Estonian Higher Education Accrediation Center

Joint Final Report

Research Evaluation on Genetics, Physiology, Micro- and Molecular Biology

Institutes evaluated

Chair of Plant Physiology, Institute of Molecular and Cell Biology, University of Tartu

Estonian Agrobiocentre, Estonian Agricultural University

Chair of Biochemistry, Institute of Fundamental and Applied Chemistry, Tallinn Technical University

Departments of Plant Physiology and Plant Genetics, Institute of Experimental Biology, Estonian Agricultural University

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1. The Evaluation Procedure

The panel evaluated the following institutes/departments:

- Chair of Plant Physiology, Institute of Molecular and Cell Biology, University of Tartu
- Estonian Agrobiocentre, Estonian Agricultural University
- Chair of Biochemistry, Institute of Fundamental and Applied Chemistry,

Tallinn Technical University

- Departments of Plant Physiology and Plant Genetics, Institute of Experimental Biology, Estonian Agricultural University

The panel obtained from the groups self-evaluation reports which were in general satisfactory.

The two main problems the evaluation panel faced were the diverse activities of the groups to be evaluated and the lack of knowledge of the various other research units in Estonia carrying out similar or complementing research. It was thus difficult to obtain a coherent picture of the scientific activities in Estonia and to make a fair assessment based on true knowledge of the actual facilities and resources available for the different groups in the Estonian scientific community. The history seems still living in many respects. Also the reorganisation of the scientific institutes and university activities is still strongly going on with various regional and science-political aspects. In this situation it would have been highly recommendable that the evaluators had been provided with a better overall picture of the situation. This would have helped to make more constructive

suggestions based on a more fair comparison of the competencies. It is still somewhat unavoidable that other than purely scientific merits at the international level are also considered. Furthermore, many of the units evaluated by this panel have emphasis on applied goals, and the assessment of their scientific merits is sometimes difficult.

The main emphasis for ranking of the research activities was based on the scientific achievements at international level.

The Panel followed the instructions provided by the Government of the Republic which were

- The novelty of the results of research and development
- The quality of research and development
- The strategy and perspective of research
- The competence of research groups and their capability for development
- Success in applying for funds and grants
- National and international co-operation
- The implementation opportunities for the research results and their importance to the Estonian society
- The correspondence of research and development to the international level

General Comments

Based on the self-evaluation reports, site visits and various discussions, the evaluation panel found the following general problems.

- Complex overall institute/department structures

  The historical scientific structures are still existing. This manifests itself as overlapping activities, improper names to describe the current and future activities of the units, and complex bureaucracy to keep up the current structures.

- Poor working conditions

  Despite the developments in a few units in Estonia, the overall working conditions including the buildings and other facilities are still unsatisfactory and probably also not in accordance with international standards for occupational health. The "polishing" that is currently occurring in some units to raise the level of working conditions is far from satisfactory. The units with poor conditions should realise that they will not attract young students, not to mention foreign scientists.

- Lack of qualified, and young personnel

  The lack of scientists with modern skills (e.g. molecular biology) creates additional competition between the groups who try to implement new skills to

their groups in order to achieve a good international level. The different Estonian research groups are not in the same position in this respect; those closer to teaching units and having good working facilities obviously have an advantage. The average age in some groups is also exceptionally high and the transfer of valuable scientific know-how to the younger generation is not taken properly care of. In some cases it also seems to be a problem that the more senior scientists with their own research interests cannot easily get education in the modern techniques. This possibility seems to depend on personal contacts to groups having the expertise or simply on financial conditions.

- Lack of critical mass

  Certain research activities in essential scientific areas are dispersed in different locations and are often "one-man exercises". Although the need to collaborate, unify activities to one location and build national and international networks has been realised, there are still groups/units who have not fully understood that this a necessity for survival internationally, and in particular in Estonia. Without a critical mass it is also difficult to create an attractive, inspiring and discussive scientific atmosphere.

- Insecurity

  It seems that the science and research policy of Estonia is not yet focused and the criteria for successful performance not established. This creates a situation where even the competent and ambitious scientists with the capability to improve Estonian science may disperse their activities to too many fields to ensure their future. This is unfortunate for the sound development of science in Estonia. Scientists who have shown their competence should have secured positions with reasonable salaries.

General Recommendations

- Plant research

Modern plant genetics and plant physiology urgently need molecular tools to complement the more traditional research methods. Therefore, the working infrastructure of plant scientists both in Tartu and in Tallinn should be reorganised. Close physical contacts with the Center of Gene Technology in Tallinn and with the Estonian Biocenter at Tartu University would guarantee that the modern developments, including DNA microarrays, proteomics techniques etc. would be on reach of plant scientists as well.

- Veterinary microbiology and diagnostics

  It is important for Estonia to support the activities and research in veterinary and food hygiene microbiology, particularly now when Estonia is entering EU and there is an alarming animal disease situation in Europe. This activity is directly related to the prospects to develop e.g. tourism and the export of animal derived food products, and obviously also to the health situation in Estonia. The existing knowledge should be retained and sufficient research and diagnostic developments supported in particular on topics specific for Estonia. Even routine activities need scientific expertise to ensure proper diagnostics and rapid response to urgent needs.

- Biotechnology and environmental research

  Biosciences and biotechnology will be extremely important fields also in the future and investments in these activities will create technological know-how and economic possibilities essential for Estonia. Likewise the need for environmental research is expected to increase. Research on the more technically and application oriented aspects of biosciences should be strengthened in Estonia to complement and create synergy with the more basic science and medically oriented activities. Teaching and research at the Tallinn Technical University in the biosciences and related technical fields should be supported and this should be done so that a good integration with the more basic and modern approaches is met. For instance, a natural synergy can be found with the Institute of Chemical Physics and Biophysics.

- Centers for education and research

  The points raised above lead to the general conclusion that efforts should be made to combine physically the currently dispersed and overlapping scientific activities into units which would create a critical mass, rapid exchange of new ideas and techniques, and better scientific synergy. Teaching should not be separated from research. This development should occur both in Tallinn and Tartu. In doing this, one should not forget the unique expertise found outside the centers.

2. Institute for Molecular and Cell Biology, Plant Physiology, University of Tartu

Senior Researchers

Agu Laisk, Vello Oja, Ülo Niinemets, Heino Moldau, Evi Padu

2.1. General Comments

Plant Physiology is one of the eight departments in the Institute of Molecular and Cell Biology in University of Tartu. The chair for Plant Physiology in its present state was completed in 1992 when the photosynthesis group of Prof. Agu Laisk moved from the Institute of Astronomy and Atmospheric Physics, Estonian Academy of Sciences to the University of Tartu. Physically, the Department of Plant Physiology is located separately from the institute while the other seven departments are located in the same building. This is reflected in the lack of direct access to various core facilities, which would be of utmost importance in development of the department into a modern plant sciences laboratory.

2.2. Evaluation of the Activity and Research

Till the end of 1997 the department clearly had two different research directions. One was devoted to the processes and factors determining the rate of photosynthesis in plant leaves. The other studied the role of cell wall ascorbate in ozone tolerance of plants. Both research groups were of equal size. Photosynthesis research group has, however, been more successful in competing international and national research grants and since 1998, the two projects have been jointly awarded by targeted funding under the title: Plant photosynthetic productivity and environment. As a whole, the group has pursued high quality research and has also been able to publish several articles in the best international journals (e.g. Plant Physiology) in the field.

Photosynthesis group has been mainly concentrated in whole plant photosynthesis with attempts to find out what determines the rate of photosynthesis in an intact plant. Scientific achievements obtained by the group are largely based on the development of sophisticated methods to study whole plant photosynthesis. The fast response gas and optical measuring systems are unique and allow in vivo studies of both the light reactions and carbon assimilation into various metabolites. More recently, the methodology has been applied into more applied environmental studies including elevated CO_2 and ozone stress. Studies with transgenic plants, on the other hand, have allowed addressing more detailed questions on the regulation of photosynthesis. An apparent drawback for the development of these latter studies is a lack of facilities and competent personnel to construct transgenic plants for their own interests. Indeed, even protein analysis, which would be important to complement whole leaf photosynthesis studies is not possible in the laboratory at present.

Photosynthesis group has been very successful in competition of research grants, both national and international, including a grant from the European Commission.

International collaboration has been extremely fruitful both in Europe and USA and includes several binational research grants.

Another group in the department has focused on cell wall ascorbate and active oxygen species in detoxification of ozone in the mesophyll cell wall of intact leaves. Although the group has been able to publish their results in internationally recognised journals, more in-depth molecular studies are needed to address relevant physiological questions.

A new research line in the department is ecology of photosynthesis, which was launched by the appointment of a productive person as an associate professor in 2000. This activity is not evaluated here since it has been mostly conducted outside the Department of Plant Physiology.

Research in the Department of Plant Physiology is mainly conducted at the whole plant level. Recent appointments in the department seem to indicate that the department is drifting away from modern plant physiology that would require combined efforts of whole plant physiology, plant biochemistry and plant molecular biology to reach a comprehensive understanding of plant functions and their response to the environment. This might also be a reason why young scientists and Ph.D. students do not find the department attractive at present. Moreover, the panel did not get a clear picture about the strategies and future perspectives concerning the development of science in the department.

Our overall evaluation judgement for the Department of Plant Physiology is **good.**

2.3. Recommendations

- The research pursued in the department is mostly very good and continuation of funding is strongly recommended. There is, however, an apparent need to reorganise the department to guarantee its survival and competence in the future. To achieve a functional and innovative infrastructure, the Department of Plant Physiology should be in close physical contact with the other departments in the Institute of Molecular and Cell Biology.

- There is also an apparent need to establish plant molecular biology laboratories inside the Department of Plant Physiology. Whole plant physiology in the department requires molecular and biochemical studies as well for the group to achieve an internationally leading position.

- The strength of the department lies now on photosynthesis research. It would, however, be important to have more diversity in the research topics in the department.

- The arrangements above would be a prerequisite to attract young scientists to develop Estonian plant science research.

3. Estonian Agrobiocentre, Estonian Agricultural University

Senior Researchers

Mihhail Sudakov, Raivo Lindjärv, Jüri Kumar, Ülo Pavel

3.1. General Comments

Estonian Agrobiocentre was founded in 1987 to take care of veterinary service of animal husbandry and part of food veterinary expertise. The tasks of the Agrobiocentre were the development of vaccines and serums, to adopt and develop serodiagnostic methods for diagnosis of infectious diseases of animals and to promote biological preparations for animals. The Agrobiocentre has a central role in veterinary microbiology. The zoonoses caused by mycobacteria, *Salmonella* spp., *E. coli*, *Pasteurella* spp. have also been important targets of research. Thus, it is an institute developing methods of diagnostics, prevention and control of animal diseases and zoonoses. It also carries out production of biological preparations, which at the time of the foundation of the institute was intended for the use in the whole Soviet Union.

3.2. Evaluation of the Activity and Research

The main themes of the research have previously (until 1996) been improvement of swine erysipelas vaccines and cultivation of microbes in fermentors, obtaining purified tuberculin for diagnostics and improvement of other diagnostics. The more recent research is dealing with molecular epidemiology of non-tuberculous mycobacterioses and studies on secreted antigens of *Mycobacterium avium.* The purpose of this project is to

adapt molecular methods for identification of mycobacteria more rapidly and precisely than is possible with conventional tests.

The groups have obtained grants from Estonian Science Foundation for basic research and funding from Estonian Innovation Foundation for applied research. The latter funding has been used to improve profylaxis and diagnostics of some zoonoses, to improve differential diagnostics and control in animal tuberculosis and paratuberculosis, and to improve PCR-diagnostics of foodborne infections. This support has been used to adopt molecular methods, and the laboratory has achieved an accredited laboratory status in mycobacterioses and tuberculin.

The research purposes as such (in self-assessment report) are well formulated and important for local farming in Estonia. The laboratory of mycobacteria has been accredited and the handling of pathogenic bacteria meets thus Estonian standards. However, the working conditions for pathogenic bacteria should be improved not only for the safety of the present working personnel but also for the laboratory to be able to attract young scientists and students. The equipments and facilities to carry out modern molecular biological methods, e.g. only one PCR apparatus, are not satisfactory.

Even taking into account the facilities, the international scientific output has been low. The scientific level of the Agrobiocentre is in its present form **satisfactory/ unsatisfactory.** Although the results concerning purely animal health questions in Estonia should be published in Estonian language, scientific results should be published in refereed journals in English. First steps towards internationalisation have been taken, and the laboratory takes part in an EU network. The laboratory is involved in two new applications to EU frame programmes. These activities should be strongly supported and encouraged.

3.3. Recommendations

- The thorough knowledge of Agrobiocentre on the animal diseases of specific importance for Estonia should not be underestimated. This experience should be delivered to younger scientists. The panel recommends that this area should be taken as a target for specific development to be able to handle tasks specific for Estonia but also to be able to struggle new possible threats. Control laboratories carrying out routine analysis may not be able to follow, apply and scientifically develop this area. Thus, it is important that scientific activities and education of experts exist in Estonia in this area..

- The panel also recommends that the know-how gained in the production of bacteriocins will be more efficiently commercialised, and separated from the research activities. However, it is clear that the economical possibilities (i.e. the areas needing these preparations are developing countries and countries of bad economical situation, such as Russia) are not promising. Possibilities to advance marketing could perhaps be explored together with international organisations e.g.

WHO, either directly or through EU.. In future the possible membership of EU may change some hinders, and it is important for Estonia to be prepared for that.

- It is important to strengthen the area of animal veterinary science and arrange more close physical and scientific co-operation with other related competent units.

4. Chair of Biochemistry, Institute of Fundamental and Applied Chemistry, Tallinn Technical University

Senior Researchers

Raivo Vilu, Peep Palumaa

4.1. General Comments

Chair of Biochemistry is a part of the Institute of Fundamental and Applied Chemistry of the Faculty of Chemistry, Tallinn Technical University. Other chairs are various disciplines of Chemistry. In the present form it was established in 1992, when prof. R. Vilu also started as professor. During 1992-1996 practically no research was carried out in the Technical University but was still carried out at the National Institute of Chemical Physics and Biophysics. At present a significant part of the research is carried out in this institute. The chair is responsible of the teaching of biochemistry and biotechnology. The main scientific research area is environmental biotechnology. In the chair, also research in microbial physiology, environmental sustainability calculations, protein structure research and food technology are being carried out.

The chair has obtained funding from the Estonian Science Foundation and targeted funding from the Ministry of Education. The staff has been active in promoting educational matters, and has had e.g. in altogether eight EU and TEMPUS projects. This, together with education load for relatively small staff has certainly had effects on the scientific output.

4.2. Evaluation of the Activity and Research

The institute considers the environmental biotechnology as the main research area. Anaerobic wastewater treatment is listed in the first place, and the target is set very high, to be a centre of excellence in the wastewater treatment. A good collaboration has been established with small companies in Estonia and abroad, and with several research groups in Sweden, Germany and so on. The goal is very ambitious considering the present

situation of the laboratory. The topic is important and suits well to the profile of a technical university, but without significant investments to equipments and e.g. a proper anaerobic laboratory this goal cannot be easily achieved. For example, the study of the action of the algal biopreparation described requires a thorough analysis of the physiology and sulfur metabolism of anaerobic bacteria.

Another main area of environmental biotechnology is phytoremediation, more precisely that involving bacterial plant root interactions. This part is a collaborative work with a Finnish group. An Estonian scientist recently obtained her Ph.D. thesis in this subject in Finland. The work dealt with rather fundamental aspects of genes involved in toluene metabolism (TOL plasmids).

Another new area is solubilisation of phosphorous by microbes. The planned treatment targets are phenol-containing soil in large ash mounds. As to the use of phosphorous from sludge from wastewater treatment plants, the safety precautions should be taken into account (i.e. heavy metals and other possible contaminants in sludge) when applying biofertilizers to fields used for food production. These aspects and the need of toxicological analysis should be added to the plan. Growth enhancing bacteria introduced to soil are being studied in some groups in various countries but their long-term efficiency in soil is often poor.

The third activity of the chair is focused on principles of quantitative assessment of sustainable development in Estonia. The calculations are based on the idea of "environmental space" and one of the aims is also to create taxation schemes based on these analyses. In addition to the co-operation of the groups mentioned it is important to include agriculture and forestry aspects to the plan, not clearly apparent from the plan. This activity appears to have had no funding according to the self evaluation report.

The Chair of Biochemistry reported to include also activities of Dr. Peep Palumaa who joined the institute recently. How he is currently and in future integrated to the Institute remained, however, somewhat unclear. He has had collaboration with good European laboratories (e.g. University of Zurich Switzerland, University of Munster in Germany, Karolinska Institutet in Sweden) and has been working abroad. His interest is in protein function, in particular metal binding proteins and their biomedical and environmental applications. At the Institute of Basic and Applied Chemistry at TTU he has been setting up bioreactor facilities for protein production for functional analyses. His expertise in biochemistry would be a good addition to TTU. More close integration e.g. to environmental biotechnology part of the work is encouraged, for example to study metals in the catalysis of the degradation of pollutants.

The scientific level of the research reported is **good/satisfactory.** Many of the results have been published in well-ranked international journals of environmental and related science. The group leader is active and internationally known.

4.3. Recommendations

- The practical work has been carried out in many laboratories which is not a satisfactory situation. Better facilities and scientific environment should be created at TTU. The scientific potential and resources of the Institute of Chemical Physics and Biophysics could be better utilised for the education of students and make the teachers load more bearable. That would also to raise the level of education and make this important research area more attractive.

- Concentration to only a few selected topics to achieve high scientific level is recommended. A natural topic for a technical university would be bioprocess physiology and engineering. These areas would also be a direct outcome of the previous activities of the group leader. This area could be the core of activities in future, but the laboratory should be equipped to be able to accomplish this goal. Continuation of funding for this group is recommended.

5. Institute of Experimental Biology at the Estonian Agricultural University

5.1. General Comments

Institute of Experimental Biology has been part of Estonian Agricultural University since 1997. This seems to be a very artificial marriage, not only because of the distance of 200 km between the two laboratories but also because of no common scientific goals or possibilities for co-operation.

Another aspect of concern is the isolated location of the institute. It is difficult to see how an attractive and creative atmosphere and infrastructure (including seminars, foreign visitors, attraction of young scientists) can be created in the present location.

5.2. Evaluation of the Activity and Research

We were impressed of the enthusiasm and high quality, at least partially, of the research in the Institute in spite of extremely difficult working conditions.

5.2.1. Department of Plant Physiology

Activity of the department is divided between two research groups. One is devoted to kinetics of photosynthetic carbon metabolism and the other to the secondary compounds of plants

Photosynthesis group:

Senior Researchers:

Olav Keerberg, Tiit Pärnik, Eevi Pärsim, Juta Viil

Expertise of the photosynthesis group lies in rapid measurements of photosynthesis and respiration by a radiogasometric method. For this purpose the researchers in the department have developed a unique device with a fast-response experimental chamber. By tracing ^{14}C labelled metabolites the group has been able to determine the rates of carbon fixation, photorespiration and mitochondrial respiration, which was further divided into decarboxylation of primary photosynthetic products and photosynthetic end products. This data on carbon fluxes is novel for scientific community. The group has also shown that blocking of photorespiration by downregulation of glycine decarboxylase gene in potato transformants did not increase net photosynthetic carbon gain. Quite surprisingly, the Keerberg group showed that increase in mitochondrial respiration fully compensated the decrease in photorespiration. Another, closely related line of research has been the modelling of the regulation of RuBP-carboxylase-oxygenase to find out the possibilities for enhancement of the carboxylation reaction of the enzyme. Both lines of research represent solid science and have yielded several internationally ranked publications.

During the evaluation period the group has pursued fruitful collaboration with Swedish researchers on the effects of cold hardening on photosynthetic carbon metabolism. Keerberg group has also been awarded with a European Commission grant 1997-2000 together with eight other European laboratories to study the control of photorespiration. International links have been maintained also by participating in several international congresses in the field of photosynthesis and respiration.

The Keerberg group has achieved admirable results under working conditions that are far from satisfactory. Evaluation group was particularly worried about the lack of proper working conditions with radioactive chemicals.

A real problem is a shortage of funding for chemicals and other consumables. Another serious obstacle for further development is the age structure of the group, and it is difficult to see how the department could attract young and enthusiastic researchers.

The scientific level of this group is **good**.

Recommendations

- It would be important for Estonian science to make sure that the expertise gained in this group will be transferred to the next generation researches. Funding of the research group should be continued. This research field would greatly benefit from transgenic plant technology and combination of these two research lines would be a way to reach internationally top level in photosynthesis research. It would be not only of scientific interest but will equally benefit the planning and future of Estonian agriculture. .

Group of secondary compounds and morphogenesis

Senior Researchers:

Ants Tohver and Lembe Laanest

This research group has adopted hairy root cultures (Ri-transgenic roots) as a method to produce secondary compounds in various plant species and to study morphogenesis. As the first attempts the group has studied alkaloid production in *Hyascyamus niger* hairy root cultures. Practical applications of the group are the micropropagation of various ornamental plants and bioreactor cultures for the production of important plant products in continuous mode. A small bioreactor has been constructed and used to produce peroxidases in horseradish hairy root cultures.

So far this research branch has been without focus. Micropropagation methods for various trees, bushes and ornamental plants have been set up and the production of hairy roots is functional in some species. The scientific goals and future perspectives of the project, however, remain unclear for the evaluation panel. The group has produced nearly twenty publications during the evaluation period but none of them has been published in internationally ranked journals.

Plant micropropagation is linked to purely applied purposes to produce woody plants for ornamental purposes and for reforestation of the fields. This activity in the Institute has been made possible by a grant from the Innovation Foundation.

On scientific basis the progress of this research group during the evaluation period has been modest and is assessed as **satisfactory/unsatisfactory.**

Recommendations

- If the group intends to continue the search of useful secondary compounds in hairy root cultures, a functional strategy must be established and it should also be evaluated whether the compounds to be produced have a sound possibility to compete commercially

5.2.2. Department of Genetics

Senior Researchers:

Tamara Enno, Oskar Priilinn, Hilma Peusha, Kadri Järve, Ljudmila Timofejeva, Sergey Tamm, Maimu Tohver, Hugo Remmelg, Irena Jakobson

The group focuses on development of Estonian and Scandinavian varieties of cereals through conventional and recently also using molecular methods. The main focus is on introgression of resistance genes from the wild Triticeae into cultivated wheat. At a moment the focus is put on cloning a full-length sequence of *Pm27*, a new powdery mildew resistance gene in chromosome 6B, discovered by the group. The other activities include identification of wheat storage protein alleles for baking applications and the development of a homozygous short-straw version of the Sangaste rye.

The group has good links to relevant institutes in Estonia: to the Jõgeva Plant Breeding Institute where cultivation and further breeding of the cereal varieties are carried out, the Technical University of Tallinn (TTU) where bread making qualities of flour are tested, and to the Institute of Chemical Physics and Biophysics on molecular biological and transformation techniques of wheat and rye.

The group has several interesting wheat varieties varying in their resistance towards powdery mildew and brown rust. They have also been able to classify the lines to young and adult stage resistance. Systematic characterisation of the lines using cytological, protein electrophoretic and molecular means and the correlation to genetic diversity, pathogen resistance and e.g. baking quality has - and will - provide a good collection of material for scientific and applied purposes also in the future. The group may have at hand a possibility to identify novel resistance genes. In this aspect, the group is at the same level as the rest of the world studying cereal pathogen resistance.

As a whole the group has made significant achievements and developments taken into account the resources and conditions available. The determination and scientific enthusiasm of many members of the group was obvious. The group has gathered wisely essential expertise for scientific and applied purposes through own efforts and collaboration, and built also a very simple but functional laboratory for molecular biological work. In particular, the collaboration with the Gene Technology Center at the Institute of Chemical Physics and Biophysics seems to have created a mutually beneficial situation. Thus, the group appears to have used "networking" successfully. Despite the very limited finances, the group members have worked certain periods abroad acquiring expertise. The group has however still limited contacts abroad and is not well known.

The ambition, progress, networking, and ability of the group to focus on important aspects during the past years is a demonstration that the group has good and sound

capabilities for future development. The importance to ensure knowledge transfer to the younger generation seems to have been realised.

The work of the group has clear national importance, and the cereal lines developed may have importance in the Northern parts of the world. The group is an excellent addition to the Estonian scientific community, and an essential resource for its plant biotechnology in the future.

The quality and outcome of the work can be considered good. However, although the group has made an effort to publish in CC journals these are not of very high quality. Taken this fact into account, the achievements of the group fall in the borderline of **good/satisfactory** at international level in this particular field.

Recommendations

- The group should now realise what it needs to bring the work at a very good level internationally and to make the group more internationally known. On one hand, the group should thrive to publish the work at better international journals, and on the other hand, to make sure to get benefits of the economic value of their cereal varieties. In doing this, the group should take care that the intellectual property rights for the work are ensured as appropriate.

- To be able to achieve this, the group needs increase in finances for infrastructure, travel and research. This should be ensured, as well as the established collaboration with other Estonian plant molecular scientists.

Tallinn, December 10, 2000

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