there are many opportunities for a university career track. The close association between the researchers and the MSc and PhD students guarantees a personalized approach that apparently assists in reaching a high level of personal satisfaction.

External oversight

There was no proof of a systematic consultation of external experts, for example through a Board of Trustees, which would allow a check of University level strategies.

Efficiency (outputs per unit input)
The productivity of the researchers of UT in terms of peer-reviewed journal publications is less than what would be considered normal elsewhere in the EU. At the same time, the amount of funding per individual researcher at ET is about 25% of the funding per individual EU researcher, suggesting that in terms of efficiency UT is doing relatively well. The average quality of the peer-reviewed papers in the UT groups investigated was exceptionally high, and most likely well above the EU standard.

Institutional environment

Uniqueness / overlap
In general, UT runs many research programmes that also could be carried out elsewhere in Estonia, for example by the EULS. Its reason of existence is not in its uniqueness of the research fields but in its competitive ability as it harbours many researchers who should be considered the top of the Estonian crop.

Perception of motivation and commitment
The researchers we have met were all highly motivated and committed. They all seem to love what they were doing and were perfectly capable of passing their enthusiasm on to the new generations of students and PhDs.

Contentedness / frustration
The level of freedom and the good chances of continued funding create a positive atmosphere. For the good scientist with good ideas and a good track record, Estonia is still heaven on earth. There were some worries about future systems of funding and about the low amounts per individual researcher.

Infrastructure
Most researchers from elsewhere would be jealous about the standard of equipment and facilities present at UT. It is really world class and therefore an important asset for high quality research. It also creates a responsibility to make the best out of it.

5.5.3. PhD education

Doctoral training

PhD supervision (on site)
The PhD students the evaluation committee has met were very satisfied with their situation and enjoyed their level of independence. That also included the foreign PhD students. Supervisors encourage independence but are always there to help. The supervisors themselves were also very much involved in the research, which created joint ownership and collaborative learning by practice. Managing the supervisor was difficult for most PhD students but they had an idea what was needed in order to do so. Inter-institutional supervision is an option. In general, the committee considered the PhD supervision on site world class.

However, there was not much of a structure in supervision and the terms of reference seemed to be determined by the individual supervisor, within the framework of the general demands of having three publications in order to be allowed access to the defence of the thesis.

PhD supervision (off-site)
There were too few off-site PhDs for a proper assessment.

PhD training
In general, the training of the PhD students was well organized. There were mandatory courses that were relevant within a PhD programme, such as statistics, scientific writing, language skills, etc. Students showed satisfaction with both the quantity and the quality of these courses. There were also options to go to other universities for additional training. International training is mandatory for each Estonian PhD and the UT PhD students were not given an exception to this rule.

It is not clear whether there are general terms of reference for a PhD. The committee had the impression that there was some room for freedom here and that the individual supervisor had an important say in this.

PhD duration (on site)
Most PhD students seemed to stay close to the four years, although the average duration was longer than for example at the groups of the EULS the committee visited.

PhD duration (off-site)
No assessment possible.

International experience
The PhD students the committee met all had international experience and that is considered to be an important asset. However, not all students gained equally well from this opportunity, because the work abroad was not always closely associated with the PhD topic.

Other activities during PhD
Most PhDs were very focused on getting the three publications out. Projects were individual based. There is no programmatic framework.

Expectation and ambition (world view)
Many PhD students are very narrow-minded in terms of their career track. They are focused on their PhD and on the following embedding in the university system but do not even get to see the possibilities of how to adjust to something else. The idea of creating their own jobs is completely alien to this group of students.

5.5.4. Interaction between research and society

Value to society

Stakeholder input to research
Researchers of UT do not interact with stakeholders in order to obtain new ideas about relevant research questions. Their programme is based on continuation of successful and productive research lines and there is no desire to explore entirely new fields unless induced by the need to branch out.

Dissemination to stakeholders
There is very little contact with non-scientists in general and that is certainly also true for farmers. The scarce contacts with farmers are unstructured. One comment was that it is nice to talk to farmers but it does no yield anything. One individual in landscape ecology had contact with NGOs and MoA and with research groups in agricultural research, but encountered obstacles in the MoA resulting in a slow communication process. The group of stakeholders is considered to be large and diverse and therefore difficult to approach. Moreover, follow-up is poor after initial contact.

State interaction
There was some, but not very well structured, contact with the MoA. Some contact is too late as the tender comes too late in the process for research tenders.

Impact of research on society
Researchers considered their work basic science and considered that a pre-requisite for a university. Researchers we met also had no need to be exposed to new scientific ideas as they were already in the front line of science and therefore created their own novel ideas. Moreover, the funding system does not support new ideas and the influence of authorities on research strategies is weak. The only driver for innovative ideas is the increase in student numbers. There was very little contact with potential users of research results. For example the world-renown photosynthesis group never had contact with those with applications interest. There was a general feeling that expertise should be maintained in the group. Staff mobility or student mobility were not considered positive elements.

Relevance to "plant and soil science" in agriculture

How focused is the group on agriculture?
The groups we met were very little focused on agriculture. At best agriculture created problems that were interesting to investigate (loss of soil biodiversity, nutrient cycling).

5.5.5. Recommendations

In general, the enthusiasm, commitment and scientific quality of UT staff are admirable. The PhD programme on site is of high quality and the students are satisfied with the programmes offered. There is also a quality guarantee system that excludes poorly functioning supervisors.
However, many groups work in isolation and have a strategy aiming at maintaining the status quo. This impedes innovation, renewal, synergy and sound competition. Some groups are also very little concerned with stakeholder interactions. This may slowly erode the licence to do research.
At higher levels of hierarchy there is no coherent strategy at all: research programmes do not seem to exist and synergy between research groups or departments is not searched for. This impedes inter- and multi-disciplinarity, important elements in the mission statement of UT. Higher management has the ambition to change this but currently lacks the tools, instruments and money to do so.

Therefore we recommend:
- UT should strategically choose not to be involved in agriculture;
- Interaction with stakeholders needs to be improved in general;
- IP activities need to be enhanced;
- Part of the research needs to become more market-oriented through private-public partnerships;
- Create urgency to co-innovate with SMEs;
- Enhance peer-review within and outside the university system;
- Enhance competition for funding;
- Enhance multi- and interdisciplinary programmes across departments;
- Stimulate staff mobility.

Regarding the PhD programme it is recommend to:

- Make terms of reference more specific and uniform;
- Structure external PhD supervision and training;
- Restrict PhD work to the PhD's own research like is happening in the best groups;
- Seek opportunities for international exposure in domain of PhD research only;
- Pay attention to societally relevant, non-research skills;
- Expose PhD students to career opportunities outside the own university and even outside research.

5.6. BiotaP LLC

Unlike other entities being reviewed BiotaP is a private company with no clear research agenda as part of its business plan. Following the site visit the view was formed that the business was delivering an analysis service to whoever could pay for it, and its financial motivation was service provision rather than knowledge provision, thus it is difficult to assess within the scope of the terms of reference.

5.6.1. Scientific quality of research

Science indicators
It is not possible to judge the company in terms of peer-reviewed journal publications as these are not a commercial motivator. The same applies to other publications.

BiotaP had a clear IP strategy, depending largely on secret know-how, with possible emerging patents to protect its market lead. The continued winning of contracts for analysis will be the proof of its scientific quality as a service company. The company had developed some in-house work flows that indicate its physical deliverables were comparable to those of similar businesses elsewhere in Europe.

BiotaP is not innovative in terms of research as it is primarily a service provider.

Multi-disciplinarity
BiotaP had good national and international collaboration in as much as state funded research projects were willing and able to pay for its analytical services. The concept of multi-disciplinarily does not really apply as the technology can be deployed in many ways, but from the company perspective it remains the same. The company was branching beyond agriculture, for instance contributing to research on forensic analysis.

5.6.2. Research environment and organization of research

Management
BiotaP had a business plan (not disclosed in detail) which defined a clear strategy for long-term sustainability as a business and employer. It was not possible to evaluate the human resource management, external oversight and efficiency.

Institutional environment
BiotaP represents a unique resource for Estonian agricultural research provided research groups can continue to afford to pay for its services. The company was very motivated and committed to its mission and seemed reasonably contented with the commercial environment in which it is operating. The company infrastructure seems excellent in its labs and offices on the TuT campus in Tallinn.

5.6.3. PhD education

BiotaP is hosting visiting PhD student to facilitate the personnel requirements for delivering on research contracts. This seems to be a successful interaction with the universities in as much as it is a commercial relationship.

5.6.4. Interaction between research and society

Value to society
BiotaP is interacting with potential investors and users (its stakeholders) to ensure a long-term sustainable business plan is in operation. In this sense stakeholder input to research is not a meaningful concept and cannot be evaluated. The value to society is the existence of a small business providing employment and creating economic activity. This culture is very much missing from TuT so as a demonstration is it very valuable and should be encouraged.

Relevance to "plant and soil science" in Agriculture
BiotaP is value in as much as it can provide analytical services to research groups that can afford to pay. Such services should be encouraged, and should be pressing for EU wide market share.

5.6.5. Recommendations

- Continue to provide a suitable policy environment for such high-tech innovation driven companies to prosper in association with the TuT campus
- Do not build research policy around the existence of such services in Estonia and in the private sector as their long term stability is not related to agricultural policy and cannot be guaranteed.

6. Overall assessment of plant and soil science in Estonia

6.1. Status and quality of research

With the exception of EULS, all other universities / institutions were viewed as falling behind international norms, but for different reasons. The quality of individual research and outputs such as papers from UT was exceptional and probably above international norms, but the total output lagged behind norms. A similar situation applied to TuT where the output was of high quality but unusually low volume for the number of researchers contributing to the review. The research institutes (ERIA and JPBI) had very poor quality as evidenced by class 1.1 journal papers, but scored much higher when considering other indicators indicative of the applied nature of their outputs. A serious reservation with ERIA in particular, but it applies to JPBI as well, is that in some areas peer review of the research is non-existent. This needs to be remedied immediately to ensure the long-term improvement of quality in these institutes. There is scope for publication of applied research in journals and other mechanisms are also available.

Overall, the tradition of long-term nurturing of researchers through PhD to independence has ensured that the quality of research being conducted is high but there is an under-performance in terms of the amount of outputs that are produced and the relative value placed on applied vs. basic research outputs.

6.2. Research environment and organisation

The three universities (TuT, UT, EULS) all provide high quality research environments. The physical infrastructure and equipment would be the envy of scientists elsewhere in the EU (and beyond). However this is let down in some cases by poor strategic management and human resource management. While each university has an overarching strategic plan, there is little evidence that this has any influence at the departmental or group scale in TuT or UT, but EULS is far better in this respect. The presence of the Soil Biology group at Tartu College seems unjustified and will be a long term impediment to its contributing to agricultural or environmental science in Estonia. The institutes both have quite serious deficits. ERIA suffers from poor internal structure of departments and variable quality of laboratory resources. JPBI has some good facilities but building modernisation will be important to its future development. A defined mandate and proper external oversight for both institutes is also necessary.

Perhaps the biggest constraint in the research environment is the structure that has resulted in the high quality of publication outputs but has created tight and inflexible working groups. Mobility between groups is relatively limited and institutional governance is almost impossible (as seen in the lack of implementation of the strategic plans at group level). TuT should give serious consideration to the issue of how to deploy its strategic plans within the biological domain in order to effectively deliver added value for agriculture and to play a proper role as a technology university within this domain and UT should perhaps give similar thought as to whether it should remain associated with agriculture at all. Its real contribution can be counted in terms of a single professor, which makes little strategic sense for the university and Estonia.

6.3. PhD education

The standard of PhD education within the plant and soil science domain of agriculture in Estonia is generally good but let down by some serious flaws. The supervision of off-site PhDs (both those working in Institutes and at other universities) is lacking. Such students are at a distinct and tangible disadvantage compared to the students integrated into research groups and permitted to work almost 100% of the time on their PhD studies. A proper system of on-site co-supervision needs to be put in place urgently.

The practice of being in full-time employment and a full-time PhD student is far from the international norm. Most of the world's top universities operate systems where PhD students are regarded as full time (unless registered part-time) and their studies are regarded as their primary goal while registered. There is a bipartite system working in the agriculture domain at the moment that is causing significant disadvantage to some students and is limiting the full potential of the system.

The loose link between PhD research and project based funding is also a difficulty across the sector. It gives rise to students not being able to focus on their research in many cases and leaves a degree of uncertainty in the groups affected. A further related issue of concern to the review group was a lack of focus during international placements. Nearly all PhD students interviewed had experience of working elsewhere in Europe or beyond, but much of this activity was only loosely related to their PhD studies. To maximise benefit to agricultural research, and plant and soil science in particular, the universities should ensure that there is a value-added benefit to each student's research programme arising from international placements.

The final issue that is unusual for PhD students working on problems related to agriculture is that the students do not necessarily see themselves as being part of "agriculture". Furthermore, elsewhere in Europe and beyond, research in the area of plant and soil science in the agricultural context nearly always has a strong link to environmental research (for example eutrophication from agriculture) which seemed to be completely lacking in many of the research groups and quite limited even in those groups for which the separation would seem impossible.

While the issues raised above are important, the main shortcoming with PhD education in the plant and soil domain of agriculture is the very limited expectation, ambition and worldview of the students involved. Elsewhere in the world PhD students consider themselves to be developing as leaders with highly valued, flexible skills. The students interviewed by the assessment panel showed little ambition, very little flexibility, had no expectations beyond working in the same group in the future and had almost no interest in the wider world. It is important that students (particularly those in the area of agriculture) gain an understanding of the importance of national identity in a European context and gain a more rounded and mature worldview.

6.4. Interaction between research and society

Compared to international norms the interaction between the research reviewed and society is very weak. This is particularly so for TuT and UT. EULS, ERIA and JPBI all do much better in this respect but fall short because they do not have proper systems in place for stakeholders to influence their strategic planning and activity and also lack any proper structured system for stakeholder dissemination (e.g. an advisory service). All institutes seemed to lack any structures that link environmental and agricultural research. The current system of individual contacts is not equitable as not all stakeholders have access to timely information and it does not account for the spatial

structure of many agricultural issues such a pest control (where dealing with a single farm in an area may not solve a problem).

The total focus on basic research at UT and, with the exception of one professor, lack of interest in agriculture means that it seems to play very little role in society in this regard compared to the size and importance of the university within Estonian financial and social structures. While TuT has a single, isolated group operating from Tartu College that has apparently good interaction with wider society, the other biology groups reviewed had completely rejected the strategic plan for the university and were operating as if not part of a technical university. If functioning properly, the groups at TuT should have a similar performance to EULS in respect to societal interaction because the nature of both universities is to bridge the “basic” and “applied” research divide.

In contrast the institutes (ERIA and JPBI) were evolving from an applied focus towards some basic research. What both lacked was a clear mandate to underpin their activities and the financial stability to be able to resist scrapping around for research funds from any source possible. The time spent on non-core activity (particularly at JPBI) was undermining the breeders’ ability to focus on their core activity and was causing a dilution of quality in that area. There is plenty of basic and applied research in breeding that this institute should be engaging in for public good but this is not possible when distracted by other non-core activity.

The biggest problem for the sector as a whole is the lack of a functioning agricultural advisory service in Estonia that could combine production, economic and environmental advice in a holistic package for farmers. If such a service were available and researchers were convinced to trust it, then many of the societal value issues could be eradicated provided research was being focused on problems of importance.

7. Recommendations

Value for Society

- The government needs to define a clear policy framework for agriculture and the environment in Estonia. Without this, it will be very difficult for research stakeholders (e.g. Ministries, farmers, processors, retailers, universities, institutes, European Commission) to formulate relevant ideas and policy related to research needs in Estonia.
- Much closer co-operation is required between agricultural and environmental stakeholders. This should start with government ministries and be developed in strategic planning for the plant and soil science domain of agriculture.
- The involvement of stakeholders in both setting the research agenda and using the beneficial results must be developed. This will require three developments:
    - Stakeholder training to understand their role in, and interaction with research;
    - Building strong representative groups for the various sectors with an interest in agricultural research that understand and value their interaction with the research community;
    - A functioning advisory system. At present dissemination of outputs is haphazard and unstructured. For agricultural research to deliver its full value to Estonian society a working advisory system is required and both farmers and researchers will need to learn to trust the system. A process of quality control will therefore be required.
- Researchers must be educated to understand that there should be an objective driving why research is undertaken. It is unsustainable for the research community and individual researchers not to ask the question "why should the government pay for my research?" Competition for resources and the eventual reduction of EU Structural Funds means addressing this issue should be planned rather than having a forced response at short notice.
- The current system of funding in the area is creating non-beneficial competition where groups and institutions are competing for funds to undertake research that is not consistent with their institutional mandate, capacity or policy. Competition should not be removed from the funding system but it should not be encourage in such a wasteful form.
- There is almost no industrial funding in the sector. This needs to be changed in order to support the social drivers for agricultural research (see points 3 and 4 above).
- There is a much unsophisticated understanding of IP, its management, worth and exploitation. Significant training at management and research group level is required in all organizations reviewed.
- All organizations have at least some excellent infrastructure and plans to develop further. This however needs to be placed in the context of making value added returns to the European Union.
- There is very little coordination of research activity across the sector. To maximize the value of infrastructure and human investment, coherent policy and management of these resources is needed at a national scale, with input from relevant stakeholders (see points 1, 2 and 3 above).

The "basic" vs. "applied" research divide

- There is a deeply ingrained understanding of the distinction between basic and applied research. There is also a learned value judgment that places greater value on basic research than applied research. The over-riding role of this distinction should be weakened to allow the research players to be more flexible and able to respond to a defined policy framework from government.

- The apparent belief that applied research does not require the same rigor and is not subject to the same peer-review is wrong and should be eradicated. The same scientific rigor must apply to all research if it is to be valuable to society.
- State funding for research should have clearly defined funding programmes that focus on basic research, translational research and applied research. All should be guided by State agricultural and environmental policy, research policy and stakeholder interaction. Success should be merit based using verifiable and peer-reviewed indicators for all programmes.
- Universities should encourage their agriculturally focused research groups to move towards "applied" research activity while retaining their core strengths and values in high quality "basic" research. Translational research programmes and interdisciplinary teamwork would be very valuable in this regard.
- The State's agricultural research institutes (ERIA and JPBI) should be encouraged to develop meaningful "basic" research in a planned manner that does not duplicate effort elsewhere and in collaboration with the universities.

Develop "Research Programmes"

- There is a need to manage agricultural research that is strategy lead rather than based on *ad hoc* projects with little planned interconnectedness and applicability.
- Research funding should be used to answer specific questions, developed by all stakeholders (see list above) rather than using an open topic based approach.
- Funding should be linked to national economic benefit / interest.
- There should be a coherent policy to reduce the research fragmentation that is found in the system at present.

Clearly define the role and operational control of the research institutes

- Both ERIA and JPBI should be given a clear mandate defining their activity and research functions. This should only be done once a national policy framework has been defined.
- The institutes could be offered reasonable core funding if they operate under the guidance of a meaningful and evaluated strategic plan (set once the national policy and planning frameworks have been defined).
- Appoint a Board of Trustees for each institute. In the short term, to oversee the recovery and re-establishment of basic standards, this should have at least 2 international members (1 head of a similar institute from elsewhere in the EU; 1 university academic with experience working in conjunction with such institutes) and other members should represent the government, various stakeholder groups and the researchers.
- Researchers in the institutes should have working and funding conditions that negate the need for "moonlighting". All activity should be defined and limited by the institute's mandate.
- A defined and peer-reviewed list of academic and non-academic performance indicators should be agreed for continuous assessment of performance. This list should reflect the need for the institutes to have their work internationally peer reviewed and its merit recognized by stakeholders.

The PhD education system

- An Agricultural Doctoral School should be formed. All PhD students associated with research groups funded by the agriculture related basic, transitional or applied research funding programmes should, early in their studies recognize and engage with the agricultural (and where appropriate environmental) significance of their research. Those working on basic research

should be educated on the context of its potential utilization and those working on applied research need to be educated in the fundamental basis of their work.

- All PhD students should be trained such that they reach basic EU standards for Doctoral Studies including:
    - research excellence (overall the current system achieves this)
    - creativity (further training in this area is needed)
    - attractive institutional environment (standard already met)
    - critical mass (defragment the system by focusing and rearranging research groups)
    - interdisciplinary research options (completely missing from the system)
    - exposure to industry and other relevant work sectors (very little activity in the system at present)
    - international networking (overall the current system achieves this, but in an unfocused way)
    - mobility (overall the current system does not widely support this, students are encouraged to remain in a very confined working space geographically).
- Consideration should be given to developing Professional Doctorates suitable for applied research in agriculture.
- Upgrade transferable skills training, particularly with a view to making PhD graduates suitable for employment in industry.

Researcher mobility within Estonian research

- Encourage greater consideration of the option for job flexibility.
- Encourage consideration of non-academic, non-public sector careers after graduating with a PhD.

8. Appendices

8.1. Appendix 1. Directive of the Minister of Education and research No 595 (14.07.2011): Approval of theme, participants, personnel and detailed organisation of the 2011 evaluation of agricultural sciences (changed at 15.10.2011).

Ministry of Education and Research

Directive of the Minister
Tartu *14 July 2011 No. 595*

Approval of theme, participants, personnel and detailed organisation of the 2011 evaluation of agricultural sciences

On the basis of Subsection 20^2(3) of the Organisation of Research and Development Act.

1. To organise the 2011 targeted evaluation in the agricultural sciences sub-field of the biosciences and environment field (hereinafter evaluation).

2. I assign plant production and related fields as the theme of the evaluation:
   1) Plant biochemistry, plant genetics and plant physiology (in the agricultural context);
   2) Agricultural ecology, plant production, horticulture, crop protection, phytopathology (including entomology, mycology and phytoparasitology), plant breeding;
   3) Soil science, agrochemistry.

3. I assign the following institutions as participants in the evaluation:
   1) Estonian Research Institute of Agriculture;
   2) Estonian University of Life Sciences;
   3) Jõgeva Plant Breeding Institute;
   4) Tallinn University of Technology;
   5) University of Tartu;
   6) BiotaP LLC.

4. I appoint the following members of the international panel responsible for carrying out the evaluation (evaluation panel):
   Roland Bothmer - professor at the Swedish University of Agriculture, panel chairman;
   Nicholas M. Holden - associate professor, Dublin University;
   Jesper Rasmussen – associate professor, Copenhagen University;
   Paul C. Struik – professor, Wageningen University;
   Felix L. Wäckers – professor, Lancaster University.

5. I approve the detailed procedure for executing the evaluation (appended).

6. This directive may be challenged within 30 days of publication, by filing a complaint with Tartu Administrative Court in accordance with the Code of Administrative Court Procedure.

/Signature/
Jaak Aaviksoo
Minister

To be issued to: participants in the evaluation, Ministry of Education and Research - research department, Archimedes Foundation Research Cooperation Centre, persons specified in the Minister of Education and Research directive No. 399 of 28 April 2011, "Formation of committee for preparing the 2011 evaluation of agricultural sciences"

Annex
APPROVED
by Minister of Education and Research directive No. 595 of 14 July 2011

Detailed procedures for executing the evaluation

1. The evaluation is carried out to provide information to the research community research and development institutions, research funding organisations, research policy planners and society at large regarding plant production sciences and the level, productiveness and influence of research fields related to plant production sciences. The results of the evaluation serve as an input for preparing research policy decisions and measures pertaining to plant production science and related fields, further development of the field, preparation of development plans and introduction of necessary changes.

2. The members of the evaluation panel carrying out the evaluation shall, before assuming their positions, sign a declaration of independence and confidentiality in the form approved by the authority organising the evaluation, and also undertake, after the end of the evaluation process, not to use or disclose to third parties any public or non-public information, such as data, documents and other information they learned or to which they were referred to in the course of the evaluation.

3. For carrying out the evaluation, the institutions participating in the evaluation shall submit, through the corresponding environment of the Estonian Research Information System, by 15 October 2011:
1) a self-evaluation report (including general information for the institution, overview of research and development activities, self-evaluation, overview of cooperation and activities aimed at the public) in the form published by the institution carrying out the evaluation;
2) data which serve as a basis for the evaluation (including personnel, research results, doctorate studies, infrastructure, research projects and financing).

4. The evaluation panel has the right:
1) to receive additional information necessary for the evaluation from participants in the evaluation, from the authority organising the evaluation, and the committee preparing the evaluation, formed on the basis of the Minister of Education and Research directive No. 399 of 28 April 2011, "Formation of committee for preparing 2011 evaluation of agricultural sciences" (hereinafter Steering Group)
2) to visit, for the purpose of obtaining additional information necessary for evaluation, the institutions participating in the evaluation, providing at least 10 working days advance notice.

5. The evaluation panel shall analyse, based on the information specified in clause 3 and 4 of this directive, the quality of research studies pertaining to the evaluation theme, the research environment pertaining to the evaluation theme and organisational structure of the institutions participating in the evaluation, the influence of the research and development activities related to the evaluation theme in society and their timeliness.

6. The evaluation panel may, as a working format, use meetings or, by decision of the evaluation panel other formats, and to involve if necessary experts who possess the information necessary for carrying out the evaluation.

7. The evaluation panel shall, as a result of the analysis specified in clause 5 of this directive, compile a report in which:

1) it gives an assessment of the scientific level of the research and development activities in the evaluation theme compared to the international level. Among other things, it shall:
- describe, assess and analyse the strengths and weaknesses of the research and development activities in the field;
- give an assessment as to the effectiveness of the performed research, including the share of scientific output compared to input;
- give an assessment as to the sustainability and integration with doctoral studies;
- assess cooperation with major domestic and international partners;
2) assess the importance and influence of research and development activities in the plant production field on Estonian society. Among other things, it shall:
- give an assessment as to the level and relevance of applied research and research and development activities;
3) give recommendations and make proposals with regard to further development and financing of research and development activity in the plant production field and for carrying out necessary changes in Estonia. Among other things, it shall:
- give recommendations and make proposals for developing the procedures for organising research (such as research programs in the field);
- give recommendations and make proposals for further developing research activities in the evaluated institutions;
- give recommendations and make proposals for ensuring sustainability of the research community.

8. The evaluation panel shall submit the evaluation report and other materials compiled during the activity of the evaluation panel to the authority organising the evaluation by 1 February 2012.

9. The authority organising the evaluation shall forward the report to the Steering Group for an opinion. The Steering Group shall submit the opinion on the evaluation report to the authority organising the evaluation within 10 working days.

10. The authority organising the evaluation shall forward the evaluation report along with the opinion of the Steering Group to the Ministry of Education and Research within five working days. The Ministry of Education and Research shall notify the institutions that participated in the evaluation and the Ministry of Agriculture of the results of the evaluation.

/*Signature*/
Rein Kaarli
Advisor to the research department
in the capacity of department head

8.2. Appendix 2. Terms of Reference for the Evaluation Panel and the Steering Committee

This document sets out the standard Terms of Reference applicable to the Panel.

Table of contents

1 Background and purpose
2 Definition of field to be evaluated
3 Organisation
4 International Evaluation Panel
5 Objectives of the evaluation
6 Evaluation criteria
    6.1 Quality of research and researcher training
    6.2 Research environment and organisation
    6.3 Interaction between research and society
    6.4 Panel recommendations for the future
7 Tasks, responsibilities and working arrangements of the Panel
    7.1 Desk research
    7.2 Site visits and interviews
    7.3 Confidentiality
    7.4 Conflicts of interest
    7.5 Publicity of the evaluation material
    7.6 Declaration
8 Timetable of the evaluation process
9 Coordination of the evaluation
10 Funding

1 Background and purpose

Discipline and research field evaluations in Estonia are one of the new elements in the long-term development of research and science policy in Estonia.

Estonian Ministry of Education and Research sees evaluations of scientific disciplines and individual fields of research as an important development tool for research and science policy. Their main purpose is to provide feedback to the scientific community and to funding agencies. Furthermore, they provide an opportunity for learning and development for all those involved. Evaluations inspire discussion and debate and help researchers and funding organisations to identify potential problems and areas of development.

In December 2010, the Commission of Research Policy decided that the quality and status of Estonian agricultural research done at the universities and at research institutes will be evaluated with respect to the international level. The present evaluation combines an external assessment by an international evaluation panel with an internal self-assessment exercise. The purpose of the evaluation is to support the future development of this research field. The main objectives of the external evaluation are: to examine the quality of the agricultural research of the R&D institutions during 2006–2010 and to provide recommendations on how to develop the research and researcher training of the field in future.

2 Definition of the field to be evaluated

The field to be evaluated consists of agricultural research and researcher training carried out by the following Estonian universities and research institutes:

- Estonian University of Life Sciences;
- Tallinn University of Technology;
- Estonian Research Institute of Agriculture;
- Jõgeva Plant Breeding Institute;
- University of Tartu;
- BiotaP LLC.

In correspondence to the Common European Research Classification Scheme (CERCS), the more specific research fields to be evaluated are:

- Plant biochemistry, plant genetics and plant physiology (in agricultural context).
- Agroecology, phytotechny, horticulture, crop protection and phytopathology (incl mycology, entomology, plant parasitology), plant breeding.
- Soil science, agrochemistry.

The evaluation should focus mainly on the research field, not on an institution, although this structure forms the basic tools for the evaluation and will be handled separately.

3 Organisation

The evaluation is commissioned by the Estonian Ministry of Education and Research. The evaluation is carried out in cooperation with the Estonian Ministry of Agriculture, Estonian Research Council, Estonian Academy of Sciences and Estonian Chamber of Agriculture and Commerce. The Minister appointed a Steering Group to lead and support the execution of the evaluation.

The members of the Steering Group are:
Ülo Mander – Chairman, University of Tartu, professor;
Sille Uusna – Deputy Chairman, Ministry of Education and Research, adviser;
Riho Gross – Estonian Research Council, Estonian University of Life Sciences, professor;
Külli Kaare – Ministry of Agriculture, Head of Department of Research and Development;
Indrek Reimand – Ministry of Education and Research, Head of Research Policy Department;
Roomet Sõrmus – Estonian Chamber of Agriculture and Commerce, Chairman of the Board;

A list of the invited Panel members, a list of the evaluation documents to be submitted and the Terms of Reference have been reviewed and approved by the Steering Group and the Minister of Education and Research.

4 International Evaluation Panel

The external evaluation will be carried out by an international panel of independent high-level experts.
The Minister of Education and Research has approved the following renowned scientists as members of the evaluation panel:
Roland Bothmer – Swedish Agricultural University, Sweden, Chairman of the panel;
Jesper Rasmussen - University of Copenhagen, Denmark;
Paul C. Struik - Wageningen University, Netherlands;
Felix L. Wäckers - Lancaster University, UK;
Nicholas M. Holden - UCD School of Agriculture, Ireland.

5 Objectives of the evaluation

The purpose of this exercise is to evaluate Estonian agricultural research and researcher training in the fields and institutions defined above in section 2. The evaluation period is 2006–2010, on which the future recommendations to be provided will be based.

The objectives of the evaluation are:

- To evaluate the quality of agricultural research in Estonia as compared to the international level:
    - To identify the strengths and weaknesses of the research;
    - To evaluate the efficacy of the research, i.e. how much output is produced in relation to the resources invested (including finances, personnel, research infrastructure);
    - To evaluate the quality and relevance of researcher training;
    - To estimate communication and collaboration with key partners at home and abroad.
- To estimate the significance of agricultural research to Estonian society:
    - To evaluate the relevance and quality of agricultural applied research and developmental activities in Estonia;
    - To evaluate the impact, involvement and implementation of research results on agricultural higher education, especially on doctoral training.
- To make suggestions and recommendations for the further development of agricultural research and research policy:
    - To make suggestions and recommendations for the further development of agricultural research policy in Estonia (i.e. specific research programs);
    - To make suggestions and recommendations for the further development of agricultural research in institutions being evaluated;
    - To make suggestions and recommendations to ensure the future supply of qualified academic and agricultural professionals in Estonia.

6 Evaluation criteria

The basic unit to be evaluated by the Panel is a university or an R&D institution.

The institutions are mostly interdisciplinary research environments. Each institution will be evaluated as such, but the focus is on the research field as a whole.

The Panel is asked to give:

- A written statement of the quality of the research, achieved results, academic contribution as well as doctoral training,
- A written statement of the quality and efficiency of the research environment and organisation,
- Written feedback about the interaction between research and society, and the impact of it,
- Recommendations for the future of the research field.

The main emphasis is on evaluating the academic research. The Panel should ensure that the evaluation takes into account all relevant materials available.

6.1 Academic quality of the research

The Panel's main role is to evaluate the quality of research and researcher training. The quality statement is based on the evaluation documents submitted by the institutions. Panel members will have the opportunity to complete this information during their site visits. All research, whether basic or applied, should be given equal weight. The quality statement must reflect the work of all the research staff listed in an institution.

Important issues to be considered include (if relevant):

- What is the international quality and status of the institution's research?
- What are the competence and cooperation relationships of the institution?
- What is the significance of the research (projects) to the professional promotion of the researcher's or professional's career?
- How innovative and challenging is the institution's research ?
- What is the impact and status of the research within each research field?
- What is the role of agriculture and research interaction in research and researcher training?
- What is the significance of research including agricultural productions or products?

6.2 Research environment and organisation

The evaluation deals with research environments, prevailing research practices and collaborative networks.

Important issues to be considered include:

- What kind of research environment facilitates the research in terms of funding, infrastructure and mobility (strengths, weaknesses, needs for improvement)?
- What is characteristic of the activity, management and administration in the field?
- Are the national and international networks sufficient (universities, research centres, enterprises)?
- How does the research interrelate with the strategies of the organisation?
- What is the role of interdisciplinarity within the research fields?
- What is the quality of the researcher training and its organisation?

6.3 Interaction between research and society

The Panel is asked to write feedback about the interaction between research and society. The feedback is to be based on all evaluation documents as well as interviews. The Panel should especially consider other activities such as expert tasks, productions and exhibitions, communication of research results to the public and the agricultural community, technology transfer and cooperation with other sectors of society.

The questions to be asked are "How actively and efficiently does the institution communicate its points and findings to various stakeholders and the rest of society and in what way does the research of the institution contribute to society?" The Panel should consider this issue from the point of view of, for example, development of agriculture, use of novel technical solutions and innovations, the impact the research has on practices. The Panel is asked to discuss the interaction between the research of the institution and society from relevant aspects.

Important issues (if relevant):

- How fruitful is cooperation between the institution and the various actors of society, and what kinds of results have been achieved?
- Is the research of the field relevantly focused with respect to the future scenarios of national as well as international developments?
- What is the academic and non-academic (business, R&D, administration,) need for research doctorates in the field, and how well is it met with the current intensity of doctoral training?
- In case of innovations, how are the results of research transferred to industrial producers and partners who are able to develop new products for the market and society?
- Is sufficient and systematic effort made to find suitable collaborators for the commercialising and visibility of productions and innovations?

6.4 Panel recommendations for the future

The Panel is asked to provide recommendations for the future development of the research field. The Panel will need to consider that the recommendations should be focused on the research field and on the single institutions.

Key issues to be addressed are:

- What strengths and weaknesses does the field have in institutions and in Estonia; for example, is there missing expertise in certain sub-fields or overrepresentation compared to the total research volume?
- What opportunities and challenges does the field have?
- How should the field improve its performance in carrying out its research?
- What kinds of means could be recommended to improve and strengthen the research performance at various levels?

The Panel should provide recommendations on:

- Research representing single-, multi- and interdisciplinarity;
- Research including agricultural productions and products;
- Development of research: staff, environment and infrastructure;
- Strengthening the effectiveness and impact of the research on society;
- Development and securing of training and research enthusiasm;
- Suggestions on how to guarantee enough research-active staff in future;
- Other issues.

7 Tasks, responsibilities and working arrangements of the Panel

In conducting the expert evaluation, Panel members will base their examination on desk research at home on the basis of the background information to be provided. Ultimately, this will supplement their view during the site visits in Estonia.

Panel members will set responsibilities within the panel and together with the Archimedes Foundation. All evaluation documents are provided by the Archimedes Foundation.

7.1 Desk research

Desk research will be carried out before the site visits. The material includes facts about the research staff and funding:

- list of publications
- collection of the best publications of institution to be sent to Panel
- members by their inquiries
- list of doctoral theses
- lists of visits and collaborations
- lists of the most important non-academic work of the research-active staff
- self-assessment exercise of the institution.

7.2 Site visits and interviews

The site visits will consist of the following sessions:

- A session for presentations organised and selected by the institution
- Interview of a subset of researchers during the site visit, for example:
    - Heads of institutions (research)
    - Professors, senior staff, postdoctoral researchers, visiting foreign scholars
    - PhD students, junior researchers

The specific timetable and instructions will be provided by the Archimedes Foundation in due time.

7.3 Confidentiality

Panel members undertake not to make any use of and not to divulge to third parties any public or non-public facts, such as information, knowledge, documents or other matters communicated to them or brought to their attention during the performance of the evaluation. Confidentiality must also be maintained after the evaluation process has been completed.

7.4 Conflicts of interest

Panel members are required to declare any personal conflicts of interest. They must disqualify themselves if they can in any way benefit from a positive or negative statement concerning the research institution and research field under evaluation. They must also disqualify themselves in the following circumstances:

- They have close collaboration with the research institutions to be evaluated (e.g. have co-authored a scientific article, research plan or funding application during the past three years, or are planning to co-author one/some of these in the near future in research field being evaluated).
- They have acted as a superior, subordinate or instructor of the research institution during the past three years.
- A member of the institution in research field being evaluated is a close person to them. A close person is:
    - their spouse (also *de facto*), child, grandchild, sibling, parent, grandparent or a person otherwise especially close to them (e.g. fiancé/e or a close friend), as well as their spouses (also *de facto*),
    - a sibling of their parent or his/her spouse (also *de facto*), a child of their sibling, their previous spouse (also *de facto*),
    - a child, grandchild, sibling, parent or grandparent of their spouse as well as their spouses (also *de facto*), a child of a sibling of their spouse,
    - or a half-relative comparable to the above mentioned.

Panel members are also disqualified if their impartiality may otherwise be endangered, or if they feel that they have a conflict of interest and are therefore disqualified to evaluate the research institution.

Therefore, if they feel that they are unable to evaluate a research institution, they must notify the Archimedes Foundation as well as the other Panel members of it as soon as possible. The clarification of all conflict of interest matters must preferably be done during the first panel meeting.

7.5 Public availability of the evaluation material

The evaluation and the ratings are confidential and for official use only. Once the evaluation has been completed, panellists are required to destroy all evaluation documents and any copies made of them, or return them to the Archimedes Foundation. The evaluation report is confidential and only for official use until publication.

The evaluation report including the main recommendations is based on the evaluation criteria defined by the Ministry of Education and Research. The evaluation report will be written and edited by the Panel members (main responsibility of the Panel Chair) with the assistance of the Archimedes Foundation. Prior to final editing and publishing, the institutions being assessed are given the opportunity to review the report to correct any factual errors. The Ministry of Education and Research will publish the final evaluation report in both printed and electronic form.

7.6 Declaration

Accepting the task as a member of an evaluation Panel, I guarantee not to disclose the information I receive as Panel member and not to use it for anybody's benefit or disadvantage as it is stipulated in the paragraph "Confidentiality". Further, I affirm that if I have a conflict of interest I will immediately inform the Ministry as well as the other Panel members of it.

8 Timetable of the evaluation process

Time / Deadline	Activity	Institution responsible
15.08.2011	Making available self-assessment forms and other evaluation materials for institutions to be evaluated	Archimedes Foundation
01.10.2011	Sending background materials to members of evaluation panel	Archimedes Foundation
15.10.2011	Sending self-assessment forms by institutions being evaluated to Archimedes Foundation	Institutions being evaluated
31.10.2011	Sending self-assessment forms and other relevant evaluation materials to members of evaluation panel	Archimedes Foundation
20-27.11.2011	Site visits by evaluation panel	Archimedes Foundation, Institutions being evaluated
20.12.2011	Sending evaluation report to steering committee and institutions being evaluated for factual corrections	Evaluation panel
10.01.2012	Returning factual corrections to evaluation report to evaluation panel	Steering committee and institutions being evaluated
31.01.2012	Sending final evaluation report to steering committee	Evaluation panel
15.02.2012	Sending final evaluation report to Minister of Education and Research with proposals for monitoring and implementation of the results of evaluation	Steering committee, Archimedes Foundation

9 Coordination of evaluation

The evaluation process is operationally coordinated by Archimedes Foundation. The duties of the Archimedes Foundation are to compile the evaluation documents collected from the research field as well as to assist the Panel during the site visits and the report editing. The administrative support and assistance for the Evaluation Steering Group and Evaluation Panel as well as the practical details of the seminars and site visits are organised by the Archimedes Foundation.

10 Funding

The evaluation is funded by the Estonian Ministry of Education and Research. The Ministry will pay an expert fee to the Panel members.

All travel expenses related to the Panel's visits and accommodation in Estonia will be covered or reimbursed by the Ministry.

8.3. Appendix 3. Panel Members

Roland von Bothmer

Roland von Bothmer is professor of crop genetics and breeding in Swedish University of Agricultural Science and senior advisor of Svalbard Global Seed Vault. He received his PhD in systematic botany from Lund University in 1975. Since 1985 he is full professor, since 1994 he also has served as director of department, deputy dean and dean of faculty, deputy vice-chancellor of Swedish University of Agricultural Sciences. Since 2008 he collaborates with Nordic Genetic Resources Center concerning the Global Seed Vault.

He is member of Royal Swedish Academy of Sciences, Royal Swedish Academy of Forestry and Agriculture, The Royal Danish Academy of Sciences and Russian Academy of Agricultural Sciences.

During his career professor von Bothmer has been involved in research in plant breeding (particularly pre-breeding), diversity in wild and cultivated plants, conservation and utilization of plant genetic resources, taxonomy, phylogeny and genetic relationships particularly in horticultural and agricultural crops and their wild relatives. He is an author of more than 360 publications and has been supervisor for 25 students who have finished their PhD or licentiate degrees.

Professor von Bothmer is chief editor for *Journal of the Swedish Seed Association* and earlier member of editorial boards of *EUPHYTICA, GRACE* (Genetic Resources and Crop Evolution), *Hereditas* and *Chromosomes Today*.

Jesper Rasmussen

Jesper Rasmussen is an associate professor in crop science in Department of Agriculture and Ecology at Faculty of Life Sciences of University of Copenhagen. He received his PhD in agronomy from The Royal Veterinary and Agricultural University in Copenhagen in 1986. He worked as farm advisor during 1980-1982, as a senior scientists in The Danish Institute of Plant and Soil Science in Flakkebjerg from 1987 to 1997, and since 1997 he has been an associated professor at University of Copenhagen.

Prof. Rasmussen has been involved mainly in research within weed science with emphasis on mechanical weed control and in various subjects related to agriculture and especially organic agriculture. In recent years his research has been focused on the use of sensors and automatisation to determine weed control thresholds and to predict the best possible intensity of mechanical weed control. He is an author of more than 150 publications.

Paul C. Struik

Paul C. Struik is professor of crop physiology, Department of Plant Sciences, Wageningen University. He obtained his PhD with distinction in 1983 from the Wageningen University with a thesis on the physiology of forage maize in relation to its productivity and quality. Since 1986 he has been full-time professor responsible for teaching and research in crop and grassland science.

He has carried out research on forage crops, potato physiology, seed production technology, crop ecology and since 1986 also research on non-food crops. Recently initiated research projects include social and agronomic aspects of biodiversity in Africa, QTL based modelling of crop growth and quality, micronutrient husbandry, modelling electron transport in photosystems of C3 and C4 plants under stress, 3D modelling, and chain management of agricultural produce in Africa.

Professor Stuik has been a member of international review committees for institutions in the UK, Ireland, Sweden, Switzerland, and the Czech Republic. He also has been the principal organiser of many international scientific conferences.

He is an author of more than 300 scientific papers published in double refereed international journals, including 5 papers in Trends in Plant Science; more than 300 other scientific papers or papers for the general public; 15 books; more than 160 abstracts in proceedings / books of abstracts. He has supervised or is currently supervising about 90 PhD students, many of them working abroad on a variety of subjects.

Professor Struik is editor-in-chief of *Potato Research*, editor-in-chief of *NJAS – Wageningen Journal of Life Sciences*, editor of *Annals of Applied Biology*, member of editorial board of *Pflanzenbauwissenschaften*, editor of a *Frontiers* journal.

Felix L. Wäckers

Felix Wäckers is full professor and director of the Centre for Sustainable Agriculture in Lancaster University and director of R&D of Biobest Belgium. He received his PhD in entomology from Agricultural University Wageningen in 1993. Since 1988 he has worked as entomologist, plant protection specialist, assistant professor and researcher in different institutions in Europe and US. Since 1995 he is a full professor and since 2009 he is also working for Biobest Belgium.

He is member of the Entomological Society of America, Dutch Entomological Society, Dutch Royal Organization for Plant Protection, Chairman of the EU Learning Network for Functional Biodiversity and Regional coordinator (UK, the Netherlands, Belgium) for the International Symposium on Biological Control of Arthropods.

Professor Wäckers has worked on biological control, risk assessment of transgene crops, insect-plant-herbivores interactions and functional biodiversity in sustainable agriculture. He is an author of more than 100 publications in peer reviewed journals, 9 book chapters, 30 other scientific publications and 3 patents. Professor Wäckers also has organised numerous international symposia and has been supervisor for 13 PhDs.

Professor Wäckers is subject editor of *Biological Control* and member of scientific advisory boards of *Journal of Applied Entomology, Open Entomology Journal* and *Open Access Journal Insects.*

Nicholas M. Holden

Nicholas Holden, of the School of Biosystems Engineering, University College Dublin, holds MSc (University of Reading, 1988) and PhD (University College Dublin, 1992) degrees in soil science. From 1993 to 1995 he was a NERC Research Fellow at the University of Plymouth and Institute of Grassland and Environmental Research (UK). Since 1995 he has worked for University College Dublin as a Newman fellow, lecturer, senior lecturer and since 2006 as associate professor of biosystems engineering. He has served as deputy director of the UCD Life Sciences Graduate School, head of discipline for Biosystems Engineering and Engineering Technology and as director of the UCD Bioresources Research Centre. He is currently head of discipline for Agricultural Systems Technology and the school's head of Teaching and Learning.

He is member of the Soil Science Societies of Ireland, Britain and America, the American Society of Agricultural and Biological Engineers and the International Soil and Tillage Research Organisation.

Prof. Holden's research is in the areas of agricultural systems and soil science. Recent work has forged links with molecular biology, parasitology and ecology. He is an author about 100 refereed journal publications, more than 150 conference publications and has supervised 14 PhD students and 11 postdoctoral research fellows to successful completion.

Prof. Holden is an associate editor of the journal *Grass and Forage Science,* has been a joint editor for a special issue of *Soil Use and Management* and is an expert team leader for the WMO commission for Agricultural Meteorology team on agricultural decision support systems.

8.4. Appendix 4. Self-assessment Form

Evaluation of plant cultivation research in Estonia (2006–2010)
Submission Form

GENERAL REMARKS
All data in this self-assessment form should represent plant cultivation research (excluding in question G3) and should cover only R&D activities and R&D personnel (teaching staff and doctoral students are not included).

GENERAL INFORMATION
Institution (entity):
Address:
Phone:
Internet home page:
Head of the institution:
Phone:
Email:
Contact person for the Evaluation:
Phone:
Email:

G.1. Percentage that plant cultivation represents in the research carried out in the institution
(Calculations should base on proportions of research financing. This evaluation covers only agricultural research in the fields of plant cultivation. The fields of plant cultivation are defined in question G.2. In your institution there may be many other fields of science represented, but we ask you to give the percentage that plant cultivation stands for).
In the following questions, you are asked to concentrate only in this portion of research.

G.2. Institution's research profile within plant cultivation research (give estimate of the percentage)
(Calculations should base on proportions of research financing. The percentages should add up to 100.)

Research field	**(%)**
Plant biochemistry, genetics and physiology (in agricultural context) (taimebiokeemia, -geneetika ja -füsioloogia (põllumajanduse kontekstis)).	
Agroecology, phytotechny, horticulture, crop protection and phytopathology (incl. entomology, mycology, plant parasitology), plant breeding (agroökoloogia, taimekasvatus, aiandus, taimekaitse ja taimehaigused (sh entomoloogia, mükoloogia, taimeparasitoloogia), sordiaretus).	
Soil science, agrochemistry (mullateadus, agrokeemia).	
Total	**100%**

G.3. Other relevant fields connected to institution's research profile

(The interaction between plant cultivation and other fields are studied. Three levels are given:
1 - normal collaboration with joint publications;
2 - common scientific projects i.e. consortia;
3 - integration through scientists working in the group.
Mark with x the columns 1, 2 or 3. More than one column can be marked in the same row).

Research field	**1**	**2**	**3**
Biochemistry			
Microbiology			
Genetics			
Ecology, Biosystematics and –physiology			
Forest Sciences			
Food Sciences			
Research relating to the State of the Environment and to Environmental Protection			
Research into Substances Hazardous to the Environment			
Animal husbandry			
Veterinary Medicine			
Geosciences			
Biotechnology			
Other (field 1)			
Other (field 2)			

Comments. Max 1 page.
(Any comments about general information what could be useful for evaluators for better understanding of current situation of institution.)

1. THE INSTITUTION'S SELF-ASSESSMENT
(Self-assessment is an important part of the evaluation. Please answer carefully.)

1.1. Describe the development of/changes in the institution's scientific expertise, funding, facilities, organization during 2006-2010
(max 5 pages)

1.2. The institution's research strategy
(Relation to the institution's appropriate strategies, priority areas in research, development measures; max 3 pages.
Describe the institution's research strategy for the next few years, the key research objectives and means to achieve these objectives.

- *What is the role of basic and applied research?*
- *Is there need for new knowledge, facilities; is the present level of funding sufficient for attaining the objectives laid down?*
- *Do the strategies of the institution support each other?*

1. 3. The societal impact of the institution's activities
(max 2 pages. Describe here how the institution's research activities and cooperation with other actors in society have promoted the activities of other societal actors, e.g. industry of SMEs, professional unions, technology competence centers etc).

1.4. Assess the academic and societal need for doctoral training within the institution's research fields and the institution's role in doctoral training (if relevant)
(max 1 page)

Comments. Max 1 page.
(Any comments about self-assessment what could be useful for evaluators for better understanding of current situation of institution.)

2. NATIONAL AND INTERNATIONAL COLLABORATION

2.1. Most important national collaboration (max 10)
(List the most important national collaboration partners of the institution (max 10). Collaborator refers to a person or a research team with whom the cooperation has generated one of the outcomes indicated in item ETIS data "Outcomes of R&D activities". Types of collaboration include e.g. joint projects, organizing common scientific events (conference), and researcher mobility.)

Organization	Type of collaboration	Year

2.2. Most important visits abroad by institution's staff (minimum duration of visit: three weeks)
(List the most important visits of each year by country in the alphabetical order. In item "Purpose of the visit" indicate clearly the objective of the visit.)

Name	Target organization	Country	Purpose of the visit	Duration (weeks)	Year

2.3. Visits of the foreign researchers to the institution (minimum duration of visit: three weeks)
(List the visits of each year in the alphabetical order. In item "Purpose of the visit" indicate clearly the objective of the visit. Data should agree with ETIS data in section visiting researchers.)

Name	Home organization	Country	Purpose of the visit	Duration (weeks)	Year

2.4. Short but particularly important visits of the foreign researchers (max 5)
(List the short but important visits of each year in the alphabetical order (max 5). In item "Purpose of the visit" indicate clearly the objective of the visit.)

Name	Home organization	Country	Purpose of the visit	Year

2.5. Most important foreign academic collaborators (max 10)
(List the most important foreign academic collaboration partners of the institution (max 10). Collaborator refers to a person or a research team with whom the cooperation has generated one of the outcomes indicated in item ETIS data "Outcomes of R&D activities". Academic collaborators include universities and public research institutes. Types of collaboration include e.g. joint projects, organizing common scientific event (conference), and researcher mobility. In outcome section describe e.g. key joint publications, researcher training, adoption and use of new technologies or new approaches etc.)

Name and organization	Type of collaboration	Country	Year	Outcome

2.6. Most important non-academic collaboration and societal impact (max 10)
(List here the most important domestic and foreign non-academic collaboration, e.g. industry contacts, collaboration with different professional unions (e.g. farmers unions, different associations (e.g. Estonian Dairy Association), research-based in-service training, etc.)

Name and organization	Type of collaboration	Country	Year

Comments. Max 1 page.
(Any comments about collaboration what could be useful for evaluators for better understanding of current situation of institution.)

3. OTHER SCIENTIFIC AND SOCIETAL ACTIVITIES

3.1. Invited presentations in international scientific conferences (max 10)

(Most important invited international plenary talks, and other invited talks (max 10).)

Name	Topic of presentation	Name and time of the conference

3.2. Invited presentations and organized domestic conferences (max 10)

(Most important organized domestic conferences and invited domestic plenary talks (max 10).)

Organized conferences

Name and time of the conference	Main topic of the conference	Main target audience

Invited domestic plenary talks

Name	Topic of presentation	Name and time of the conference

3.3. Memberships in editorial boards of international scientific journals (max 10)

(Give only the most important memberships (max 10).)

Name	Journal	Period

3.4. Memberships in editorial boards of domestic scientific journals (max 5)

(Give only the most important memberships (max 5).)

Name	Journal	Period

3.5. Memberships in committees and in (advisory) boards of business companies or other similar tasks of no primarily academic nature (max 10)

(Give only the most important memberships (max 10).)

Name	Company/organization	Tasks	Period

Comments. Max 1 page.
(Any comments about other activities what could be useful for evaluators for better understanding of current situation of institution.)

8.5. Appendix 5. Data provided by the Estonian Research Information System ETIS

- **R&D activities:**
  - List and description (incl. project number, title, description, project leader, senior personnel, duration, financing) of R&D projects;
  - Summarized data tables.
- **R&D infrastructure:**
  - Number and total area of labs and other research related rooms and facilities;
  - List of most important equipment, apparatuses and instruments (up to 30 and advisably with minimum cost 10 000 euros).
- **Personnel:**
  - Names, positions and CV-s;
  - Summarized data tables by positions held;
  - Age structure table;
  - Defense of doctoral dissertations;
  - Implementation of doctoral studies;
  - Awards and recognitions.
- **Outcomes of R&D activities:**
  - List and description of publications by classification;
  - List and description of other R&D based activities;
  - List of most important publications (up to 30) with full text;
  - Number and description of patents, patent applications and plant variety right certificates.

All data are from period 2006-2010.
All sections have options for making comments.

8 Soola Str
Tartu 51013, Estonia
Tel + 372 730 0324
www.etag.ee
etag@etag.ee

Eesti Teadusagentuur
Estonian Research Council