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The significance of scientific development at the Latvia University of Agriculture

The proceedings devoted to the 70th anniversary of the Latvia University of Agriculture (LLU) have now been made available in English from the plenary session and thematic sessions of the scientific conference. Many more people will now have a chance to get acquainted with our scientists' research work over the years, especially emphasizing the achievements of the last years' fundamental and applied researches for the whole of society, ensuring the participation of academically educated specialists in the national economy, science and culture, and joining the European and global academic processes.

The proceedings present the newest research results in agriculture, biology, engineering and the social sciences. The scientific history and current research results of the neighboring Lithuanian University of Agriculture and the Estonian University of Life Sciences are also included.

Starting from its beginning, the Latvia University of Agriculture has been the only university in Latvia which is oriented toward rural development. The university research activities are focused mainly on the fields of food, veterinary medicine, agriculture and forestry. At the same time we are aware that the LLU is the only university in the Zemgale region, and that fact gives us the responsibility to develop our intellectual potential in other fields of science also. The development of the technology and science park and the business incubator is proceeding in cooperation with employers' professional organizations and local governments. The Technology and Science Transfer Center has been established. The research and training farm "Vecauce" is becoming one of the most progressive education and science centers in the Baltic countries. The establishment of the biogas reactor, cogeneration station, modern dairy farm and the creation of the biogas and milking technologies' research groups are the latest achievements of the "Vecauce" training farm. The Center of Renewable Resources is initiated in the city of Jelgava. The Forest and Wood-pulp Products' Research and Development Institute in Jelgava, established in cooperation with the Latvian Wood Industry Federation and the joint stock company "Latvijas Valsts Meži", has had a significant input in the research development of LLU.

LLU has implemented the European Regional Development Fund (ERAF) and European Social Fund (ESF) projects for more than 1.3 million lats during the last two years. Modern equipment for laboratories, training places for students and support grants for doctoral students have been developed within these projects. The number of doctoral theses, especially in the engineering sciences, forestry science and economics, have increased significantly. The LLU projects "Establishment of joint universities' research group in system biology " and "Attraction of human resources for research in renewable energy resources" have gained ESF support. Being the BOVA (Baltic universities of agriculture, forestry and veterinary medicine) network coordinator, the LLU has concluded a cooperation agreement with a similar network in the Nordic countries whose goal is to improve master and doctoral studies and to promote the research work.

All these and many other activities have contributed to the effectiveness of the research work in all the faculties and scientific institutes of LLU. We hope that our current and future research results will allow our university to become recognized not only in the Zemgale region and Latvia, but also internationally.

Finally, I want to express my thanks to the editorial board for preparing the proceedings of the 70th anniversary conference.

Research Activities of the Latest Decades in the Faculty of Agriculture

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Abstract. Research activities in the Faculty of Agriculture comprise three main specialisation lines: Field Crops, Horticulture and Animal Science which are associated with other subjects like Soil Science and Management, Grassland, Crops Breeding, Plant and Animal Biology, Plant Protection, Weed Science and Fertiliser Use etc. Traditionally our research strategy is to be engaged in two directions: 1) to provide intellectual services and sound scientific basis for Latvia primary agricultural sector and 2) to incorporate into the interdisciplinary research sector on Latvia, the EU and global scale. Brief overview of activities and results within these spheres is given related to the period starting from 1990 up to now with relevant ideas and propositions for the future prospects. Interinstitutional and international research cooperation and possibility to provide knowledge and services for society are the main pillars of our future development.
Key words: Latvia agriculture, research priorities, agricultural research.

Introduction

In 1992, two faculties – Faculty of Agronomy and Faculty of Zootechnics – were merged and Faculty of Agriculture was established. Three main specialisation lines Field Crops, Horticulture and Animal Science which are associated with other subjects like Soil Science and Management, Plant Biology, Plant Protection, Weed Science, Fertiliser Use were organised within the Faculty. Therefore the main field of research and education was to provide students with competence in the primary agricultural production sector – crop and animal farming. At the same time some part of research activities were related to the environmental aspects, forestry and other sectors through cooperation with other faculties of Latvia University of Agriculture (LLU), research institutions in Latvia and abroad as well. This time was also very important due to the active start of international cooperation. Number of our staff and post-graduate students has a possibility to be involved in different workshops, to attend conferences, and to participate in study courses and short–term on–site training programmes. Besides a number of foreign researchers have visited the Faculty and contributed to our research and teaching activities, and promoted establishment of good professional relationship. It has stimulated our research activities, staff involvement in international research programmes, and expert groups, and has given a good basis for long-term cooperation with international partners.

Our research strategy is to follow the two lines: 1) to provide intellectual services and sound scientific basis for Latvia agricultural sector and 2) to incorporate into the interdisciplinary research sector on Latvia, the EU and global scale. Therefore our contribution and achievements may vary and sometimes it is not easy to determine where our efforts have been more effective either for implementation of small and very practice-oriented tasks or participation in large scale international projects. In general, the latter is good for knowledge and capacity building but the first one – for acknowledgement of our mission and importance for Latvian society.

The period starting from 1990 up to now has been rich in many research–related activities; still it also reflected radical changes going on in economy and social sphere of this country. In the present article we would like to summarise only the main activities and changes, and also to discuss the results that could be important for future developments. The layout of article reflects the main research lines traditionally existing in our Faculty.

Soil science and soil fertility

Soil research obviously has a high importance due to its functions within ecosystem and as a media for agricultural production. Until 1990, the Soviet (Russian) soil science approach and standards were dominating in Latvia. Their differences from the international standards caused real difficulties to use the national soil information outside the country. Therefore the introduction of FAO and the USA methodology of soil diagnosis, classification and information use was one of the research priorities. Series of field and

laboratory studies of for application of international methodology, compatibility studies of previous data with new ones, and data preparation for international data bases were implemented. These activities were performed in close cooperation with the European Soil Bureau, researchers from Sweden, Denmark, the USA and other countries. As a result Latvia soil information is represented in Soil Map of the European Union, the European Soil Data Base, Global Soil and Terrain Database and Soil Atlas of Europe (Karklins, 2005a; Soil and Terrain …, 2000; Soil Atlas …, 2005; the European Soil Database, 2004; The European Soil …, 1998). We are looking forward to follow up these activities for updating the above mentioned soil databases, development of new applications as well as providing the new established European Soil Data Centre with relevant high quality soil information which may be used for many scientifically and politically important issues on the EU level. The implementation of the EU framework project "Environmental Assessment of Soil for Monitoring" (2006-2007) related to the development of unified indicators for assessment of soil threats, risk zones and degradation feasibility shows recent development of these activities. This project coordinated by Cranfield University linked up 37 research institutions across the EU and made significant contribution to common understanding in the sphere of soil protection, harmonisation of monitoring networks, research methods, and information standards.

Soil and land protection and sustainable management, resources inventory, monitoring, data acquisition methods, information use were the objectives of several projects running in Latvia where our researchers were leaders or participants – one of them being "Three Level Agricultural Land Monitoring in Latvia" (1992-2001), which was designed as extensive, and therefore rather expensive monitoring programme. Probably at that time we were not able to draw up strong enough administrative and organisational strategy to fulfil a scientifically interesting and practicably sound programme which could generate the valuable information about anthropogenic impact on Latvia soils and land use pattern. Weakness of political interest led to a gradual decrease of funding, and finally the programme was stopped even without a possibility to process the obtained results. Unfortunately several attempts to re-establish National-wide soil and land monitoring programme did not succeed. Probably the development of modern and economically relevant soil and land monitoring programme with sustainable long-lasting organisational-financial framework is one of the priority tasks of our researchers.

"Building sustainable capacity and ownership to implement UNCCD[1] objectives in Latvia" (2005-2008) financed by the United Nations Development Programme was another more recent but a short term project. This project mainly did not generate new data about Latvia soils or land resources but it served as an attempt to provide an overview about our current situation, future needs and ways for implementing the ideas, transferring knowledge and developing new products and applications in the field of sustainable land/soil management. One of the priorities is to establish a reasonable and effective legal and institutional basis for these activities, and to develop a relevant and long-lasting financing mechanism.

Parallel to the above mentioned activities a research was done (A. Kārkliņš) for the development of Integrated Soil Information System in Latvia. The main objectives were to propose a scheme for soil resources inventory which meets requirements of international standards including soil diagnosis methodology and application of the World Reference Base for Soil Resources (WRB) as a tool for soil classification. Also renewal of national soil classification was planned. These activities successfully were reflected in several publications (Karklins, 1995, 2002, 2007, 2008; Latvijas augšņu …, 2009).

The future trends are to follow up with research and development in the field of soil and land resources inventory, and the main areas of interest are as follows:

- comparison of the soil units of national (genetic based) classification system with the WRB and vice versa;
- development of methodology for historical soil data transformation into the modern standard;
- development of methodology for soil/land degradation assessment;
- monitoring of changes of soil properties related to the non-traditional use of agricultural land (afforestation, continuous cropping, cultivation of energy crops etc.).

[1] United Nations Convention to Combat Desertification

Another line of research activities is related to soil fertility issues, nutrient flows in agriculture, environmental aspects of manure and fertiliser use, crops' fertilisation strategy and methods. If the period of the 1960-1990s was characteristic of intensive fertiliser use with rather little attention paid to the economic and environmental consequences then the past two decades are continuously stressing these issues and putting them as dominating priorities. The shift has been very sharp due to the economic and political reasons, and thus new developments were very indispensable. Therefore researchers were involved in several international projects like "Agricultural Run-off Management Study in Latvia" (1992-1993), "Development of Code of Good Agricultural Practice for Latvia" (1999), "Improvement of the Fertilising Normative – especially Manure Standards" (2001-2002), "Managing Inputs of Nutrients to Avoid Insufficiency or Excess" (1998-2002), and national projects like "Fertilisation Optimisation According to the Principles of Good Agricultural Practice" (2001-2003) etc.

These activities (A. Kārkliņš, I. Lipenīte, R. Vucāns) are related to the development of fertiliser and manure use environmental risk assessment methods as well as recommendations for implementing the propositions drafted in the Code of Good Agricultural Practice; for accumulating of experimental data necessary for the development of agronomically, economically and environmentally sound fertilisation schemes; for the development and validation of the models for environmental risk assessment, e.g. plant nutrient balance, manure outcome and chemical composition calculations applicable on-farm level, yet compatible with the EU requirements (Karklins, 2005b; Karklins, Lipenite, 2005).

Implementation of the EU Nitrate and Water Framework directives, HELCOM recommendations, the Code of Good Agricultural Practice, and similar strategic documents require relevant national-based methodologies and various normative values. As most of them should be obtained experimentally investment for such research is tremendous. Therefore an attempt to coordinate all agronomical experiments which could contribute to any valuable data necessary for meeting the above mentioned objectives is undertaken. However still a number of high priority topics like nitrogen, methane, and carbon emissions from agricultural land and animal operations, carbon sequestration, nutrient leaching etc. practically are not studied based on solid experimental approach. Actually it is a fundamental science not fitting into the short-term project framework dominating nowadays in Latvia.

Plant and soil biology

Long-term investigations of symbiotic nitrogen fixation, nodule formation, and effectiveness of inoculation were carried out at the Department of Plant Biology under the guidance of prof. V. Klāsens. Occupancy and symbiotic features of *Rhizobium leguminosarum* in Latvia's soils have been determined (V. Klāsens, I. Januška, A. Anševica) during the past two decades. The academic staff has established the main environmental factors effecting nodule formation, *Rhizobium* occupancy in host plant roots, effectiveness of nitrogenisation, and their effect on legume yield formation and its quality (V. Klāsens, B. Mārka, V. Šteinberga, I. Alsiņa, S. Ošlapa). The obtained results showed that the yield increase was determined mainly by the characteristics of the soil and less by the biological features of symbionts. Therefore one shall distinguish the terms potential and real effectiveness of nitrogenisation. Streptomycin resistance (V. Klāsens) and genetic identification (L. Dubova, A. Anševica) of *Rhizobium* strains are used. Collection of an active *Rhizobium* strains (approximately 40) is maintained, examined and passed to farmers.

Determination of soil biological, microbiological, and enzymatic activity was carried out during the past decade (L. Dubova).

Regulation of plant growth and development, yield formation and its quality are the main interests of the teaching staff dealing with plants. The effect of illumination and light spectra on seed germination (V. Klāsens) and plant growth (I. Alsina) has been examined. Researchers of the Department have investigated the effect of environmental factors on the quality of grain (V. Klāsens) and vegetables (I. Alsiņa, A. Bāliņš).

An active cooperation with universities and research institutions in Sweden, Finland, Russia and the United States of America has resulted in joint publications, scientists exchange and research activities.

Two doctoral theses (V. Klāsens – Dr.habil. agr., and I. Alsina – Dr. biol.), 15 master degree and 70 bachelor, and diploma papers have been developed and defended during the past two decades.

Soil tillage, weed control and precision field management

Weeds biology and control. The main research was devoted to the development of methods and testing of new herbicides which have appeared relatively recently, spread out intensively, and are used for weed control. Also following the environmental consequences and attempt to reduce the use of different chemicals including herbicides, some research was performed with its low-rate application. Therefore our research was devoted to the development of recommendations for wild oat (*Avena fatua* L.) control in spring barley fields as well as optimisation of weed control for sugar beets grown on sod calcareous loamy soils (Lapiņš, Bērziņš, Rubenis u.c., 1998; Korolova, Lapinsh, Berzinsch, 2000).

Application of reduced herbicide dosages on weed infestation was studied for spring barley. The post-effect of reduced herbicide dosages on weed's next generation was studied as not only the first year effect, but also weed survival and its distribution afterwards is important. It was done in vegetation trials in Denmark using goosefoot (*Chenopodium album* L.) as a test plant (Kopmanis, 2005).

Distribution of invasive weed species *Heracleum sosnowskyi* Manden is a great problem for Latvia. Initially it was introduced in the 1950s for forage production, though very soon it distributed and ran out of the control. Presently we are participate in the assessment of its distribution and development of recommendations for mechanical, chemical, biological and integrated control of the mentioned weed species (Bērziņš, Oļukalns, Lapiņš u.c., 2003).

Our long-term research activities are connected with monitoring of weed infestation in crops. Some observations performed in permanently erected monitoring plots in Kurzeme and Zemgale regions showed that some weed species have totally disappeared during the past 50 years, and special measures have to be initiated to protect biodiversity of local gene pool. Results show that growing of cereals prevailing in these regions and usage of herbicides has increased distribution of pansy (*Viola* spp.), wild buckwheat (*Polygonum convolvulus* L.), and speedwell (*Veronica* spp.) compared with the area where herbicides were not used. High level of infestation with weeds was observed also in perennial grasslands, where many of weed species are poisonous for domestic animals (Korolova, Lapinsh, Berzinsh, 2006; Lapinsh, Korolova, Berzinsh, 2008).

It was observed that in a sowing year of perennial legumes (red clover, white clover, alfa-alfa and fodder galega) as well as in the first production year of grasses tank mix of herbicides pendimethalin and bentazone provide the highest effect. Some negative effect of chemicals on leguminous plants was observed but it was compensated by the yield increase. Phytotoxicity of herbicides mainly was influenced by soil type and texture but less by species and variety of legumes. Phytotoxicity of herbicides MCPA, bentozone, amidosylfuron and tribenuron–methyl differed also among perennial grasses grown: cock's foot, perennial ryegrass, meadow foxtail, timothy and meadow grass. Herbicide MCPA showed relatively lower impact on cultivated grasses. The study included also the ability of competition between cultivated grasses and weeds. Different species of perennial grasses show different competition ability with weeds in the year of sowing. Post-effect of herbicides in the first production year of perennial grasses showed an increase of yield and a decrease of number of weeds in crop stands (Lapiņš, Bērziņš, Adamovičs et al., 2001).

Soil tillage. A long term stationary trials for optimisation of soil tillage systems in cereals–grasses crop rotation in sod calcareous soils were started in 1982. The experiment included the comparison of traditional annual ploughing, periodical ploughing, and minimal tillage as well as deep loosening technologies. Results showed that annual soil ploughing in six-field crop rotation could be replaced by one ploughing per crop rotation period without significant yield decrease; in other years ploughing was replaced by shallow ploughing at the depth of 10-12 cm (Kroģere, Liepiņš, Ausmane et al., 2005).

In trials for investigation of soil tillage–drilling technologies for winter wheat and spring barley experiments showed that soil deep loosening gave higher positive effect for winter wheat that for spring barley. Deep soil loosening before winter wheat drilling showed positive effect on wheat grain yield also in the repeated sowings. Significant influence of chisel ploughing on soil resistance was established only in the place of

action; in the rest of soil volume the resistance did not changed or even increased. Direct drilling without soil reversing significantly decreased the yield of spring barley, yet it increased for winter wheat. Autumn application of glyphosate reduced the difference between treatments of spring barley drilling methods (with and without soil reversing). Soil moisture at the depth of 0-45 cm was significantly lower in plots covered by plants in dry-season years, and made substantial lack of water at the spring barley tillering stage and after it. It was accompanied by significant higher soil resistance in spring barley sowings. The relationship between soil moisture and soil resistance can be described by linear correlation, while among soil moisture, soil resistance and grain yield – by multicolinear coherence (Lapins, Berzins, Kopmanis et al., 2005a, 2005b).

Precision field management. Precision field management technologies gain growing popularity among Latvia farmers. Therefore the adaptation of equipment available on market, its evaluation and recommendations for its use are relevant. The main objective of research was to find scientific explanation for differences of soil tillage in fields with uneven soil pattern and fertility. It was concluded that humus content and the depth of topsoil were the most significant factors which should be taken into account for differentiation of soil tillage for winter wheat. GIS cartograms give the possibility to decrease the depth of soil tillage in particular field spots, if the depth of topsoil is deeper than 36 cm. The mentioned feature was observed in 60% of the whole field area. It was realised that soil resistance above 600 kPa cm^{-2} in subsoil significantly reduced the yield of winter wheat; although the cartogram of soil tillage differences allowed the decrease of the total area for soil deep loosening by 48%. Trials to prepare weed infestation cartograms for differentiation of herbicide dosages were carried out. Significant influence on field elevation, the depth of topsoil and humus content to soil moisture in topsoil and below it was obtained in all treatments with and without soil deep loosening. Soil moisture effected the soil resistance in all soil layers up to 50 cm from the soil surface in both treated and non-treated plots. The analysis of yield maps did not verify the positive effect of soil deep loosening on winter wheat grain yield in the first year after tillage, while in the next year (due to more rainfall) treatments with soil deep loosening gave significantly lower winter wheat grain yield. (Dinaburga, Lapins, Berzins et al., 2008; Dinaburga, Lapiņš, Bērziņš, 2009).

Plant protection

Starting from the 1990s the main research problem was to introduce the integrated approach for plant protection oriented on small size (compared with the previous period) farming units, generally private farms. One of the research objectives was to introduce the new system, for forecasting and warning against crop destructive organisms, using new forms of organisation and including information technologies and Internet services. Pathogens and pest's damage thresholds and criteria were studied, and software for forecasting of cereal and potato diseases and pests were developed. To minimise the pesticide use for field crops and to produce the agricultural products more ecologically friendly experiments were focussed on Integrated Plant protection strategy. The PC software was developed where pesticide usage was adjusted based on studies about the pest and disease biology, cultivars resistance and weather influence. The PC models NegFry and PC-cereal diseases which are the intellectual property of Danish Institute of Agricultural Sciences were used in co-operation with their authors.

Wherewith, a wide research of biology and epidemiology of the potato late blight *Phytophthora infestans* and other potato diseases was carried out. The oospores were found in 80-94% of the investigated cases. Potato leaflets with two or more separate spots are the samples were oospores could be found on the field conditions in Latvia. Many potato leaflets with two spots were observed at the end of a growing season when the disease severity exceeded 50%. The occurrence of oospores means that potato late blight control might be performed by crop rotation and the use of certified seed material; and the usage of fungicides may not be effective.

Models were introduced in Latvia on the basis of the study of development of major crops and pathogens, motivation of pesticide usage, choice of pesticide dosage and its optimisation, optimal intervals between spraying, and design of database according to unified scheme.

Wheat leaf diseases are the most important diseases of wheat. Detailed understanding of pathogens populations' structure and biological peculiarities of pathogens life cycles is necessary for integrated plant protection. Existence of *Pyrenophora tritici-repentis*

teleomorph (pseudotechia with asco spores) on the straw after over wintering were confirmed and described for the first time in Latvia.

Sharp development of snow mould (caused by *Microdochium nivale*, previous term *Fusarium nivale*, teleomorph *Monographella nivalis*) was observed in 2005-2007. Crop variety is an important factor affecting snow mould infection. The main reason of sharp development of the disease is too early sowing time of winter wheat. Uncommon meteorological conditions (long and warm autumn) served as the main reason for unexpected development of snow mould.

Ergot of triticale and rye (caused by *Claviceps purpurea*) is a widespread disease, it is not possible to control the disease by fungicides, and therefore the influence of different agroecological factors was investigated. Optimal crop management is important to avoid ergot occurrence in rye and triticale. More sclerotia were found near a field margin (>1 m) in comparison with the zone more deep in the field. Sclerotia germination was noted in the beginning of May, but peritheciums with asco spores developed considerably later; therefore an infection is possible for a longer period – from the end of May to the end of June. Development of diseases becomes one of the most important risk factor for oilseed rape cultivation on the conditions of intensive management. Phoma stem canker (caused by *Leptosphaeria* spp., anamorph *Phoma lingam*) is one of the most important diseases of oilseed rape over the world, also in Latvia. Different symptoms on the leaves colour and morphology of pure cultures confirmed the occurrence of *L. maculans* and *L. biglobosa* in Latvia. Teleomorph of pathogen was found for the first time in Latvia, and identification of species has been done for the first time in the Baltic region.

In recent years, particular attention is also paid to the research that relates to the possible cultivation of genetically modified (GM) crops in Latvia, their economic importance and problems. Due to the small territory of the country and scattered fields all around the country, it is not possible to find the specific regions where only GM crops could be grown in Latvia. According to the data available by Latvia Rural Support Service, rape and potatoes are grown all over the country and rapeseed areas are also rapidly increasing. GM Bt maize cultivation which is resistant to pests, is not an issue in Latvia, since we have no specific maize pests. In Latvia where relatively small fields dominate, pollinating insects transfer pollen from the GM fields to the conventional and biological ones contaminating honey with GM rape pollen; and therefore production of certified organic honey becomes impossible.

One of the most important co-existence requirements is to define the separation distance of 4000 m for fully fertile GM rapeseed from its conventional and/or organic congeners. The problem is that additional costs arise from the compliance with management and inspections. The deficiency of basic information on the state of ecosystem before expansion of genetically modified organisms (GMO) in the environment is one of the essential problems in risk evaluation in Latvia. Economic analysis of growing conventional and GM rapeseed was performed.

Crop science and grassland management

Similar to other branches the Department of Plant Production took an active part in elaboration of normative documentation for the re-established country at the beginning of the 1990s. The first regulations for *seed* production, and normative and methodological standards concerning seed quality were worked out by the Department. A. Ruža together with his colleagues (A. Adamovičs, J. Lauva, V. Ruža) prepared a scope of standards, normative documents and methodological guidelines for seed and grain as well as they were involved in the elaboration of different provisions, regulations, and legislative initiatives (*Plant Protection Act***,** Seed Act, etc), that were developed and harmonised according to the EU regulations.

Animal production was developed as key industry and field crops were grown mainly for fodder supply before the 1990s. Hereby technological issues and quality standards mainly were focussed on that issue. The grain was grown also as a source for human food; therefore other quality aspects became outstanding. Thus the necessity to develop integrated standards for assessment of grain quality was topical. Considering common development tendencies in plant production, the changes need to cover not only narrow technical aspects but the whole system including the research.

Numerous field trials were performed on all varieties grown in different soils and various regions of Latvia until 1990. However, the majority of investigations were practically oriented and aimed to fulfil the main demand in that period – increase of

yield production. Comparatively small amount of theoretical studies was done that might provide the usage of experimental results for the new situation. After the 1990s, a number of field trials decreased dramatically but the remaining were reorganized to meet the changing requirements. Quality parameters, economic consequences, performance of new varieties, fertilisation, plant protection aspects, and environmental aspects etc. were the main issues for cereal research. The new varieties of intensive or very intensive type were introduced in the past and present, having specific cultivation requirements as well as new machinery was introduced. All together it gives the new challenges for crop cultivation science.

Comparatively wide scale field trials with different species of cereals and grasses were provided. Effects of different meteorological and soil conditions, mostly for the influence of fertilisation with nitrogen, on the yield quality indices were revealed. Protein content and Zeleny index or sedimentation value (SV) as protein quality indices, apart of gluten content, and especially gluten quality, are accepted as the main quality criteria in the European Union and in other Western countries. Unfortunately, no investigations were performed on these quality criteria until 1997. The aim of our first investigations was to clarify an influence of various soil and meteorological conditions on different winter or spring wheat yield and grain quality indices complex development process, correlation relationship between quality parameters, most important influence factors, stability of genotypes of variety, possible deviations of face value in different meteorological conditions, and growing media. Investigations clarified the influence of agro-ecological conditions on winter wheat quality indices, and showed that the average yearly meteorological conditions were the major factor influencing gluten content and its quality for all varieties investigated. It is necessary to select varieties having most stable gluten content and gluten index for all introduced varieties in varying meteorological conditions for production of qualitative food grains from winter wheat. Nitrogen *rates* cannot be appointed equal in every following year, but *fertilisation* should be differentiated in dependence on vegetation period of variety, its potential crop productivity, foregone range of qualitative indices, and characteristics of vegetative period principally. Investigations of such a type were coordinated between the research institutions of Latvia that gave possibilities for more effective use of material resources, laboratory equipment, and, most important, the obtained results are comparable for different regions of Latvia.

Investigations done on a regular basis on seed long-term storage and providing inspection of seed quality parameters (germination, seedling vigour, growing intensity of germs, and shoots) revealed that the less decrease in germination of seeds was obtained for oats with some deviations amongst varieties, while the type of storage has a significant influence on germination parameters for other species with respect to storage type over a span of 10 years period. A decrease of germination was most affected by storage in special chamber. Germination was lost completely for rue and summer barley after a 10-years storage period. Germination was similar, but with less decrease of germination, for seed stored in jute sacks on usual conditions. The best results (except rye) were obtained for storage in hermetic plastic bags. Therefore cereal seeds (except rye) stored in hermetical plastic bags can maintain stable germination over 85% during a 5-10 years storage period, if previously the seeds are dried up to 10% moisture.

Wide, complex investigations in the grassland management and forage production areas were provided under the guidance of Prof. A. Adamovičs. Important information was obtained, based on the results of field trials and laboratory analyses, on the following issues: competition between legumes and grasses, and interaction in grassland agro-phytocenosis, characteristics of photosynthesis process in different agro-phytocenosis, biomass accumulation and quality development for different species in various agro-phytocenosis, overground part pattern along layering horizons in different agro-phytocenosis, energy value of yield obtained from different species and agro-phytocenosis, plant nutrient off-take with a yield, the post-effect of different grasses and mixed swards on quantity and quality of grain yield. The data obtained serves as the basis for next stage – elaboration of theoretical models for the development of field crops quantity and quality.

Research programme has been started on the possible use of field crops for production of renewable sources of bioenergy (biogas, bioethanol, and solid biofuels) (Adamovics, 2007).

Investigations on plant breeding and seed farming were provided under the guidance of Prof. I. Belicka. Scientific investigations were provided within the framework of several projects financed by the Ministry of Agriculture and the Scientific Council of Latvia. Number of students were involved, and 45 graduation papers were prepared based on the studies of morphological features as criteria for selection of elite plants and perspective plant lines, studying the resistance of varieties to different diseases, comparison studies of barley varieties suitable for Latvia climatic conditions, etc. Special work was accomplished by cultivating barley lines with high protein content, crossbreed of hull-less barley varieties, and developing of hull-less barley selection in Latvia. Work was provided also in breeding of winter wheat evaluating the quality of awned and awnless wheat lines. As a result varieties of summer barley 'Klinta' and 'Malva', and wheat variety 'Moda' (Otto) were developed. Three doctoral theses were presented under the supervision of I. Belicka.

The research results of are presented in publications of the Department of Plant Production and Institute of Agrobiotechnology (Adamovics, Adamovica, 2007, 2007, 2008, 2008; Balodis, Gaile, 2008a, 2008b; Belicka, Legzdina, 2001, 2002a, 2002b; Gaile, 2008a, 2008b; Gutmane, Adamovics, 2008; Ruza,1997; Ruza, Karele, 1999; Ruza, Kreita, 2008; Ruza, Adamovics, Bankina et.al. 1994; Ruza, Adamovics, Bankina et. al. 2004; Kronberga, 2008; Kunkulberga, Ruža, 2008; Linina, Ruza, 2004).

Horticulture, apiculture, and vegetable production

The Department of Horticulture carried out their research in four main directions – fruit production, vegetable production, ornamentals, and apiculture. At the beginning of the 1990s one of the main research topics carried out was cranberries (*Vaccinium oxycoccus* L.) – European or local Latvian forms. Comparing with the American large berry cranberries, the advantage of ours was a shorter growing cycle and an improved quality of berries. It was worked on the breeding direction. Both the physical and chemical mutageneses were used for breeding a highly productive wild clones. In the nursery of the breeding material, 172 cranberry genotypes were studied, most of which were collected in Latvia and part of them – in Estonia and Russia. Clones derived in the breeding cranberry were tested for growing on crop conditions and recovered bogs. Some research was carried out on the propagation of the best genotypes by hardwood and softwood cuttings, planting establishment, plant density, substrates, morphological, and biological properties of plants, etc. This research led to the selection of several most valuable clones – V-63583, V-63383, B-83 etc. that gave the highest yield and berry quality (Gronskis, Liepniece, 2004).

The research with the newly introduced variety of the American large berry cranberries (*Vaccinium macrocarpon* Ait.) was commenced in 1985. Due to the favourable climatic conditions in Latvia and huge areas of the high moss peat bogs, opportunities opened for commercial areas to grow the new crop there. Currently 100 ha have already been planted by the large berry cranberry plantations, and Latvia takes the third place world-wide. Plantations of the highbush blueberries are close to 200 ha (Abolins, Gurtaja, 2006; Abolins, Liepniece, Sterne, 2009).

Alongside with the large berry cranberries, *Vaccinium* variety – the highbush blueberries were investigated as the second introduced from the USA. Visiting 19 enterprises and farms in four fruit–growing zones of Latvia dealing with cranberry and highbush blueberry cultivation included the study of the varieties of large berry cranberries and highbush blueberries, their physiological condition after the hibernation period, the production technology, features of the location, yield, and quality. A research was also carried out on the propagation of the highbush blueberries by softwood cuttings (M. Āboliņš, M. Liepniece, D. Šterne, R. Sausserde). Plant nutrition trials were carried out in cooperation with researchers from the Laboratory of Mineral Nutrition of Plants at the Institute of Biology the University of Latvia.

The second research direction was qualitative breeding of the planting material using a variety and rootstock combinations. The research was carried out within the framework of the research project "Development of Sustainable Systems for the Production of Fruits and Vegetables" and carried out together with Pūre Horticulture station (2001-2004), and the project "Development of Technologies of the Horticulture Products and Quality Model on the Agro-ecological Conditions of Latvia" (2005). The best graft combinations were found (Abolins, 2004; 2006) as a result of these projects.

Research is carried out in cooperation with Latvian State Institute of Fruit Growing on the gene pool of berries, mostly, black currants, and their usefulness in the selection. As a result, a researcher K. Kampuss has defended his doctoral thesis "Research of Black, Red, and White Currant (*Ribes* L.) Genetic Resources in Latvia". Currently, new doctoral researches are being carried out by D. terne "Temperature Influence on the Winter Hardiness and Productivity of the Highbush Blueberries (*Vaccinium corymbosum* L.*)*" and by D. Feldmane "Influence of Irrigation and Chip Mulches on the Sour Cherry (*Prunus cerasus* L.) Production and Fruit Quality".

In apiculture, the main direction of the research is conservation and selection of genetic resources of Latvian local honeybee (*Apis melifera*) as part of Latvia's fauna. Latvian local honeybee excels with very good hibernation ability in the climatic conditions of Latvia, but there is a need to eliminate such unwanted signs as an extra aggression and swarming proclivity in the selection process, thus, building resistance to diseases and raising productivity of honey. The training and research farm of horticulture and apiculture of the Faculty is the only place in Latvia dealing with the research and selection of Latvian local honeybee using the instrumental insemination of queen bees. In collaboration with Latvian Apiculture Society, the research is carried out on the development of honeybee breeding. Apiary tested systems are used for its development. So, for instance, bee hives rating systems, morphological analysis systems etc. are included in the programme of the honey bee breeding documentation. It should be noted that honeybee breeding has not existed until now in Latvia. Thus, the whole system is built from the scratch (A. Krauze, V. Brusbārdis).

The research carried out in the ornamentals is mainly market-orientated. Growing of different ornamental trees and shrubs in containers was studied. Research was carried out on the ornamental plants for different types of inoculation as well as the aquatic breeding and cultivation technologies. The research is also carried out on the mixed farming system, and evaluation of the planting stock of the ornamental trees (A. Dižgalve, M. Liepniece, A. Bērziņa, A. Balode, R. Sausserde).

The ongoing research in vegetable production which was started in the earlier periods was continued also in 1990 with different changes and additions. Latvia became an open market and less known vegetable varieties rapidly went into our farms. Therefore, in the beginning of the 1990s, one of the research directions was related to the research of these species with the aim to develop an agro-technical package of measures to ensure early and total yield as well as quality of the standard level in Europe, thus, minimising manual work. Under the guidance of Prof. M. Baumane and K. Dzērve, trials were established to study the properties of the new varieties and hybrids, their suitability to specific growing conditions and the aims in order to choose the best-fitting technology for a high-quality output.

The project "Use of the Local Gene Pool for Conservation and Development of Vegetable Varieties Suitable to the Ecological Conditions of Latvia" was launched by the Department of Horticulture in 1997. Within the framework of the project, research was carried out on identification, restoration and the cucumber gene pool, and on the establishment of new parent plant lines for the production of new hybrids. The research was concluded with L. Lepse doctoral thesis "Using of the Morphological Criteria and Molecular Markers in Renewing of the Cucumber Variety 'Dindoņa Zaļie Ķekaru'.

In the middle of the 1990s, research was started on the development of agro-technics for commercial herb cultivation (I. Žukauska). The aim of the research was to develop criteria for risk factor reduction at the critical stages of growing herb species. The research findings are published and reported in conferences.

Identification and evaluation of genetic resources, study of factors favouring the diversity of wild plants and formation of collections take a growing role on the international level. With the increase of interest in the genetic material of herbs and medicinal plants in Europe, in 2000 with the aid of the gene pool of the Nordic Countries, an international cooperation project "Culinary Herbs and Medicinal Plants in the Nordic and Baltic Countries. Conservation Strategy of the Genetic Resources" was launched. The aim and assignments of the project are to develop a strategy *in situ* and *ex situ* for conservation of herbs and aromatic plants, creation of collections or their supplementation, characterisation of the collection by descriptors developed by the project participants, and strategy for conservation of species. Within the framework of the Nordic Gene Bank and the cooperation project of the Baltic Countries, descriptors for the species *Origanum vulgare* L. and *Thymus spp.* L. are developed (I. Žukauska).

Since 2005, the programme supervised by the Ministry of Agriculture "Genetic Resources of Agriculture and Food, Livestock, Forestry and Fishery in the Programme of the Sustainable Use of the Long-term Conservation" is being implemented. Projects are implemented on the conservation and research of the genetic resources of the aromatic and medicinal plants, obtaining high-grade, safe and healthy food products derived from genetically, physiologically, and bio-chemically diverse plant material. Evaluation and selection of the genetic diversity of oregano (*Origanum vulgare* L.) and thyme (*Thymus ssp.* L.) species are done in relation with the physiologically active substances in their composition (I. Žukauska).

The research of the genetic resources applies the method of the molecular markers more and more widely, e.g. for studies of the diversity of Latvian aromatic and medicinal plants (A. Balode).

In the vegetable production, research is carried out on the effect of physiologically active compounds on the growth and development of vegetables, and enrichment opportunities of vegetables by mineral elements which are deficit in Latvia (I. Alsiņa).

Animal breeding

Research provided by the teaching staff of the Department of Animal Breeding (existing in LLU up to 2005) was represented by a range of investigations that belonged thematically to several directions and periods. Investigations in general outline the choices and characterisations of animal traits needed to provide the selection process as well its usage for implementation of pedigree and selective programmes.

First direction relates to the choice of animal traits, estimation of measurement and characterisation potentialities paying a special attention to the assessment of quality of lamb carcasses, quality of growing, and immunological traits (D. Kairiša).

Another important direction was the research of economically beneficial animal traits, aimed to investigate cow's individual milk production characteristics and parameters. Research on individual milk production was started with the investigations of lactation persistency. Factors influencing the concentration of lysozyme, stability aspects of milk production, variability of features as well as the influence of intermediate stage between parturition on individual productivity were investigated in the process of milk production. Freezing-point of milk and different milk composition parameters were investigated according to the interests of production quality controlling body (D. Jonkus).

In poultry farming the following items were investigated: influence of plant additives on production quality, morphological traits of eggs, correlation of traits in cross-breeding, relationships between chicken feeding and their productivity, and specific features of poultry production in Latvia (J. Nudiens).

Principles of usage of herd-book were analysed in Horse-breading sector, investigations were provided on horses exterior and working capacity, assessment was performed for the results of genological analyses, and a pedigree programme was elaborated for horse population in Latvia (G. Rozītis).

Investigation of methods for assessment of genetic value of animal traits. Investigations on linear statistical models were started in the last decade of the former century aimed at defining assessment models for bulls that should be most suitable on Latvia conditions. Factors influencing cows' productivity have to be revealed as well as factors with most substantial proportion should to be included in the model used for valuation. Dispersion components were determined by means of computer software LSMLMW and MTDFREML, and then used for further calculations of genological values. A software VCE was used for the estimation of genetical and phenotypical parameters. A computer software PEST was used for animals breeding value estimation. Both "father" and 'animal' models were used for the assessment of cows. Linear statistical models for milk livestock assessment, particularly, applying BLUP 'animal' model, in the first stage of investigation resulted in a doctoral thesis elaborated by L. Paura in 1999. Further investigations using linear statistical models were connected with the necessity of transition from standard cows lactations data to "test-day" data use. Work was completed in 2008, when R. Zutere upheld her doctoral research.

Methodical aid for the establishment of selection programmes in milk cattle-breeding was worked and used for training of students and elaboration of selection programmes for specific populations. This computer software was improved in the Laboratory of *Quantitative Genetics and was named as* "ZEVS10" (Z. Grīslis, V. Kižlo, E. Jeņikejeva). Findings were continued aimed at making some parameters of model more accurate, and

researchers presented information in scientific conferences on the elaboration principles of animal breeding programmes in Latvia.

Conservation of genetic resources of domestic animals in Latvia. In respond to call of FAO to participate in the preparation of the world's first Report on situation with *genetic* resources of animals, the *Ministry of Agriculture of the Republic of Latvia organised Advisory* Committee of Pedigree Animal Genetic Resource Maintenance and *Working group that prepared a report in 2003*. Project coordination was performed by our *Laboratory of Quantitive Genetics with the participation of* M. Līdaks, R. Beķere, A. Veģe et al. Organised work in connection with the conservation of genetic resources in Latvia actually started only in 1995 with the measures of Latvian Blue cow breed maintenance. The foundation of Data Processing Centre starting its activities in 1997 served for positive improvement information acquisition on domestic animals breeds. Vital role in updating animal genetic resource research and preservation work during the last decades of the 20th century were practical initiatives supported by the Nordic Council of Ministers and practically organised by the Nordic Gene Bank of Animals in the Baltic countries. In 2000 the Ministry of Agriculture established a work group of specialists who developed the first version of Domestic Animal Genetic Resource Maintenance and Research programme. The programme defined 5 protected domestic animal breed populations in Latvia – these breed populations were established in Latvia in the historical time: Latvian Brown and Latvian Blue cows, Latvian White pigs, Latvian Horses (draught horses), and Latvian Dark-Headed sheep.

Molecular genetic methods in animal breeding. Proposition in the usage of molecular genetic methods in breeding work was given by the participation in Project "EURO-CAD" of the Nordic and Baltic countries, guided by the Nordic Gene Bank of Animals that was performed by the participants from Norway, Finland, Estonia, Lithuania, and Latvia in the period of 2000-2003 (a coordinator from Latvia – Z. Grīslis). The main objectives of project – use of *microsatellite* DNA marker method (20 *microsatellites) for investigation of genetical diversity and similarity, and origin of cow population in the* Nordic and Baltic countries. Biomaterial (blood) samples were obtained from 3 Latvian cow breeds: Latvian Blue, Latvian Brown, and Danish Red in Latvia. Sheep populations were analysed separately. Analyses were taken from Latvian Dark-Headed sheep.

Since 2006 the implementation of molecular genetic methods became more realistic in our Faculty, and equipping of the Laboratory of Molecular Genetic Investigations was started. The main task of the Laboratory is investigation of domestic animals at molecular level and obtaining the characteristics of *genetic* resources.

Since 2007 wide scale scientific activities have been ongoing in the Laboratory of Molecular Genetic Investigations. Close collaboration continues with the Laboratory of Genomics and Bioinformatics from the Faculty of Biology, the University of Latvia, resulting in possibilities to publish number of scientific papers on myostatin *gene.* In 2009, a 4-year project was started, aimed at investigating polymorphism of milk protein genes within Latvian cow populations, and also at preparing information needed for transition to GAS (gene assisted selection) in our milk cow populations.

Animal nutrition

Under the guidance of Prof. J. Latvietis, the Department of Animal Nutrition worked out animal nutrition standards for control and rationing daily ration settings on the increased (20-30) criteria number as well as recommendations for the use of the standards were developed; at the same time cows, pigs, sheep, and horse feeding rations were defined using computers (J. Latvietis, L. Kārkla, J. Ozols et al.). The standards gained popularity among practitioners. Due to their popularity, the standards were repeatedly published for different breeds of cattle until the end of the 1990s.

Extensive scientific studies were carried out explaining: a role of microelements in animal nutrition (I. Rūvalds, J. Lielais), and an effect of using different biologically active substances in nutrition of farm animals and poultry (S. Zaharčenko, U. Osītis, L. Kārkla). At the same time the research was done giving biological and zootechnics assessment for new, non–traditional feeding stuffs and forage additives (J. Latvietis, L. Kārkla, L. Degola et al.), and seeking ways of solution to the problem of forage protein (J. Latvietis et al.), testing, and comparing feedstuffs processing methods (R. Kristapa, A. Sleze). Much work has been done to introduce new methods to evaluate feedstuffs and to implement standards in nutrition of cows (U. Osītis).

In 1998 the Ministry of Agriculture adopted the new ration setting system for nutrition of highly productive cows based on aforesaid approach. In contrast to the old system which used oat nutritional units, cows' energetic needs and feedstuffs containing energy amount are expressed in a new unit: net energy for lactation NEL. The new system, besides measurement of energy, rationalises fibre fractions – neutral (NDF) and acid (ADF) detergent fibre as well as protein fractions – in rumen degradable and in rumen undegradable or by-pass protein.

The most important task in nutrition of highly productive cows is to achieve higher consumption of food for every cow, consequently to accumulate more energy. It turns out that the amount of feedstuffs – hay, haylage and silage – consumed by a cow can be foreseen by ascertaining the total amount of fibre in these feedstuffs that are called "neutral detergent fiber" (NDF).

The ration setting according to the customary norms for crude protein or digestible protein of ruminant nutrition does not meet physiological peculiarities of these animals.

Any protein or substance containing nitrogen (e.g. soya oilcakes or carbamide) degrade in the ruminant's rumen microorganisms down to ammonium, then it used to produce microbes' protein, i.e., microbes work and they also grow themselves in the rumen. The protein amount produced by microbes is rather constant quantity for a cow; therefore, very important part of protein is that which passes non-degraded through the rumen. Thus, protein rate-setting relates to new notions – degradable and undegradable protein in the rumen.

Theoretical explanation of the new system and possibilities of practical application in setting of cow feed ration can be found in the book "Evaluation of Feed–Stuffs in Ruminants' Feeding" (1998) by U. Osītis and publication "Summary of Feed-Stuffs Analyses Results" (2000) by U. Osītis, S. Strikauska, A. Grundmane. Basing on these studies, software "LEDA" was developed to set cows' food rations for all levels of productivity. Both the books and software are available in all Regional Agricultural Advisory Centres throughout Latvia. The Laboratory of Agrochemical Analyses performs forage analyses in compliance with the new norm system requirements.

Currently, the best Latvian herds give 8000, 9000, and 10 000 litres of milk per lactation cow. To ensure stability of the high milk-yield, it is necessary to have further scientific study stage in order to define still smaller protein fractions in feedstuffs consumed by cows. Without these scientific studies it is impossible to set further feed rations with the help of the latest generation software which is meant to ensure milk yield of 9000, 10 000 and more. Therefore, under the guidance of U. Osītis the Laboratory of Agrochemical Analyses approbated the methodology recommended by Cornell University (the USA) to ascertain protein fractions, and compared their results with the results of other leading European laboratories (Uppsala, Prague). Cornell University evaluation system of crude protein partitioned it into three fractions: A, B, and C. Fraction A contains soluble non-protein nitrogen NPN; fraction C has unavailable nitrogen or bound true protein being defined as acid detergent insoluble nitrogen; and fraction B contains true protein and has three subfractions – B_1, B_2, and B_3. Now all the aforesaid fractions are definable by chemical methods in a laboratory. Hitherto, defining was possible only using cows having rumen fistula and it was very expensive.

All the time we have had an extensive cooperation with other agricultural universities in Sweden, Germany, Great Britain, and Denmark.

Basing on the performed studies, scientific and practically significant books and brochures have been written including text books: J. Latvietis "Nutrition of Farm Animals" (1991), "Pig Nutrition Norms" (1994, 1998), "Catalogue of Forage" (1996), "Cows Nutrition Norms and Feedstuffs Requirements" (Ositis, 1995), "Evaluation Systems of Feedstuffs Energy and Protein in Different European Countries" (Ositis, 1996), "Evaluation of Feedstuffs in Ruminant Nutrition" (Ositis, 1998), "Beef Cattle Nutrition" (Ositis, 2000), "Dairy Cows Nutrition" (Ositis, 2002), "Complex View of Animal Nutrition" (Ositis, 2004, 2005), and "Horse Nutrition" (Ositis, 2007).

During the last decade two doctoral theses (L. Degola and A. Trūpa) have been developed and defended in the Department of Animal Nutrition.

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Science of Veterinary Medicine from 1990 to 2009

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Abstract. The article presents analysis of the directions of scientific activities of the academic staff of the Faculty of Veterinary Medicine of LLU, the most significant achievements as well as the most urgent problems being solved today. During the period of time from 1990 to 2009, investigations were not restricted only on the productive animals but also on solving very important food hygiene issues and pet (mainly dogs) health problems. Dynamics of the morphofunctional processes in the digestive system in ruminants since their birth till the transfer to the ruminant status have been investigated. Also studies are carried out on the digestive apparatus in the ostrich and its morphological peculiarities and changes in onthogenesis; strongilatosis of the digestive organs in goats of different age, their effect on the stomach morphofunctional condition, body metabolism as well as on the quality indices of goat's milk and meat. Investigations have been started in novel scientific directions in veterinary medicine in Latvia – in electrocardiophysiology, veterinary anaesthesiology, and dentistry. In co-operation with the Riga Technical University, the scientists of the Faculty are carrying out a new high-quality prosthesis of blood vessels, implants of hernia patches and other types of clinical approbation on experimental animals. Investigation of reproductive problems in domestic animals is continued. Risk factors of endoparasitoses-zoonoses infection in Latvia have been analysed focusing on trichinellosis and toxoplasmosis. Investigations are carried out on a very urgent problem of the epidemiology of food borne infections – contamination possibilities of meat products with the pathogen *Lysteria monocytogenes* genus bacteria, *Yersinia* genus bacteria, and mycobacteria.
Key words: animals, health, food hygiene.

Introduction

In Latvia, the focus of research in veterinary medicine has been changed a little after regaining Latvia's independence. Investigations have been carried out not only in productive animals but also in solving urgent health problems in pets, mainly dogs.

In the 1990s, there were several main research trends. Firstly, more profound studies were carried out on dynamics of morphofunctional processes of some organ systems and problems of etiopathogenesis of pathologies in different animal species and age according to the new technological peculiarities of that time.

The second veterinary research direction at the Faculty of Veterinary Medicine (FVM) was to work out and upgrade the general and specific preventive methods of early diagnostics and treatment in the new economic circumstances of the 1990s. Scientists of the FVM worked in the above-mentioned research directions corresponding to the specificity of each department. In addition, most of the leading academic staff–researchers repeatedly had participated in professional extension studies of the relevant institutions in some of western economically developed countries and seriously evaluated scientific research work perspectives of his/her own department.

Veterinary Medical Problems Investigated from 1990 to 1999

At the Department of Anatomy, liver pathologies of milking cows and their prevention were studied under the guidance of Dr.habil. med.vet. Z. Brūveris. Investigations of the functional morphology suggested that an effective and original preparation may be worked out on the basis of *Richocel* for the treatment of hepatosis of the liver pathology most often occurred in milking cows that did not have an analogue in the world. The scientists of the Department found out that the cellulose, which is a constituent part of *Richocel,* inhibits reduction of holine in the fore-stomachs and facilitates its reaching the intestinal tract so providing its effective absorption. This preparation normalizes metabolism of carbohydrates and fats and decreases the fatty dystrophy of hepatocites. In 1999, J. Rimeicāns was awarded the Dr.habil. med.vet. scientific degree in veterinary hepatology.

Another scientific theme at the Department of Anatomy was investigation of the effect of different animal keeping technologies on the skeletal development in younger cattle of Latvian brown breed in postnatal onthogenesis. The research results were included in A. Mugurēvičs' doctoral dissertation that was defended in 1997. The work showed the influence of the keeping technology on the breed of Latvian brown dairy cow's some metacarpal and metatarsal bone ostoemetrical indices.

The scientific work of the Department of Physiology in the 1990s was associated with experimental investigations on physiology of digestion. By using a new method of intra-gastric pH-metric measurement in veterinary medicine but widely used in human medicine in that time for the stomach functional diagnostics, under the guidance of Dr.habil.biol. E. Birģele a research was carried out on the functional bases of intra-gastric pH-dynamics in pigs of different age. The pH-dynamics was determined in various stomach glandular zones in a condition when the hydrochloric acid producing fundal glands are in conditionally dormant stage (in the morning in non-fed animals "on an empty" stomach) and after the most physiological gland irritant – feed (E. Birģele, A. Garančs, I. Keidāne, D. Žilvinska). The effect of various feed on the pig stomach cardiac, fundal and pyloric glands secretory function that determines the intra-gastric pH-dynamics in these different glandular zones was studied. The activity of the stomach enzymes, evacuation of the stomach content, as well as the activity of some stages of gastro-duodenal system regulatory mechanism is dependent on the intra-gastric pH-dynamics.

During this period of time, attention was also paid to cardiopathy in swine, namely the sudden death of swine (O. Parčinskis). Carrying out the heart morphometry, massometry and voluminometry in swine, significant differences were determined in swine of different age with different types of pathologies in organs and tissues that helped understand the mechanism of setting in death (thanatogenesis) in cases of these pathologies.

Under the guidance of Dr.med.vet. Ļ. Jemeļjanovs, investigations on urgent diagnostic, treatment and preventive methods of animal internal non-contagious diseases were continued at the Department of Internal Non-Contagious Diseases (later division) paying a special attention to younger cattle. It is known that diseases of the newborn animals very often are manifested as ailing of the young ones (without clinically expressed typical signs of the disease) thus causing difficulties of making etiological diagnosis of the basic disease. To make the diagnosis more precise, researchers of the Department recommended a new complex follow-up plan of the newly born calves. To treat rationally the widely spread dehydration in young animals they recommended a new way of examination, which was not previously used, to determine the stage and type of dehydration that enabled to choose the most precise therapy of the organism rehydration.

Scientists of the Department of Surgery and Obstetrics were engaged in leading and carrying out very urgent at that time investigations in accordance with their specificity.

Under the guidance of Dr.med.vet. Z. Polītis and Dr.med.vet. A. Jurdžs, veterinary surgeons worked out new operation methods in cases of bone and joints traumatic injuries in dogs, started to investigate hip dysplasia in some breeds of dogs and the use of some indices of radiomorphometrical parameters in the early diagnostics of hip dysplasia in dogs (O. Kozinda). Scientists also examined a new biologically active preparation developed in Latvia for the wound treatment, studied occurrence of hoof diseases in cows kept in different conditions, and the influence of these diseases on the animal productivity.

In the late 1990s, research was started in a new veterinary branch in Latvia – veterinary dentistry (A. Ilgažs). The occurrence of dental diseases in dogs, types of diseases and their preventive measures have been also started to investigate.

In the field of obstetrics and gynecology, continuing the started research by Dr.habil.med.vet. professor I. Afanasjevs, under the guidance of his former student Dr.med.vet. V. Antāne, extended studies on hormonal regulation of animal sexual cycle and reproduction performance are continued. A clinical approbation of new immune-contraceptive preparations is carried out and their toxicity verified. Investigations are started on the udder health evaluation in a cow herd by the somatic cell count and lactose concentration in the bulk milk samples.

Important research was carried out at the Faculty of Veterinary Medicine in the 1990s on upgrading and working out methods of general and specific prevention, early diagnostics and treatment of contagious diseases as well as in the field of veterinary legislation.

In co-operation with the State Veterinary Service, instructions of prevention and control of infectious diseases, criteria and regulatory acts of administration of the new veterinary medicaments were worked out under the guidance of Dr.habil.med.vet. A. Nicmane, Dr.med.vet. E. Liepiņš, Dr.med.vet. R. Trubka.

In Latvia, under the guidance of P. Keidāns, for the first time was found out the coccidiofauna in young animals, epizootology of coccidioses was investigated and treatment-preventive means were worked out in Latvia. Analyses of the occurrence of swine coccidiosis in regions of Latvia were carried out (A. Krūklīte, D. Keidāne), infection dynamics was investigated in a certain period of time, the most effective treatment preparations of coccidiosis, balantidiosis and helmithoses in cases of miscellaneous infection (trichopol together with panacur or himcoccid together with rintal) were experimentally determined.

Research Activities from 2000 to 2009

Since the year 2000, when the structural changes at the Faculty took place and it was reorganized into three institutes, scientists together with their doctoral students, master students and regular students continued an extended and profound research of the above-mentioned problems as well as turned to the solution of significant issues of food hygiene.

At the Preclinical Institute of the FVM, the investigations previously started in the 1990s were continued on physiology of digestion in ruminants in the postnatal onthogenesis (E. Birģele – adviser, Z. Brūveris, A. Ilgaža, D. Keidāne, P. Apetjonoka). Problems associated with digestive upsets in calves are still acute. This fact is approved by wide and many-sided investigations by scientists of many countries in recent years. That is obvious because exactly in the first month of postnatal development in the stomach of a calf very important morphofunctional, microbial and enzymatic changes take place.

Dynamics of physiological processes in the digestive system in ruminants have been investigated from their birth till the transfer to the ruminant status in association with the age of the animal and the feedstuff they are fed. Scientists have investigated the correlation between the morphofunctional parameters of the liver parenchyma, dynamics of the blood biochemical indices, the abomasum morphofunctional condition, as well as the pH changes in saliva and the fore-stomach in newborn calves, in calves during the period of feeding colostrums and milk, and in calves in the transfer period to rough forage.

The regulatory mechanism of hydrochloric acid secretion of the abomasum in calves in postnatal onthogenesis – the influence of histamine H_2 receptors and M-holinoreceptors blockers on the HCl secretion in calves of different age in association with the feed they are fed have been studied. That is important to know because the neuro-humoral secretion regulatory processes of the abomasum determine in many ways a united and coordinated activity of the animal digestive system organs.

Part of the results of the above-mentioned experimental investigations was included into A. Ilgaža's promotion work "Cow's *Bos Taurus* stomach functional adaptation in the early postnatal ontogenesis", which was successfully defended in 2007 (adviser E. Birģele).

Scientists of the Preclinical Institute of the FVM at present are also involved into morphofunctional studies associated with less traditional productive animals in Latvia – ostrich (A. Mugurēvičs, I. Dūrītis), goats (E. Birģele, D. Keidāne, A. Ilgaža), and further investigations are also envisaged into deer.

As to the ostrich, it should be stressed that their breeding in Latvia (and also in other European countries) is associated with the rapidly increasing demand for produce of animal origin with a decreased fat and cholesterol content. It has turned out that in Latvia and other European countries ostrich chickens suffer from high mortality – only about 50% of ostrich chickens reach age of four months. In this connection it is of great importance to investigate the morphological peculiarities of the digestive apparatus in the ostrich, some structural changes in onthogenesis in particular, because there are very few data on this matter. Part of the results of this investigation is included into I. Dūrītis' promotion work (adviser A. Mugurēvičs).

In Latvia, goat breeding is also expanding, therefore investigations are needed to justify production of high-quality and value products of these animals. Nematodes infection in the digestive tract of goats is one of the most important causes of weight loss and decreased productivity in animals. Investigations of recent years show evidence

that in Latvia many parasitoses are spread in goats (P. Keidāns, D. Keidāne, A. Krūklīte), the most actual problem of which is strongilatoses of the digestive organs. What is the influence of this infection on the morphofunctional condition of the goat stomach in different postnatal periods of onthogenesis, how it reflects on the blood biochemical indices, and how it influences the quality indices of goat's milk and meat – these are the issues scientists of the Preclinical Institute have been involved to solve (E. Birģele, D. Keidāne, A. Ilgaža).

D. Keidāne has completed writing her doctoral thesis about the functional condition of the goat's stomach in relation to the animal nutrition and parasitocenoses of the digestive tract.

It is generally known that in the gastro-intestinal tract in humans and animals, helicobacteria may occur many of which are pathogenic and may cause different pathologies of the stomach, intestines and liver (stomach ulcer, gastroenteritis, etc.). A question arose – is it possible in goats with a digestive tract strongilate infection in the abomasum to have at the same time helicobacteria? (It is considered that basically the source of these bacteria is contaminated food or faeces consumed orally.) And how it is with *Helicobacter pylori* in the dog's digestive tract? In order to have professional extension courses in veterinary pathology as well as to acquire the newest diagnostic methods of *Helicobacter spp.*, Mg.med.vet. D. Bērziņa went to the Faculty of Veterinary Medicine of the South Korea Chanbuk National University (2005). At present intensive studies are carried out on *Helicobacter spp*. presence in the mucous membrane of dog's stomach – in the zones of cardiac, fundal and pyloric glands. This research is included into D. Bērziņa's doctoral thesis (adviser E. Birģele).

Important investigations have been carried out at the Preclinical Institute on electrocardiophysiology in dogs. This is a new direction of veterinary medicine in Latvia (G. Avdoško, D. Upeniece, E. Birģele). Regularities of electrocardiophysiological parameters as well as their differences in Cocker Spaniel, Rottweiler and German Shepherd dogs in connection with the age and breed peculiarities of animals were investigated. Novel data were obtained allowing assessing a cardiac functional state of healthy dogs in a complex manner as well as to reason about electrocardiogram (ECG) parameters and their differences in dogs. For the first time separate ECG parameters were analyzed in connection with the age of an animal and peculiarities of a certain breed of dogs. For the first time the application of 10 ECG leads for dogs and the use of this method in veterinary medicine had been assessed.

Further on it was important to find out the effect of currently widely used anaesthetesia substances on the functional parameters of the hearts of dogs. With this work investigations had started in veterinary anaesthesiology both experimentally *in vitro* on an isolated heart of a frog to find out the effect of premedication and anaesthesia agents on the heart rate rhythm and the contraction power of the heart muscle and in dogs *in vivo* (G. Avdoško). *In vivo* studies of dogs and *in vitro* studies of frogs demonstrated that premedication agent atropine sulphate together with acepromazine maleate has a negative chronotropic effect, whereas general anaesthesia agents ketamine hydrochloride and diazepam act in opposite manner – increase the heart rate, which gives a positive chronotropic effect.

Research in veterinary anaesthesiology is continued on the above-mentioned premedication and general anaesthesia (narcosis) agents effect on the eye functional parameters in dogs (L. Kovaļčuka).

The issue of the effect of the widely used premedication agents and anaesthetics on the different organism functions, in fact, is at the very beginning stage of its investigation.

At the Clinical Institute of the FVM, in the period from 2000 to 2009, several actual trends of scientific research have been started. Co-operation with the Riga Technical University has appeared to be very perspective – together with professor Dr.habil.sc.ing. V. Kanceviča in solving different orthopedic and blood vessel problems in human medicine as well as in veterinary medicine of small animal clinics.

Under the guidance of Dr.med.vet. A. Auzāns, a preclinical approbation of blood vessel prostheses and hernia patches made of composite materials is carried out on experimental animals (A. Ozols, K. Drevinska, O. Kozinda).

Nowadays, one of the main problems in medicine is the high morbidity and human mortality from the heart-circulatory system pathologies. Human doctors have proved that the injured part of the artery may be partly substituted with a synthetic prosthesis. However, it should meet many requirements, the main of which are longevity, elasticity,

non-toxicity, etc. Therefore, approbation of new high-quality prosthesis of blood vessels on experimental animals was and is absolutely necessary and very urgent.

The same refers to the experimental investigations at the Clinical Institute concerning the composite materials worked out at the Riga Technical Institute for implants of the hernia patches (in rabbits) and weaved prostheses in case of cranial cruciate ligament rupture in dogs (K. Drevinska, A. Auzāns, O. Kozinda).

At the Clinical Institute, prof. Dr.med.vet., Dr.habil.agr. A. Jemeļjanovs[1] and Dr.med.vet. V. Antāne together with their doctoral students and regular students continue investigations on the reproduction problems in productive and non-productive animals.

During 2002-2004, Dr.med.vet. V. Antāne was a project coordinator in Latvia and took an active part in the international project "Farm animal reproduction – reducing infectious disease and conserving local genetic resources". Faculties of Veterinary Medicine of the Universities of Agriculture of all three Baltic States and Biological Centre of the Swedish University of Agricultural Sciences in Uppsala were involved in this project. Further on also the Belarus Academy of Agriculture and the Agrarian Business Institute in St. Petersburg joined the next project "Animal farming in transition – the role of animal reproduction" (2005-2008).

Under the guidance of Dr.med.vet. V. Antāne, mainly problems dealing with the udder health of cows were studied – changes in indices of the udder health and immunoglobulins in milk and blood of cows transferring to the pasture period (I. Kociņa, Ļ. Jemeļjanovs). It was important to find out if some indices of the udder humoral immunity and the cell immunity of the udder in cows were changing during this period, which would show evidence of the udder health status in general. The authors studied the immunoglobulin (IgG, IgM, and IgA) concentration in milk and blood of cows when the keeping and feeding conditions were changed, as well as assessed the correlation between Ig concentration in milk, blood and somatic cell count in milk. According to these criteria, some medical preparations for treatment of subclinical mastitis were also assessed (V. Antāne, I. Lūsis, Ļ. Jemeļjanovs, M. Mangale). The studies have proved that changes in somatic cell count, lactose concentration and immunological parameters in milk allow assessing objectively the udder health condition in the cow.

At the Clinical Institute, investigations are also continued on the problems of metabolism in milking cows mainly in perinatal period, when energy deficit often occurs (L. Liepa); also investigations on small animal dentistry are being continued. One of the most widely spread pathologies in the mouth cavity in dogs is periodontitis in different stages of development. Connection of this pathology with the bacteria spectrum in the mouth cavity and in the duodenum is also studied (A. Ilgažs). Part of the results of this investigation is included into A. Ilgažs' doctoral thesis that is being written now.

O. Kozinda has completed and submitted his doctoral thesis about the hip dysplasia in dogs and its early diagnostics using x-ray morphometrical parameters.

Investigations at the Institute of Food and Environmental Hygiene in 2000-2009 in general were and are carried out into two closely related blocks: risk analysis of endoparasitoses-zoonoses infection in Latvia (P. Keidāns, A. Krūklīte, D. Keidāne, E. Eihvalde), and epidemiology and control of the productive animals and foodborne infections (E. Liepiņš, R. Trubka, A. Valdovska and others).

As to endoparasitoses-zoonoses, investigations were focused on trichinellosis and toxoplasmosis. Trichinella species spread in the game animals and domestic pigs in Latvia are investigated, the risk factors are shown and epidemiological situation of trichinellosis in recent years in Latvia is also found out. The main object of studies was foxes, which in 28% of cases were trichinella infected in all regions of Latvia. Identification of the trichinella larvae took place at the Danish Experimental Parasitology Centre in Copenhagen. The authors have proved that in Latvia there are three trichinella species distributed – *T. spiralis, T. nativa*, and *T. britovi,* and all of them are dangerous to humans. A conclusion has been drawn that more effective diagnostic method of trichinellosis is a tissue digestion in artificial gastric juice.

As regards toxoplasmosis, scientists have shown that it is a widespread parasitosis in domestic animals in Latvia. Toxoplasmosis infection was diagnosed by latex agglutination reaction in 30.4% of pigs, 44% of cats, 46.6% of dogs, 45.0% of sheep, and 40.0% of goats. The most important risk factors of infection are the environmental contamination

[1] Professor A. Jemeļjanovs' and his headed scientific institution "Sigra" scientific activities are described in this edition separately.

with oocysts of toxoplasma passed by cats and their ability to survive for a year or more; insufficiently cooked meat, milk and other products of infected animals; an increasing number of rodents and stray cats; ignoring measures of precaution in contact with animals (P. Keidāns, A. Krūklīte). For more complete risk analysis, more extensive epidemiological investigations are needed.

In recent years, studies in food hygiene have become more intensive at the Institute of Food and Environmental Hygiene of the FVM. Analysis of human health risk factors caused by using cow milk and dairy products has been carried out (E. Liepiņš). Researchers have shown that an acute problem still is contaminated milk and dairy products with enterotoxins produced by *Staphylococcus aureus* (R. Joffe). Investigations show evidence that in Latvia on average 77% of the isolated *S. aureus* strains causing cow mastitis are able to produce enterotoxins, most often enterotoxine A serotype. Investigations in this field are of great importance because a very significant part of the risk of enterotoxemia is developed by subclinical mastitis affected cows, also those the milk of which does not reach the market.

Investigations on epidemiology of food borne infections are also carried out in another direction, namely, possibilities of meat products to become contaminated with *Listeria monocytogenes* genus bacteria (A. Bērziņš), *Yersinia* genus bacteria (M. Terentjeva, A. Bērziņš, E. Liepiņš), as well as mycobacteria (A. Zirnītis, E. Liepiņš, G. Cicers). An important role of transmitting these bacteria from one environment to another belongs to the raw material of the certain product of animal origin and its processing stage.

At present the focus is on the investigation of *L. monocytogenes* in cold smoked meat products. The factors connected with *L. monocytogenes* contamination of cold smoked meat products during the production process in some enterprises in Latvia are studied. In co-operation with the Faculty of Veterinary Medicine of the Helsinki University, a molecular typing of the isolated and identified *L. monocytogenes* by pulsed-field gel electrophoresis (PFGE) is carried out. Results of the investigation are included into Mg.med.vet. A. Bērziņš' doctoral thesis that will be soon completed.

Occurrence of the pathogenic *Yersinia* genus bacteria was tested in swine by-products, carcasses and tonsils (M. Terentjeva, A. Bērziņš, E. Liepiņš). It appeared that 54 of tonsils were tested positive for *Yersinia spp*., where *Y. enterocolitica* 4/0:3 and *Y. pseudotuberculosis* accounted for 50% and 5%, respectively. Both *Yersinia* species were recovered from by-products (48%), while *Y. enterocolitica* (23%) – only from carcasses. The prevalence of *Yersinia* on by-products was significantly higher in tongues and liver than in other parts of the pluck set.

High prevalence of *Yersinia* on by-products and carcasses may present concerns for public health. The results of this study indicate that possibilities of *Yersinia* contamination of by-products and carcasses may occur during pig slaughtering from *Yersinia* positive tonsils. It is very important to continue these investigations in the same way as investigations on the possibilities to contaminate pork with mycobacteria from the mesenteric lymph nodes affected by caseous necrosis, and not only from them. In co-operation with the Centre of Biomedical Investigations of the Latvia University it was stated that in a slaugthterhouse of one particular meat processing enterprise where pigs were slaughtered from different regions of Latvia, in 35.8% of pigs caseous necrosis processes were found in mesenteric lymph nodes, in 70.6% of them mycobacteria were isolated. Carrying out genotyping, it turned out that all of them belong to *Mycobacterium avium* species, although with different phenotypic features.

It should be stressed that investigations in this field are deepened and extended because they are connected with the provision of consumers with healthy and safe foodstuffs of animal origin. Furthermore, this research is included also in the FVM doctoral students M. Terentjeva's and A. Zirnītis' promotion work.

Conclusion

Research carried out at the Faculty of Veterinary Medicine of LLU in different veterinary sub-brunches during the period from 1990 to 2009 was focused mainly on three objectives:

1) renewal of the scientific and academic personnel (to increase the number of doctoral students; to stimulate the motivation for successful doctoral studies);
2) science development in universities;
3) development of applied research and increase of its proportion.

We consider that these objectives are more or less successfully completed, although the science of veterinary medicine in Latvia is not included in the priority science group to apply for the EU financing. Thanks to the co-operation with the Ministry of Agriculture, Veterinary and Food Department, Food and Veterinary Service, and with its National Diagnostic Centre many issues have been solved in co-ordination and co-operation.

The nearest objective of our scientists at the Faculty of Veterinary Medicine of the LLU is to extend the international scientific co-operation as well as to continue the mutual co-operation with related scientific institutions of Latvia. In that way we will be able to supplement some sub-branches of veterinary medicine with high-level specialized scientific investigations both in terms of their leading and completion.

Also, in the future the urgent problems investigated at the Faculty of Veterinary Medicine may be conditionally grouped into four blocks. The grouping is conditioned because in one research direction of today's veterinary science investigations of several relevant sub-brunches are included:

1) elaboration of research system for obtaining a high-quality, safe and healthy produce of animal origin;
2) etiopathogenetic problems of most common non-infectious animal diseases and prevention of disorders caused by them;
3) epidemiology of most dangerous animal contagious diseases in Latvia, development and implementation of modern diagnostic, treatment and preventive methods;
4) investigations of the body functional processes of small animals (pets), studies of pathogenetic disorder mechanisms of different body functions and prevention of these disorders.

In all these directions of investigations the science of veterinary medicine welcomes young talented doctoral students!

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Scientific Activities of Forest Faculty

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Abstract. The article presents a systematic evaluation of the research carried out at the Forest Faculty since Latvia regained its independence The research has been arranged in two groups: the forestry group and wood processing group. The following major directions of research have been reflected: the evaluation of forest and wood raw material resources, forest inventory and management planning, evaluation of volume and quality of the growing trees and harvested round timber, silviculture and forest ecology, complex evaluation of the quality of wood from commercial tree species, the expansion of the diversity of complex utilization of wood, inventory of timber flow and simulation.
Key words: main research fields, timber volume, quality, forest inventory, wood science and processing.

Introduction

The forest sector which is based on local renewable resources is one of the leading sectors here in Latvia with the fastest development, which has recently occurred during the years of independence. That is the reason why the research in the fields of forest science and complex utilization of wood are among the priority support themes.

When evaluating the scientific activities the whole period of Latvia's independence can be dividend into three separate periods:

1. From 1990 to 1995 the academic staff were involved in the elaboration of legislation of a new faculty, forest policy, laws and regulations, national standards and the sector's development of a programme (masterplan). In this period fundamental scientific research could not be carried out due to lack of finances and human resources.
2. From 1995 to 1999, positive tendencies started to take shape in the development of scientific research. Under the leadership of profesor H. Tuherms, the section "The complex and perspective evaluation of wood as a material" was carried out. The research was carried out in cooperation with the Latvian State Institute of Wood Chemistry and Latvian State Forest Research Institute"Silava". It was devoted to the evaluation of the quality of pine and spruce wood, characteriztion of physical and mechanical properties and explanation of anatomical and chemical composition. During that period the following questions were also addressed:
    1. Sewage sludge usage in fertilizing tree nurseries and forests (under the leadership of professor I. Mangalis).
    2. Evaluation of the current standing timber (volume) increment (Prof.I.Liepa).
    3. Elaboration of sawnwood drying procedures (associate prof. J.Staprāns).
    4. Forest policy and the role of the state in supporting private forestry (prof.H.Tuherms).
3. The third period started in the year 2000 when the leading enterprise of the woodprocessing sector SC „Latvijas Finieris" started to show interest in financial support of the elaboration of market oriented research programme "Physical mechanical properties of birch wood and birch plywood depending on the growing conditions of trees and plywood manufacturing technology". A further rapid development of science was deliniated by the establishment of the Forest Development Fund at the Ministry of Agriculture and SC „Latvijas valsts meži" – "Latvian State Forests" involvement in the financing of scientific research orders. Consequently, the subject-matter of research expanded rapidly.

The scientific subject-matters researched at the Forest faculty can be divided into two groups: the forestry group, which pertains mainly to the Silviculture and Forest utilization department and wood processing field, where the Department Wood Processing

is involved as well as Forest and Wood Products Research and Development Institute (MeKA).

Description of forestry research

The scientific activities of the academic staff of the Forestry and Forest Utilization departaments took place in 4 research directions:

1. Evaluation of forest and wood raw material resources.
2. Forest inventory and management planning.
3. Evaluation of growing tree's and prepared round timber's volume and quality.
4. Silviculture and forest ecology.

Evaluation of forest and wood raw material resources

In forecasting the development of the forest sector and evaluation of the carbon cycle, it is important to clarify the wood resources in the forest, the structure and amount of round timber, the types, amount and the directions of the utilization of residues derived from wood processing.

Professor I.Liepa (2008), has calculated and analysed the actual forest growth of pine and spruce using the complicated and differenciated method of growth –increment calculation. That is the diference between the potential growth increment from which the deadwood of the forest growth and the annual amount of the volume felled are deducted.

According to the data of 2005, it was stated that in the coniferous forests of Latvia 11.95mil. m^3 of the standing volume of timber is formed annually and 2.06 mil. m^3 die, which results in 9.89 mil.m^3 of a natural annual increment. Deducting the fellings, the actual annual increment is obtained in all the coniferous forests, which is 4.26 mil.m^3. Since the commercial forests of Latvia account for 82% of all the forests, the actual increment of standing volume of timber in these forests is 3 mil.mз, which is considered to be a reserve of balanced use of the standing volume.

The second direction of the research carried under the leadership of professor I.Liepa is connected with the evaluation of carbon attraction in the surface parts of trees and roots (Liepa, Blija, 2008).

The need for clarifying the biomass of the whole stand has become very topical over the last 10 – 15 years, when it was provided by the activities of the Kyoto protocol. The aim of the protocol is to reduce the effect of the emissions of gases causing the greenhouse effect. The countries which have supported the protocol (Latvia ratified it in 2002) have to systematically evaluate the capacity and dynamics of gas emission and accumulation that cause the greenhouse effect.

Forests are the chief attractors of carbon among dry land ecosystems. In the research on the structure of Latvia's spruce forest tree biomass, choosing sample trees in the three most widespread forest types (Oxalidosa, Myrtilloso-sphagnosa and Myrtillosa mel.) transitional coefficients were obtained for calculating the amount of different parts of the tree.

The total amount of Latvia spruce is 117.095 mil. t from which 60.2 % is trunk, but 39.8 % is a non-trunk fraction part. These data characterize the reserve of the commercial use of forest and are the out-going basic data for calculating the amount of the accumulated carbon.

Under the leadership of profesor L. Līpiņš in 2003 and 2004 the research on the structure of the wood raw material sources and the effective use of it was carried out. The necessity of this research was determined by the substantial changes in both – wood treatment and wood processing types and technologies. The diversity of the use as well as the total amount of wood increased. More and more thinner and shorter trees were delivered for processing. Debarking of round timber, manufacturing of pulp chips and granulating and briquetting of wood processing residues was being introduced on a wider scale. The use of wood residues and low value wood for generating heat energy increased.

It has been stated in the research that in the prepared round timber amount 80 % of timber is obtained from the final felling. This proportion does not differ in state owned and private forests.

Regarding the assortment structure, the greatest proportion is made up by the assortments used for sawing – 51.5 %, followed by pulpwood - 31.7 %, firewood – 10.2 % and veneer logs – 6.0 %.

The structure of round timber in the final felling in state and private forests does not differ substantially. The round timber structure differs in state and private forests in intermediate fellings. In state forests the yield of small-sized logs is 9 ÷ 18 % higher, while in private forests the yield of deciduous firewood is twice as high as in state forests.

The balance for round timber has been made, taking into consideration the import and export volumes. The total volume of residues after felling and that which is of potential use has been estimated. The balance of wood resources used for generating heat energy has been made (4.66 mil. m^3 2003), where residues from wood processing make up the greatest proportion – 1.57 mil.m^3, firewood - 1.3 mil.m^3 and felling residues – 0.89 mil.m^3.

The output, residue structure, amount and utilization trends of the products obtained from woodcutting, veneer and plywood manufacturing, matches and charcoal production as well as fibreboard manufacturing have been estimated.

It has been calculated that the income from 1 m^3 of processed veneer logs for plywood production is 115 LVL (164 EUR), that is twice as much as in wood sawing, but 7 times less than in producing veneer for furniture finishing.

Forest inventory and forest management planning

In 2004 under the leadership of the Dean of the Forest faculty asoc. professor D. Dubrovskis, a research group " Precise Forestry Research Group" was established at the Latvia University of Agriculture in cooperation with the staff of Forest and Information Technology faculties. The necessity of establishing such a group was motivated by the rapid development of information technology worldwide over the last decade. It provides the development of new solutions to forest and wood resources inventory, planning, analysis, and control. The aim of the project group is to carry out research on forest inventory and planning processes, demonstrate innovative solutions and increase the competencies of the employees and students of the forest sector. The research group has the following aims:

- forest inventory which includes the development of measuring instruments and the development of forest inventory and wood resources measurement methods;
- planning of forest management, which includes the development of new methods and new generation software;
- forest logistics, which includes the research into the processes of timber preparation and transportation, simulation and creating an information technology support system.

The research group has carried out the projects ordered by the SC Latvia's State Forests, Ministries of Agriculture, Environment, Education and Science and Metrum Ltd., as a result of which several prototypes of computer software and programmes have been created:

- „Ozolin's algorithm beta version" (virtual measurement) – a programme prototype developed for the evaluation of the felling site fund to forecast SC „Latvia's State Forests" round timber supply;
- „Mežvērte"- the software developed for evaluating the fund of the felling site, which includes the analysis of the virtual measurement analysis of trees, forecasting the round timber output and the calculation of the felling site value. The programme can be used for private forest evaluation and in evaluating the amount of compensation for the protected territories;
- „Meža eksperts" – forest inventory, a forest ownership evaluation and forest management planning software programme, which was developed for planning forest property management, assessing the value of the forest property and for registration and control of economic activities. The programme is used for providing private forest management for both individual forest properties and combined forest properties. Currently, the users of the programme are private forest owners, associations of forest owners, assessors of real estate and providers of forest consulting services;
- „MAPIS"- the use of the forest management planning information system Web for education of private forest owners, forest evaluation and forest management planning. The forest owners can get free access to the programme through the Internet. Through this programme forest owners can become acquainted with the

planning principles of forest property management in a practical way and prepare the forest management plan for their property;

– „Kokmateriālu plūsma beta versija" – the support programme prototype of decision making in optimization of round timber transportation and sales. The prototype of the programme is devoleped as a simulation model of forest logistics processes. This programme will enable the forest owner or logging enterprise to calculate the optimal round timber structure and determine the optimal delivery enterprises.

Taking into account quite a substantial subjective factor and the influence of accidental errors in forest inventory, solutions are being researched to improve or replace the existing methods with less labour consuming semi-automated and automated methods. Here one should mention the study of the remote sensing method.

Up to now the use of satellite photos in forest inventory and forest management control has been studied. The use of LIDAR (laserscanning technology) in forest inventory and detemining the growth parameters as well as the use of unmanned aerial vehicles in forest inventory and management control, the solutions to recognize the photos have been worked out. The programmes of accummulating and processing of the data of forestry measuring tools have been developed.

Evaluation of volume and quality of growing trees and prepared round timber

A group of researchers under the leadership of professor L. Līpiņš, within the framework of national research programmes, has explained the dimensial and qualitative evaluation of pine, spruce, birch, aspen and grey alder trunks. The occurrence of defects in wood, branching charecteristics, as well as factors influencing rot and the relationship with the trees dimensional characteristics (the proportion of height and diameter, the length of the green crown part and the size of the branchless part of the trunk, etc.) have been clarified (Līpiņš, Sarmulis, 2002, 2005).

It has been stated that for each tree species the trunk quality and wood value is determined by different factors. The trunks of our major coniferous trees are straight. Since fungal damages to pine, including rot, occur quite seldom, the major factor influencing the evaluation of quality is branching, particularly the length of the branchless part. In the case of spruce, the occurrence of fungal damage is an important defect in wood, and the branching influences wood quality of the trunk to a lesser extent than in the case of pine.

In the case of birch and aspen, the most essential factors are the ocurrences of fungal damage, followed by crookedness and branching. The resulting marketable timber and the value of trunk wood in grey alder are determined by the diameter of the trunk and crookedness, but the influence of branching is considerably smaller. A more detailed description of findings can be found in the collections of scientific articles.

In the framework of the market oriented research programme, in the years 2004 and 2005, under the leadership of professors L.Līpiņš and I. Liepa, broad research was carried out on the interdependence of industrial tree species' bark thickness and changes in taper depending on the round timber diameter and length and taking into account the region of tree growth and the location in the trunk.

The necessity of the research was determined by the situation that existed in the manufacturing, when a new national standard „Round timber measuring" was approved in 2003, which complied to the European standards. The new standards provided for different principles of measuring round timber parameters. It was impossible to be applied in Latvia since there were no adequate regulations here.

In the course of research, it was stated that the region of tree growth does not influence the indicators of bark thickness and taper coefficient, therefore the measurements obtained in different regions of Latvia were combined in a common data bank, that enhances the credibility of the data obtained.

The mathematical processing of data proves that the thickness of pine and birch round timber bark is influenced both by the place on the trunk (the assortments prepared from the trunk butt-end, middle and top of the tree) and by the diameter in the place of the measurement. In spruce, aspen and alder the thickness of bark is not influenced by the location in the trunk, because the bark is uniform over the whole length of these tree species.

The paper presents mathematical correlations for evaluation of bark double thickness in mm and %, depending on the diameter in the place of the measurement, as well as the volume in %. Tables have been made up to select the indicators.

Mathematical correlations are used in an authomatic measurement processes of round timber.

It has been stated that the timber taper is considerably influenced by the tree species, location in the trunk, diameter and length.

According to the obtained taper indicators, new original round timber volume tables were deloped, where the diameter at the smaller end was used for determining the volume. When checking the accuracy of the tables for measuring 30 m^3 volume (one truck load), it was found that the volume obtained from coniferous logs was with twice a smaller error, but for birch veneer logs a four times smaller error than determining the volume according to the middle part diameter, which is practiced in most Western European countries.

Mathematical correlations between packing case logs, small diameter logs, match logs pulpwood and stacks of firewood loaded timber of average diameter and capacity coefficient have been found. The option tables of capacity coefficients have been made up where the evaluation of the stacking quality has been included as an additional factor.

A new, simple and inexpensive method for calculating the capacity coefficient has been proved as useful, using digital photos and net graphical design. It can be used for both – timber loaded onto trucks and for big timber stacks. The results of the research are summarized in the book under the title „The measurement of round timber"(2007).

Silviculture and Forest Ecology

At the Department of Silviculture regular repeated research on the growth of introduced tree species, the structure and productivity of stands is carried out at the Forest research station of the Šķēde forest area under the leadership of professor A. Dreimanis

The introduced species extend the variety of tree species and in many areas it provides valuable wood production for practical use. The first plantings of the introduced tree species in the Forest research station of the Šķēde forest area were carried out at the end of the 19th century and a lot of the stands are over 100 years old. In the forest area one can find valuable, biologically significant and productive forest stands of European beech, European white fir, European larch, red oak, Weymouth pine, Douglas fir and other tree species. The results of the research from the last decade have been collected and summarized in several publications (Dreimanis, 2001; 2006, Dreimanis, Šulcs, 2006). In the conditions of Talsi hilly relief, these species have reached high productivity and they have a high resistance to frost, but thicker trees may have a volume of 6-8 m^3.

The productivity and structure of grey alder has also been described in the context of growing biomass (Miezīte, Dreimanis 2008).

Grey alder had not been thoroughly researched for almost 50 years in Latvia. It was considered to be a less significant tree species. Due to the limited resources of fossil fuel, it has the capability to produce biomass for obtaining chipped wood for fuel. At the beginning of the 21st century grey alder occupied 4th place among other tree species by the stand area which was 190.6 th.ha (data of 2006). Empirical formulas have been developed during the research process for the determination of leafless growth above the ground biomass of grey alder in freshly cut and absolutely dry conditions in trees with a diameter of up to 26 cm. Mathematical models have been developed for calculating biomass of grey alder stands depending on the average diameter of the stand and basal area. The distribution of the number of trees by diameter stages, the length of the green crown and cumulative frequency values of the number of trees, basal area and growing timber have been studied (Miezīte, Dreimanis, 2008). The average increment of most stands are within the limits of 5 – 10 t ha^{-1} per year.

In natural biotopes of different tree species the occurrence of lichen species has been studied. (I.Straupe, J.Donis).

The diversity of species and environment quality are charecterized by the occurrance of lichen species in natural forest biotopes, where the anthropogenic influence is smaller. Thirteen lichen species have been found in pine natural biotopes. Their exposition on pine and spruce at different heights of the trunk depending on the points and ecological factors (has been clarified (Straupe, Donis, 2006).

In oak natural biotopes 28 lichen species have been found. The variety of these species at the height of 0.5 m is smaller than at the height of 1.5 m. It is connected with the physical differences of the bark at different ages of trees. (Straupe, Donis, 2007).

Overall, in the sites of black alder 6 lichen species belonging to 6 genera have been found. The epyphite lichen identified in the sites are morphologically divided into: crustose lichen – three species (50 %), foliose lichen – two species (33 %) and fruticose lichen – one species (17 %), *Arthonia spadicea* and *Graphis scripta*, which in natural forest biotopes indicate suitable conditions for particularly endangered species – special biotope species and testify for high humidity of the air in the stand. In addition, *Arthonia spadecea* is a particularly protected species in Latvia. Black alder forests in Latvia are very significant areas for biological diversity. This is proved by the results of the research: in black alder sites there is a greater variety of epyphite lichen in comparison to the researched spruce sites, which corresponds to the data described in literature.

Research into wood processing

The Department of Wood Processing together with the Institute MeKA, other departments and institutes directed their research in the following major directions:

1. Complex research programmes on industrially significant tree species in an operational chain: forest – wood- end product – market requirements.
2. Expanding the versatility of the use of wood.
3. Inventory of timber flow and simulation.

Complex research programmes

From 1995 to 1999, under the leadership of professor H. Tuherms a part of the research programme "Complex and Perspective Evaluation of Wood as a Material" was carried out. The research explained the dimentional and qualitative evaluation of the wood from the trunks of pine and spruce which were grown in different conditions, differences in anatomical composition, differences of physical properties (colour, moisture content, density), mechanical properties (ultimate strength and modulus of elasticity at different loading types), the output of sawnwood and distribution according to quality, the possibilities of improving the timber drying process and the protection of construction timber from biodegradation.

The obtained results proved high quality parameters of Latvia's softwoods and its competitiveness in the world markets.

Over the period of 2000 – 2005, a market oriented research project was implemented" Qualitative Indicators of Birch Wood and Birch Plywood Depending on Growing Conditions of Trees and Plywood Production Technology" (head of the project – professor H. Tuherms). This project was suggested and co-financed by SC „Latvijas Finieris". The research programme was carried out in three stages. For each stage the tasks were clearly specified. As a result of the research, recommendations for growing high quality birch wood, the dimentional and and qualitative evaluation of the birch trunk wood veneer logs from the merchandise point of view. Research on imported birch veneer log parameters, birch wood and birch plywood physical-mechanical properties was also carried out (Миончинскис и др., 2004). The methodology for forecasting the mechanical properties of plywood and calculating standard timber constructions with plywood elements, the changes of optical properties of birch veneer and plywood depending on veneer exposure after peeling, seasoning procedures and veneer exposure after drying, complex research has been developed on the use of birch plywood in interior furnishing and producing cargo containers.

Using the results obtained from the research on the physical, mechanical and visual properties of the birch wood growing in Latvia, and also adapting to the requirements of the end users, the stock company „Latvijas Finieris" 2 substantially new products were created:

- *Riga Ship ply* – plywood which is used in producing insulation panels for liquified gas containers. The strength parameters are two times higer than in the case of standard plywood, enabling this plywood to be used in ship building in Korea, Japan, China and France.
- *Riga Decor – varnished high quality plywood, the decorative surface of which has been obtained by gluing the base plate with* 0.8 mm thick peeled veneer.

The implementation of the third complex research programme began in the year 2005 and finished in 2009. It proceeded with the evaluation of soft hardwood species – aspen, grey alder and hybrid species. Under the leadership of professor H. Tuherms, a subprogramme was implemented at the faculty – „Utilization of Hardwood in the Mechanical Treatment for Obtaining New Products"

As a result of the project for the first time a complex research on the grey alder and aspen wood grown in Latvia had been carried from the point of view of wood science and forest merchandise, using modern research methodology, which enabled the researchers to carry out their research according to the EU standards. Due to this approach, the results are internationally comparable (Tuherm, Ludvigsone-Rudzīte, 2006). For the rational utilization of wood potential in the mechanical treatment, mechanical properties of the wood of these species have been determined, the drying procedures have been worked out and also the possibilities to improve the performance properties, including the surface hardness have been studied. The possibility to improve the performance properties of grey alder and aspen wood through thermal modification has also been proved. The market demand for various types of grey alder and aspen products has been studied (Spulle et al. 2008). The possibilities of using soft hardwoods in construction and wood articles production have been evaluated.

Expanding the versatility of the use of wood

Since wood is most often used in construction, several research projects were carried out to expand the versatility of the use of wood. Under the leadership of the associate professor Andrejs Domkins the following projects were carried out: " Research on the Use of New Products in Construction", " Stating the Conformity of Latvian Pine Wood to the Construction Standards of the USA", "An Innovative Use in Creating New Products", "Wood Plates of Increased Specific Strength", etc.

As a result of the research, the summarizing and evaluation of the regulations and standards has been carried out. Technical instructions have been elaborated for the use of the new construction wood products in Latvia. Recommendations have been prepared for the elimination of the limiting factors of the use of wood.

In cooperation with a certification institution accredited in the USA, the testing of sawn pine timber, produced in Latvia, was carried out and a report prepared for the Standardization Committeee of Sawn timber of the USA. Basing on its decision, the Latvian pine wood has been included in the list of accepted foreign species, determining standard strength parameters and assigning a designation for grading Scot.P.(I)LAT, thus opening the ACV construction timber market for the Latvian manufacturers.

An important factor in the use of wood for construction purposes is the improvement of its fire resistance, therefore fire resistance tests of the flooring and other construction elements as well as wood composite materials were performed. The possibilities of increasing fire resistance were analysed (Bukšāns, Morozovs 2007, 2008).

Thorough research was carried out on pallet constructions. The strength of these constructions and the durability or their joints, (Spulle, Pušinskis 2006). The possibilities of gluing wet wood have also been researched as well as aprobation of non-damaging quality control methods for different wood materials and gluing types (Iejavs, 2007).

Combining the competencies of scientists, plywood manufactures, competencies of transport and chemistry, a new kind of plywood to be applied in the field of transport was developed. These are the so called wood plates with an increased specific gravity, which ensures the reduction in the use of wood material and lower use of fuel per one unit of load.

Timber flow inventory and simulation

The research in this field started with the development of classifier of energy and pulp chips as well as code system (head assoc. prof. K. Būmanis). First the evaluation of the classification used in Latvia was performed and the experience of Sweden, Finland, Estonia and Lithuania was summarized. The classifiers of round timber assortments, energy and pulp chips used in Latvia have been made, which include the name of the respective assortment and its description, making use of: tree species, diameter, length, quality and other parameters. It enables the users to create a uniform information system in the sector. The development of the round timber flow model has been carried out.(head prof. P.Rivža). By using this model it is possible to perform the current timber flow evaluation and determine the scenarios for development. As a game variant, this model gives the students an opportunity to get acquainted with the timber market and have a better understanding of its functioning.

As a separate task, the development of theoretical and experimental model of fuel wood flow and evaluation of quality requirements have been completed (assoc. prof. K.Būmanis).

As a result of the project, the fuel wood product specifications and quality descriptions have been performed. The methodology of quality evaluation has been developed and the necessary data have been accumulated and summarized for the development of system model. Contacts have been established and international cooperation started in the field of standardization of fuel wood products and quality evaluation. Internationally acknowledged tests have been carried out for the fuel wood products. A system model has been developed by means of which it is possible to analyze the demand and flow to the industrial or target customer. Auxiliary tools of the system have been developed to optimize the product flow and analyze the future scenarios as well as carry out the economic calculations of the flow.

Conclusion

It has been planned to continue part of the research which pertains to carbon attraction evaluation in the ground surface part and roots of other tree species and, to the factors influencing the structure of timber and also to the use of mass method in determining the volume of round timber and chipped wood.

The "Precise Forestry" research group will turn to forest logistics research in the future. It has been planned to develop the competencies of IT technologies for supporting decision making. In the future research will be carried out on the issues of forest management planning (creating forest landscape, developing land reclamation systems, etc.) Innovative solutions to obtain forest information will be developed (LIDAR, unmanned aerial vehicles, etc.) and it has been planned to create an algorithm library which will be used in forest sector and to use it in the form of data processing prototypes (LEGO principle).

In the field of wood processing it has been envisaged to continue the research on the methods of improvement of wood properties, increasing fire resistance, the use of new composite materials and the use of wood finishing materials.

The existence of research activities is connected with the prioritising and development of state ordered research programmes and establishment of Forest sector competence centre. We are always open to new ideas and ready to cooperate with the enterprises within the sector in the development of different information technologies and innovative solutions.

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Agricultural Engineering and Pedagogical Sciences at the Faculty of Engineering

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Abstract. At the Faculty of Engineering, research is carried out in two directions – engineering sciences, and pedagogical sciences. In the sphere of engineering sciences, the main directions of research are: development of mechanization means for conditioning of energetic plant biomass that is needed for production of solid fuel; supply of optimal microclimate on pig farms; efficient utilization of solar radiation in grain drying and production of hot water; production of alternative fuels; influence of biofuels on dynamic parameters; consumption of fuel and composition of exhaust gases of internal combustion engines; usage of climatic factors in the process of grain conditioning and storage; development of animal production machinery and technologies; research in energo efficiency of water supply and waste water engineering systems, and development of waste water aeration equipment management systems; development of biogas production technologies; research in technological, ecological and energetic aspects of micro-cogeneration in autonomous energy supply using biogas. In the sphere of pedagogics, the main research trends are: ecology of education, competence in rural environment, professional and career education, life quality in the context of home environment, and natural and engineering didactics.
Key words: engineering science, pedagogical science, biomass, biofuel, education.

Introduction

The Faculty of Engineering was founded in 1944. Till 1996 it was called the Faculty of Agricultural Mechanisation. During the whole time of its existence, the teachers together with pedagogical work have actively carried out research. It was promoted by establishment of post-graduate courses at the Academy in 1945 and the right to award scientific degrees in 1946. During the Soviet times, 86 teachers were awarded the Doctor degree (Candidate of sciences), and 7 – Doctor hab. degree. During that period at the Scientific Council of the Latvian Agricultural Academy and specialized councils at the Faculty, in the field of agricultural mechanization and electrification, 160 Doctoral and 7 Doctoral hab. theses have been defended. Since 1991, 5 teachers of the Faculty have obtained Dr.sc.ing., 8 teachers – Dr.paed. scientific degree, and 5 teachers – Dr. habil. sc.ing. degree. The present article summarizes information on the scope of scientific activities at the Faculty since 1991 up to the present.

Grain Pretreatment and Storage

Pretreatment and storage of grain is a traditional and long-term field of research at the Faculty (E. Bērziņš (1934-2004), J. Palabinskis, A. Āboltiņš, P. Rivža, I. Arhipova, S. Arhipovs, A. Lauva). Energetic research in grain drying technologies is continued. The research has resulted in the doctoral hab. thesis of the long-term supervisor of the research direction professor E. Bērziņš (Bērziņš, 1996). The 1990s of the last century in Latvia were characterized by reconstruction of grain dryers and construction of new buildings. During the research, new grain drying and storage technological and technical solutions were developed. Several grain drying and aeration technologies and equipment constructions have obtained patents (Soviet Union (SU) patent 1706455, Russian Federation (RF) patent 2016504, Latvian (LV) patent 10740). The optimal regimes for grain drying with active aeration and grain feeding in layers (Раецкис, 1990) and grain after-drying with aeration (Палабинскис, 1998) were substantiated in order to apply the heat accumulated in grain in the dryer for carrying out of moisture for drying in the subsequent process of aeration. A theoretical model for evaluation of the efficiency of usage of heat accumulated in grain in the process of after-drying has been developed. One of the main trends of practical research in the 1990s was preparation of recommendations for practitioners for improvement of grain drying and storage efficiency using mathematical modelling of grain drying and storage processes in different stages and conditions of drying and storage. The aspects of methodology and mathematical

modelling of grain drying and storage processes have resulted in two Doctoral theses (Arhipova, 1994; Āboltiņš, 1993) and one Doctoral hab. thesis (Rivža, 1995). Since 1990, the results of this research have been presented in 16 presentations in international scientific conferences and 37 publications, including issues of international character (Berzins, 1993; Aboltins, 1997; Aboltins, Berzins, 2004).

With the changes in the equipment of grain drying, the researchers of the group in co-operation with the Agricultural Machinery Certification and Testing Centre followed the procedure of this process and participated in evaluation of the grain drying equipment. Since 1996, co-operation with the company "Baltic Instruments" Ltd has been continued, in the result of which an up-dated grain active ventilation process control equipment GK-01 with a three-phase non-contact commutator BK-01 using the patented algorithm has been developed (LR patent 12096).

At the end of the 1990s, active energy research in grain drying air heating solar collectors started. A two-flow stationary solar collector has been developed for simultaneous comparative research in two different absorbents, and sun-following equipment has been built that serves as the carrying base for experimental solar collectors to investigate their construction and efficiency of absorbents with the following scope 360° and the following step 0.5°. The results of the research show that the obtained amount of heat from the sun-following collector with metal absorbent is up to 43% larger than that of a stationary collector. A pilot project of a mobile pull-up solar collector has been developed. The research is being continued.

In the middle of the present decade, research in ozone application technologies has been started in grain drying at low air temperature. In laboratory experiments it has been stated that carrying out of moisture from grain is more efficient if grain is actively aerated with ozonized air. Laboratory experiments prove efficiency of the presence of ozone in the process of grain active aeration.

Machinery and Technology of Animal Production

In the first half of the 1990s, professor A. L. Skramans (Profesors ..., 2005) (1915-1996) actively continued to work in the field of animal housing machinery and developed a two-stage pulsator for milking machines which, according to the evaluation of Danish experts, corresponded to the EU requirements. The professor organized also production of it and at that time it was very popular and demanded.

Under the leadership of professor J. Priekulis, research in rational milk production technologies and machinery including environment protection aspects has been carried out. He has elaborated methods and economically evaluated different milk production technologies. The results of the research are summarized in two monographs (Priekulis, 2000; 2008). Research in milk production technologies has resulted in a promotion work (Zujs, 2005). A Latvian patent (13276) has been received for the technical solution for economy of heat energy during automatic washing of the milking equipment. According to the request of the Ministry of Agriculture and Environment, different normative materials on technological design of animal farms taking into account environmental aspects were developed, including preparation of two standards. The research results are reflected in 66 presentations at international scientific conferences, 20 publications in international scientific issues, and 101 other publications.

The leading researcher A. Laurs carries out research in the new dairy technologies including precise dairy production and management systems. He has participated in remaking of the international standard on milking equipment. The research of A. Laurs and J. Priekulis is summarized in a monograph (Laurs, Priekulis, 2001).

Recently a new field of research has arisen – application of milking robots. The research results are reflected in 33 presentations at international scientific conferences, 36 publications in international scientific issues, 26 publications in scientific issues in Latvia, including four monographs, and 55 other publications.

Sapropel Extraction Technologies and Energetic Plant Biomass Conditioning

At the beginning of the 1990s, the Scientific laboratory of Mechanics of Agricultural Machines continued experimental and theoretical research in physical-mechanical properties of Latvian lake sapropel (Ē. Kronbergs, A. Kaķītis, A. Mežs, I. Plūme, and A. Vidužs). The research allowed designing a sapropel extraction equipment in the lake Lobe (Ē. Kronbergs, A. Vidužs, A. Mežs, SU patent 1609883) and supervising its production.

After the Land reform, when large collective and state farms were converted into smaller ones, obtaining of sapropel becomes too expensive for them. According to their needs, small-scope technologies for extraction and application of sapropel and lake biomass were developed, patented and researched (LV patents 11752, 11753, 12127, and 12155). These investigations have resulted in a dissertation (Kaķītis, 1999). The research results are presented in 9 presentations at international scientific conferences, 5 publications in international scientific issues, 4 publications in scientific issues in Latvia, and 18 other publications.

Due to the increased energy costs and different legislation limitations on environment technologies, extraction of sapropel currently in Latvia is almost stopped. In the 1990s, co-operation with Rupert Bevan, a researcher from Great Britain, was started. After defending his Master paper (on application of sapropel), R. Bevan was the initiator of the establishment of the company "Zander Corporation". Its operation is active in development of different environment technologies in Asian and African countries.

At present, with energetic and ecological problems dominating today, the Scientific laboratory is working at development of mechanization tools for conditioning of energetic plant biomass that is needed for production of fuel. During the research, several patented facilities have been developed (LV patents 12409, 12435, 12465, 13447, and 13597).

The statements obtained in the research are reflected in the proceedings of international conferences "The 1st and 2nd World Conference on Application of Biomass" (Kronbergs et al., 2000; 2004) and in the proceedings of European conferences on application of biomass in Amsterdam and Berlin (Kronbergs et al., 2002; Smits et al., 2007), as well as in the proceedings of other international scientific conferences. The research results are presented in 44 presentations at international scientific conferences, 44 scientific publications in international issues, and 8 other publications. The research has resulted also in a promotion work (Nulle, 2008). At present the dissertation of M. mits "Mechanisation of culm material conditioning processes" is almost finished, and it is devoted to the development of design methods of biomass cutting and compacting mechanization tools. The doctoral student J. Lāceklis-Betmanis is carrying out research in pressure oscillations in tractor hydraulics systems. Master students G. Liepiņš, D. Ancāns and A. Hausmanis are developing mechanization tools for application of them in obtaining of alternative energy, but E. Repše is investigating application possibilities of the program "Working model" in modelling of operation of agricultural machines.

Chain Equipment and Disc Brakes

Under the leadership of professor G. Uzkliņģis research started earlier in rolling chain links and conveyor chain equipment is continued. In the result of the research, a new theory for designing of the chain equipment, increasing of the quality and resources using dismountable plate chains with rolling friction links and multi-step sprockets has been developed, two-shaft and multi-shaft rolling chain contour universal mathematical model has been elaborated, as well as an optimal link synthesis and rolling chain selection method has been developed, and geometrical-kinematic criteria for evaluation of the quality of the chain contour have been elaborated. For his research work, professor G. Uzkliņģis was awarded the degree of Dr.habil.sc.ing. (Uzkliņģis, 1994). The link rolling process, its insurance and mesh of such chain with sprockets have been investigated. The chain constructions are patented (LV patents 10417, 13694, and 13695). Experimental research proves working ability of such chains. Lately research is carried out in increase of the operational abilities of single disc brakes (G. Uzkliņģis, J. Feldmanis). Theoretically and experimentally brake shoe wear and heating in co-operation with the Jelgava Machine Building plant are investigated. In the result of the research, the construction of such brakes has already been improved. The main results: uniform wear of brake shoes along the whole active surface and complex design methodology of such brake friction couple, considering wear as well as heating. The research results are presented in 9 presentations at international scientific conferences, 6 scientific publications in international issues, 10 scientific publications in Latvia, and 20 other publications.

Optimal Microclimate and Usage of Solar Energy

Under the leadership of professor I. Ziemelis, research is carried out in technical ensuring of optimal microclimate on pig farms and on usage of renewable energetic resources. Constructive, heat, technical, economic and other parameters of electrically and hot water heated concrete floors and panels for pig farms have been determined (SU

patent 1687152, LR patent 12465). They are tested in laboratory and farm conditions. The main combined pig heating (infrared radiation and heated floors) parameters have been determined (SU patent 1595412, LR patents 12996). Several pig lie heating pressure control constructions have been designed, produced and introduced. Engineering and technical aspects of pig radiation with ultraviolet rays are researched in. The research results are reflected in proceedings of 18 international conferences, 29 scientific issues, and 9 other publications. Pig farm ventilation systems using heat exchangers and heat pumps are developed and tested in laboratory and farm conditions (LR patents 13559, 13712, and 13726). The research results are reflected in proceedings of 28 international conferences, 7 scientific issues, and 16 other publications. Lecturer L. Kanceviča has prepared doctoral thesis "Solar energy collector with reflectors", and doctoral student Ž. Jesko is working at promotion work "Substantiation of several original constructions of solar energy collectors".

Resistance of Wood and Flaky Constructions

Under the leadership of associate professor V. Pušinskis (1936-2008) and in co-operation with the Department of Wood Processing of the Forest Faculty, research in birch wood and birch veneer application properties and the quality of pallet material have been continued. V. Pušinskis was awarded the degree of Dr.sc.ing. (Пушинский, 1996). The results are presented in 9 presentations at international scientific conferences, 10 scientific publications in international issues, 6 scientific publications in Latvia, and 14 other publications.

Professor G. Vērdiņš researches in the field of resistance of flaky construction material shapes. In the result of the research, three Latvian patents for different constructive solutions have been obtained (No. 12079, 12104, and 12191). The research results are presented in 4 presentations at international scientific conferences, 4 international scientific issues, 5 scientific issues in Latvia, and 2 other publications. Further research trends are: improvement of construction material corrosion resistance and application of nanomaterials in lubricants.

Servicing and Rational Application of Machinery

In the 1990s, research in the field of servicing and rational application of agricultural machinery was continued (J. Tupiņš, M. Ķirsis, J. Lācars (1935–2003), G. Aizsils). For this research Z. Grants obtained the degree of Dr.sc.ing. (Grants, 1995). The research results are reflected in 10 presentations at international scientific conferences, 8 articles in international scientific issues, 6 scientific issues in Latvia, and 38 other publications, including 4 monographs. At present the researchers of the Institute of Power Vehicles (G. Birzietis, D. Berjoza) are continuing research in the field of power vehicle dynamic parameter registration and analysis. In the result of the research, a patented equipment parameter registration system has been developed (LV patent 13704). The research results are presented at 4 international scientific conferences, and 4 international scientific issues.

Under the leadership of professor J. G. Pommers (worked at the Faculty till 2000), a research was carried out in the field of automobile application properties (power vehicle body coefficient for determination of air resistance, changes in fuel consumption, etc.). For research in this field, J. G. Pommers was awarded the degree of Dr.habil.sc.ing. (Pommers, 1993). This research has resulted in the promotion work of D. Berjoza (Berjoza, 1999). The research results are presented in 4 presentations at international scientific conferences, 2 scientific publications in international issues, 2 scientific publications in Latvia, and 28 other publications. Professor Pommers has researched also into the aspects of development of higher education and technical terminology. These issues are reflected in 8 presentations at international scientific conferences, 4 scientific publications in international issues, 3 scientific publications in Latvia, and 18 other publications.

Obtaining and Application of Biofuels

At the end of the 1980s, under the leadership of professor V. Gulbis (1929-2008) research in the field of alternative fuels was started and is still going on: usage of wood gas, ethanol-gasoline mixture, biodiesel fuel – rape seed oil ethylester and methylester fuels and their mixtures with fossil diesel fuel as well as pure rape seed oil as fuel in diesel engines. For research in the field of alcohol fuel application, G. Birzietis was awarded the

degree of Dr.sc.ing. (Birzietis, 1997). R. Šmigins has prepared promotion work on the influence of biofuels on the parameters of diesel engines, and I. Dukulis – on modelling and optimization of rape oil as a biofuel logistics system. Doctoral student V. Pīrs is researching into application of bioethanol in internal combustion engines. Technology for wood waste gasification and purification, and cooling of wood gas in order to obtain qualitative wood gas for application in gas diesels and gas engines at small capacity (up to 1 MW) cogeneration motor stations has been developed. Research in ethanol–gasoline mixture mutual solution has been carried out. Characteristic curves of octane number variations in different types of gasoline have been obtained. Characteristic curves of engine effective power, torque, fuel consumption as well as exhaust gas component CO, HC changes depending on the engine revolutions and load with the engine operating with pure gasoline as well as with 5 to 20% ethanol mixture fuels have been obtained based on the research carried out on the engine testing stand. Several types of diesel engines have been changed for work with pure rape oil, and research into the changes of dynamic, economic and ecologic parameters on the engine stand as well as on the roller stand has been started. The engine Ford Sierra 2.3L has been equipped with oil pre-heating system, and on the engine stand characteristic curves of power, torque and fuel consumption have been obtained with the engine operating with pure rape oil. Research into usage of rape oil fed cars has been started. The first test results have been summarized in real driving cycles as well as using the roller stand MD-1750 and the precise fuel consumption measuring device AVL KMA Mobile. To increase credibility of the results, synthetic experiment methods have been elaborated, which allows to maximally approximate the automobile laboratory measurements to actual operation conditions. Deep research in combustion processes for diesel engines operating with diesel fuel and biodiesel fuel mixtures has been carried out. In the result of deepened research in combustion processes working with biodiesel fuel and its mixtures at definite revolutions of the crankshaft and stable injection outpace angle reduction of indicated pressure was stated. The experiments also proved that the pace of pressure reduces if RME concentration in the mixture increases, which is related to reduction in fuel heating capacity. The research results are reflected in 40 presentations at international scientific conferences, 29 articles in international scientific issues, 14 scientific issues in Latvia, and 33 other publications, including 4 monographs.

In future, research in the technical solutions of biogas application in power vehicles as well as in the ecological and economically effective solutions in perspective automobiles and tractors of the 2nd generation is planned.

Under supervision of the leading researcher G. Brēmers, laboratory type equipment for obtaining of absolute alcohol with the method of salt distillation method has been developed, and a new raw alcohol distillation method has been elaborated that is called "continuous operation non-phlegm salt distillation" and experimental equipment for improvement of the method has been developed. Application of these methods in production could reduce the energy consumption for dehydration of bioethanol by up to 50%, which would in turn allow reducing the bioethanol production costs. Basing on experimental research experience of the above-mentioned methods, the newest congruent bioethanol dehydration method has been elaborated which implementation could reduce the energy consumption even more (by 70%). In order to make the method closer to practice, at present in laboratory equipment research in congruent dehydration technology units and construction principles of the equipment is carried out. The developed constructive solutions are protected by five Latvian patents (No. 13350, 13351, 13507, 13691, and 13810). The research results are reflected in 15 presentations at international scientific conferences, 11 articles in international scientific issues, including the proceedings of the 14th European Biomass conference (Bremers et al., 2005), and in 6 scientific articles in Latvia as well as in 2 other publications.

Protection of Electro Engines and Kinds of Alternative Energy

At the Institute of Agricultural Energetics, the research started by professor A. Grundulis (1934-2004) was continued in automated protection of electro engines (A. Šnīders, P. Leščevics, and A. Galiņš). After 1990, basing on this research, one doctor hab. dissertation (Šnīders, 1993) and one doctor dissertation (Galiņš, 1996) were defended. The research results are presented in 5 presentations at international scientific conferences, 8 international scientific issues, 13 scientific issues in Latvia, and 10 other publications, including 6 monographs. At the beginning of the 1990s, under

the leadership of professor A. Grundulis, research was started in the field of the kinds of alternative energy (A. Galiņš, K. Zihmane-Rītiņa) – wind, solar, biofuel energy sources and combined energo supply. In the result of this research, one doctor dissertation has been defended (Zihmane-Rītiņa, 2008). With the initiative of professor A. Grundulis, on farm "Toleni", Vircava village, a solar collector was installed with the absorber area of 120 m^2 (1992), and it was used for scientific research, grain drying and practical technological demonstrations. On this farm also a wind investigation site was built where wind data were collected. At present, two wind generators produced at the Institute of Agricultural Energetics are installed there. The research results are presented in 17 presentations at international scientific conferences, 15 international scientific issues, 4 scientific issues in Latvia, and 19 other publications. Simultaneously research in alternative ways of heating was carried out (A. Galiņš, E. Visockis), and in the result a doctor dissertation was defended (Visockis, 2008).

Under the leadership of Dr.sc.ing. V. Dubrovskis, a laboratory was established for research in biogas production processes. In the laboratory, 3 bioreactor blocks with 4 bioreactors in each were installed where the biogas production process and potential from different kinds of biomass are investigated (I. Plūme, I. Straume). At present, on the basis of the laboratory research, three promotion papers, one bachelor paper and one master paper are elaborated. Also self-made laboratory equipment for research in dry fermentation processes has been installed. The results of the original research carried out in the laboratory (in 2008 – 22 investigations) are presented in 13 presentations at international scientific conferences, 12 articles in international scientific issues, 6 scientific issues in Latvia, and 9 other publications.

Control of Technological Processes

Under the leadership of professor A. Šnīders, research (A. Laizāns, R. Šeļegovskis, I. Straume, and A. Jēkabsons) is carried out in micro-cogeneration technological, ecological and energetic aspects in autonomous energo supply using biogas that is obtained from wastewater slime and agricultural biomass in the process of anaerobe processing in methane tanks; in energo activity of water supply and wastewater engineering systems, and improvement of the management quality of wastewater aeration equipment and frequency regulated electric drive using invariant management principles with improved parameters. Mathematic and simulation modelling in MATLAB-SIMULINK environment with variable parameters in the process has been done for wastewater aeration tanks as non-stationary wastewater oxidation objects developing a virtual model of the aeration tank with adaptation ability. Methods for aeration, micro-cogeneration and heat supply engineering system transition process for simulation modelling in SIMULINK environment and optimization of operation have been developed elaborating physical system parameter virtual adaptation models for determined and stochastic perturbations with virtual adaptation of changing in time parameters during the whole length of simulation of the process of technological equipment operation. The constructive solutions developed in the result of the research are protected by 4 Latvian patents (No. 13364, 13476, 13620, and 13787). The research has resulted in a promotion work (Šeļegovskis, 2005). A. Laizāns has finished a promotion work on improvement of the management and energo efficiency of wastewater aeration engineering systems. Doctoral student I. Straume continues to work at promotion work on application possibilities of regulated micro heat and electricity cogeneration stations as autonomous heat and electro energy sources on farms. The research results are summarized in 17 presentations at international scientific conferences, 17 articles in international scientific issues, 6 scientific issues in Latvia, and several other publications.

Professor G. Moskvins researches in intellectual systems and technologies in the field of agriculture. Based on the theoretical principles of the intellectual system and artificial intellect methods, mathematical insurance and devices for testing and evaluation of the compliance of agricultural products, food and other products have been developed. For summary of the research results, the author was awarded the doctor hab. degree (Moskvins, 1996). For the technical and technological solutions obtained in the result of the research, 67 patents have been obtained, including 12 abroad. The research results are reflected in 17 reports at international scientific conferences, 17 articles in international scientific issues, 6 scientific issues in Latvia, and 18 other publications, including 7 monographs.

History of Education, Science and Machinery

At the Faculty, also research in the field of the history of education, science and machinery is carried out (K. Vārtukapteinis, J. Ozols, A. Čukure, J. Tupiņš). The research results are presented in 21 presentations at international scientific conferences, 6 articles in international scientific issues, 17 scientific issues in Latvia, and 87 other publications, including 14 monographs.

Pedagogical Environment Research

Research in the field of pedagogics at the Faculty started already in the 1960s. The first dissertation in pedagogical sciences was defended already in 1967 by J. Blīvis, a teacher of the Department of Tractors and Automobiles (Бливис, 1967).

The research in pedagogical science is concentrated at the Institute of Education and Home Economics and is carried out mainly in countryside environment or in organizations related to rural areas. The selection of the themes, aims and tasks of the research is determined by the necessity to solve education problems in regions. The research is carried out in the sub-branches of comprehensive schools, higher schools, and adult and branch pedagogics in five research trends: ecology of education, competence in rural environment, professional and career education, life quality in the context of home environment, and natural and engineering didactics. Pedagogical environment research was started in the 1990s and is still continued (A. Aizsila, I. Apsīte, R. Baltušīte, B. Briede, I. Katane, L. Pēks, T. Sēja (1955-2009), etc.). Long-term pedagogical experience of researchers and achievements of the graduates from the Faculty of Agricultural Mechanization at work have been evaluated. It has been stated that it is strongly influenced by the social environment of studies and the formal education obtained in it. The statements were theoretically substantiated and experimentally tested that essential characteristics of pedagogical environment are multifamily, activities friendly to the participants of studies and possibilities to manage their emotional conditions. Under the influence of human ecological theories and conceptions, education ecology research was continued and it transformed and extended through formation and development of the branch of educational ecology. In the result of the research, the philosophical-methodological basis of education ecology was developed and the role of education ecology among the many sub-trends of human ecology was substantiated. Recently work at development of the conceptual substantiation of ecology education is continuing. The research characterizes the multiformity of the educational paradigm today, which shows the changing processes in society, development of science and pluralism in the democratic educational environment. Scientific substantiation of the ecological paradigm in education and complementarity of conceptual approaches has been given. The system approach in development of environmental models has been substantiated respecting the structural, functional and evolutionary aspects of environment, and the basic principles of ecological approach in education have been formulated and substantiated. The research has resulted in a promotion work (Katane, 2005). The research results are reflected in 54 presentations at scientific international conferences, 62 articles in international scientific issues, 5 scientific issues in Latvia, and 38 other publications, including 4 monographs. In the future dissertation of R. Baltušīte "Development of future teacher readiness for professional activities in school education environment" research is carried out in scientific substantiation of the notion "readiness for professional activities" and techniques of diagnostics as well as in development of the model of future teacher pedagogical internship at school. In the doctoral dissertation of I. Kalniņa "Development of secondary school student competitiveness in the process of non-formal career commercial education at country school", research is carried out in the scientific substantiation of the notions "personal competitiveness" and "competitive specialist", development of techniques of diagnostics and indicator systems as well as in elaboration of non-formal commercial education didactic model in the context of career education at school. In the doctoral dissertation of D. Penke "Professional self-determination of countryside students in the process of elementary school career education", a career education model at country school has been developed, and work is carried on at periodisation of human professional formation and development, scientific substantiation of personal professional self-determination and its diagnostics. The scientific and practical contribution of the research in education quality of future teachers is substantiated in the future dissertation of I. Apsīte "Development of reflection in teacher education at higher school".

Competence as a Topical Pedagogical Category

At the end of the 1990s theoretical and practical research in competence as a topical pedagogical category was started (B. Briede, A. Zeidmane, and M. Laitāne). The aspects, kinds and components of research in competences, relation of competence with micro-, mezzo-, exo-, and macro-systems as a necessary precondition for today's specialists in any branch have been evaluated. Research is continued in development, evaluation of competence, and professional characteristics. A further education model of agricultural advisors has been developed and introduced in the Latvian Rural Advisory and Training Centre and acknowledged at the Ministry of Agriculture. The advisor competence levels included in the model are the base for systematic organization and formation of the content of further education. The research has resulted in two promotion papers (Briede, 1996; Laitāne, 2003). Definite results in the research in competences have been achieved also in several future promotion papers: A. Sala "Development of student research competences in course papers", V. Tomsons "Development of life-long education competences in undergraduate studies", O. Turuševa "Learning competence development models for first year students". The research results are reflected in 56 presentations at international scientific conferences, 63 articles in international scientific publications, 8 scientific articles in Latvia, and 20 other publications, including two monographs.

Professional and Career Education

Professional and career education research (A. Aizsila, B. Briede, A. Ķirse, L. Pēks, T. Sēja, and I. Soika) in the sphere of formal as well as informal education is carried out in co-operation with other structural units of the LLU, Latvian higher schools, Latvian professional secondary education schools and colleges as well as with foreign educational institutions. In the 1990s, proposals for development of a model for training of farmers, its content and implementation in agricultural technical schools and schools were elaborated. Based on the research results, a further education program for training teachers and a series of didactic teaching aids were developed. They are approbated in work with more than 500 working or future teachers. The changes in the Latvian professional education system are analyzed from the approach of regional development, and methodical proposals are developed for preparation and assessment of scenarios for development of the system of education. Four scenarios of the development of professional education are elaborated: traditional, economic, sustainable development, and co-operation. Their assessment criteria are defined: quality of education, interests of students, possibilities to use the EU funds, decrease of social stress, co-operation with enterprises, etc. The research has resulted in two promotion papers (Aizsila, 1997; Sēja, 2008). It is continued also in future promotion papers, for instance, I. Soika "Dialogue for motivation of rural vocational secondary school students for studies at higher schools", I. Augskalne "Research in the world outlook of professional school students", L. Alondere "Readiness of youngsters for studies at college". The research results are reflected in 74 presentations at international scientific conferences, 84 articles in international scientific publications, 8 scientific articles in Latvia, and 53 other publications, including two monographs.

Life Quality in the Context of Home Environment

Life quality in the context of home environment includes research in improvement of the quality of persons and society as one of the strategic aim guidelines of continuous life-long education and one of the aims of the model for the development of Latvia (Z. Beitere, V. Dišlere, I. Līce, A. Pridāne, S. Reihmane, I. Spulle, and V. Vanovska). The research evaluates life quality conceptions, theories and their development trends as well as life quality multi-dimensional aspects: social, economic, political, welfare, safety, sustainability etc. The research stresses life quality indices, its objective and subjective criteria; UNO human potential development index and its components: lifetime, health condition, welfare level, etc.; quality of life in the context of ecosophy and ecology; correlations of primary (raw materials, natural environment) and secondary (things created by people) environment and its influence on personal development. Several investigations are devoted to evaluation of consumption, its alternatives and influence from the point of view of philosophy, ecosophy, psychology and economics as well as to the positive and negative aspects of consumer education. In this respect there are many investigations in home economics education development problems: content to be acquired, aim, co–ordination of tasks and results, formation of creativeness and

self-realization need; socialization and culturalisation processes in the context of life quality economic, spiritual and cultural criteria. The research has resulted in two promotion papers (Dišlere, 1997; Līce, 2005). Scientific and practical contribution can be already seen in several future promotion papers: A. Pridāne "Implementation of the principle of life quality in home economics education at primary school", and N. Vronska "IT in home economics studies at higher schools". The research results are reflected in 36 presentations at international scientific conferences, 39 articles in international scientific publications, 6 scientific articles in Latvia, and 9 other publications, including one monograph.

In the field of natural and engineering sciences, one promotion work has been defended (Zeidmane, 1996) and there is some contribution also in several future promotion papers: I. Bīmane "Didactic model of land surveying and geodesy courses", S. Čerņajeva "Development trends of the study program of mathematics in engineering in Latvia", O. Vronskis "Substantiation of methodical techniques in virtual studies of engineering disciplines".

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Dimensions of Agri-Environmental Research in the Department of Environmental Engineering and Water Management

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Abstract. The impact of human activity on the biosphere has produced global environmental problems related to the natural resources and risks to ecological health such as soil and water pollution calling for new solutions that help sustain the development of agriculture and protection of water resources. The present paper begins by recalling the historical and project context from which a research work in the Department of Environmental Engineering and Water Management has arisen in the 1990s after historical and structural changes in the society of Latvia. The paper provides a discussion on research fields dealing with some of the core issues and approaches currently faced by the department, such as monitoring of agricultural run-off, environmental risk assessment, climate change impact evaluation, and water quality modelling. It can be emphasised that understanding the complex interactions between the use of land for agricultural production and water quality is essential in promoting the sustainable water management in agriculture and healthy environment.
Key words: agricultural production, environmental risk, water monitoring, modelling.

Introduction

The paper summarises the main research results of the Department of Environmental Engineering and Water Management, and provides some perspective on the attempts to cope with environmental consequences of agricultural production. Every human activity has, and always has had, an impact on the environment. This also applies to agriculture. Development of production systems has resulted in intensification, specialisation and concentration of the agricultural production. The impact of these changes has been obvious as much for the environment as for the water ecosystems (Jansons, 1999; Haraldsen et al., 1998).

Farmers use commercial fertilisers, manure and other materials, and/or crop rotations to replace nutrients withdrawn from the soil during production of agricultural crops (Busmanis, et al., 2001). Without replacing the soil with nutrients, crop yields or quality would decline in most cases (Haraldsen et al., 2001). Primary nutrients for crop growth and development include nitrogen, phosphorus, and potassium, but other macro- and micro-nutrients are also important. If improperly applied, fertilisers can leach into the groundwater or drain into the surface water (Vagstad et al., 2000a; 2000b; Busmanis et al., 2001; Deelstra et al., 2009). Nutrients in the surface water can cause eutrophication, oxygen depletion, fish kills, and reduction in recreation opportunities (Bechmann et al., 2004). High nitrate levels in drinking water also have adverse human health effects. In all countries of the Northern Europe, agriculture is estimated to be responsible for the greatest contribution of phosphorus and nitrogen to coastal waters (Vagstad et al., 2001).

Both the EU Nitrates Directive (ND) and Water Framework Directive (WFD) require that Latvia like all the Member States control the impact of agriculture on the surface and ground waters (Jansons et al., 2005). When assessing water quality, it should be considered whether all the territory of Latvia or only part of it, with the highest impact of agriculture measured in terms of high nitrate content ($\geq$50 mg L^{-1}) or eutrophication phenomena, should be designated as nitrate vulnerable zones (NVZs). In addition, the risk that in the near future freshwater bodies or marine waters may contain more than 50 mg L^{-1} nitrates (11.3 mg L^{-1} NO_3-N) and become euthropic, if actions in agriculture are not undertaken, also is a relevant aspect for designation of the NVZs. The risk assessment performed in the Department using GIS tools was based on the data of soil and groundwater media, run-off, potential erosion risk, agricultural activities, such as agricultural land and arable land use, animal density, soil drainage, and application of fertilisers (Jansons et al., 2005).

The Ministers for Environment of HELCOM member states met on November 15, 2007 in Krakow, Poland, to adopt an ambitious overarching action plan to drastically

reduce pollution to the Baltic Sea and restore its good ecological status (HELCOM Baltic Sea Action Plan, 2007). The key component is a plan to reduce nutrient loads and ways how to allocate these to the countries in the region. The inland water bodies receive nitrogen and phosphorus emissions which are a net result of both diffuse and point source pollution. In the assessment of non-point agricultural pollution, it is crucial to be able to control nutrient emissions and exclude other loads, i.e., from point sources: large livestock farms and wastewater from urban areas. HELCOM recall (HELCOM Baltic Sea Action Plan, 2007) that countries should apply harmonised principles and monitoring methods for quantifying non-point losses throughout the sea catchment area in order to obtain comparable and reliable estimates on the waterborne inputs from both point sources and non-point sources entering into the Baltic Sea. In addition, climate change calls for a more effective environmental policy to protect the water resources of the Baltic Sea.

The net effect of agricultural loading to the Baltic Sea cannot be easily predicted without using nutrient leaching models in combination with run-off models (Ziverts, Jauja, 1999) and river transport models. The predictive capacity to simulate riverine nutrient fluxes as a function of changes in human activities is facilitated by the nested modelling approach addressing nutrient fluxes from farm scale over regional scale addressing type river basins with characteristic land use patterns in the various Baltic Sea water districts up to the basin wide scale. Due to a substantial share of the anthropogenic phosphorus and nitrogen load origins from agricultural land there is a need for new innovative approaches in modelling to identify and implement the most cost-effective countermeasures on a regional and local scale.

Historical Background

After the collapse of the former political and economic system in 1990/1991, Latvia like the other Central and East European countries went through dramatic changes in agricultural sector (Jansons, 1996; Stalnacke et al., 1999; Jansons et al., 2003; Vagstad et al., 2002) as well as in all other sectors of economy. Higher education system and research programmes were transformed to meet the Western standards. In 1951 the Department of Land Reclamation of Latvia Agricultural Academy was founded. The most important research fields of the Department before the 1990s were as follows:

- subsurface drainage;
- application of wastewater and slurry for irrigation;
- irrigation scheduling;
- subsurface drainage for irrigation.

After the above mentioned changes in 1993 the Department of Land Reclamation was reorganised into the Department of Environmental Management, and in 1995 – into the Department of Environmental Engineering and Water Management. Among the most urgent topics currently put to the scientists of the Department, we may list the following:

- monitoring and assessment of non-point source pollution from agriculture;
- monitoring and assessment of area point source pollution (large animal farms) from agriculture;
- assessment of the measures to mitigate agricultural pollution to the coastal and marine environment;
- watershed modelling.

International cooperation in research projects described in Table 1 was an important factor in institutional strengthening; research capacity building and providing opportunity significantly upgrade the technical capacities for agri-environmental research being essential for the implementation of national and international commitments in environmental control undertaken by the government. As can be seen in the Table, the main cooperation partners of the Department in agri-environmental projects and research programmes were scientists from Sweden (Swedish University of Agricultural Sciences), Norway (Jordforsk/Bioforsk), and Denmark (Danish Agricultural Advisory Centre). Cooperation and transfer of knowledge and equipment enhanced the capacities of the Department to design and implement the water monitoring programmes so that they were also suitable and attractive for research and educational purposes (Vagstad et al., 2001; Deelstra et al., 2004). Moreover, it was of great importance that a monitoring programme similar to the existing ones in the Nordic countries (e.g. Norway and Sweden) was implemented and specifically aimed at assessing the impact of agriculture

Table 1

Main international scientific projects of the Department of Environment and Water Management

Project and project leader in Latvia	Project partners	Year
Baltic Sea Environmental Programme, Project: Agricultural Run-off Management Study in Estonia and Latvia (P. Bušmanis)	SLU and JTI, Sweden	1993
BAAP (Baltic Sea Agricultural Action Programme) BEAROP project, Phase I (P. Bušmanis)	SLU and JTI, Sweden	1993-1997
BAAP (Baltic Sea Agricultural Action Programme) (P. Bušmanis)	Swedish Farmers Federation	1993-1997
Drainage Basin and Load of the Gulf of Riga, sub-project: Soil and nutrient losses from small catchment (V. Jansons)	Jordforsk, Norway	1993-1997
Drainage Basin and Load of the Gulf of Riga, sub-project: Nutrient losses from agricultural areas with high livestock densities in Latvia (V. Jansons)	Jordforsk, Norway	1995-1996
Baltic Sea Experiment. BALTEX Project (A. Zīverts)	M. Plank Institute and GKSS	1997-2002
Development of a Code of Good Agricultural Practices, the Republic of Latvia (P. Bušmanis)	Denmark, DAAC	1998-1999
Environmental Monitoring in Agriculture. Nordic–Baltic Cooperative (V. Jansons)	Jordforsk, Norway	1997-2000
BAAP (Baltic Sea Agricultural Action Programme) BEAROP project. Phase II (P. Bušmanis)	SLU and JTI, Sweden	2000-2002
Baltic Sea Regional Project (Component 2, sub-task: Monitoring and Assessment) (V. Jansons)	WB & GEF (HELCOM)	2004-2007
Joint Baltic Sea Research Programme (BONUS), RECOCA (Reduction of Baltic Sea Nutrient Inputs and Cost Allocation within the Baltic Sea Catchments) project (V. Jansons)	Stockholm University, Baltic Nest Institute	2009-2011

on the surface water quality in Latvia. A detailed description of monitoring network, research methods and technologies can be found in the articles presented by Jansons (1996, 1998), Jansons et al. (1999, 2002, 2007), Deelstra et al. (1996, 2004), and Vagstad et al. (2004).

In addition, it has to be noted that scientists of the Department have been involved in the implementation of relatively large number of national research projects. About 32 projects were financed by the Ministry of Agriculture, the Ministry of Environment, the Environmental Agency, Latvia Council of Science, and Latvia University of Agriculture during 1993-2008. The most active project leaders/managers were Prof. P. Bušmanis, Prof. V. Jansons, Prof. A. Zīverts and Prof. R. Sudārs.

Monitoring of Agricultural Run-off

The environmental assessment of representative small watersheds and farms was started at selected locations in Latvia. Catchments and demonstration activities were selected to respond to regional differences and farming intensity. In 1994, the measurement of leaching and run-off losses of nitrogen and phosphorus was started in several agricultural catchments. The main objective was to quantify losses of nutrients to the surface waters and the groundwater from agricultural sources. Lack of reliable monitoring data for the estimation of agricultural pollution sources was a common

problem in the post-Soviet countries, including Latvia. Designs of the monitoring system have been coordinated with the Nordic institutions (Deelstra et al., 1996) to ensure the comparability of the data sets and quality assurance measures. For these reasons, it was also important that the applied measurement methods/equipment and procedures were sufficiently advanced to comply with international scientific standards and knowledge/technology transfer from the Nordic countries including training in operation/ maintenance of monitoring stations, equipped with data loggers and automatic flow proportional sampling. In order to assess agricultural pollution in Latvia, diffuse source monitoring programmes (Jansons, 1996, 1998) were implemented in 3 monitoring stations (Bērze, Mellupīte and Vienziemīte small agricultural catchments) with ordinary agricultural practice and in 3 drainage fields within these catchments (Fig. 1). In addition, a specific monitoring programme was established in 3 monitoring points (Vecauce, Ogre, and Bauska catchments) representing large pig farms as point pollution sources with high rates of animal manure (slurry) application (Sudars et al., 2005). A description of monitoring sites is presented by Jansons et al., 2002, 2007.

Non-point Source Agricultural Pollution

Figures 2 and 3 provide information on temporal and spatial trends of nutrient run-off from monitoring sites. The variations in nutrient run-off are considerable. The lowest non-point source losses were measured at the Vienziemīte monitoring site where the share of arable land within the catchment was 4-5% during 1994-2008. The highest diffuse source nutrient losses occurred in the Bērze site, and exceeded by far the

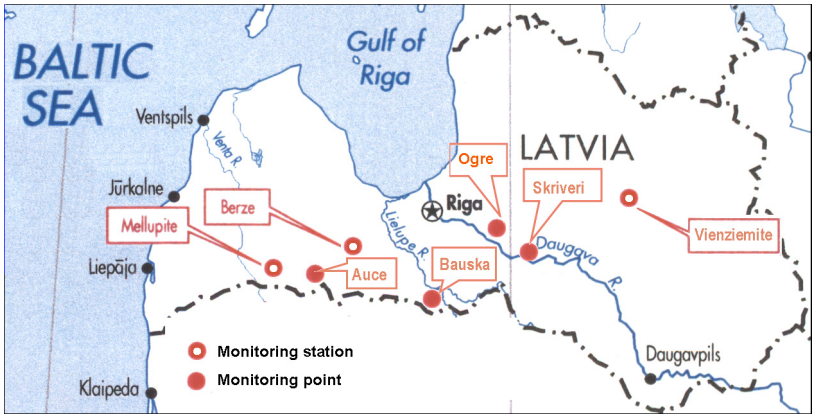

Fig. 1. Agricultural run-off monitoring stations and monitoring points in Latvia.

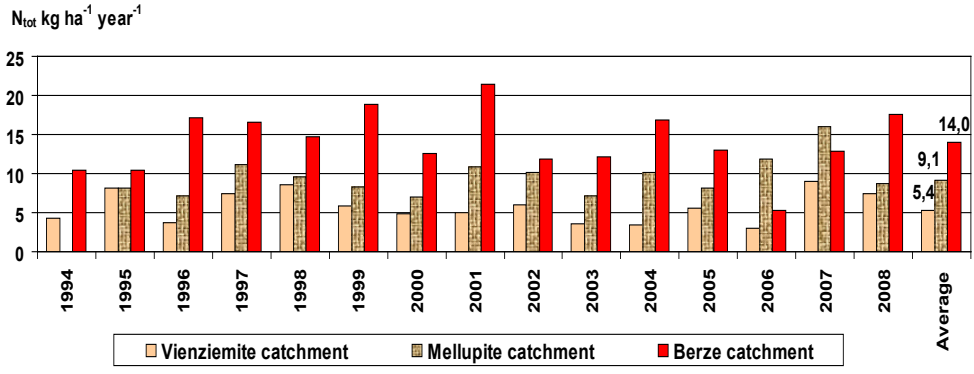

Fig.2. Nitrogen run-off from small catchments.

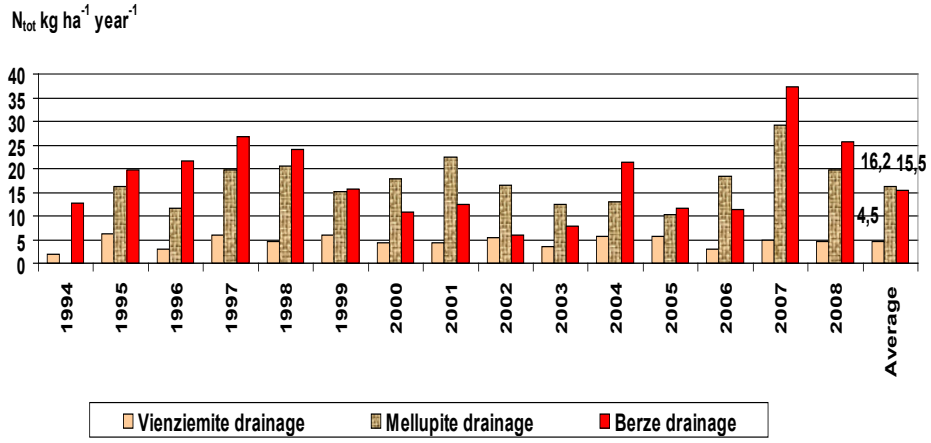

Fig.3. Nitrogen run-off from drainage fields.

losses in Vienziemīte (Jansons et al., 2002). In Mellupīte, where agricultural land use might be considered as moderately intensive for Latvia conditions nitrogen losses were about 9 kg N ha^{-1} annually. The lowest losses measured in the catchments' scale were 1.8 kg N ha^{-1} and 0.03 kg P ha^{-1} annually, while the largest annual losses were 21.4 N and 0.52 kg P ha^{-1} respectively. Generally, it seems that nitrogen loads are higher from the field drainage systems compared with small catchments' scale. At the same time, phosphorus run-off was higher in small catchments.

The diffuse source nutrient losses in the Bērze and Mellupīte small catchments appear to be low as compared with the recorded losses on similar conditions in the Nordic countries (e.g. Norway and Sweden). Nitrogen losses ranged between 15 and 70 kg ha^{-1} annually during 1994-1997 in 8 small catchments in Norway and Sweden (Vagstad et al., 2001). The average annual measured nitrogen run-off was 30 kg N ha^{-1}. These losses were approximately three times higher than the average losses (9.7 kg N ha^{-1} annually) from Bērze, Mellupīte and Vienziemīte small catchments, thus indicating differences in leaching regimes and agricultural practices between areas in Latvia and the Nordic countries. The difference in fertiliser applications may be one important factor. In Latvia catchments, the annual average nitrogen application per ha of agricultural land was: 4-5 kg ha^{-1} in the Vienziemīte catchment, 13 kg ha^{-1} – in the Mellupīte catchment, and 30 kg ha^{-1} – in the Bērze catchment during 1994-1999. Although the average applications are low, some fields within the Bērze catchment received 160 kg N ha^{-1} annually. Another reason for the observed differences in N losses may be different hydrological regimes (Deelstra et al., 2004, 2005, 2007, 2008, 2009), leading to longer water residence time, and therefore higher nutrient retention in Latvia catchments.

The correlation test between the share of arable land and nitrate contents in the run-off was tried at the small catchment and drainage field scale (Fig. 4) (Jansons et al., 2002). The result showed that this relation could be established despite the indirect causality between the nitrates losses and the use of land.

Point Source Agricultural Pollution

The impact studies by Haraldsen et al. (1998), Jansons (1998), Sudārs et al. (2005), and Bērziņa et al. (2009) give examples of a long-term investigation into the consequences of point source pollution on the water quality. The measurement results presented by Jansons et al. (2002) in the catchments with current or past high animal densities (including pig farms with the annual production capacities of 10-30 thousand pigs) showed very high losses with the average of 46-48 kg N and 2.7-3.4 kg P ha^{-1} annually. The data on phosphorus loads in Bauska and Ogre catchments reflect an extreme deviation from natural water quality status, and point sources are assumed to have major impact via direct run-off of applied slurry. Moreover, in one particular slurry dumping field of 50 ha in Bauska catchment, losses exceeding 10 kg P and 250 kg N ha^{-1} annually were recorded. In one of these catchments (Ogre) farming activities ceased

in 1991/1992. The results indicate (Fig. 5) that such farm land still may function as "area point-source" with risk of significant losses of nutrients to the aquatic environment (Jansons et al., 2002).

Agricultural Pollution Risk Assessment

Geographic Information System, which is designed to organise, store, and access large quantities of spatially referenced data, is an excellent tool for the assessment of

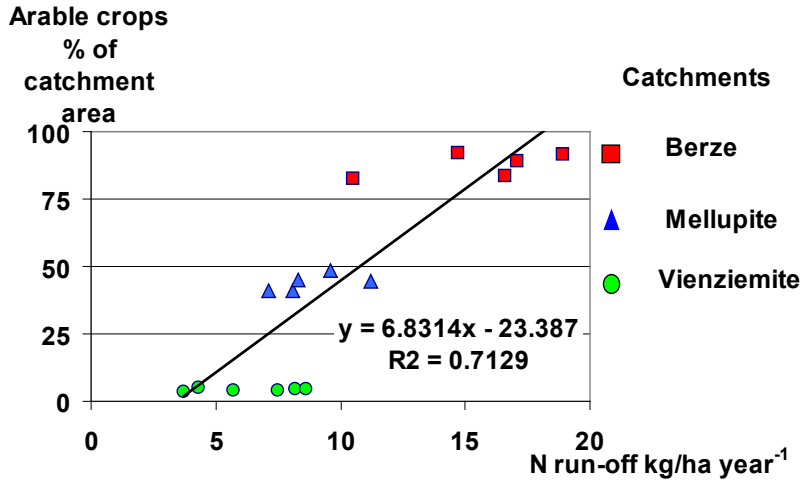

Fig. 4. Nitrogen run-off in relation to area of the arable crops in small catchments (1994-1999).

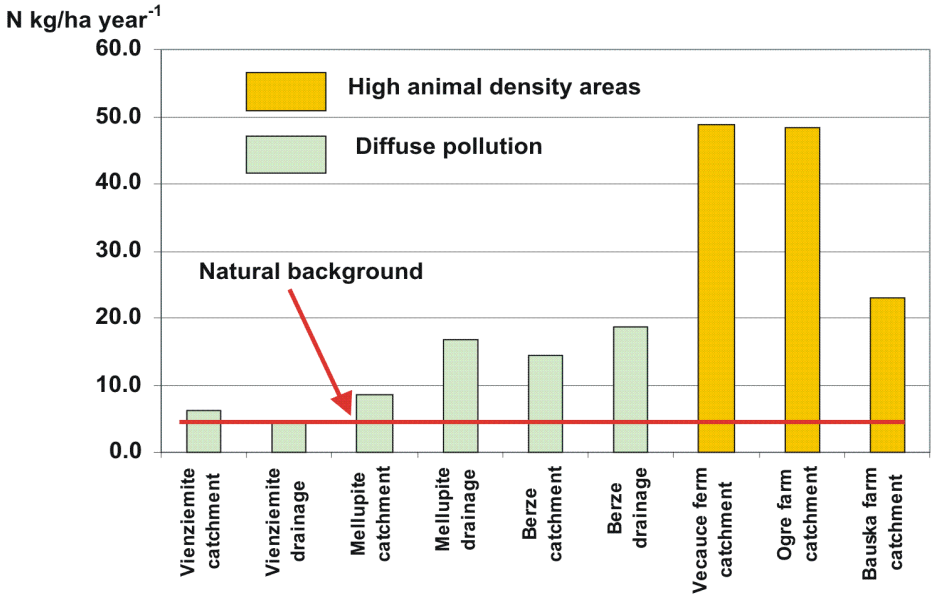

Fig. 5. Mean values of nitrogen losses from agricultural non-point sources and point sources (high animal density areas, 1994-1999).

environmental risk of agriculture. Due to the lack of monitoring data the first designation of vulnerable zones in Latvia was performed using GIS Multi-Criteria decision-making analysis (Kirsteina, Dzalbe, 2000). There are two main groups of factors: natural impact and the impact of human activities. The nitrate pollution risk assessment was based on the data of soil and groundwater media, run-off, potential erosion risk, agricultural activities, such as agricultural land and arable land use, animal density, soil drainage, and application of fertilisers (Jansons et al., 2005). These factors have been used for the GIS Multi-Criteria decision-making analysis. Statistical data traditionally available on administrative level were merged with georeferenced land cover data, and maps are presented pointing out the impact of different factors. Factor weights have been computed according to the results of the expert evaluation. The resulting impact data layer yields a map for potential agricultural risk areas in Latvia. The result of this scientific approach was used for designation of vulnerable zones in respect of the EU and national legislation (the Nitrate Directive). Finally, part of the territory located in the central part of the country, in the Lielupe river basin or Dobele, Jelgava, Bauska, and Riga administrative districts having the most intensive agricultural production and highest pollution risk, was designated as nitrate vulnerable zone (NVZ). The designation of NVZs should be revised every four years; unless not the whole territory of the country is designated as NVZ. The procedure demonstrated in this study seems to provide an effective method for assessing environmental impact from the regional perspective. It may also be used to provide a first assessment on the regional level before zooming in to focus on specific conditions such as nitrates and eutrophication, for detailed analyses.

The proper farming profile, methods, and several restrictions for the territory of NVZs should be used according to the crop, weather and soil conditions (Jansons, 1999). Therefore, the first version of the Code of Good Agricultural Practice (Busmanis et al., 1999) was prepared by the scientists of LLU under a joint Danish–Latvian Project coordinated by P. Bušmanis.

Pollution risk is an unavoidable element of our everyday activities, and it is also unavoidable in agricultural sector (Dzalbe et al., 2005; Jansons et al., 2007; Berzina et al., 2008). There is always a degree of uncertainty about the type, e.g., soil loss, nitrogen and phosphorus concentrations (Berzina et al., 2007), and the extent of adverse impacts which could arise. The probability analysis that is a common method in hydrologic studies could be used to describe the water quality, e.g., the likelihood of an event where an event is defined as occurrence of a specified value of the random variable (Jansons et al., 2009). The assessment of long time data series (1994-2007), obtained from the non-point source agricultural run-off monitoring programme, has shown that nitrate nitrogen concentrations depend on the scale of monitoring system (drainage plot, drainage field, small catchment) and intensity of agricultural production system. The available long-term data series and use of the probability curves allow the assessment of the variations of nitrate concentration on the scale of the plot, drainage field, and small catchments. Jansons et al. (2009) presented the estimation of risk exceeding the threshold limits (11.3 mg L^{-1} NO_3-N) of the nitrates concentrations. High risk to reach nitrates concentrations over the limits has been found (about 30% of samples) in field drainage of the Bērze monitoring site (Fig. 6). With regard to the small catchments' scale nitrates concentrations over limits could be expected (15% of samples) in the Bērze catchment with high intensity of agriculture.

The highest risk to reach nitrates concentrations over the limits was reported by Sudārs et al. (2005) in Bauska pig farm point source monitoring point. About 77% of water samples in the drainage channel from 50 ha slurry utilisation field have nitrates concentrations over limits during the period of 1995-2003.

To some degree the presented study and interpretation of nitrate data may be used for designation of water quality standards and designation of nitrate vulnerable zones.

Water Quality Standards for the Agricultural Run-off

For the EU Member States, the overall aim of the Water Framework Directive (WFD) is to achieve "good ecological status" and "good surface water chemical status" in all water bodies by 2015. Lagzdiņš et al. (2007a, 2007b, 2008) summarised the data of water quality that was collected monthly over twelve years (1994-2006) in Latvia agricultural monitoring sites. All available total nitrogen (N_{tot}) and total phosphorous (P_{tot}) concentration data were analysed using normal distribution curves. Percentile selections of data plotted as frequency distribution were used to establish boundaries of

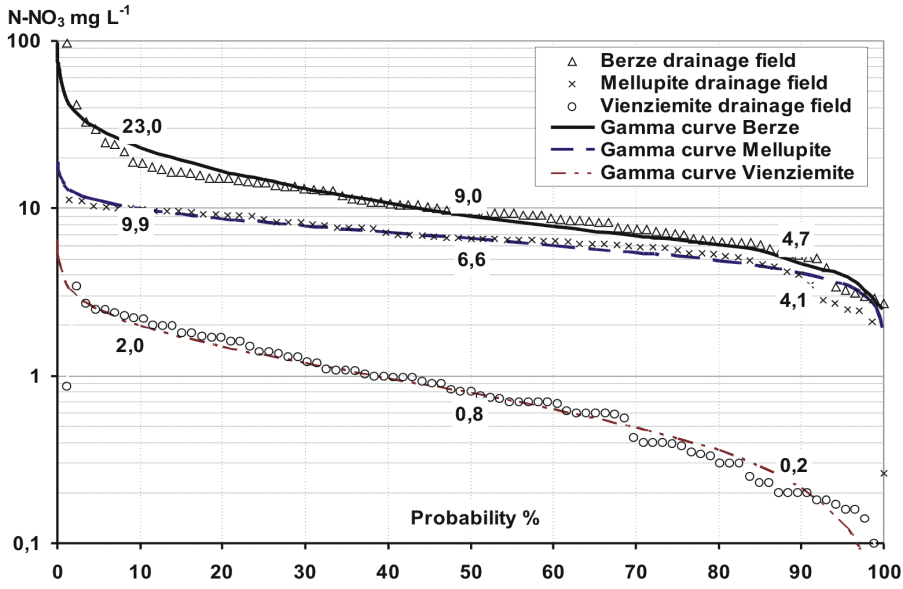

Fig. 6. Probability curves for NO_3-N winter concentration in the drainage field run-off.

Table 2

Recommendations for water quality (N_{tot} and P_{tot}) standards in agricultural areas

Quality	N_{tot} (mg L^{-1})		P_{tot} (mg L^{-1})	
	field drainage run-off	channel and main drain run-off	field drainage run-off	channel and main drain run-off
High	<4.5	<1.5	<0.015	<0.025
Good	4.5-5.5	1.5-2.5	0.015-0.020	0.025-0.050
Moderate	5.5-10.0	2.5-7.5	0.020-0.075	0.050-0.150
Poor	10.0-12.0	7.5-10.5	0.075-0.135	0.150-0.250
Bad	>12.0	>10.5	>0.135	>0.250

water quality standards. The research showed that in small agricultural streams good chemical status represents concentrations of <2.5 mg N_{tot} L^{-1} and <0.05 mg P_{tot} L^{-1}, but in the drainage system water – <5.5 mg N_{tot} L^{-1} and <0.02 mg P_{tot} L^{-1}. The paper (Lagzdins et al., 2008) also deals with the surface water quality assessment and recommendations for the classification system based on nutrients concentrations (Table 2).

From monitoring to the discharge and water quality modelling

Due to the costs and practical aspects, it is not possible to measure the complete load of nutrients from agriculture. The spatial and temporal variability in loads can be very large due to natural conditions and differences in agricultural practices. Thus, the practical approach is to monitor in pilot areas supposed to represent typical conditions

with regard to climate, soils, crops, and management practices. However, from the viewpoint of the marine environment and the regional drainage basin level management it is a prerequisite to know the total loads from agricultural activities. Specific tools (models) are therefore used to up-scale the monitoring results from pilot areas (drainage fields, small catchments) to the river basin (regional) level, and for this reason modelling and monitoring are integrated parts in the future management schemes of non-point sources in agriculture.

Hydrological models are an important part of water quality modelling. In many cases, these models are integrated into water quality models. In the 1990s, the development of hydrological models was started by A. Zīverts in LLU. The Professor has participated in one of the world's largest projects within hydrometeorology – BALTEX since 1995. Several versions of conceptual mathematical model METQ for modelling of hydrological processes (METQ96, METQ98, METQ2007BDOPT) were calibrated and tested during the period of 1996-2007. Description of the hydrological processes of METQ is similar to the HBV-type watershed simulation model developed in SMHI (Sweden). The METQ model allows simulating the daily run-off regime as well as actual evapotranspiration, water storage in different soil layers, groundwater table dynamics, and other elements of water balance (Ziverts, Jauja, 1999). The METQ was tested for the application in the river basins with various sizes, including the large scale river basins like the Daugava river (Jauja, 1999). Moreover, METQ was used for discharge modelling medium size rivers (Apsite et al., 2008) and agricultural monitoring points in small catchments and drainage fields, where the measurement structures are not constructed.

Complex watershed models can be extremely powerful tools to assist in the development, and implementation of practical water quality management strategies in agriculture. Water quality simulation and modelling for that purpose so far is not developed in Latvia. Therefore, the Fyris model developed in Swedish University of Agricultural Sciences (SLU) was selected for simulation of the water quality. The cooperation between the Department and SLU continued in the Baltic Sea Regional project (2004-2007). Furthermore, a comprehensive training and upgrading of the modelling competence is considered a significant contribution to the capacity building in management of agricultural pollution. Therefore, experience and BSRP created additional research capacities of the research team of the Department that had very positive future development in the field of modelling: the National Research Project (NRP): Climate Change Impact on Water Environment in Latvia (2006-2009). The Department is responsible for work package – WP2 Climate Change Impact on the Nutrient Run-off from Drainage Basin[1]. Implementation of the research results will develop capacities for water quality modelling, where progress in Latvia has been too slow. The Fyris model was validated for water quality assessment in the Bērze river. This modelling activity has established an empirical link between water quality and load measurements on the field and small catchment level (the Bērze monitoring station), and medium sized river level (the Bērze river). The assessment of the Fyris model performance and the applicability of the models supported implementation of the required activities of WFD and could be used for the evaluation of Latvia share of nutrient load in pollution of the Baltic Sea. Use of the regional climate change data with the calibrated modelling tools in the next phase of NRP will provide scientific evaluation of climate change impact on the surface water quality. The water quality sampling programme started in 2005 provided data for the first attempts of simulation for the Bērze river and 15 sub-catchments of the river. The results of modelling for sub-catchment 12 are shown in Figure 7. The results of the Fyris model calibration showed a good coincidence (r=0.79) between the simulated and the measured nitrogen concentrations for the calibration period of 2000-2008. It is necessary to take into account that water quality samples were collected on the event basis by Latvia Agency of Hydrometeorology (2000-2004), but since 2005 on a monthly basis by the Department.

Taking into account variation of weather conditions, successful modelling approaches in future will depend on the availability of long-time data series of water quality for the river and sub-catchments. The experience from other sites suggests that longer data series and data runs than that gathered here would be required to improve the results of modelling. Therefore water sampling should be continued.

[1] See: http://kalme.daba.lv/en/wp2/

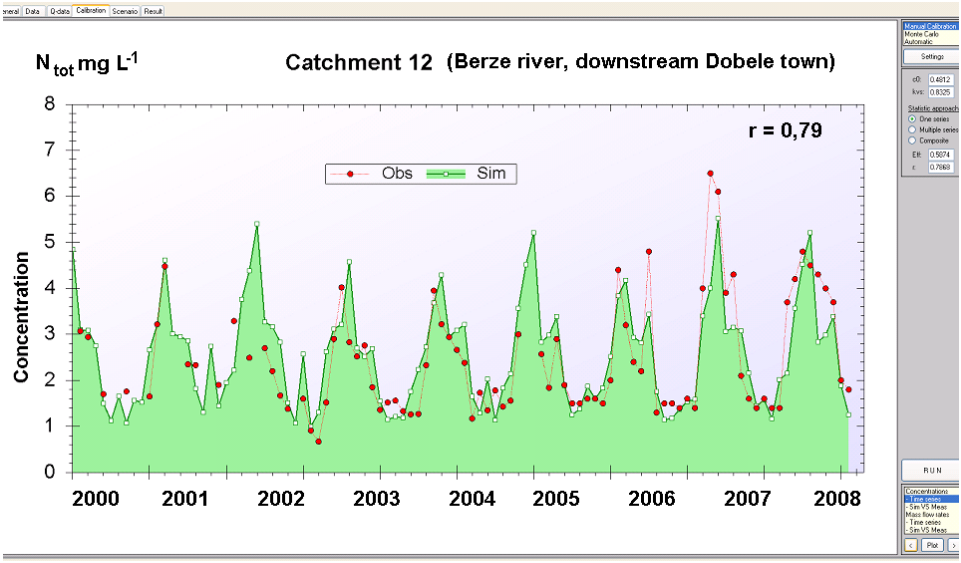

Fig. 7. Measured and simulated nitrogen concentrations in the Bērze river.

Summary and Conclusions

Agricultural and environmental problems have to be analysed on a different scale, taking into account the natural and anthropogenic impacts. The examples discussed here illustrate how the theory, research and practice of agro environmental studies, in contact with other disciplines such as ecology, hydrogeology, soil science, GIS, and mathematical modelling, address the most urgent water pollution problems currently faced by the society in the Baltic Sea basin.

Environmental conditions, such as weather, soil type and fertility, soil moisture, and the stochastic variability of these conditions, in turn, influence non-point sources nutrient losses. The issue of interactions between natural variability (soil, hydrology) and human impacts on different scales is very complex and requires further investigations.

An important finding of the research is that water quality standards for drainage water as well as for small catchments with intensive agriculture should be less stringent than for rivers, otherwise it will not be possible to fulfil the objectives set by the WFD in agricultural areas.

A further recommendation is that modelling should be a key component of the catchment management systems. This technique allows the assessment of management actions that are difficult to quantify through environmental monitoring; linking the catchment-scale evaluation of pollution sources with the effects of management changes implemented on the farm scale.

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Materials and Technologies for Rural Engineering: Investigations and Practice

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Abstract. The main research area in Civil Engineering and Technology deals with materials in all aspects starting with raw materials, the analysis and developing of material technology, and ending with reliability and optimization of engineering structures. The developing and investigation of materials and structures with needed properties has become one of the most important sectors in this research area. Reliability of structures – the new research field – was developed depending on the use of different new materials and taking into account environmental effects, especially in agricultural buildings. During the last decade due to support from European funds and financial resources from Latvian Academy of Science, theoretical investigations have been performed and modern equipment has been obtained. In the future, the development of the scientific research activities and results will depend on material resources and international scientific activities of researchers.
Key words: building materials, modification, optimization, reliability.

Introduction

The basic task of the Civil Engineering branch at the Faculty of Rural Engineering is educating of engineers and technologists for building industry, educators and researchers. Real progress in education and building of plants is impossible without research. During the last decades, active scientific work characterizes the Civil Engineering branch at the Faculty of Rural Engineering in respect of the teaching staff as well as of postgraduate, master and bachelor students. Research activities are the basis for new research facilities, for improvement of education quality, and long-term cooperation with international partners. The research in Civil Engineering and Technology is mainly related to the following issues:

- developing of new materials and technologies for thermal isolation and soundproof materials;
- optimisation of wooden, concrete, steel and composite structures;
- reliability analysis of structures;
- investigation of environmental effects on different kinds of materials.

Optimization and Strengthening of Structures

Concrete structures. Because of economic activity, an increase in the processing waste quantity and pollution of the environment is taking place. Very important up-to-date problem is collection, storing, keeping and utilization of aggressive sewage and liquid manure. In the case of wet technology in the process of removing manure in farmhouses, the water content of manure can reach from 95 up to 97%. In order to protect the environment, safe keeping of those liquids is possible by using large containers near to the farmhouses and agricultural factories.

The economic solution of containers is reinforced concrete (RC) cylindrical reservoirs. However, they have several disadvantages. In the case of prefabricated reservoirs very often a leak between elements takes place. Special systems for early detection from small leaks, especially in underground storage tanks, have to be developed. Under action of tension, flexure, temperature gradient as well as concrete shrinkage, cracks can form in the vertical and horizontal direction of reservoir wall. That causes a need of expensive repair techniques for treatment of cracks. In order to assure the impenetrability and durability of the wall it is necessary to check for the material strength and crack formation.

The stress analysis and optimum design of the wall of open aboveground monolithic cylindrical reservoir has been performed, and optimum parameters of reservoir wall taking into account strength and serviceability limit state requirements and discrete material properties have been determined (Brauns, Andersons, 2000; 2002).

In new constructions and especially in renovation of structures, fibre reinforced plastic (FRP) strips are increasingly used as strengthening material of reinforced concrete elements. Immunity to corrosion, low weight, resulting in easier application in confined space, elimination of the need for scaffolding and reducing in labor costs as well as high tensile strength and large deformation capacity are the main positive characteristics of FRP. The addition of externally bonded reinforcement to prefabricated RC beams may be applied to increase structural safety and decrease risk aspects. The behaviour of RC beams with flexural strengthening has been studied. The effect of external FRP reinforcement on failure mode and stress distribution is determined (Brauns et al., 2003).

Basing on the test results and numerical analysis of RC beams with external flexural FRP reinforcement, the following conclusions are drawn:

- application of external flexural reinforcement on structurally balanced beams alters its failure mode;
- unstrengthened beams failed by a collapse of concrete in compressed zone. Beams with external flexural strengthening failed by collapse of concrete in tension at the end of FRP ribbon and following diagonal shear crack;
- the increase of ultimate bending moment for externally strengthened beams is about 7-10% but decrease of maximum deflection – 17-30%.

Composite structures. In many cases very effective is the use of concrete steel composite structures. According to Eurocodes implemented in Latvia, the plastic resistance of a concrete-filled column is given as a sum of the components and taking into account the effect of confinement in the case of circular sections. In investigations performed, the stress state in composite column has been determined by taking into account the non-linear relationship of modulus of elasticity and Poisson's ratio on the stress level in the concrete core. It is determined that the effect of confinement occurs at a high stress level when structural steel acts in tension and concrete in lateral compression. The stress state and load bearing capacity of a section in bending is determined by taking into account non-linear dependence on the position of neutral axis. Because the ultimate limit state of material is not attained for all parts simultaneously, to improve the stress state of a composite element and to prevent the possibility of a failure the appropriate strength of concrete and steel should be used. The safety of high-stressed composite structures can be improved by using ultra-high-performance concrete (UHPC).

Taking into account the design strength of steel and concrete as well as limit ratios of the circular hollow sections, the analysis of load bearing capacity of the composite column is performed (Brauns, Kreilis, 1998). It is shown that the load limiting factors are concrete design strength and diameter thickness ratio. Using concrete with strength class C35/45 and steel with grade Fe235 the load bearing capacity of the composite column increases by 20% in comparison with concrete of class C30/37. For a thin wall hollow section instead of thick wall the steel economy can be 50% (Brauns, Rocens, 2004b).

The optimization of working conditions and cross section area of a composite structure as well as the prevention of a failure in the case of small thickness of structural steel and fire can be realized by using appropriate strength of concrete and steel. By using UHPC as steel element filling the increase of load carrying capacity can be significant.

The stability of steel-face sandwich panels under bending and axial loading is studed, and the effect of core material stiffness is determined (Brauns et al., 2005).

Investigation and Optimization of Laminated and Short Fibre Materials

Modification of wood in wooden composites. Hot pressing is one of the important stages during the production of wood-based composites when mats of resinated wood fibers, particles, flakes or veneers are consolidated under heat and pressure to create close contact and form bonds between the wood constituents. Mat deformation is, however, not uniform across the material thickness resulting in a density profile in pressed composite boards. This in turn has significant effects on the physical and mechanical properties of the final product. The initial mat structure and the mechanical properties of its components govern the overall mat stress–strain relationship. Due to the viscoelasticity of wood, some elements exhibit time-dependent creep behavior and they may undergo stress relaxation.

As resin in wooden composites is employed in limited amount, bond efficiency relies on the degree of mat densification, which should be high. Increasing mat density, however, causes detrimental effects such as increased weight and wood consumption,

and excessive thickness swelling in service when the product is subjected to high humidity conditions.

Mechanically modified wood by compression, to flatten its cavities, and by cavity filling with other materials improves wood strength and stiffness. The mechanical and hygromechanical quality of wood composite boards depends on the properties of layers and on the alignment of these (Brauns, Rocens, 2007a, 2007b).

Structural changes in technological pressing of wooden composites. Studies on wooden composites have focused on the relationships between processing parameters and material properties caused by densification. In manufacturing of a composite board the basic function of the pressing operation is the development of an adhesive bond between individual flakes or veneer sheets while minimal glue spread is utilized.

The structure of a mat made of fibres exhibits a double cellularity. Void space among the strands results from the inherent randomness of the deposition process, and the flakes include the cell lumen. It is thus possible to distinguish not only two different voids, but also two different densities: the density of the mat, and the average density of the fibres. During the first stage of pressing, voids space between flakes is eliminated from the mat structure and the flakes get into contact. Further pressurization enhances the collapse of cell walls and the lumen volume is decreased. The volume of the mat is the sum of the volume of the flakes and of the void space. At this stage, both the density of the mat and that of constituent flakes increase.

Viscoelastic behaviour of wooden composite. Viscoelasticity influences wood modification when wood flakes or veneers are under static pressure and subjected to changes in temperature and moisture content. In these situations, wood can be adequately treated as a linear viscoelastic material.

The high pressure applied during the manufacture of wood composites, coupled with the random mat structure, results in a non-linear and non-uniform mechanical response of the wood constituents. Time-dependent stress-strain relationships, instantaneous and delayed strain recovery, permanent deformation, and temperature and moisture-dependent stress relaxation may intervene during the pressing process.

Influence of composite structure on hygromechanical behaviour. The distribution and properties of densified flakes determine the load carrying capacity of the board. Oriented strand boards can increase the strength and the stiffness of wooden composites. Nevertheless, the warping of panels is very high. As a result, the quality of wood composite boards depends on the properties and alignment of flakes.

In general, wooden composites do not display symmetry with respect to the midplane; their properties can be either asymmetric or antisymmetric. The composite has been analyzed as a system of parallel elementary layers. The local co-ordinate system has been associated with the principal directions of the elementary layers. In order to approximate the stress state, stress-gradient-dependent force-stresses and couple-stresses are used in the model.

The multilayer model and model based on the laminate analogy was used to determine the behavior of layered and fiber composites. Non-symmetric moisture distribution causes linear expansion and hygromechanical warping. Curvatures resulting from hygrodeformation of wood were computed using the method developed in (Brauns and Rocens, 2004a).

The midplane strains and curvatures of wooden composites depend on the content and distribution of moisture. The hygroscopic deformation model contains seven veneers with equal thickness of 1.4 mm. The partial density of plywood (birch) is 660 kg m^{-3}. The results, which compare the properties of densified and of customary wood, showed the effect on curvature of an asymmetric non-linear distribution of moisture and antisymmetric structure at uniform moisture content.

Estimation of fibre length effect. Short fibres can offer advantages of economy and ease of processing (Brauns, Rocens, 1998; Brauns, Andersons, 1998). However, when the fibres are not long enough, the equal strain condition no longer holds under axial loading, since the stress in the fibres tends to fall off towards their ends. This lower stress in the fibre, and correspondingly higher average stress in the matrix compared with the long fibre case, depresses both the stiffness and strength of the composite. It is therefore necessary to quantify the change in stress distribution as the fibres are shortened.

Several models, ranging from fairly simple analytical methods to complex numerical packages, are commonly available. The simplest is the so-called shear lag model, which

is based on the assumption, that all of the load transfer from matrix to fibre occurs via shear stresses acting on the interface between the two constituents.

The method developed gives possibility of examining the predicted stiffness as a function of fibre aspect ratio, fibre/matrix stiffness ratio and fibre volume fraction, and other effects on the distribution stresses as well as predict whether fibres of the specified aspect ratio can be loaded up enough to cause them to fracture.

Determination of elastic characteristics and strength of materials. The mechanistic approach is adaptable to the computation of composite material properties that characterize the material averaged responses, such as the prediction of composite compliances from micro-mechanical analysis. For a general composite laminate loaded in an arbitrary direction, a systematic approach is needed in order to predict the stiffness and the stress distribution. Simple cross ply and angle-ply laminates are not balanced for a general loading angle. If the plies vary in thickness, or in the volume fractions or type of reinforcing fibres, then even symmetric laminate is prone to tensile-shear distortions (Brauns, Rocens, 2008b). Computation is necessary to determine the lay-up sequence required to construct a balanced laminate. The fibre aspect ratio, fibre to matrix stiffness ratio, and fibre volume fraction affects the stress distribution as well as the elastic properties of short-fibred material. The fabric function of spatially reinforced composite can be fixed experimentally and used for the determination of elastic properties. By using the properties of unidirectionally reinforced structural elements, the orientational averaging allows determining the lower and the upper bond of elastic characteristics (Brauns, Rocens, 2006).

On the basis of the strength analysis the form of material failure can be predicted. A phenomenological failure criterion provides feedback for material improvement via structural changes and supplies quantitative strength characteristics of material that reveals pivotal to rational engineering design.

The method developed permits determining the stresses in a thin laminated structure by means of an experimental deflection function. It is established that the fracture occurs at maximum couple-stresses. For some laminates the delaminating takes place under action of interlayer shear stresses. The failure criterion permits predicting the sites of a fracture and possible load-carrying capacity of a shell upon loss of the stability. For strength-related properties, a failure criterion can provide feedback for material improvement via structural changes.

Investigation of materials with adaptive properties. Laminates can be designed to provide the desired strength and stiffness characteristics required for specific applications. The bend-twist coupling results in twisting of a structure, when a pure bending is applied but stretching twisting coupling can occur when a tensile load is applied. This behaviour is influenced both by the material characteristics of the laminate and geometric properties of the structure to which it is assigned.

The use of fibre-reinforced composite rotor blades enables a number of possible passive aerodynamic control options. The investigation of coupled deformation effects of laminated composite materials to obtain the necessary twist and strength of material is an important up-today problem. However, considering the membrane-bending stiffness coupling effects, not only the complexity of the design process increases, but also the risk of introducing effects that are difficult for designers to detect and account for.

The rotor blades are usually made using fibreglass mats, which are impregnated with polyester or epoxy. The blades may be made wholly or partially from carbon fibre, which is a lighter, but costlier material with high strength. Wood–epoxy laminates are also being used for large rotor blades. Experimental results indicate that wood is both a viable and advantageous material for use in wind turbine blades. This material is reasonably priced, domestically available, ecologically sound, and easily fabricated with low energy consumption.

Anisotropic properties of fiber-reinforced materials provide that the blade twists into stronger winds to reduce transient loading. By using adaptive blades with twist coupling there is a possibility of keeping good, steady power-production and smooth out unwanted peaks in loading. On the basis of investigations it is determined that in the case of in-plane balanced laminate anti-symmetric orientation of skin layers can be used to ensure the necessary adaptive warping and strength of the laminate under action of radial force in the rotor blade (Brauns, Rocens, 2008b).

Developing of New Materials and Technologies for Thermal Isolation and Soundproof Materials

The foam gypsum production technology and the acquired material (density – 200-700 kg m^{-3}) quality investigation is the main research field. The objective of the research is to develop a construction material to be used for heat and sound isolation. Along with this, a research has been initiated to develop a foam gypsum mixture by using various organic fillers.

Theoretical and experimental research on foam gypsum drying process. The world technical progress in construction of buildings is nowadays aimed at the use of materials with desirable properties where in multilayer constructions each layer carries out the functions it is assigned to. Gypsum binders are widely used in manufacturing gypsum paperboard, sound and heat isolation material in building monolithic one-to-two storey houses. The drying of gypsum products is an obligatory requirement for the technological process that significantly influences both its physical qualities such as density and heat conductivity coefficient and its mechanical qualities. For example, the strength indicators in dried gypsum are several times higher than in a wet sample. The authors have made experiments where the drying of foam gypsum can be researched by electrical methods, which do not destroy the material during the experimental process (Iljins et al., 2009)

Measurements of heat transfer of multi-layered wall construction with foam gypsum. A new wall structure and its manufacturing technique have been developed by the authors (Skujans et al., 2007). An experimental wall fragment has been manufactured. It consists of the following layers: internal finishing layer (gypsum boards and vapour insulation), foam gypsum, thermal insulation (polystyrene), and a plaster outer layer. The construction element's heat transfer coefficient U was determined by applying specially developed equipment and software. According to the experimental test, the coefficient's U value for the multi-layer construction with the foam polystyrene thermal insulation is 0.36±0.10 W m^{-2} K. The manufacturing technology with foam gypsum is used for quick building of one and two storey houses. With the foam gypsum apparent density it is possible to regulate the heat inertia of the wall construction.

Experimental research of foam gypsum acoustic absorption and heat flow qualities. It is well known that acoustic absorption and heat flow indices of materials of open or closed pores are different. It is expected that the research will allow developing a material for which it is possible to acquire the preferable pore structure depending on application. Up to know the research has been made on foam gypsum acoustic absorption qualities, modifying the foam gypsum material density, layer thickness as well as production technology. It has been stated that all these parameters influence the qualities of foam gypsum acoustic absorption, which enables to develop such foam gypsum structure that can be used for production of acoustic absorption layers and acoustic insulation panels. Because of acoustic parameters' conformity with normative regulations, the use of different acoustic materials in modern civil engineering will continue to increase (Iljins et al., 2009).

Conclusions

The investigations in the Civil Engineering science are based both on theory and experimental research work. The development tendencies in the Civil Engineering science are linked with the applied engineering problems and development tendencies of Latvia. The major areas of research activities in the future are:

- elaboration and investigation of building materials incorporated by particular properties of considerable industrial interest and competitiveness, the use of the local and recyclable raw materials in production;
- economy of energy and environmental resources;
- integrated development of strategy and technology of construction production with the progressing activities in European Union.

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Research at the Faculty of Food Technology

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Abstract. Active scientific work has been done at the Faculty of Food Technology during the last decade. Many teaching staff members and PhD students are involved in different national and international research projects providing good basis for further development of the research. The main research areas in food science and technology deal with food in all its aspects starting with raw materials, analysis and development of processes and technologies, and ending with safety, healthiness and quality of ready-to-eat food products. Food packaging has become one of the most interesting sectors in this research area. The new research field – riskology – has developed in close relation with the food safety. The identification of factors influencing the development of catering industry is one of the research problems studied by the young researchers of the Faculty. Through support from various European funds and other financial resources, modern equipment and measuring devices have been purchased. It is envisaged that, in the future, development and results of the scientific research activities will largely depend on the scientific material resources and facilities available for the researchers.
Key words: food safety, quality, packaging, hospitality management.

Introduction

The basic task of the Faculty of Food Technology is educating of knowledgeable food scientists and technologists for food industry, public catering, hotel management, and research. It is known that real progress in education and food production is impossible without research. During the last decade the teaching staff as well as postgraduate, master and bachelor students of the Faculty of Food Technology have been carrying out intensive scientific work. These years have been very important also due to active start of the international cooperation. A number of the Faculty staff and post graduate students have had a possibility to be involved in different projects and workshops, to participate in conferences, study courses, and short-term on-site training programs. Many young researchers have defended their theses which have been supported by the European Social Fund grants allowing attendance at international conferences and workshops. It should be mentioned that during this period there was a unique situation, which has never happened before and is not likely to happen again, when four young staff members from the same office simultaneously were writing their theses. The close cooperation between PhD students and their supervisors (e.g., prof. L. Dukaļska and S. Muižniece-Brasava, prof. V. Kreicbergs and E. Straumīte and I. Grāmatiņa) facilitates success of the young researchers. The experience and advice of the supervisors have helped the young researchers prepare high-quality doctoral theses in due time. The continuous development of research activities is the basis for new research facilities, improvement of education quality, and long-term cooperation with international partners.

The aim of this review is to show the development of the research activities in food science and technology at the Faculty of Food Technology.

The research in food science and technology is mainly related to the following issues:

- new food products from the raw materials of plant and animal origin and their production technologies;
- safety of food products;
- food packaging and optimization of food storage conditions.

New Food Products from Raw Materials of Plant and Animal Origin and Their Production Technologies

The research on new food processing technologies and new products is still very topical, especially regarding healthy food and methods of its providing.

During the last ten years, several doctoral theses made at the Faculty of Food Technology have been closely connected with issues of food quality and processing. E. Straumīte defended her promotion work "Research on baking properties of rye flour produced in Latvia" where she had studied dynamics of the formation of reducing sugars

in the rye flour scalds. I. Grāmatiņa made her research on possibilities of enlarging the use of oat flakes in a diet (Gramatina et al., 2006; 2008). The aim of her research work "Oat hydrolysates in food" was to work out a new technology for obtaining hydrolyzed oat flakes and to determine the chemical composition of soluble and insoluble fractions of hydrolyzed oat flakes. Special attention was devoted to distribution of soluble fiber β-glucan between soluble and insoluble fractions. F. Dimiņš can be regarded as the leading researcher in honey quality studies in Latvia. His promotion work "The indices of honey quality determination" expanded and improved the already carried out research on this theme (Dimins, Kuka, 2007; Dimins et al., 2006; 2008a; 2008b). The research of I. Beitāne's promotion work deals with properties of prebiotics and their use in production of new functional food products, which allows supplementing dairy assortment with new fermented products.

The research within project No. 5 of the State Research Program in agrobiotechnology "Innovative technologies for obtaining added value, safe and healthy food products from genetically, physiologically and biologically diverse raw materials of plant and animal origin" is being carried out at the Faculty of Food Technology. The title of the project is "Production technologies of new food products rich in functional components". The aim of the project: development of the production technologies of new food products rich in functional components from traditional and non-traditional raw materials of plant and animal origin.

The project covers the following activities:

- evaluation of the qualitative and quantitative properties of physiologically active compounds of *Origanum vulgare* L. and *Thymus ssp.* L. collected during the research expeditions;
- study of qualitative and quantitative changes in spices harvest depending on the clone of the spice and the growing conditions, evaluating the content and composition of volatiles as well as of the antioxidant and microbiological activity;
- determination of the most suitable flaxseed varieties for oil production, and development of new production technologies for preserving active compounds using natural components from the plants grown in Latvia;
- improvement of the production technology of bread with increased nutritional value using cereal varieties rich in functionally active substances and bred in Latvia;
- evaluation of the content of functional components (vitamins, resistant starch, etc.) in potatoes, assessment of the changes in amino acid composition and reducing sugars in potatoes during their thermal treatment, and working out of recommendations for optimum thermal treatment parameters which would preserve the most of functionally active compounds;
- development of new processing technologies of non-traditional raw materials of animal origin in order to increase the value of these products and extend their shelf life.

One of the parts of the mentioned research program is analysis of herbs grown in Latvia. In the promotion work of Z. Krūma "Plant family *Lamiaceae* herbs for rapeseed oil aromatization", suitability of basil, oregano and thyme, grown in Latvia, for production of aromatized oil has been studied (Galoburda et al., 2008; Kruma et al., 2007; 2008). The volatile and phenolic compounds of the herbs grown in Latvia as well as conditions necessary for aromatization have been investigated.

Ostrich breeding has been recently started in Latvia, therefore processing of ostrich meat has become an urgent issue. One of the research topics is "Quality of ostrich meat and its products". The chemical composition of ostrich meat has been analyzed and compared to that of beef and poultry. Various physical and chemical parameters (pH, colour, texture, microbiological indices, and microstructure) of ostrich meat and beef have been analyzed. It has been found that beef is similar to ostrich meat regarding its chemical composition. A new technology for preparing marinated ostrich meat using *sous vide* treatment has been developed, and the optimum technological parameters have been established. Study of ostrich meat is currently the research topic of PhD student J. Ķīvīte.

The major research directions and several promotion works associated to bread technology are: possibilities for improvement of wheat bread nutritive value and development of new technologies for added-value bread production using oat and buckwheat flour (D. Kļava), biologically activated grain (T. Rakčejeva), fermented whey (E. Sturmoviča), as well as studies on baking properties of wholegrain flour made

from different cereals (Kozlinskis et al., 2008; Kunkulberga et al., 2007; Rakcejeva et al., 2008a; Zagorska et al., 2008). The "bakers' team" (including D. Kunkulberga, T. Rakčejeva, D. Kļava, E. Straumīte, and I. Grāmatiņa) has good collaboration with several enterprises, for example "JLM group" Ltd, "N. Bomja maiznīca Lielezers" Ltd, the State Institute of Cereal Breeding, Priekuļi State Institute of Plant Breeding, JSC "Rīgas Dzirnavnieks", and company "Jelgavas Dzirnavnieks".

Optimization of the storage conditions of fresh, chilled and frozen fruits, berries and vegetables grown and harvested in Latvia, as well as their processing products and the factors and tools of the quality preservation is another major research area at the Faculty of Food Technology (Bluka, Cakste, 2007; Mūrniece et al., 2008; Seglina et al., 2008). Its scientific novelty is related to the use of new freezing and storage parameters for improvement of sensory properties of fruits and berries and for preservation of their quality, development of a chemical protective layer and a new treatment method for fruit preservation, and study of physical and chemical properties of frozen desserts (promotion work of S. Kampuse). Further research will deal with possibilities of chilled storage of foods, factors influencing the storage of refrigerated and frozen fruits and vegetables, as well as factors influencing the storage of frozen fruits and berries. Practical importance of that research is based on the use of optimum parameters in various freezing stages taking into account the type of the product. The developed recipes and technologies are used in production enterprises.

The Safety of Food Products

One of the researchers' study objects at the Faculty of Food Technology is food safety, which is closely related to the development of the new research field – riskology (Rakcejeva et al., 2008b; Stumpe-Vīksna et al., 2008a; 2008b). Within the scope of the project "Risks in agriculture and private forestry", a research was conducted on hazard analysis in food and catering industry. Based on the obtained results, PhD student A. Melngaile worked out a promotion work on microbiological risk factors in public catering. As a result, risk management models were developed for technological processes of the production of high doneness semi-products and ready-to-eat products. Currently, a study on hazard analysis of technological processes in the catering industry is being conducted on the processing of game meat (deer and beaver meat). During establishment of safe process parameters, the quality and sensory properties have been especially emphasized.

Food products obtained in organic agriculture are becoming increasingly more popular among the customers. J. Zagorska in her research project (later concluded with a thesis) searched for an answer to the question whether safe organic milk is comparable with the milk obtained in conventional agriculture (Zagorska, Ciprovica, 2008a; 2008b).

PhD student A. Veršilovskis developed a doctoral thesis on the subject "Development of sensitive analytical methods for determination of carcinogenic mycotoxin sterigmatocystin in food systems" (Veršilovskis et al., 2008a; 2008b; 2009).

Food Packaging and Optimization of Food Storage Conditions

Because of its continuous development, novel information on the new materials, and up-to-date technologies, food packaging has become one of the most interesting sectors in food chain. Food technologists are concerned about the influence of the new biodegradable materials on food quality during its storage. In comparison to conventional materials there are a few studies available on interaction between biodegradable materials and different food products; therefore this is an area of research interest to a group of the Faculty's young researchers (Straumite et al., 2008).

Assistant professor S. Muižniece-Brasava defended her PhD thesis on the use of environmentally friendly plasticized biodegradable polyhydroxybutirate (PHB) material and its influence on packaged food quality during the storage time. Part of the study deals with the influence of controlled modified atmosphere on fruit respiration rate during the storage time. The research was carried out using the newest and most perspective locally grown apple and pear varieties in order to preserve their quality and increase the storage time using up-to-date packaging technologies and combining them with active packaging. The experiments on application of new environmentally friendly packaging materials to fresh fruit packaging were done, and the optimum parameters for storing the fruits grown in Latvia as well as optimum modified atmosphere packaging (MAP) environment for retail packaging were defined. At present, a research on the development

of new technologies for production of frozen high-doneness foods and thermal processes during the storage is going on.

The study on the influence of a protective gas mixture on the storage of fruits and vegetables included evaluation of the changes in the fruit and vegetable respiration rate during their storage. Quality changes in the fresh vegetable and vegetable salad mixes have been studied during the MAP storage, and changes in the biochemical, physical and chemical parameters, colour intensity, content of starch, vitamin C, and carotene have been analyzed.

Hospitality Management and Education

Identification of factors influencing the production processes in catering industry is one of the research problems based on detailed analysis of the operation and management of a catering enterprise. The solving of topical industry questions will help employees understand the operational processes in catering enterprises. One of the most relevant aspects, which are being studied at present, is the quality of personnel. This topic is closely connected with the development of tourism education policy.

Disappearance of the time and distance barrier has brought global co-operation and competition instead of national segregation. Global markets, international agreements and transnational companies have an ever-increasing influence on public co-operation principles. The networking between countries, enterprises and people has become a very popular operational model with hundreds of partners involved. Therefore communication plays an extremely important role nowadays. Knowledge is a major driving force of development in any field. Various competences such as foreign languages, communication, and computer skills and practice are the most important prerequisites for a successful start in labour market. In order to develop skills and competences necessary for catering employees it is important to integrate the theoretical knowledge into industrial practice.

International Cooperation in Food Science Research

In the last five years, the teaching staff of the Faculty of Food Technology has gained significant experience whilst accomplishing several European-funded projects side by side with researchers from various institutions of European countries. The topics of the already completed European projects were mainly associated with collecting and analysis of information, but today new horizons open up due to the well-equipped laboratories where experimental research on food quality and safety can be carried out.

During 2002-2005, the Department of Food Technology was among the first participants from LLU being involved in two comprehensive studies – EcoPac QLRT-2001-01823 "Recyclable and biodegradable eco-efficient packaging solutions for the food packaging", and PackTeck G1RTC-CT-2002-05068 "Assimilation and standardisation of environmentally friendly packaging technologies within the food industry"; Latvian co-ordinator of the projects was professor L. Dukaļska. The main tasks of the projects were dissemination of information within participating countries on the problems related to the influence of used packaging on the environmental pollution, educating of consumers about packaging materials of the new generation and their introduction into market, and the present recycling technologies of used packaging.

The national coordinator of another two projects, mentioned below, was professor D. Karklina, head of the Department of Food Technology. The aim of the project SafeFoodNet FOOD-CT-2004-513988 "Chemical food safety network for the enlarging Europe" (realized in 2005-2006) was to gather information on the level of chemical contamination of the foods in European Union and the role of surveillance institutions in its detection. The project 104934-CP-2-2003-1-PT-ERASMUS-TN "Integrating safety and environmental knowledge into food studies towards European sustainable development" involved participants from nearly all the universities dealing with research and education in food science in Europe. The main objective of the project was comparing and unifying the study programs in food science. The project was prolonged several times and is still active.

The international project involving all Nordic and Baltic countries at a national level is supervised by professor I. Ciproviča, dean of the Faculty of Food Technology. The aim of the project is to generalize the knowledge and research results on the changes in fat, protein, and carbohydrates in the processes occurring in cheese maturation. Within the project various workshops for PhD students, conferences and symposiums for exchange of experience, as well as training in partner institutions have been organized. One of the

latest projects is the international EUREKA project "Application of antimicrobial lactic acid sourdough in bread production"; project leader – assistant professor D. Kunkulberga.

Research Facilities at the Faculty of Food Technology

During the last decade, modern equipment and measuring devices have been purchased thanks to the support from various European funds and other financial resources.

The financing from the European Regional Development Fund (ERDF) was obtained for arrangement of the Packaging Material Property Testing Laboratory, and the official opening of the renovated and well-equipped laboratory was held in May, 2005. In LLU it was the first laboratory which was arranged and modernized with the support from ERDF and the European Social Fund (ESF). The Faculty staff appreciates greatly such a benefit which allows performing research at an advanced and up-to-date level. The Laboratory was created with the aim to modernize the process of PhD studies in food science, and is mainly used by PhD students in their research work.

The Microbiology Research Laboratory is another newly equipped facility arranged thanks to the support from the Ministry of Economics of Latvia within the project "Establishment of laboratory of material radioactivity and hygiene". The Laboratory is suitable for studies in two directions: evaluation of microbial contamination of various foods, and studies in food microstructure.

The internal projects of LLU support the improvement of its infrastructure, and the recently installed Laboratory of Bread Technology is one of the examples. The main initiators of the establishment of this laboratory were assistant professors D. Kunkulberga and D. Kļava. In the Department of Food Technology, "a bakers' team" is created – five young researchers joined their efforts to do extensive research into bread quality and related topics.

The Sensory Laboratory is in use already for several years, and its organizer is assistant professor E. Strautniece. Always when research is dealing with the development or storage of a new product, sensory analysis is applied. In the Laboratory, sensory evaluation is done by undergraduate, Master degree and PhD students whenever their studies relate to taste, flavour or texture of a product.

The Department of Chemistry received a contribution from the State of Nordrhein-Westfalen in Germany – the Laboratory of Water Analysis which is provided with modern analytical equipment (UV/VIS spectrometer, photometer-microprocessor, thermoreactor, CSB-COD reactor, pH-ionometer, turbidimeter, pH-mVmeters, conductometer, oxymeters, etc.). In the Laboratory it is possible to determine more than 40 different chemical and physico-chemical parameters of water: content of different ions, pH, redoxpotential, conductivity, turbidity and colour, content of oxygen, the chemical and biological oxygen demand, and contamination with organic substances. The laboratory equipment can also be used for quality evaluation (composition, physico-chemical parameters and their changes during storage) of different food products and drinks.

Besides, thanks to the funds obtained from the EU and LLU projects, the Department of Chemistry purchased and improved the Scientific Laboratory of Chemistry of Natural Substances by equipping it with modern analytical equipment, of which the main and most relevant is the high pressure liquid chromatograph. As a result of the work of researchers and young scientists, several methodologies have been created for determining various parameters (e.g. carbohydrate content in honey, juices, beer, etc.) in food products using a high-pressure liquid chromatography, the content of hydroxymethilfurfural (HMF), vitamin B_2 content in bread, beer, etc., as well as vitamin E content in oils. To determine the content of various vitamins in food products, the fluorimeter is used, but the proline content, activity of invertase and amylase in honey are determined with the spectrophotometer. The refractometer is used to determine the dry matter of juices and to assess the water content in honey; the polarimeter is used for analysis of different sugar solutions. Laboratory equipment (gas analyzer) allows assessing the content of different gases (O_2, CO_2) in soft drinks.

Conclusions

The research results of the last decade have shown that there are many young knowledgeable and talented researchers at the Faculty of Food Technology.

The European Social Fund grants, the purchased modern equipment and measuring devices, creative cooperation between PhD students and their supervisors, as well as

international research projects promote and favour the research activities taking place at the Faculty and are a prerequisite for further successful achievements in the local and international research space.

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Scientific Concern of Economists at the Turn of the Century

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Abstract. Scientific concern and interests of the academic staff of Faculty of Economics have formed and developed in relation to crucial political, economic and social changes occurring in Latvia since Latvia regained independence in 1991. The first stage of the Agrarian reform was characterised by the elaboration of the concept (project) for the State strategy in agriculture, draft law "On Agriculture", and the system of economic mechanisms for the implementation of conceptual strategy in Latvia. During the second stage the academic staff of Faculty took a governing part in the elaboration of the programme "Scientific Fundamentals for Agricultural Development in Latvia" that was published as a monograph. Later the leading researchers of Faculty participated in the research programme "Risk Factors, Assessment of Risk Factors and Risk Management in Latvia Agriculture" and consequently also in the second phase of the mentioned programme "Management Systems of Risks and Crises in Latvia Agriculture". The research results were compiled in two scientific monographs. The broad and multiform themes of postgraduate students also comprehensively characterise the diversity of research activities undertaken in the Faculty. The study of agricultural and rural diversification problems and solutions is an outstanding and long-term research course for Latvia in the structure of the European Union. The scientists and postgraduate students belonging to different departments of the Faculty also deal with other topical aspects in macroeconomics, microeconomics, regional development, finances and crediting, marketing and other spheres.
Key words: science of economics, postgraduate studies, research projects, development.

Introduction

At the last decade of the previous century and the beginning of the first decade of the 21st century the scientific concern and interests of the academic staff of Faculty of Economics formed, changed and developed within the context or in relation to radical political, social and economic changes in the country. Political, economic and technological processes in Latvia after regaining the independence caused the necessity for efficient applicable researches and fast economic use of the research results.

The studies to be undertaken required the competence not only in economics, but also in management, since exactly the management problems were and still are the most outstanding problems in the transition period to the market economy. Besides the research competences are indispensable not only in the sectors of primary production, but also in the secondary sphere, i.e., manufacturing and processing industry of agricultural and forestry output. The analysed period of 20 years in the research activities of economists and management specialists thematically is broken down in several periods.

The first period is related to the land, agrarian and economic reform. After Latvia regained its independence the scientists of economics, especially – those of the agrarian economics, had to address problems related to the formation of the research base for the implementation of the agrarian reform and current land reform. It is generally known that during the first years of the land and agrarian reform the material and technical base of agriculture as well as agricultural production sharply collapsed. The restitution of land properties to a great extent re-established the structure of those small-scale farms existing in Latvia as typically agrarian country in the 1930s. Such fragmentation of economic units met the absolute necessity for the use of modern technologies and practical inability to produce competitive agricultural produce in the amount and quality demanded by the market. This period, the period of the collapse of socialistic agricultural production, continued in correlation with the process of the first stage of land reform.

The second period started when the state administration institutions were able to finance partially the research necessary for the state administration needs. An especial programme of national significance for the elaboration of scientific fundamentals for the development of agriculture in Latvia started operation in 1996-1997.

The national accreditation of the Faculty postgraduate study programme, its wide-scale development, and diversification of research themes may be relatively considered as the beginning of the third period.

Risk management of agriculture and private forestry as well as the assessment of economic opportunities or threats, and consequences in agricultural and forestry risk management are one of the most outstanding research trends in agrarian economics. As of 2002 the Faculty economists have been engaged in the mentioned research programme.

The following two problem groups to be studied have become extremely topical and moved to the foreground with Latvia's integration into the European Union and the world economics:

1) efficient use of resources for generation of higher value added;
2) diversification of sectors and types of activities for the use of those areas having become useless for the production of food stock and products.

Besides periodically several researchers of the Faculty do research also in various other projects.

In general the research activities of the academic staff of Faculty of Economics relatively may be classified into three macro-directions by departments according to the research content:

1) business and business management;
2) finance, credits, book-keeping and accounting;
3) agrarian and regional economics, marketing.

Specific directions of the research activities are concentrated in every department.

General Reform Period of Economics

The suspension of production extinction and recession to promote the stabilisation processes of the primary production and the secondary – processing production was the main concern of the Faculty scientists at the initial stage of implementation of a general economic reform and the first stage of land reform.

Evaluating political and economic processes, the leading economists have formulated their own opinion (Špoģis, 1996) that two primary conditions are necessary for targeting Latvian agriculture into natural and upgrowth course of development:

1) the law "On Agriculture" determining the national strategy of Latvia in agriculture;
2) the body of economic mechanisms and instruments, and the system for implementation of the national strategy defined by the law "On Agriculture".

Ā. Ūdris, the Minister for Agriculture of that time, recognised and started to develop the first condition in the second half of 1994 by asking the scientists and experts to elaborate the Concept for the National Strategy in Agriculture and the draft law "On Agriculture". This concept was developed by a group of economists (K. Špoģis, A. Boruks, J. Lapše, A. Miglavs, R. Zīle) (Koncepcija ..., 1994).

At the beginning of 1995 the draft law "On Agriculture" was finalised in compliance with the basic principles of the national strategy included into the Concept. The draft law was followed by the order of the Ministry of Agriculture (MoA) for the elaboration of development programmes for agriculture and related sectors, as there was a need for economic mechanisms and instruments to implement the law "On Agriculture" and the strategy incorporated into the law. Section 5 of the Concept is still topical and worth of citing even after 15 years:

"5.1. The process of farm competitiveness shall be promoted... Strong farms working with sufficiently large capital may purchase and apply efficient machinery and contemporary technologies, use loans efficiently, create new jobs in processing–sales cycles and ways..."

5.2. Also very many micro- and small farms will operate along with the strong farms. Thus it is necessary to promote the principle stating that each rural and provincial town family has land to be used according to the family interests and capabilities" (Koncepcija ..., 1994).

Determining single requirements for the elaboration of the Common Agricultural Development Programme, the experts wrote: "The national programme for agricultural development shall be the body of managerial, technical, technological, biological, agronomic, zooveterinarian, intellectual, economic, and other measures and provisions that are logically arranged for the achievement of definite goals" (Špoģis, 1996).

E. Grinovskis (1996) has published his version of the concept for the agrarian policy.

Elaboration of Scientific Fundamentals for Market Oriented Agriculture in Latvia

During the second stage due to implementation of the research programme of national significance "Scientific Fundamentals for Agricultural Development in Latvia" the elaboration of the first sub-programme "Agricultural and Rural Development of Latvia Integrating into the European Union" was committed to the economists of Faculty under the guidance of K. Špoģis. The other five sub-programmes and research leaders were as follows:

1) production of unpolluted and high-quality food (A. Jemeļjanovs);
2) development of new and improved technologies for the production of food products (D. Kārkliņa);
3) development of new varieties of field crops (M. Belickis);
4) breeding of productive animals and poultry (J. Nudiens);
5) development of a competitive horticulture system (M. Skrīvele).

The research results were comprised in a scientific monograph "Scientific Fundamentals of Latvia Agriculture" (1999). Scientific fundamentals of agriculture may be classified into 5 thematic or problem groups:

1) assessment of producing capacities of Latvian agriculture on the conditions of market economy, and measures and tendencies for launching, implementation and development of potential opportunities;
2) directions for the structural development of sectors displaying the priority sectors;
3) terms for development of agricultural priority sectors and establishment of infrastructure, technical and technological reconstruction of the terms;
4) problems related to minimising production costs, maximising income and quality management as the basic conditions of sectoral competitiveness;
5) possible economic mechanisms and instruments for the state impact and aid.

The other four sections contain the research results provided by the specialists of other research sectors for the scientific provision of higher-value food production, problem solutions related to pre-processing, processing and storage of agricultural produce, and scientific aspects related to the perfection of productive animal and poultry.

Economics of Risk Management

It is well known that under the conditions of market economy sectors of primary production as well as manufacturing sectors are subjected to various risks and factors affecting risks. This problem is also very topical on the conditions of Latvia; therefore since 2002 riskology has its own research programme "Risk Factors, Assessment of Risk Factors and Risk Management in Agriculture of Latvia" the leader of which is Professor P. Rivža. Scientists of several fields of Latvia University of Agriculture and other institutions participate in the programme implementation.

Later this programme was transformed into the programme "Management Systems of Risks and Crises in Agriculture of Latvia" with the sub-projects "Economic Opportunities and Threats of Risks and Assessment of their Consequences" (leader – K. Špoģis) and "Risks and Economic Threats of Crises Related to Primary and Secondary Spheres and Assessment of their Consequences". The research results are published in two scientific monographs – "Risks in Agriculture and Private Forestry" (2005) and "Management of Agricultural and Food Risks" (2007) – and several other publications. The research results are grouped by several directions.

The study of management quality risk of agricultural enterprises and farms has become a notably topical direction in riskology, since the consequences of inefficient, unprofessional, incompetent, careless or incorrect management are increasingly threatening expressed in the results of economic operation. Intellectual, social, economic and disposition risks are studied especially by their classification and assessment of opportunity and threat indicators.

The second direction – economic assessment of natural risks in the regions of Latvia, notably identifying the possibilities for the decrease of negative consequences related to uncontrollable risks and increase of potential benefits in the regions of Kurzeme and Zemgale.

A wide-scale research direction is started and continued in risk management in private forestry. The studies on the use of finances and credits as well as insurance aspects are also important courses of the research.

Researches are started on risk in the industry of rural tourism.

Nowadays the main consideration is paid to the management risk of agricultural enterprises, particularly to the strategy of an owner and manager of an agricultural enterprise as well as to the problems of specialisation and concentration. The research showed an essential and consistent impact of production concentration on the quality of management, and its expression in higher yield and productivity.

However the strategy of rural farm managers (owners) in the management of long-term investment to a great extent forms the efficiency of an enterprise structure. The research started on risk management opportunities in senior management was expanded.

The study of risk management in agricultural enterprises and companies turned to be a significant research object. A new research direction – systems of logistics as a risk management method and instrument in agricultural enterprises appeared in this stage.

Other areas of risk management studies are private forestry. Economists have an efficient cooperation with specialists of crop farming, plant protection, and food safety.

Thematic Interests and Research Tendencies of Postgraduate Students in Economics

Wide postgraduate studies of the Faculty reveal multiform research interests of PhD students. Themes of the PhD papers fall under several sub-branches of the science of economics, while several themes are intersectoral, and related to the sub-branches of management and social sciences.

The most extensive group of PhD research is related to regional economics. At the same time several themes indirectly fall under the sub-branch of the science of regional economics.

The second largest thematic group is related to marketing. Several studies of postgraduate students are devoted to the problems of business financing and crediting.

Research related to the science of management comprise two directions: macroeconomics, microeconomics and business management including economic efficiency of the resources use and factors, while the other direction is the management of education and regional development, thus showing the recent actual and business topicality related to the formation of knowledge society. Several PhD students have chosen themes, where regional development is connected with social economics. The least interest of postgraduate students is paid to the issues of agrarian economics.

At present, around 70-80 PhD students are active and each of them is working with economically or socially significant thematic that contains some novelty.

Grouping of PhD themes in compliance with the economic sectors shows that quite few of them are related to agriculture, forestry, fishery and hunting, some are related to mining and manufacturing industries, while the wide range of service sectors govern, as it is also in the structure of GDP.

Problems of Agricultural and Rural Diversification

Diversification of agricultural sectors, sub-sectors, auxiliary sectors and types of activities has become outstanding already with the integration process into the European Union (EU) marking the production volumes allowed for Latvia under the framework of the European common market. It became evident that land and other resources stay unutilised for agricultural production.

Problems of diversification intensified after joining the EU, when resources of the Structural Funds envisaged for financial support of the countryside were disbursed: inadequately small amount of resources of the Structural Funds was allocated for Latvian agriculture and rural areas – only 17% of the total amount, thus radically decreasing the competitiveness of agricultural produce on the European common market. Rural farms discontinue commercial production of agricultural produce and agricultural raw materials; land is rented or sold; concentration of land resources and industrialisation of production occurs. Land is used more extensively for other non-agricultural purposes – accumulation of the solar energy into the biomass of plants, and the use of biomass for energy resources.

Problems of diversification require adequate and new solutions based on the fundamentals of economics and management. Therefore since 2001 researchers of the Faculty have participated in project "Diversification of Latvian Agriculture Integrating into the European Union". Economic problems of Latvian agriculture resulting from the processes of land reform and forecasted already before integrating into the system of the European Union common market were being solved under the scope of this project.

The second project "New Opportunities of Rural Diversification of Latvia and Problem Solutions on the Conditions of the European Union" (leader – K. Špoģis) already concentrated on the new problems caused by the provisions of the European common market and the EU financial support (Structural Funds), as they enhanced the exclusion of Latvian land areas from the production of food products and raw materials.

Since 2009 the third research project or the third research stage on diversification "Structural Fluctuation of Agriculture, Processes, Factors, Consequences and Visions of Agricultural Transformations" (leader – professor K. Špoģis) has been started, and postgraduate and graduate students are involved in the implementation of the mentioned project.

Other Research Projects and Directions for the Efficient Use of Primary Production Factors and Resources

The book "Countryside – the Heart of Latvia" (Strīķis, Rivža, Špoģis et al., 2002) summarises the research findings of these projects as well as it is devoted to the evaluation of results of the first decade following the agrarian reform including emotional, social and economic assessment of consequences of the mentioned reform.

Some scientific publications are related to the education in economics and the main of them are comprised in two editions: "Higher Education in Economics for the Countryside" (2003), and "Faculty of Economics, Latvia University of Agriculture" (2008).

Recently the academic staff of the Faculty has actively participated in national and international projects both as leaders and executors, thus gaining valuable experience for further research and educational activities. The main projects (and its leaders) are as follows.

"Use of Micro Credits for Social and Economic Development of Rural Areas", "Use of Mentoring Principles and Methods for the Establishment of the Knowledge Society", and "Application of the Network of Foresight Specialists Supporting Rural Development Policy, Improvement of Database of Agricultural Scientific Research and Equipment, and Provision of Presidency of the Association of European Academies of Agriculture, Food and Natural Sciences" – these projects were led by Prof. B. Rivža.

Professor V. Strīķs leads several projects related to the studies of social capital. Professor V. Kozlinskis – EEA/Norwegian Project "Developing and Delivering Innovative Training Modules for Baltic Executives Using an Interdisciplinary Approach to Entrepreneurship and Advanced Technologies" as well as a national project "Impact of Differentiated Rates of Value Added Tax for Individual Food Groups on the Consumption of these Products and Competitiveness of Producers of the Mentioned Products".

Professor I. Pilvere leads several projects. "Assessment of Administrative Burden and Costs to Farmers", "Assessment of Administrative Burden and Costs in Regulatory Enactments of Food Safety", "Ex-ante Assessment of the Project "Latvia Rural Development Programme for 2007-2013"" and "Ex-post Assessment of SAPARD Programme for Agricultural and Rural Development of Latvia", and "European Union Funds and the EU Financing for Development of Latvian Agriculture".

Professor V. Buģina – "Development of Cooperation in Latvian Agriculture on the EU Conditions" and "Methodology for Assessment of Natural Resources within the Context of Environmental Sustainability in Vidzeme Region". Professor A. Vilciņa – "Resources of Bread Production Companies and Impact of Resources on the Development of the Sector". Professor I. Jakušonoka – "Possibilities for Financing and Development of Small Enterprises in Rural Areas of Latvia". Professor Ī. Vītola – "Improvement of Latvian Tax System for Provision of Economic Development and Social Equity".

Associate professor A. Eglīte is a leader from Latvian part in an international project of 6 countries "CHANCE – Community Health Management to Enhance Behaviour". Associate professor I. Jurgena – "Assessment of Forms of Commercial Activities within the Contexts of Multilateral Interests and Synergism". Associate professor A. Zvirbule–Bērziņa – "Development and Improvement of Professional Master Study Programmes in Cooperation with Employers, Companies and Municipalities". Associate

professor J. Kaktiņš has participated in projects "Development of System Technologies for Management of Risks and Crises in Agricultural Forestry" and "Development of Cooperation in Latvian Agriculture on the EU Conditions", an associate professor U. Ivans – "Programme of Innovative Development in Zemgale for 2008-2013". Assistant professor M. Pelše is a leader of the project "Evaluation of Economic Operation and Profitability of Biogas Production".

Future Visions

Our future researches are focussed on several economic problems important for country and requiring high level scientific solutions:

- diversification of sectors and types of activities for efficient use of land and other agricultural resources operating on the conditions of the European common market;
- generation of higher value added in primary and secondary production;
- essential increase of labour productivity in agriculture;
- establishment of the policy of protectionism for agricultural and rural development;
- models of partnership for the promotion of rural women entrepreneurship;
- economic terms for the production and use of energy resources of agricultural origin;
- problems and improvement of tax system for economic development;
- possibilities to decrease administrative burden in entrepreneurship etc.

Conclusions

Scientific concern of the Faculty research may be classified into several periods and research directions.

1. The initial period of the Agrarian reform – the scientists of the Faculty were the leading participants in development of the concept for the State Strategy in Agriculture, draft law "On Agriculture", and the system of economic mechanisms for the implementation of the law and targeting for the achievement of strategic goals.
2. Participation in the elaboration of scientific fundamentals of Latvia agriculture.
3. Establishment of postgraduate studies in the Faculty followed by the extensive student research activities.
4. Research programme in riskology.
5. Agricultural and rural diversification on the conditions of the EU Common Agricultural Policy and impact of globalisation processes for Latvia.

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Faculty of Social Sciences: Results – Achievements – Prospects

S. Bremze
Faculty of Social Sciences

Abstract. A wide range of scientific activities was carried out at the Faculty of Social Sciences during the time period from 1990 to 2009 and they are reflected in the following paper. The establishment of new structural units: the Department of Pedagogy and the Group of Sociological Researches, dealing with social sciences, testifies to the scientific potential of the teaching staff of foreign languages and social sciences. The establishment of the Faculty of Social Sciences, one of the youngest of the nine faculties of the Latvia University of Agriculture (LLU), testifies about the necessity to fulfil the mission of the development of the contemporary highly educated, well trained practitioner–public manager. The University graduate has to be a leader, well equipped with the highest quality knowledge on the latest scientific achievements in public management, the management of social sciences, having good foreign language skills and using these skills on a daily basis and communicating them, applying information technologies while carrying out the mission of being a citizen and patriot of the Latvian State. The LLU is a study process oriented higher education institution therefore the results of investigations are student oriented. Therefore, the description of the scientific activities which focus on the creation of valuable and contributing members of modern society, and on the sustainable development of urban and rural areas, is carried out. The most significant scientific activities for the development of the Faculty of Social Sciences and the society and their results are described.
Key words: scholars, science, dissemination of knowledge, rural areas, higher education.

Introduction

Contemporary socio-economic conditions and lifestyles have determined the establishment of the unique Faculty of Social Sciences at the Latvia University of Agriculture LLU). At present there are three departments at the Faculty of Social Sciences: the Department of Sociology (at present 30 faculty members) has grown to be the largest and the second largest is the Department of Languages (28 faculty members) and the Department of Philosophy has 8 faculty members. In 2009 the Department of Languages celebrates its 65th anniversary.

The departments have defined the main directions of their research. The organization of international scientific forums and the publication of the proceedings has become one of the most effective means of disseminating the innovative knowledge.

In the time period from 1990 until 2008 the completion of eight Doctoral Papers testifies to the scientific potential of the Departments and the lecturers. The main aspects or criteria by which the Departments can be assessed are the following: research contributions, contributions to international scientific conferences, completed doctoral and master papers, published books and articles, participation in international projects, international research collaboration.

Publications and the reviewing of research papers, articles for international scientific journals and dissertations, participation in international projects, writing and publication of books are the results to be recognized as being academically worthy and of scientific value.

Although many scientific activities were carried out, only the most meaningful were selected for discussion.

The Main Areas of the Research

The Faculty of Social Sciences has a special mission and role at the LLU. The teaching staff of the Faculty takes part in the scientific activities of the University being represented by philologists and pedagogues, philosophers and sociologists who focus their scientific interests on the activities of the society and the development of the community, paying special attention to the treatment of socio-economic and culture problems not only in urban and rural areas but also in higher education.

The scientific activities of the scholars of the Faculty of Social Sciences have had and have at present a complete strategic function. They are mainly aimed at the recognition and study of social phenomena which are topical in social life at the moment of research and have some impact on higher education as well. Research work has not been guided or managed between the Departments of the Faculty. It is initiated by the researchers themselves. Some scholars have been carrying out research in accordance with their own scientific interests. Nevertheless it is possible to define the main directions of the research carried out by the faculty members.

The Department of Sociology has defined 3 main areas for research:
1) public management and the sociology of organisations; 2) social inclusion and exclusion; 3) regional and rural development.

The priorities of the scientific activities of the teaching staff of the Department of Philosophy are the following:
1) philosophical problems of human personality and culture; 2) research in the philosophy of science, bioethics, the philosophy of education and the philosophy of religion; 3) studies on Latvian and European philosophical thought.

The priorities of the scientific activities of the Department of Languages are:
1) life-long education; 2) development of professional competence; 3) content and language acquisition integrated learning studies.

Public Management and the Sociology of Organisations

The Department of Sociology organized the international scientific conference "Social Capital" in 2002 in order to draw scholars' attention to the phenomenon of "social capital" and to disseminate innovative knowledge on the positive effect of synergy and its impact on the further development of society.

Objective rules as being essential in the field of public management which should be taken into account in organisational management are discussed by associated professors of the Department of Sociology J. Ābele and V. Bariss in their books on public management: "Strategic Management" (2006) and "Organizations" (2008). The authors point out that "all can be regarded from the organisation theory point of view, for example, state institutions, labour environment, family, etc. Successful functioning depends on the competent application of organisation theory" (Ābele, Bariss, 2008).

A high level of application competence of innovative knowledge in the field of societal organisations means better communication. Associate professor V. Bariss, to underline the necessity to satisfy the need for better communication stresses, that it is important to think about the impression the speaker wants to make upon the listener. Practical advice in the application of contemporary social, psychological knowledge, methods, language culture and the art of rhetoric have been elaborated by V. Bariss. He has developed his theories in the book "Applied Public Speech". In the introduction the author stresses that his "aim is to form better communication skills" (Bariss, 2008).

Innovations in public management and innovative public management processes in the state institutions of higher education have become the subject of D. Štefenhāgena's PhD research.

Social Inclusion and Exclusion

To promote the quality of the social environment in order to develop communication for the establishment of social contacts and partnerships with social institutions and public organisations is some of the research being carried out by the researchers of the Department of Sociology. Research on the social inclusion and exclusion situation in Jelgava was carried out under the guidance of professor A. Zobena, associated professors V. Bariss, J. Ābele, J. Ķusis, assistant professors M. Krūzmētra and S. Dobelniece by V. Kronberga, L. Rasnača, L. Barisa, L. Paula, G. Kronberga, I. Liepiņa, D. Bite and L. Janmere with the assistance of specialists of the Jelgava city government. In such a way the plan for further social development was elaborated as a programming document to receive EU SF financing for 2004-2006. The strategy for the activities of the Latvian state government and priorities for the investment of EU structural means were elaborated. The results of the research provided the basis for the united document according to which financing is assigned and which was unilaterally adopted by the European Commission. EU financed activities became a substantial landmark for the elaboration of the plan. Researchers developed substantiation for the further development of projects of corresponding institutions of selfgovernments for the time

period 2004-2010 to eliminate social alienation. The research was elaborated within the framework of the cooperation programme of the Baltic sea region 2001 financial support (Socioloģiskais …, 2004).

In 2008, in the Department of Sociology two dissertations were completed concerning social inclusion and exclusion: by the lecturer L. Brokāne on social psychology, and by the lecturer S. Dobelniece on social work.

The lecturer of the Department of Sociology V. Korpa, being a doctoral student of the Latvia University, is carrying out her doctoral research on the harmonization of family life and work planning, focusing on family friendly jobs. The doctoral student and lecturer of the Department of Sociology, J. Millere is researching the life quality in families with children having special needs and the lecturer A. Grīnfelde is developing her Doctoral theses in economics on the life quality of pensioners in different regions of Latvia.

To cover several aspects of social inclusion and exclusion, S. Dobelniece, E. Caune and V. Korpa, lecturers of the Departments of Sociology and Philosophy, are working on the joint grant project of the Latvian Council of Science "Formation of the Family Friendly Work Environment in Latvia: from the Point of View of Business Organizations".

Regional and Rural Development

The importance of communication among the people, different ways of communication, the development of communication technologies, the significance of infrastructure and logistics for regional and rural development were the key topics of the international scientific conference "Communication and Community" in 2001, which was organized by the Department of Philosophy.

The need to pay more attention to regional and rural development has captured the researchers' interest. The lecturers of the Department of Sociology focus on research concerning employment problems in rural areas and regions of Latvia. Co-operative research takes place at 6 universities of Latvia on the labour market in Latvian regions under the guidance of associate professor V. Bariss.

The problems of women in rural areas, their readiness and possibilities to form businesses are being researched by assistant professor M. Krūzmētra. The problems of local governments are being researched by V. Kronberga and L. Barisa.

The purpose of the research which was carried out was to promote social partnership, to restructure institutions and organisations in order to empower them, to provide assistance, to designe models of development, and so on. At present nine former doctoral students of the Department of Sociology are working on their doctoral theses, five of them in the field of regional and rural development: L. Rasnača on unemployment problems and their treatment in small towns; L. Paula on partnership as social innovation for rural development; Ž. Krūzmētra on the restructuring of the society of small towns; D. Bite on models of regional development; D. Kaufmane on tourism systems' models in different regions of Latvia.

The group of researchers: J. Ķusis, D. Bite, Ž. Krūzmētra, L. Rasnača, A. Putnieks and N. Pauliņš have been investigating the sustainable development of small towns since 2006. The main objective of the research is to ascertain if and how municipalities use new possibilities created by the administrative territorial reform to become centres of employment and services. Scientific discussion about the problem of the definition of a small town was initiated during the investigation. The group has begun to develop the Resource Centre of Small Rural Towns and has developed the web page www.mazpilsetas.lv in 2008.

Currently Assistant Professor S. Dobelniece is carrying out research on social inclusion policy in rural areas of Latvia.

Philosophical Problems of Human Personality and Culture

The notion of culture and the theories of culture, paying attention to the phenomena of culture crisis and marginalism have been investigated by assistant professor Z. Andersone. Her investigations on the "history of culture from the postmodernists point of view" are presented in the books "Culturology" Part I (Andersone, 2001) and "Culturology" Part II "on the philosophy of culture as discourse into culture" (Andersone, 2002).

The problem of consciousness in Latvian philosophy during the nineteenth century has been studied by I. Leikuma. The results of the research are presented in the book "The

Problem of Consciousness in Latvian Philosophical Thought at the End of the Nineteenth – the Beginning of the Twentieth Centuries" (2002).

Philosophical and psychological problems of human personality both theoretically and practically, including problems of self-awareness, alienation and life position were examined by the professor of the Department of Philosophy A. Strods and the lecturer I. Leikuma. The results of the studies of alienation are contained in the book by A. Strods "Alienation and We". In his book A. Strods concludes, that "alienation is not only a social, but also an antropological and ontological phenomenon" (Strods, 2005).

Research in the Philosophy of Science, Bioethics, Education, and Religion

The essence of religions and the description of various religions have been studied and elaborated by the lecturer of the Department of Philosophy I. Trep s in the book "Philosophy of Religion" (2000).

Two years later research on the historical development of the philosophy of science, on the development of positivism and neopositivism was carried out by assistant professors of the Department of Philosophy K. Lūsis and L. Leikums. The results of the studies on methodological problems, scientific reasoning and the issues related to sociology, the organization and psychology of scientific work were reflected in the book "Philosophy of Science" (2002).

The lecturer of the Department of Philosophy G. Brāzma defended his PhD theses on bioethics and the philosophy of life sciences in 2007. The manuscript of the monograph "Bioethical aspects of the Creation and Termination of Human Life" has been prepared for publication.

The lecturer of the Department of Philosophy E. Caune has carried out research on the philosophy of education, particularly concerning higher education. J. Vuguls researches philosophical aspects of the religions of the world. The main topic of his research is the practice of hesychasm – the philosophy on the basis of/according to which the unity of the world is stressed.

The lecturers of the Department of Philosophy have tried to compare "contemporary views on problems discussed in the context of Western cultural traditions and the topics related to reasoning, consciousness, ethics, religions, history, personal values and issues of postmodernism from the point of view of contemporary philosophy" (Praktiskā filosofija, 2008). As a result, the book "Practical Philosophy" (2008) was written by the academic staff of the Department of Philosophy L. Leikums, K. Lūsis, E. Apsīte, G. Brāzma, E. Caune, I. Leikuma, S. Poča and J. Vuguls within the framework of the scientific research project of the Ministry of Education and Science.

Studies on Latvian and European Philosophical Thought

It has become a good tradition for the lecturers of the Department of Philosophy to study the Latvian historical and scientific heritage and to reflect it not only in lectures but also in publications.

It should be noted that on the basis of comprehensive long-term investigations several articles and prefaces for books on the history of philosophical ideas in Latvia during the eighteenth and nineteenth centuries, including the New Latvians movement and one of its leading exponents K. Valdemārs, have been written by assistant professor of the Department of Philosophy K. Lūsis.

The researcher and lecturer of the Department of Philosophy I. Trepšs organized scientific conferences dedicated to the outstanding Latgalian scholars K. Raudive in 1999 and N. Trep s in 2003 as well as the conference dedicated to the distinguished twentieth century Latvian philosopher and interpreter of the E. Husserl's phenomenological movement, T. Celms, in Valka in 2007.

At present, the lecturers of the Department of Philosophy are carrying out comparative research of the philosophical thought of Germany, France, Russia, UK and the USA. The major area of research is devoted to the history of Latvian philosophical thought. I. Leikuma in her research is focusing on Latvian identity in the context of historical developments. L. Leikums, S. Poča, A. Strods, I. Trepšs, Z. Andersone have studied history of Latgale (Eastern Latvia) concerning philosophical thought and the contemporary problems of culture of Latgale.

Members of the Department of Philosophy, assistant professors G. Brāzma, E. Caune, L. Leikums have had the possibility to describe the results of their researches and participate in discussions on themes such as bioethics and the philosophy of life

sciences, the philosophy of education, particularly higher education and its problems, the methodology of scientific reasoning and the issues related to the sociology of organizations and the psychology of scientific work and other themes, organized by Latvian Radio and other mass media.

Life-long Education

Research on the development of young lecturers' pedagogical skills was carried out and The Young Lecturers' School of Pedagogical Proficiency at the Latvia Academy of Agriculture was organised by associate professor of the Department of Languages S. Bremze.

The research and the activities of The Young Lecturers' School of Pedagogical Proficiency stimulated the establishment and development of the Department of Pedagogy. The teaching of pedagogy and psychology allowed the Latvia Academy of Agriculture to reorganize into the Latvia University of Agriculture in 1995 (Bremze, 1991).

Since 1990, two members of the staff of the Department of Languages, S. Bremze and D. Grasmane, have investigated the problems of the study process and adult education, students' and labour market needs regarding foreign language skills, students' competences, cross-cultural communication and other relevant subjects.

Associate professors S. Bremze and D. Grasmane have had joint publications with the visiting professor of Surrey University (UK) J. Hobrough, on the recognition of cultural diversity and the impact of the Bologna process on the development of the higher education system and its reforms in Eastern Europe at the end of the 20th and the beginning of the 21st centuries.

The processes in the higher education system were highlighted from the university instructors' point of view by S. Bremze and J. Hobrough and they carried out research on "Changes in the Lifelong Education of a Lecturer" (Bremze, Hobrough, 2007) which concluded that higher education in Latvia (and Eastern Europe as well) is more focused on the improvement of the study process and less on scholarship and its dissemination.

The staff – associate professors S. Bremze and D. Grasmane of the Department of Languages assisted in the maintenance of the international scientific projects "Changes in Higher Education in an Expanding Europe" (Surrey University, Great Britain), "Food Choice and Eating Habits" (Roehampton University, Great Britain), and "Latvia on its Way to EU" (Latvia, Germany, UK, the Netherlands, Finland, USA, Lithuania).

Content and Language Acquisition Integrated Learning

Research on the choice of the lexis or vocabulary for the organisation of the conference in English and in German was carried out by the lecturers of the Department of Languages S. Bremze and M. Kaltīgina. A book was developed on international scientific conference organization in a multicultural environment in the Latvian-English-German languages "Konference-Conference-Konferenz". The book was published twice (1996, 1998). It is widely applied in the study programme "External Relations" and in international conference organisation as well (Bremze, Kaltīgina, 1996; Bremze, Kaltīgina, 1998).

On the basis of social partnership within the framework of the international scientific project the Department of Sociology together with The Higher School of Informatics and Economics of Olstyn Society of General Studies researched "Changes in Human Values" after Latvia and Poland joined the EU. To draw attention to necessity of an intercultural approach in social life, which also meant learning and recognizing the differences of cultures, traditions and values, the conference "Multicultural Communication and the Process of Globalization" was organized in 2003. Attention was paid to the advantages and disadvantages of the processes of globalization. The conference was organised by the Department of Languages together with the Sonnenberg Organisation, Germany. The main topics for the discussions were the multicultural environment, the assessment of values and the teaching/learning of professional language and the role of communication.

Professional foreign language teaching was also promoted by the German language lecturer R. Sipoviča and English language lecturer D. Skrupska. Selections of contemporary terminology developments in publications in German on water and air pollution, the protection of the environment including publications on chemistry, biology, geology, medicine were determined in several dictionaries, such as:

"German-Latvian Dictionary for Landscape Protection" 6000 words (Sipoviča, 1998);

"German-Latvian Dictionary for Construction Works" 18 000 words (Sipoviča, Ozola, 2005);

"German-Latvian-Russian Dictionary for Scientifically Technical Translations" (Sipoviča, 2009). The dictionary created a well elaborated basis for teaching German and English in the speciality "Rural Construction".

The lecturer D. Skrupska, being a member of a work group, took part in the development of the "English-Latvian-English Forest Sector Glossary" (2007).

To stress the importance of the role of the Latvian language as the official state language, the role of its history and development in the history of the development of the Latvian state, in 2007, the Department of Languages arranged the conference of the Latvia State Language Commission "State Language: Semantic Aspect". Presentations were also made by the lecturers of the Department of Languages M. Putniņa and O. Mališeva.

Most of the teaching staff of the Department of Languages are involved in the realization and interpretation of scientific projects and papers on multifunctional agriculture, agrobiotechnology, animal welfare and health, the power industry, material science, forestry science, humanitarian sciences, environmental science, issued by all the Faculties of the LLU.

The lecturer of the Department of Languages A. Gaters is the indispensable reviewer and English language editor of all the research papers published in the English language.

J. Hobrough, visiting professor from the Surrey University, UK, has become not only a regular guest lecturer but also organizes international scientific events in order to disseminate the obtained knowledge in international scientific forums in Europe and Asia. He is also an indispensable editor and reviewer of the publications in English at the LLU.

As it was shown by S. Bremze and J. Hobrough (Bremze, Hobrough, 2007), Latvia University of Agriculture was mainly oriented toward the study process and therefore all scientific activities of the university lecturers were also study process oriented. Therefore the development of study programmes was made possible by the sound theoretical foundations of previously carried out researches and written dissertations by D. Grasmane, S. Bremze, and L. Maļinovska.

The teaching staff of all departments of the Faculty of Social sciences supervise and review Doctoral, Master and Bachelor papers, as well as teach philosophy, sociology and foreign languages in all study programmes of all the Faculties of the LLU.

The development of the study programmes for the Departments of Sociology and Languages became a crucial point in their existence. The elaboration of the study programmes of the departments was a logical consequence for survival at LLU for sociology and languages.

The teaching staff of the Department of Languages has had traineeships at Oxford University, UK; Sheffield University, UK; University of Wales, UK; University of Surrey, UK; Salzburg University, Germany; Dronten University, the Netherlands. On the basis of scientific research in such fields as sociology, philosophy, pedagogy and psychology and obtained doctoral degrees, contacts, visits and studies in Latvia and at universities abroad, as well as scientific research concerning labour market needs, several study programmes were open at the Faculty of Social Sciences, and at the Department of Languages two study programmes were created and received accreditation being the first of such a kind in the Baltic states: Bachelor's programme "External Relations of Organisations" and the Master's programme "Project Management".

The Department of Sociology opened two study programmes "Sociology of Organizations and Public Administration" and "Public Management".

On the basis of the developed doctoral papers in sociology, the Department of Sociology plans to open a Doctoral Study Program in Sociology in 2010.

Development of Professional Competence

From 1990 to 2009, four doctoral dissertations have been completed by the teaching staff of the Department of Languages: D. Grasmane, S. Bremze, M. Kaltīgina, L. Maļinovska. Four more are getting prepared. 14 lecturers of the teaching staff have received a Master's degree.

Before Latvia entered the European Union there were several scientific conferences which were given international recognition and they were of great importance for the Latvian academic community as well, for the role of Latvian, English and Russian languages and their relationships were widely discussed at the conference: "The Role of

Languages and The Process of Integration into Europe" in 1996, which was organised by the Department of Languages.

Development of professional competence, the equality of women and men were the key issues of the conference "Woman Yesterday, Today and Tomorrow" organized in 1999, by the Department of Languages.

Higher education institutions carry out the function of the professionalization of the young specialists, therefore the lecturers of the Department of Languages in their researches pay great attention to the acquisition of methods of teaching, which assist the students of the study programme "External Relations" acquire professional and scientifically methodological competences in the university study process. The development of professional competences of the students of "External Relations" is the theme of assistant professor L. Turuševa's PhD theses, which she is currently working on.

Former doctoral students of the Doctoral study programme in Pedagogy**,** lecturers of the Department of Languages O. Turuševa, I. Gode and O. Mali eva are carrying out their doctoral researches. O. Turuševa-Čivžele is carrying out her doctoral research on the development of study competence for the first year students of the LLU.

In order to raise the quality of the teaching/learning process and to develop students' learning competence, I. Gode's Doctoral Paper is on hypertexts as a means for the development of the students' ability for independent studies and O. Mališeva's is on the history of the development of professional foreign language competences.

M. Parčinska, the lecturer of the Department of Languages, has participated in 17 scientific projects as a researcher, in the following fields: agricultural and veterinary higher education food hygiene and quality control; parasitic and infectious diseases; animal physiology, welfare, laboratory examinations; farm animal reproduction problems.

N. Ogurcova has assisted in the maintenance of joint international scientific projects of The Agricultural Technique Institute of the Technical Faculty with Germany on the development of milk production technologies (2001-2004) and the provision of up-to-date sustainable milk production (2005-2008).

Initially the philosophy of conference organisation was to stimulate the research work of the departments, to motivate all scholars, including young lecturers, to be involved in scientific activities and to develop publications in order to promote scientific work and increase the quality of the scientific papers of the faculty members. It was decided to organize scientific conferences by the departments in succession annually. Well organized conferences and the Jelgava palace as a conference venue became an attraction for scholars from abroad. The global idea or goal of the organisation of the international scientific conferences was to provide the possibility to meet, to discuss and to disseminate innovative knowledge.

Since 2004, by the proposal of the Department of Languages, the name of annual International Scientific Conferences of the Faculty of Social Sciences has been "New Dimensions in the Development of Society". Starting with 2007, the conferences are organized by a work group formed of the members of all the three departments of the faculty.

International recognition was given to the LLU Faculty of Social Sciences 4th Annual International Scientific Conference "New Dimensions in the Development of Society", which was held on September 25-26, 2008. The participants were from such countries as Lithuania, Estonia, Latvia, Poland, Ukraine, England, the Czech Republic and Finland, and they presented reports, had scientific discussions and workshops: "Sociology", "Rural and Regional Development", "Pedagogy", "Public Administration and Philosophy". The themes for discussions were: Administrative Territorial Reform and Small Towns; Social Capital; NGO Network's Role in the Multicultural Environment and Tolerance; Dichotomies of Values in Public Administration, Innovative Administrative Processes; Cultural Diversity; Further and Life-long Education, Changing Thinking Patterns as a Resource; Development of the Personality in the Changing Social Environment; Application of Innovative Knowledge in Practice Using Interdisciplinary Approaches.

The results of scientific research of the faculty members of all the departments were reflected in the scientific papers presented in international conferences and were published in the Proceedings of all international scientific conferences organized by the Faculty of Social Sciences. International recognition of the conference Proceedings would be an advantage also for opening of the Doctoral programme in sociology.

The lecturers of the Department of Languages have had presentations not only at local scientific conferences but also in Bulgaria, Finland, Portugal, Spain, Greece, the Netherlands, Denmark, Germany, Austria, Great Britain, Russia, Belarus, the Ukraine, Poland, Hungary, and the Baltic States.

Every year students' scientific conferences are held at the LLU to promote students' research abilities in foreign languages. In the spring of 2009, the Department of Languages is organizing the annual International Scientific students' conference "Youth in Science and Professional Practice". In the meantime students' scientific conferences are organized in sociology and philosophy as well by the Departments of Philosophy and Sociology.

Students' papers from the USA, Georgia, Ukraine, Russia, Belarus, Lithuania, and Latvia are submitted regularly.

Associate professors of the Department of Languages S. Bremze and L. Maļinovska take part in the reviewing of scientific papers for international scientific journals on the development of professional competences, the further education of teachers and lecturers in the system of life-long education, the enhancement of foreign language skills of future specialists, hospitality business, changing thinking patterns and work place improvements, competitiveness as a pedagogical concept, project management, organizational culture, the dynamics of the professional development of a specialist and the development of IT. Associate professor D. Grasmane has reviewed several doctoral dissertations dealing with the importance of mutual relationships in the study process.

S. Bremze, D. Grasmane and L. Maļinovska have had publications on their researches in the UK, Portugal, Colombia and other countries in internationally recognized journals.

Conclusions

The outcomes of the researches are reflected in a number of books, booklets, articles, projects and study programmes developed by the staff of the Faculty of Social Sciences of the LLU in which university orientation on study process was substantiated. The main directions of the scientific activities from 1990 to 2009 were the following: public management and the sociology of organisations; social inclusion and exclusion; regional and rural development; philosophical problems of human personality and culture; philosophy of science, bioethics, education and religion; Latvian and European philosophical thought; life-long education; development of professional competence; content and language acquisition integrated learning studies.

Results of the researches on philosophical issues on innovative thinking in the 21st century which were studied and discussed are regarded as a basis for the development of innovative thinking for the future politicians and practitioners, professionals whose competence should be applied as a basis of innovative thinking, investigation and innovative activities.

Research and developments in foreign language acquisition and studies of foreign language learning and teaching as professional languages has been the evidence for the necessity of foreign language acquisition for the development of the communicative competence in Latvian and international labour market as well. Carried out researches on introduction of innovations into the development of regional development, small towns, application of innovations in administration processes as well as in higher education – not only for the Department of Sociology but also for the Department of Languages – make a good foundation for further development of study programmes in external relations, sociology, public administration and project management in English, German, Russian, French and Spanish languages, and new study programmes for ERASMUS and NOVA/ BOVA as well.

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Information Technologies Step into New Scientific Areas

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Faculty of Information Technologies

Abstract. The Faculty of Information Technologies of the Latvia University of Agriculture was founded in 2001 by uniting the Department of Physics, the Department of Mathematics, and the newly established Department of Computer Systems and Department of Control Systems. The main directions of scientific activities at the Faculty are: 1) application of information technologies in forestry (leading researcher – I. Arhipova); 2) heat and mass transfer (leading researcher – U. Iljins); 3) computer control systems (leading researcher – E. Stalidzāns); 4) bioinformatics (leading researcher – L. Paura); 5) systems and synthetic biology (leading researcher – E. Stalidzāns); 6) pedagogics (leading researcher – A. Zeidmane); 7) modern elementary mathematics and didactics of mathematics (leading researcher – L. Ramane); and 8) educational management (leading researcher – A. Vintere). In 2008, the Laboratory of Computer Control of Bioprocesses was established and equipped with computational servers, laboratory bioreactor, and sets of Programmable Logical Controler (PLC) based micro automatics. The Faculty of Information Technologies organizes biannual international conferences. The first and the second conference took place in the years 2004 and 2006 under the title "Information and communication technologies for rural development". The title of the conference has been "Applied information and communication technologies" since 2008. Participation in European scientific projects is the main future objective to use advantages of the European research area and to implement recent scientific achievements of the European Community.
Key words: information technologies, computer control, forestry, systems biology, pedagogics.

Introduction

The beginning of scientific activities at the Faculty of Information Technologies (ITF) can be found in the activities of its departments which formed the basis for ITF. The scientific activities at the Institute of Informatics of the Latvia University of Agriculture (LLU) from 1992 to 2001, and at the newly established ITF starting from 2002, can be divided into the following trends:

- application of simulation modelling methods and tools for the modelling of the technological processes of production (1990-1995);
- establishment of expert systems for the diagnostics of grain sorting machinery and choosing of separators (1990-1995);
- the Analytic Hierarchy Process and its usage for decision making (1994-2009);
- the influence of information and telecommunication technologies on the development of the regions of Latvia (1994-2005);
- information systems of risk analysis (2003-2009);
- dynamic modelling of the labour market demand and development of a long-term forecasting system (2005-2007).

Application of simulation modelling methods and tools for the modelling of the technological processes of production began with the development of the simulation model for the reception of grain at the complex of grain primary processing (Bērziņš, Rivža, 1995); later the model of the all grain primary processing complex was developed (Rivza, 1995). These models were developed as complex simulation models of mass attendance system in several stages. The simulation modelling system SITA C, developed at the Institute of Mathematics and Informatics of the University of Latvia, was used as the modelling environment (Jonin et al., 1992). The modelling of grain primary processing, especially the modelling of grain drying, was studied by S. Arhipovs (Arhipovs, 2005).

I. Arhipova, the doctoral student of the Institute of Informatics of LLU, developed the first expert system in the agriculture of Latvia – a prototype of expert system for the choice of separators in the grain winnowing machines (Arhipova, Rivza, 1994). Also a

prototype of the expert system for technical diagnostics of the grain winnowing machines was developed.

The AHP method (The Analytic Hierarchy Process) – a decision-making method popular in the world – developed by T. Saaty (Saaty, 2007), was first applied in Latvia at the Institute of Informatics of LLU in 1995 when making a decision about the territorial distribution of the grain primary processing companies (Rivza et al., 2001). Since 1995 this method has been popularized and taught to the undergraduate, master and doctoral students of the LLU. Thanks to this, the AHP method is applied in many graduation papers and dissertations. It is also applied in searching for a better developmental scenario of both higher and secondary education, in the evaluation of administrative-territorial division as well as in the evaluation of the regional development scenarios (Rivza, Rivza, 2007).

Within the framework of the co-operation projects of the Latvian Council of Science ("The risk factors, their evaluation and risk management in the agriculture of Latvia" and "The management systems of risk and crisis in the agriculture of Latvia"), the prototypes for the risk evaluation information system of a public catering company (Avsjukovs et al., 2004) and for the risk evaluation information system of a fruit and vegetable processing company were developed.

Research on the development of information and telecommunication technologies in the regions of Latvia as well as its influence on the economic development of a region was started in 1996 (Rivza, 1994), and later was continued in E. Kopeika's dissertation "Information and telecommunication technologies for the regional development of Latvia", which was successfully defended in 2007.

Participation of the Faculty's scientists P. Rivža, E. Kopeika, I. Ruža, and I. Arhipova in the project "Studies of the long-term forecasting system of labour market demand and the analysis of improvement opportunities" of the ESF National programme "Labour Market Studies" resulted in the development of the dynamic model of the labour market and, on the basis of it, the labour market forecasting system in the environment of "Powersim Studio" (Darba tirgus …, 2007). The labour market forecasting system was introduced at the Institute of Statistics of the Ministry of Economics of the Republic of Latvia, and now is being applied for analysis and forecasting of the labour market.

Information Technologies in Forestry

Within the framework of the collaboration between the Forest Faculty and the Faculty of Information Technologies, an interdisciplinary team of researchers from the scientific disciplines of information technologies and forestry was established. In 2005, the methodological basis of the forest inventory and management planning algorithms was studied; project leader – I. Arhipova, executors – D. Dubrovskis, S. Arhipovs, J. O s, S. Daģis, I. Sīle, J. Donis, and J. Zariņš (Daģis, Arhipovs, 2006; Sīle, Arhipovs, 2006). In order to define the requirements for the information system of forest management planning, within the framework of the project carried out in 2006, a model of the information system objects of the forest management planning process was developed, which is a precondition for further development of the information system; project leader – I. Arhipova, executors – D. Dubrovskis, S. Arhipovs, J. Ošs, S. Daģis, I. Sīle, J. Donis, and V. Osadčuks (Arhipovs, Arhipova, 2006). Within the framework of the Forest development fund project of 2007, an information system model of the forest territorial planning was approbated. The model consisted of the following blocks: the obtaining of forest inventory data, the strategical, tactical and operational forest management planning, and the control of management activities; project leader – I. Arhipova, executors – D. Dubrovskis, S. Arhipovs, J. Ošs, S. Daģis, I. Sīle, I. Šmits, and V. Osadčuks (Dagis, 2007a; 2007b; Smits, Dagis, 2007).

The model of the information system objects of the forest management planning consists of three subsystems:

- the subsystem of forest capital value;
- the subsystem of geographical information;
- the subsystem of wood resources flow.

As a result of the research performed within the framework of the previous projects, a detailed first unit of the information system – the subsystem of forest capital value – was developed. The unit of geographical information has been implemented partially, but the unit of wood-pulp resources flow has not been implemented. In order to develop a full-value support system for decision making concerning forest management planning,

a research (development of models) was needed into the management processes of the wood-pulp resources flow and the regularities of different-level plan hierarchy in correspondence with the conditions of Latvia.

Therefore the aim of the Forest development fund project of 2008 "The support system for the strategic, tactical and operative planning of forest management" was not only to study theoretically the structure and functioning principles of the support system for decision making regarding the forest management planning, but also to show in practice its application possibilities to the public at large: leading researcher – I. Arhipova, project executors – D. Dubrovskis, R. Ozoliņš, S. Arhipovs, S. Daģis, I. Šmits, A. Mežals, and V. Komašilovs (Smits, Dagis, 2008).

The application of Web (http://mapis.itf.llu.lv) was developed, which practically shows the opportunities to apply the object models developed within the framework of the previous projects and serves as a basis for the planning of forest management, for improvement of the professional skills of people employed in the forestry industry, and for training and consulting of the forest owners.

As a result of collaboration between the faculties:

- the Web application of the forest management planning information system (FMPIS) was developed, which is envisaged for public presentation of the functioning of the system with the following subsystems: determination of the forest capital value, and determination of the economically optimal amount of felling;
- the information on the planning objectives for the forest management and a wood-pulp supply company was defined;
- an information system model, which supports decision making concerning supply of wood-pulp resources at different planning levels, was developed including:
  - optimal choice of renewable wood species;
  - choice of an economically efficient forest stand cultivation model;
  - economically efficient determination of the parameters of the main felling;
  - determination of the investment capital return of the forest infrastructure;
  - the model of the flow management of wood-pulp resources;
  - forecasting of the amount and value of round timber.

The following objectives were set within the project for the years 2009-2010:

- classification of the decisions and aims of forest management and a wood-pulp supply company depending on the planning level;
- analysis of IT standard solutions for the planning systems of forest (wood-pulp) resources;
- development of the algorithms of forest (wood-pulp) resources planning system;
- analysis and evaluation of the planning system algorithms at different hierarchy levels taking into consideration the conditions of Latvia;
- development and description of the application scenarios for the models of forest transportation planning.

The results of the project have been presented at several international scientific conferences and published in the proceedings of the conferences.

Mathematical Modelling of the Forest Stands

Dr.silv. R. Ozoliņš, Professor (Emeritus) of the Department of Mathematics of ITF, has been carrying out research into the forestry science already since 1970. On 8 September 2004, the Latvian Academy of Sciences awarded him the title of the State Emeritus Scientist for his research on the trunk forms of the tree species more often found in the forests of Latvia. For R. Ozoliņš' lifetime contribution to the development of the forest science in Latvia, the Ministry of Agriculture of the Republic of Latvia awarded him the highest award of the forest industry, "Gold Cone", on 26 January 2007. The research into mathematical modelling of the forest stands is being continued. Latvian and Finnish companies use the algorithms developed by R. Ozoliņš for the designing of a virtual dustsheet and contour line.

Heat and Mass Transfer

A co-operation has been established with the Faculty of Rural Engineering into researching the qualities of a foam plaster and other molded building materials (Skujans et al., 2007). The leading researcher from ITF is professor U. Iljins. The materials under research interest are characterized by a high level of humidity in the initial samples, which determines that during the first stage of the drying process the prevailing

are the qualities of the surrounding air which absorbs the moisture, but the qualities of the materials start to determine the drying process only after a certain period of time. Therefore before starting the research on the drying of such materials it was necessary to work out a corresponding research methodology of humidity. Electrical humidity determination methods with electrodes built in the samples were recognized as the most appropriate. Several publications dealing with the calculations of the corresponding forms of electrodes and their distribution were presented both at conferences organized at LLU and abroad (Iljins et al., 2008). The results of the research on the material drying were presented in Latvia and at an international scientific conference in Italy (Iljins et al., 2009).

A co-operation is being carried out with the Faculty of Engineering concerning the research on solar collectors (Iljins, Ziemelis, 2004) – I. Pelēce, lecturer of the Department of Physics, in her dissertation compares the conventional flat plate solar collectors with our patented semispherical solar collectors.

Modelling of Water Pollution

The development of phosphorus (P) index was the first attempt to design a model suitable for the assessment of phosphorus runoff risk in the conditions of Latvia, taking into consideration the experience obtained by the scientists of several European countries and the USA in design of the index. P index is recognized as an easy applicable instrument at the farm level for carrying out a qualitative assessment of risk caused by agricultural activities, when the phosphorus compounds may pollute the surface waters. Taking into consideration the physical and chemical qualities of phosphorus, the development of its runoff models is especially complex and labour-intensive. Within the framework of the project, P index was modelled by combining the conclusions of environmental engineering and the possibilities provided by information technologies for efficient model designing suitable for risk analysis under certain circumstances on the basis of the present knowledge and approach to the forecasting of phosphorus runoff risk (Bērziņa, Zujevs, 2008). E. Stalidzāns, A. Zujevs, L. Bērziņa, and R. Sudārs were involved in the implementation of the project.

Computer Control

The computer control as one of the trends of the master studies became a part of the scientific activities of the Faculty around the year 2006, when a bee wintering building with an automated temperature regulation and an air recirculation system was put into operation for the project of the Institute of Agrobiotechnology of LLU (Stalidzans et al., 2004). It was envisaged to place bee colonies in the bee wintering building with an appropriate-for-bees temperature for the period of time from November till March with the purpose to economize honey and physiological resources of bees. Different thermoregulation experiments are possible in the bee wintering building concerning bees or other objects. The size of the bee wintering building is 6×4 meters, the height – 2.40 meters. The control system is designed on the basis of the programmed logical controller Siemens S7-224. The control system co-ordinates functioning of eight temperature sensors, three ventilators, and one electric heater.

The computer control applies also to another project connected with bees: grant of the Latvian Council of Science "Determination of the bee preswarming situation according to the parameters of microclimate dynamics" (leading researcher – E. Stalidzāns, executors – J. Meitalovs, and A. Histjajevs). Within the framework of the project, a system for monitoring the temperature and relative humidity of two bee colonies was designed using the digital sensor systems "Dallas Semiconductor" with parallel connected sensors (Meitalovs et al., 2009). In order to find out whether the changes in microclimate are characteristic to bee swarming, television surveillance (2 video cameras) is switched on at the moments of significant changes in the indications of microclimate, which allows detecting the cause of the changes – swarming of bees or external conditions (thunderstorm, extreme temperature, or something else). Both the indications of sensors and the videotape recordings are stored in the computer.

A training set "TraSe" has been developed for university students specializing in information and communication technologies for industrial applications to simulate physically two types of industrial computer control tasks: 1) early deviation recognition, and 2) real-time control. The training set addresses some methodological issues that can be solved by training sets based on real physical processes (Mednis et al., 2008).

"TraSe" uses the feature of a rolling ball to keep predictable direction on a horizontal surface (Fig. 1). "TraSe" is developed as a game where two players develop programs and algorithms allowing computers to compete for better performance. The defending player using a starter mechanism has to hit with his ball the ball started by the attacking player. The computer of the defending player can see the actions of the attacking ball by a webcam.

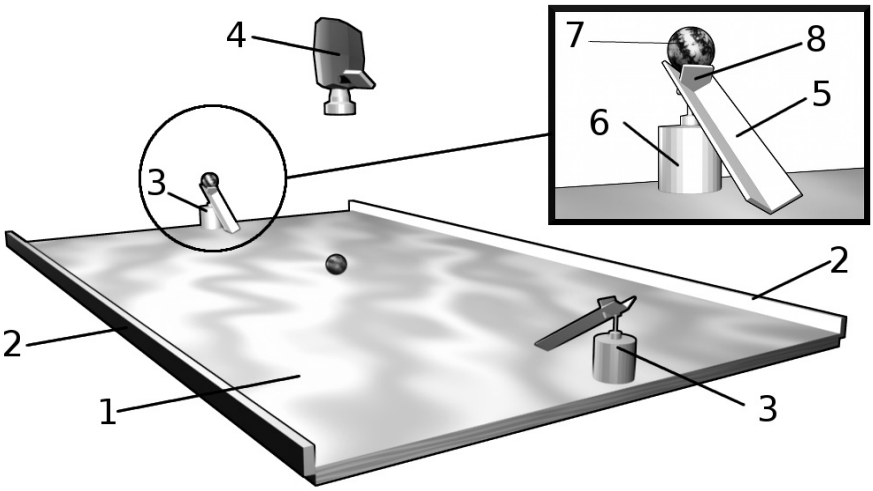

Fig. 1. Training set "TraSe": 1) a table; 2) two side guards on the long sides of the table; 3) two starter mechanisms; 4) a webcam; 5) a trough; 6) a stepper motor; 7) a ball; 8) a stopper mechanism.

In case of a single player, the following exercises can be performed: determination of a trough angle, forecast of the ball trajectory by speed and direction, determination of the table angle by the trajectory of the ball, avoiding visible obstacles on the way of the ball, scanning of invisible obstacles on the table by registering perturbations of the ball trajectory.

The tasks can be solved using methods of artificial intelligence, statistics and other methods. Time and information constraints request creative development of algorithms. Thus the skills of industrial control task performance optimizing can be developed.

The concept of "TraSe" is developed by E. Stalidzāns, M. Mednis, and S. Viļums. The mechanical and electronic parts as well as the control system are made by M. Mednis and A. Stalidzāns.

E. Stalidzāns deals also with the issues of the computer control of complex production lines and systems (Stalidzāns, 2007).

Further development of the trend of computer control is connected with the use of artificial intelligence and other methods in the management and analysis of industrially applied processes.

Bioinformatics

Bioinformatics is an interdisciplinary field which comprises application of computer science for the analysis and processing of biological, agricultural and molecular genetics data. The development of modern biology, genetic technology, as well as agricultural technologies and scientific research performed in these trends are connected with the obtaining, storage and processing of a significant amount of data and information, therefore it is necessary to have specialists to be able to deal with the issues of these fields.

The first steps in this direction were made in 2005, when ITF in co-operation with the Norwegian University of Life Sciences, University of Copenhagen (The Royal Veterinary and Agricultural University), University of Tartu, Lithuanian University of

Agriculture, and St.Petersburg State Agrarian University, established the Bioinformatics Network, within the framework of which the project "Nordic–Baltic–Russian academic network in bioinformatics" was developed for the financing of the Nordplus Neighbour programme (project leader – I. Arhipova, executors – L. Paura, and E. Stalidzāns) (Arhipova, Bāliņa, 2004; Arhipova, 2006a, 2006b; Paura, Arhipova, 2007). Within the framework of the project, international courses were organized for the master students of the Baltic States. Foreign guest lecturers were invited from the University of Copenhagen, Norwegian University of Life Sciences, University of Tartu and other higher education establishments. The themes of the courses covered a wide range of topics and were arranged into three larger themes:

- biology (the courses took place at the Lithuanian University of Agriculture in 2006);
- analysis of biological data (the courses took place at the University of Tartu in 2007);
- bioinformatics (the courses took place at LLU in 2007).

Together with the implementation of the international project, within the framework of the EU Structural Fund project "The modernization of the information technology study programmes at the Latvia University of Agriculture" (project leader – I. Arhipova, 2005-2007) ITF improved its master study programme. One of its main objectives was improvement of the curriculum for the study programme trend "Bioinformatics".

Systems Biology and Synthetic Biology

In 2005, after the involvement into the international bioinformatics project "Nordic–Baltic–Russian academic network in bioinformatics" (lead by prof. I. Arhipova and implemented within the framework of the programme Nordplus Neighbour), E. Stalidzāns became interested into the systems biology; the theme of his dissertation is close to the new scientific discipline. The mission of the systems biology is: by means of mathematical modelling integrate the huge amount of the accumulated molecular biology information into a single, dynamic holistic perspective in order to show how the systems' qualities of an animate emerge out of the molecular interaction and, at the same time, to provide an opportunity to anticipate precisely and quantitatively the reaction of the cells towards the performed genetic modifications or changes in the external environment.

There are excellent preconditions for the development of systems biology at the ITF, because the field is interdisciplinary and the computer technology is one of the most powerful instruments in the systems biology (Žukova, Stalidzāns, 2006). Besides, this trend agrees with the activities of the master study specialization "IT in Biosystems". This has facilitated intensive participation at international conferences (6 conferences in 2006) in order to understand the present developmental stage and future trends of the systems biology and to choose "the main emphasis" of future scientific activities when getting involved in international projects. The application of control theory methods for the management of biological systems by means of technical and biological aids was chosen as the main research trend (Mozga et al., 2006). The main instrument in this trend is the computer, which is used for the solution of modelling and optimization problems. At present the research on the trend of systems biology is performed by four doctoral students (according to their enrolment): I. Mozga (Artificial intelligence for the dynamics modelling of glicolysis processes (Lagzdina et al., 2008)), U. Grunde-Zeiferts (Computer control algorithms for the molecular processes of cells), V. Brusbārdis (The control network model of the thermostress reaction of a human cancer cell), and T. Rubina (Computer modelling of the structure of biochemical control networks).

One of the themes addressed is the analysis and contrasting of technical and biological systems and their control principles on the scale of many generations (Mozga et al., 2007).

Since 2007, ITF has been co-ordinating the international innovation transfer project "Modular education for interdisciplinary systems biology" (MOSBIO) (Stalidzans, Mozga, 2008). The project is implemented within the framework of the "Leonardo da Vinci" programme, and the partners involved in the implementation of the project are from Germany, Finland, Spain, and Estonia.

The projects related to the systems biology and financed by the Latvian Council of Science are being implemented: "Rationalization of biofuel production by means of the dynamic models of biochemical reaction networks" (project leader – E. Stalidzāns,

executors – L. Lagzdiņa and I. Mozga) – from 2008, and "The application of cell control networks for the control of bioprocesses" (project leader – E. Stalidzāns, executors – T. Rubina, I. Mozga and V. Brusbārdis) – from 2009.

The Biosystems Group has been increasingly more involved in the activities of the synthetic biology since 2008. The representatives of this new discipline, which is close to systems biology, try to apply the principles of technical system designing when designing systems from biological elements. A very important part of the synthetic biology is the forecasting modelling of the systems functioning.

In 2009, within the framework of the European Social Fund (ESF) activity "Involvement of human resources into the scientific activities" (1.1.1.2.), a 3-year project "The formation of the Latvian interuniversity scientific team in the field of systems biology" (headed by E. Stalidzāns, the senior researcher of ITF) was approved. The partners in this project are the scientists and students from the University of Latvia and the Riga Technical University, thus ensuring a high quality of interdisciplinarity necessary in the systems biology.

In the future it is planned to expand co-operation with the Institute of Microbiology and Biotechnology (under the leadership of prof. U. Kalnenieks) of the University of Latvia where the applied methods of metabolic engineering fit well with the modelling technologies applied by the Biosystems Group.

Pedagogics

Research in pedagogics (leading researcher – A. Zeidmane) covers mainly the didactics of the study courses on the sciences. In 2007, within the framework of the LLU research project No. XP 61 "Studies of the developmental tendencies of engineering education" (project leader – A. Zeidmane, executors – A. Vintere, and I. Ozola), the main emphasis was laid on the research performed on issues related to the development of cognitive abilities:

- the role of the studies of natural sciences in the development of cognitive abilities was established (Vintere, Zeidmane, 2007);
- the factors determining information technologies as an instrument for the development of cognitive abilities were identified (Vintere, Zeidmane, 2007);
- the role of languages in the development of engineers' competencies within the study process was evaluated (Malinovska et al., 2007);
- the methods applied in teaching the natural sciences were evaluated (Zeidmane, 2007).

In 2008, within the framework of the LLU research project No. XP 112 "Engineering education for the development of knowledge society", the following was succeeded:

- "Knowledge Structure" in engineering in relation to the engineers' special and professional qualifications was evaluated (Zeidmane, Vintere, 2008);
- components describing the information and communication abilities, their integration and evaluation in the engineering education were found out (Zeidmane, Vintere, 2008).

Educational Management

Educational management is a relatively new scientific trend in Latvia; however, several research issues are topical also at LLU:

1) organization of the engineering study process (leading researcher – A. Zeidmane);
2) integration of information communication technologies (ICT) into education (leading researcher – A. Vintere);
3) organization of the mathematics study process (leading researcher – A. Vintere).

In order to improve correspondence between the supply of higher education and the tendencies of public development, the ITF in co-operation with the scientists from the Faculty of Engineering and the Faculty of Rural Engineering carry out continuous, co-ordinated and systematical studies of the tendencies in the field of engineering education, which includes research, experience exchange, co-operation between all parties involved in the educational process, etc. In 2008, within the framework of the project of the Latvian Council of Science "Research of competencies needed for engineers in the labour market of Latvia and the development of these competencies during the study process" (leading researcher – A. Zeidmane; executors – L. Maļinovska, S. Strausa,

K. Vārtukapteinis, and A. Vintere), the challenges facing the engineering education were identified (Zeidmane, Vintere, 2008):

1) changes in the practical training of engineers (sustainability, complexity, risk management, ability to see the opportunities, etc.);
2) changes in the engineering labour force (lack of abilities in the industry, changes in the generations, global mobility, etc.);
3) changes in the curriculum of engineering education (structural changes, broadening of variety, etc.);
4) transfer from engineering education to the development of engineering abilities.

In 2009, a team of researchers is continuing to carry out the project No. 09.1444 of the Latvian Council of Science "Research on the possibility of developing the competences needed for engineers during the study process" (project leader – A. Zeidmane; executors – L. Maļinovska, S. Strausa, A. Vintere, S. Čerņajeva, and S. Atslēga). Within the framework of the project, the role of languages and ICT in the development of engineering competences during the study process has been evaluated, the role of co-operation in the development of competences has been found out, and the possible models under the Latvian circumstances have been identified.

Within the framework of the research trend "Integration of information communication technologies (ICT) into education" (leading researcher – A. Vintere, doctoral student of the doctoral programme "Educational Management" of the University of Latvia), ICT in society management in Latvia have been evaluated, and theoretical aspects of ICT integration into education as well as the role and place of ICT in the study process and its development have been identified (Vintere**,** 2006a).

From the aspect of ICT integration into education it has been found out that qualitative changes in technologies nowadays require also significant changes in the society, therefore changes in the education based on ICT become especially important. The consequence of the ICT development is globalization, which causes several new types of risks that influence the welfare and safety of every individual. The research has showed that the new technologies provide possibility of both improving and destroying the individual's safety and welfare (Vintere, Bogdanovs, 2006; Vintere, 2008). Information literacy is one of the main preconditions for an individual's legal capacity (the capacity to use social activity opportunities offered by the community). It is obvious that information literacy is closely related to ICT. An individual's skill to use the computer and the Internet is a significant assistance in the exploration of the world and in the use of social activity opportunities offered by the community (Vintere, 2008).

The integration of ICT into education requires also new competences for the teaching staff, which should be planned and implemented together with the integration of ICT into education. In the result of research, ESF project "The improvement of the LLU academic staff's competences regarding the data processing technologies" has been implemented (Aboltins, Vintere, 2006).

The research has showed that for successful integration of ICT into education, the management of an educational establishment and its vision of the meaning of ICT not only in facilitation of the teaching/learning process but also in the strategic planning have a special role (Vintere, 2006b, 2009; Zeidmane, Vintere, 2008). Education faces a specific set of objectives: to alter the study programmes, standards, technical aids and, as the most important, methods in order the teaching/learning process implemented at school would correspond to the changes in ICT taking place in the society and to the future perspective of the economy based on knowledge. In this way there were identified problems which emerged when significant cultural and organizational differences, having started the integration of technologies, had influenced the environment of modern educational management. An encouraging study environment facilitates the educational quality. Within the framework of the research, the issue on the enrichment of the study environment with ICT has been addressed (Vintere, 2009).

Within the framework of the research trend "Organization of the mathematics study process" (leading researcher – A. Vintere), the factors determining the development of the mathematics education, as well as the problems and their possible solutions have been identified. The factors determining the educational quality, as well as the possibilities of facilitating the quality of the mathematics study process at LLU have been evaluated. The possibility of applying ICT in the mathematics study process has been evaluated (Vintere, 2009). The research resulted in modernization of the mathematics

study process within the framework of the ESF project "Modernization of the mathematics and physics study process at the LLU" (Vintere, Aboltins, 2007), and in establishment of an international co-operation network with the University of Siauliai.

The Beginnings of Doctoral Studies

A significant moment in the scientific activities of ITF was September 2006, when the first graduates of the ITF master study programme started their studies in the newly developed doctoral study programme "Information Technologies". A little later the Biosystems Group was commenced – its scientific activities officially started at the meeting of the Department of Computer Systems in January 2008. At the beginning, doctoral students I. Mozga and U. Grunde-Zeiferts were involved in the activities of the Biosystems Group under the guidance of E. Stalidzāns; the themes of their dissertations related to the issues of the systems biology.

Besides the scientific activities, the Biosystems Group organizes scientific seminars, 90-minute meetings open to the public, where different discoveries and tendencies related to biology are discussed. Also representatives of the Faculty of Agriculture participate at these seminars; in particular should be mentioned Dr.agr. Z. Grīslis' helpful assistance. The events organized by the Biosystems Group are attended by the scientists from Germany, Spain, Finland, the Netherlands, Estonia, and Lithuania.

The renovated room No. 307, appropriately equipped and envisaged not only for seminars and scientific activities but also as a venue for creative work of the present and future doctoral students, was opened in December 2007. The room is used by the Biosystems Group for its weekly seminars as well.

In summer 2009, already 12 doctoral students were studying at the ITF doctoral study programme. In the future it is planned to broaden the doctoral study programme by involving its first graduates as scientific advisors of the doctoral students in the teaching/learning process.

Establishment of the Laboratory of Biosystems Computer Control

The specializations "Computer Control" and "Information Technologies in Biosystems" of the ITF master study programme may also mutually supplement the trend of biosystems computer control. In 2008, in order that the Laboratory of Biosystems Computer Control could start functioning, within the framework of ERDF financing the project "The equipment of the Laboratory of Bioprocesses Computer Control at the Faculty of Information Technologies of the Latvia University of Agriculture" was implemented under the leadership of E. Stalidzāns and A. Paura. The obtained equipment consisted of 3 parts:

1) a laboratory bioreactor with a control system which sends the results of temperature, oxygen concentration, pH value and other data measurements to the computer enabling to study the dynamics of the control process (produced in Latvia by the company "Biotehniskais Centrs");
2) computer servers for computing the bioinformatics and systems biology problems, which is a necessary precondition for comparison of sequences, optimization of biochemical networks, and solution of other problems addressing a significant number of figures. By means of these servers it is also possible to study the speed and efficiency of different computing algorithms;
3) microautomatic sets, produced by the company "Siemens", are envisaged for realization of computer-designed management systems with programmed logical controller sets S7-200 and S7-300 which are widely applied in industry. The microautomatic sets include different sensors (pressure, temperature, distance, etc.), executive mechanisms (electromotor, output blocks, etc.), and blocks for different kinds of communication (including use of the Internet) between the controllers.

The future prospects of the Laboratory of Bioprocesses Computer Control are closely linked with the development of the bioprocesses modelling methods in order to be able to realize the computer control algorithms based on developmental forecast of the bioprocesses. It is planned also to improve the management system functionality of the laboratory bioreactor with the possibility of diagnosing deviations of the processes.

ERA-Net Project "ICT-AGRI"

Thanks to participation of the ITF staff, Latvia is represented in the 7th framework programme ERA-net project "ICT-AGRI" which will address the issues of the application

of information technologies in agriculture covering the following topics: agricultural communication systems, agricultural robots and automatized machinery, precision cultivation of grain, management of agricultural environment, precision cattle breeding, evaluation and documentation of agricultural produce quality, agricultural decision support systems, systems of farm management, and agricultural information management. As a result of the project we hope to integrate into the European-level network of the specialists of information technologies, which deals with agricultural problems. Thus we will also have an opportunity to introduce in Latvia the innovations created within the framework of joint projects. The period of the project implementation is from 2009 to 2013.

Conclusions

In the field of science, the Faculty of Information Technologies is successfully co-operating with other faculties of the LLU, higher educational institutions of Latvia, as well as with partners of other European countries. Scientific trends are being developed which agree with the specializations of the master study programme (systems analysis, computer control, and information technologies in biosystems which comprises bioinformatics, systems biology, and synthetic biology) as well as with the study courses provided by the Department of Physics and the Department of Mathematics. The team of researchers performing studies in pedagogy functions as a separate trend. The projects of the Latvian Council of Science, European Social Fund, European Fund for Reconstruction and Development and other projects for researching and providing the Faculty with the necessary equipment are being successfully implemented. Besides, the ITF successfully uses the unique opportunity provided by LLU to co-operate with other faculties in developing information technologies as a powerful instrument in any scientific discipline and business sector. Thus, the trends of scientific activities are developed jointly with other LLU faculties: Faculty of Engineering, Forest Faculty, Faculty of Rural Engineering, Faculty of Agriculture, and others. The doctoral study programme, developed in 2006, plays a very important role for further scientific development of the Faculty. The project "ICT-AGRI", which will be implemented within the 7th framework programme from 2009 to 2013, provides an opportunity to integrate into the relatively specific sphere of the agricultural application of IT at an international level.

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The Experience of RI "Sigra" towards Improved Research Capacity and Better Integration into European Research Area

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Abstract. Requirement of consumers towards quality and safety of food is increasing. The society is more materially secure, better informed and educated, and is paying more attention to food quality and health issues than 10-15 years ago. Industries, working in the field of growing and processing of animal food are interested to implement and use technologies which would ensure high-quality and healthy products. The Research Institute of Biotechnology and Veterinary Medicine "Sigra" was founded in 1946 as the Institute of Zootechnics and Zoohygiene within the Latvian Academy of Sciences. In 1956, the Institute was reconstituted under the Ministry of Agriculture. Since 1963 it has been located in Sigulda, and in 1998 was integrated with the Latvia University of Agriculture. The mission of "Sigra" is to develop scientific methods for obtaining high-quality, non-polluted, safe and healthy products from animals. The main research areas are: production methods of animal-origin products, improvement of the genetic potential of domestic animals, practical application of the genetic potential of various breeds, elaboration of selection conditions for healthy and economically profitable breeds, investigation of beef cattle breed acclimatization possibilities and cross-breeding effectiveness, elaboration of a beef-production system, elaboration of fodder preparation methods for increasing of the preservation and feeding-value, ecological aspects in the field of production of animal-origin products, development of new methods for prophylaxis and treatment of infectious and non-infectious diseases, organic farming, and elaboration of vaccines against infectious diseases and medicines from plant extracts.
Key words: consumers, food quality, safe food, healthy food.

Introduction

Fundamental sciences are critical to development since they act as the building blocks for the new technologies. The development of new and improved tools for control of animal diseases is unlikely to be successful without the basic knowledge. A strong base of fundamental science is essential if progress is to be made and if the competitiveness of European industry is to be improved.

Five potential barriers to the efficient transfer of technology to enable development of new products are identified: quality management, intellectual property rights, facilitation of technology transfer, education and training, and infrastructure. It is essential to minimize or overcome the effects of these barriers if the EU is to remain competitive, and to produce innovative and new products. Many enabling factors are involved in a successful delivery of the new products. Perhaps one of the most important is the urgent need to establish a method for Europe to identify innovation, ensure that the scientists involved understand the need to acquire patents and to fill the critical gap which currently exists between the science and the major pharmaceutical companies. A series of recommendations for action and research are made to improve the potential and reality of technology transfer.

The Research Institute of Biotechnology and Veterinary Medicine "Sigra" (RI "Sigra") of the Latvia University of Agriculture (LLU) is the leading research centre in Latvia and in the Baltic region in the field of elaboration of research for production of high-quality, uncontaminated, safe and healthy food of animal origin. "Sigra" has obtained significant experience which can be used in the further scientific and research work. The developed promising research teams at "Sigra" as well as the qualitative research carried out using insufficient research equipment demonstrated the feasible development potential. In order to become an excellence centre and to implement high-quality research, support for reinforcing research potential was necessary. Knowledge and experience improved, equipment updated, as well as targeted partnership with research centres in the EU, having similar scientific interest, is what "Sigra" was missing for achievement of the goal till recently.

Only international collaboration in common European research area can ensure further development of agriculture science including food research. Soon after regaining independence, "Sigra" developed activities in the EU Common Research Space. For example, "Sigra" participated in the project "SafeFoodNet" and received funding within the 6th Framework Programme. Activities were continued in the 7th Framework where the project proposal "Unlocking Animal Food Quality Research Potential in Baltic Region by Developing Scientific and Technical Capacities of the Research Institute "Sigra"" (BaltFoodQual) was submitted.

The scope of the project is to develop science-and-technology (S&T) potential of the research excellence centre in Latvia –"Sigra" – in order to enforce high-level research on animal feed and food quality in collaboration with research teams from other EU countries, as well as to contribute to the development of research capacity of the Baltic region and its integration into the European Research Area (ERA).

The long-term objectives of "Sigra": to stimulate realization of full research potential of the enlarged European Union by unlocking and developing the present research potential in one of the convergence regions – the Baltics.

Short-term objectives of "Sigra":

1) to strengthen capacity of researchers to participate at EU level in the research projects and activities on animal feed and food quality;
2) to improve technical capacity to carry out high-quality research on animal feed and food quality and their impact on consumers' health;
3) to promote collaboration with other research institutions in the ERA, having similar scientific interest, in order to use research capacity more synergetically and efficiently.

Main activities planned:

1) secondments of the research staff;
2) development of the "Collaboration Research Program";
3) acquisition and development of research equipment;
4) organization of conferences and workshops;
5) participation in international exhibitions and congresses in order to disseminate information about the projects and the research institute;
6) publishing and dissemination of a brochure;
7) publications in scientific journals.

Results expected:

1) upgrading of the research and technical development (RTD) capacity and research quality;
2) better integration of the research team of "Sigra" into the ERA;
3) improved capacity of "Sigra" for participation in FP 7 projects;
4) formation of the Centre of Excellence in the research of veterinary medicine and animal science on the base of "Sigra".

Technology Transfer

There is an urgent need for the research scientists to understand technology transfer processes as many of the scientists do not consider the future development of their discoveries. The need for collaborative work between all concerned must be emphasized. A mechanism is needed which delivers flexibility by allowing a scientist to work collaboratively employing other specialized experts as necessary. It is often important to patent new discoveries so that companies are then prepared to take the risks involved in development.

The increasing gap between what is happening in research and the breeding and veterinary medicine practice (of an average-size breeding organization) must be recognized and addressed. We need to:

– optimize research to applicable results by increasing exchange of knowledge and technologies;
– increase collaboration between research and industry by decreasing the distance between new knowledge and new products.

Public funding normally supports activity at the front of the research-and-development (R&D) pipeline with industry picking up the costs once the uncertainties and risks are reduced to the point that a return on "shareholder" investment can be realistically envisaged. The point along the pipeline and which industry is willing to invest varies by sector, and the investment returns in agriculture are generally low. Therefore, public

funders need to ensure that they are willing to fund both basic and strategic research relevant to farm animal breeding and reproduction if we are to realize the promise offered by current developments in the biological sciences. Mechanisms that support shared-cost projects between industry and public funds in the middle of the pipeline are particularly valuable mechanisms that should be developed further.

Technology transfer needs to be (come) an integral part of research. It is crucial for innovations to be implemented continuously. However, it is complicated for scientific results and, what is more important, the opportunities for the practice of scientific results to get their way to the breeding and artificial insemination (AI) organizations. The old situation of implementation from R&D in an institute/university to the research, science and development (R, S&D) in a company is a top-down approach that is not working anymore – a more interactive approach is needed. R&D of the industry will (need to) be more involved in/with the research in the institutions.

Examples of technology transfer are:

- government-industry-research programmes;
- club of interest around (complicated, precompetitive) research/education project;
- technology transfer facilitators partnering several (small-scale) industries and research organizations.

Public funding support of the pipeline should include appropriate structures and mechanisms that promote both business development from the research base, and product and process innovation in industry. Knowledge transfer networks or similar mechanisms that deliver two-way facilitation at the interface of scientific capability and industrial need within specific technology sectors are valuable mechanisms. In the animal breeding and reproduction sector, the combination of excellent scientific opportunities and structural challenges within industry means that public support of relevant knowledge transfer mechanisms is appropriate if the potential benefits are to be realized. "Sigra" has close contacts with more than 30 partner organizations (private farmers, professional associations) in Latvia to ensure technology transfer in the fields where the Institute is carrying out its activities.

Relevance to the Objectives of the Food Quality and Safety Priority

For Latvia as well as for European consumers, safety is a most important issue concerning food. Recent episodes have undermined public confidence in the capacity of the food industry and of the public authorities to ensure that food is safe. The European Union's food policy must be built around high food safety standards in order to protect and promote health throughout Europe. The objective of "Sigra" is to improve the health and well-being of Latvia citizens through a higher quality of their food, somehow re-addressing the classical "farm-to-fork" approach by giving priority to consumers, demands and rights for high-quality and safe food. This approach has a relevant impact on food production, i.e. we move from the needs of the consumer along the production chain rather than simply assessing the safety of the food being produced. However, food safety with respect to chemical contaminants cannot be assessed without appropriate exposure assessments and surveillance programmes from farm to table and increased capability of the scientific advice system, so as to guarantee a high level of human health and consumer protection. This implies that comparable standards of food safety should be elaborated and implemented throughout Latvia. Science has a paramount role concerning food safety, through the identification of sources and pathways of contamination, the assessment of the actual importance of specific pollutants and their impact on health, the elaboration of strategies for risk control and management which will assist in ensuring protection, particularly with the identification of the more exposed and/or vulnerable population subgroups. Therefore, the completion and smooth operation of the internal market for foodstuffs make it necessary to examine and evaluate scientific questions relating to food in such disciplines as medicine, nutrition, toxicology, food hygiene, biotechnology, and chemistry, particularly when these questions concern human health.

The primary goal of "Sigra" activities is to promote and facilitate the interaction of interested local parties with mainstream research activities, with EFSA and other international and supranational bodies or activities. The impact of this "Sigra" work will be at both national and European level. Problems will be characterized in terms of existing resources, infrastructures, organizational features, data sources, points of strength and weakness, with a view of contributing to improved understanding of gaps

and needs, and to highlight actions needed to harmonize processes in Latvia with those of the member states. At the European level, the results of "Sigra" will mainly contribute to a better integration of Latvia institutions involved in food safety with ongoing activities and bodies of the European Union, and to the development of durable links to join mainstream European research in related scientific fields. This work will ultimately lead to societal benefits in terms of consumer health.

Networks and Centres of Excellence

The 7th EU Framework Programme seeks to reduce fragmentation, develop synergies, avoid duplication, and enhance integration and coordination of the programmes of research. With major problems in animal food production, it is important to strengthen competencies and networking aimed at increasing collaboration between research centres, reference laboratories and other stakeholders. This is an essential component in strengthening the research area and in ensuring that Europe's position is not undermined.

Research should be concentrated in centres of excellence. Research institutions should avoid covering the complete range of subjects and instead should concentrate on specific areas of excellence although this could create the risk of "islands" of research and reduced knowledge about activities at other centres of excellence. Integration of researchers and good communication links are essential, and provisions should be made to encourage this. "Sigra" has advanced an aim to reach conformity to the requirements of the Excellence Centre in the year 2010.

Education

High-quality research needs to feed an effective R&D and innovation pipeline that delivers new or improved products and processes. To be effective and efficient, support is needed for people development – skills of the scientists and knowledge transfer (KT) professionals working in the research base and industry by means of:

- high-quality education encouraging a constant flow of young people interested in careers in the biological sciences applicable to animal agriculture and in veterinary medicine;
- graduates with the skills needed by the research base and industry including the interface of mathematics and biology, and of genomics/genetics and reproduction;
- encouragement of young scientists to take up research or innovation careers in the animal agriculture and veterinary medicine sector and to remain there as they grow in skills and experience;
- access to training in specialist skills (including KT and innovation);
- recognition that KT requires skilled professionals who understand and work with both the research base and industry. These individuals need appropriate training, public funding support and career opportunities. Fine-tuning with industry of methods, which works, is vital;
- fostering continuous professional development through distance and life-long learning mechanisms;
- people movement and sharing of best practice among and between the research base and industry through mobility funding;
- effective networks, partnering schemes and communication channels for professionals in the sector (industry and academia) to access up-to-date information and best practice across the whole EU and to propose common research programmes to the EU.

The research and innovation structures at both national and EU level need to ensure a healthy R&D pipeline with an appropriate balance between:

- "blue-skies" basic research of unknown application;
- strategic pre-competitive research aimed at particular applications or challenges;
- applied research with a direct and near market application in mind;
- innovation and development that convert scientific developments into wealth creation or other societal improvements.

"Sigra" pays attention to mentioned above issues in the field of education.

The Sigulda branch of LLU was founded in the year 2005 on the basis of "Sigra", and every year about 150 students are learning there. During the last five years, 5-6 post-graduate and 2-3 master degree students of LLU take their courses at "Sigra" yearly.

The Most Significant Investigations and Projects during the Years 2001-2009

The future activities will differ from the present situation – after fulfilling the development research capacities of "Sigra" till the level of the Excellence Centre in the field of veterinary medicine and animal science in the year 2010, "Sigra" will have such intellectual and technical potential that will allow determining the slightest changes in the metabolism dynamics of the animal's organism, and in such a way identify and solve the possible problems in animal feeding and in the evaluation of the animal's state of health as well as make the necessary recommendations to private farmers (Sematovica et al., 2008; Šematoviča et al., 2008; Valdovska et al., 2008a; 2008b; Zitare et al., 2002; 2003a; 2003b; 2005).

During the last ten years, investigations into morphofunctional state of the animal organs' tissue in the norm and pathology have been started in the world. Only regularities of the changes in cell structure allow investigating the new medicines and their effectiveness in order to solve issues pertaining to disease prophylaxis, to evaluate homeostasis of the animal's organism systems, possibilities of producing animal products and their conformity to the criteria for healthy and safe food products. The lifetime, destruction (apoptosis) and regeneration abilities of the organism's functional basic element – cell – are dependent on the environmental influence. If cell regeneration is not in the norm, functional deviations and diseasing process take place which clinical expression not always appear instantaneously. Morphofunctional characterization of cells, tissue and organs in the norm and pathology is essential in disease pathogenesis investigations as it has been observed in the investigations of cow spongioencephalopathy (BSE) pathogenesis during the last years and while compiling a database on differential diagnostics of animal diseases connected with nervous system diseases. To deepen the investigations, a new morphological laboratory is being developed at "Sigra" in which investigations in histology, histochemistry and immunohistochemistry will be carried out by using the newest equipment and updated investigation methods. The investigations on Latvian Brown cattle breed PRL gene have begun to develop traits that will improve milk quality and quantity (Jemeljanovs, Konosonoka et al., 2008; Jemeljanovs, Sterna et al., 2008; Jemeljanovs, Zitare et al., 2008; Sjakste, 2008).

Provision of the population with microbiologically non-polluted safe and healthy food products is one of the main tasks of the producers. The investigations carried out at "Sigra" are connected with the identification of microbiological pollution sources of animal-origin food products in all links of these products' production chain. By using modern methods of microbiological investigations (chromomeric culture medium, BBL Crystal microorganism's identification system, Fourier transform infrared spectroscopy, etc.), different food polluting pathogenic microorganisms such as *Salmonella* spp., *Listeria monocytogenes, Bacillus cereus, Staphylococcus aureus, Pseudomonas aeruginosa*, etc. have been identified. During the investigations a special attention is paid to microbiological and mycological analyses of animal feed because the quality of animal feed affects animal health and safety and harmlessness of the raw materials of animal-origin food. The investigations into determination of atlatoxines B1, B2, G1, and G2 in animal feed, and atlatoxine M1 in milk by using ELISA equipment have been started (Jemeļjanovs, 2004; Jemeļjanovs et al., 2006a; 2006b; Konosonoka, Ciprovica, 2003; Konošonoka et al., 2004; 2008).

List of the Projects Elaborated at "Sigra"

"Innovation technologies for obtaining high value, safe and healthy food products from genetically, physiologically and biochemically multiform plants and animals raw material" within the State Research Programme "Agro Biotechnology" (2006-2009).

Collaborative projects

Investigation of the regularities of plant conversion and biotechnological processes in animals for obtaining high-value food (2008-2004).

The influence of agrotechnological factors and health and welfare of domestic animals on the safety and quality of sustainable food products (2006-2009).

Investigation of the possibilities of evaluating grass fodder quality risk factors by regulating the fermentative processes during preparation, storage and feeding (2001-2004).

The influence of domestic animals' feeding factors on the cholesterol level and fatty acids composition and amount in the obtained animal food products (2001-2004).

The influence of destructive etiopathogenetic processes on the animal's physiological status and production (2001-2004).

Etiopathogenesis of cow's mastitis caused by the prevailing conditionally pathogenic microorganism associations and elaboration of scientifically based amboceptors for their prophylaxis (2001-204).

Etiopathogenetic investigation of the reproductive system diseases, elaboration of scientifically motivated medicines and their influence on the product quality (2005-2008).

Investigation of the influence of the feeding value, hygienic status and aerobic stability of preserved fodder on milk quality with combined double effect additives (2005-2008).

Optimization of the protein metabolism processes in the organism of domestic animals for increasing the production quality in sustainable farming systems (2005-2007).

Morphofunctional investigation of the digestive system and its innervation, and a correlative analysis of the characterization of biochemical changes in the organism for diagnosis of diseases (2005-2008).

International projects

EC 6th Framework Programme Project "Chemical food safety network for the enlarging Europe" – SafeFoodNet.

EC 7th Framework Programme Project "Unlocking animal food quality research potential in Baltic region by developing scientific and technical capacities of the Research Institute "Sigra"" – BaltFoodQual.

During the last 10 years, 44 projects in applied science funded by the Ministry of Education and Science and the Ministry of Agriculture were elaborated. At the beginning of the year 2009, "Sigra" has started to elaborate new projects funded by the Latvian Council of Science – "Investigations of the composition of cow milk lipids and their influencing ferments in connection with the content of carotinoids and tocoferol in the fed out feed", and "Factors influencing formation of the polycyclic aromatic carbohydrates markers – benzo(a)antracene, benzo(a)pyrene, benzo(b)fluoranteen, and chrusene – by using traditional meat and fish smoking methods in Latvia".

Conclusions

For further development of "Sigra" over the next 10 years it is vital to foster a creative environment for fundamental research and to stimulate investment in research, in particular in the fields of molecular biology, immunology, genomics, bioinformatics, etc. It is important to recognize that there is a considerable overlap between many of these disciplines which suggest that the fundamental sciences must be considered in a holistic manner to achieve the best results from research. A sound and stable base for fundamental science is vital if innovation and development of new tools are to be successful. To achieve this, programmes need to be established which inherently support fundamental research either directly or indirectly linked to the priority diseases and animal welfare.

A multidisciplinary approach should be encouraged involving all those whose input has the potential to identify or develop new concepts and take these through to proof of concept stage (European Technology Platform …, 2006).

According to the Strategic development plan of LLU, "Sigra" should reach research capacities corresponding to the level of the Centre of Excellence, therefore it is important to identify all the functions which ideally would be included in the terms of reference for such a Centre and to develop a virtual centre which would involve all centres of excellence around Europe combined in a way to enable ultrafast information links and methods for data exchange.

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The Output of the Research Institute of Agricultural Machinery since 1990

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Research Institute of Agricultural Machinery

Abstract. The research work at the Research Institute of Agricultural Machinery is connected with investigations into soil mechanics, the choice of energy-saving and rational technologies for the production of agricultural crops, seeking out possibilities for the mechanisation of non-conventional agricultural crops, and research of rational utilisation of alternative sources of energy. Studies have been conducted to raise the soil tillage quality, and to reduce energy requirement and costs. Motivation is given for the design parameters of the soil tillage mechanisms, more efficient soil tillage methods and technical means. Mathematical methods have been developed for the investigation of the technological processes of soil tillage and the choice of rational technologies for growing agricultural crops. Investigations have started lately in the application of the GPS technologies in precision agriculture and assessment of the ecological aspects of soil tillage mechanisation. The work has started in the recent years at the development of technologies and means of mechanisation for growing non-conventional crops: cranberries, highbush blueberries, sea buckthorns, etc., and for processing their products. A machine system has been developed for growing large cranberries; experimental models of the machines have been made and tested. As a perspective direction can be noted a theoretical research into rational use of the sources of renewable energy, the development of machine designs and their practical application. Experimental collector equipment has been developed, which follows the movement of the sun, for the use of the energy of solar radiation. Solutions are sought to use the plant biomass for the production of energy. Equipment has been made for heating piglets in the piggeries where the air carried out of the piggery by the ventilation systems is used as a source of heat. Ecologically harmless technologies are offered for biological agriculture. The work is going on at the issues of mechanised growing and harvesting of technical crops: flax and sugar beet. Various flax harvesting technologies have been worked out and economically motivated depending on the specificity of the flax growing farms and their financial resources.
Key words: agriculture, mechanisation, technology, renewable energy, machinery.

Introduction

The Research Institute of Agricultural Machinery was founded in 1960 in Ulbroka as the Scientific Research Institute of Agricultural Mechanisation and Electrification. During its existence the Institute has changed its name several times. Since 1998, the Institute has been integrated into the Latvia University of Agriculture (LLU) as an independent legal entity; and since 29 September 2004, it has been operating in its present legal status – an agency of LLU.

At the initial stage its operation was connected with regional machine building, i.e., the development of machines and tools for small peasant farms and household plots. At the assignment of the Ministry of Agriculture, technical documentation was made up there, as well as pilot samples, and the specimens of machinery purchased in the European countries were tested. After receiving positive conclusion from the Baltic Machine Testing Station, the machines were sent for manufacturing. In approximately a four or five year period, the former Institute of Mechanisation designed about 40 machines and sent them for manufacturing.

The output of this period is reflected in popular science articles, brochures, catalogues, designs of the buildings, technical documentation of the machines, and working drawings. The previous system of scientific publications had failed but a new one was not created yet. The collections of articles, synopses of lectures and other materials had to be published on one's own effort and initiative. In 1991-1992, the system of financing changed from the financing of the entire institution to the financing of individual grants; determination of equitability, or nostrification, took place. The law "On Scientific Activity", adopted at the end of 1992, stabilised the situation, fixed the status of research institutions and researchers, the order of financing, etc.

The stage of local machine building came to an end in 1993-1994. With the development of a new form of large-scale agricultural production, a new direction of the future research-technological investigations appeared. During this time the number of the staff decreased approximately from 90 to 35. However, the scope of the themes to be studied was very wide. In the year 1995, the Institute was engaged in the implementation of 10 projects, or grants, financed by the Latvian Council of Science (LCS). When the LCS financing for the years 1996-1997 started, stricter criteria were introduced, such as participation at international conferences, scientific publications, patents, etc., and thus the researchers of the Institute gradually acquired the skills that are necessary for the participation at the conferences abroad, and long-term cooperation developed with the research institutes in Lithuania, Poland, and Belarus. Participation took place practically in every country of Central Europe. The most important directions of the activity of the Institute gradually evolved, and the number of themes decreased. After the year 2000, using the subsidies assigned by the Ministry of Agriculture, several modern items of the research equipment were acquired, mainly for the studies of rational use in precision agriculture and in the field of energy. Since 2005, the Institute has been receiving base-financing, and since 2006 – also financing for the execution of the LLU research projects, which provides an opportunity to expand investigations in the principal directions as well as to start arrangement of the infrastructure. The following sections of the paper contain an exposition and a future vision of the research directions.

Results and Discussion

Soil tillage mechanics, energy-saving soil tillage technologies and machines

Soil tillage mechanics is a subdivision of science about the functional relationships of agricultural technological processes and machines. Their cognition provides a possibility of solving the mechanisation issues of agricultural production in a more motivated, economical and faster way. That is why the studies in soil tillage mechanics have been unofficially conducted already since the time when the Institute started its operation, but officially as a theme of research – since 1997.

The theoretical and experimental investigations into the energy requirement of soil tillage processes, as well as the technical solutions and recommendations for energy reduction have been included into several dozens of publications with a common subject matter in Latvian, Russian, and, since 1997, also in the English language. Approaches have been formulated and motivated concerning the course of the soil tillage technological processes and energy requirement. In contrast to the previous views, a hypothesis was advanced and proved that the draft resistance of the operating parts of the machines and the respective soil tillage energy requirement depend on the impact of dual forces upon them: the forces which are determined by the mechanical properties of soil (the mechanical strength (hardness) of soil which causes resistance to the penetration of the operating parts into soil, as well as resistance to its deformation), and the forces which depend on the physical properties of soil (the forces of weight and inertia caused by the transferred mass of soil, as well as resistance to friction and adhesion). Guided by this conclusion, relationships of the strength of materials and theoretical mechanics are applied for analytical determination of the forces acting upon the operating parts of the machines and their elements (Vilde, 1999a).

Mathematical methods have been worked out for the investigation of the soil tillage technological processes allowing the determination of the soil transfer and the force of its impact on the operating parts of the machines, finding their rational design and optimal parameters of the technical equipment in order to ensure high-quality soil tillage with a minimum consumption of energy (Rucins, Vilde, 2006) The obtained analytical relationships are used for determination of the optimal parameters of the operating parts of the machines and the draft resistance in connection with the technological properties of soil (Vilde, 2003). These methods and the obtained relationships allow motivation for the solution of an energy-saving technology and design of the operating parts, the development of highly efficient, economic machines and aggregates for the basic soil tillage and its pre-sow preparation, as well as finding ways of their efficient application.

Approximately half of the draft resistance of the soil tillage machines (ploughs) arises due to the resistance of soil sliding along the surfaces of the operating parts. In order to study this phenomenon more extensively and intensively, a computerised tribometric stand was developed in 2003 and was used by the students of master and doctoral studies

for working out the promotion papers, as well as for other investigations connected with the tillage and the physical-mechanical properties of soil.

Motivated, more efficient energy-saving technologies and machines have been worked out on the basis of the research materials for the basic and pre-sow tillage of soil. In all, 16 kinds of machines are developed for more efficient soil tillage under zonal conditions.

The main directions are substantiated for joining technological operations of soil tillage and the design solutions of combined stubble breakers; ploughing and cultivation aggregates are worked out. The combined machines allow optimisation of the technological processes for the basic and pre-sow tillage of soil, reduction of the completion times of operations, fuel, labour and costs by 14-30%. The developed and recommended solutions are applied in the machine designs (drag-looseners, cultivators) at the enterprises of Latvia.

A new improved method has been worked out for the optimisation of the functional parameters of soil tillage aggregates (Vilde, 1999b). The optimum parameters: the speed and the working width of the machine to gain maximum efficiency of the soil tillage aggregates with minimum energy (fuel) consumption, the relations of the draft power of the tractor and the specific resistance (power) of the machines being as the functions of speed. In order to achieve high specific efficiency of the soil tillage aggregates with a minimum consumption of energy, machines should be used with a low coefficient of the dynamic resistance. By means of this method optimal parameters of harrowing, ploughing and cultivation are determined. They are applied to substantiate the working width of the designed machines and aggregates, as well as to choose and complete sets of machines for the high-speed and powerful tractors. Normative documentation of the energy requirement of technological processes and fuel consumption have been worked out and the specific consumption of fuel calculated for growing the field crops by the intensive, conventional, simplified and minimised technologies, as well as the amount of fuel which is necessary for Latvia (Vilde, 1995).

On the whole, by using the revealed solutions in the conventional soil tillage technology it is possible to save 24-36% of energy (46-110 kWh ha^{-1} and the corresponding 12-27 kg ha^{-1} of diesel fuel), to raise labour efficiency by 16-32%, and decrease the costs by 14-26%. By optimising the operation of the sugar beet harvester it is possible to lower its energy intensity by 20-30%, and save 5-8 kg ha^{-1} of diesel fuel.

The future research will be devoted to the reduction of the energy requirement of technological processes as well.

Precision agriculture, GPS technologies

In the recent years, in cooperation with the Institute of Soil and Plant Sciences, investigations are evolving in "Precision Agriculture". Owing to the possibilities of the new machines and equipment, the GPS technologies, with the help of the global positioning system, allow to find, analyse and react in a corresponding manner to the qualitative properties of the cultivated plots of land and implement an agricultural farming system (soil tillage, fertilisation, selection of sorts, etc.) that is most suitable for them.

In order to coordinate the investigations in the development, introduction and determination of the efficiency of the technologies applied in precision agriculture, as well as to acquaint with them students, agricultural specialists and farmers, the Research Centre for Precision Agriculture is being formed on the basis of the Research and Study farm "Vecauce" of LLU. The curriculum "Global positioning technologies in agriculture" has been worked out for training of the students of LLU Technical Faculty, etc. For its better acquisition, a manual has been written and published with the help of the EU co-financing under the title "Global positioning technologies in agriculture" (Vilde et al., 2008). This direction is considered as perspective, and the work should be continued.

Investigations into mechanised sugar beet growing and harvesting

A new stage started in the solution of problems of mechanised sugar beet growing in 1990, when, due to the sugar deficit in the country, possibilities were sought how to avoid it and satisfy the needs of the population and food industry by means of self-made beet sugar. The production of beet sugar had fallen to 16 thousand tons a year, which ensured only about 20% of the need for sugar in Latvia (Vilde et al., 1996). Principal attention was paid to the reduction of labour consumption in thinning–weeding of sugar beets and the use of machinery that is more suitable for the conditions of the peasant farms, as

well as to mechanised growing of the most suitable sorts of beets. In cooperation with "Uzvara–Lauks" Ltd it was found out that, using quality seeds with a high germination power and appropriate precision seeders, it was possible to sow the seeds at extreme distances (16-18 cm) and thus manage without thinning of the beets and, applying efficient herbicides, also without weeding and inter-row cultivation of the plantations. As the most suitable for the peasant farms were recognised one-man harvesters which did not gather the leaves. These harvesters were coupled to a 2-3 row tractor for the farms with smaller sugar beet areas, and 6 row mobile harvesters for large farms.

With the use of the methods of the probability theory and mathematical statistics, distribution relationships between the plants and their density were theoretically determined in the sugar beet plantations, as well as their impact on the expected yield, which was confirmed in experimental investigations. It was found out that the distribution inhomogeneity of the plants was functionally dependent on the germination power of the seeds on the field: the higher was their germination power, the higher was their homogeneity of distribution, and vice versa (Vilde, Cesnieks, 2005). The structure of the sugar beet production costs was analysed and recommendations were worked out for their reduction paying particular attention to more efficient usage of the more expensive machines (Vilde, 2002).

In 1995, a conception was worked out and successfully implemented for the development of the sugar beet production in order to fully ensure Latvia with home-made sugar of up to 100 thousand tons a year (Vilde et al., 1996). In 1998, altogether 68 thousand tons of beet sugar was harvested, which was the highest achievement in comparison with the other pre-war and post-war production volumes. The technology and the level of mechanisation of sugar beet production were approaching the standards achieved in the countries of Western Europe, yet the production costs, due to a lower remuneration of the workers, were lower. Investigations should be continued because sugar beet growing and sugar production in Latvia can be restored.

Investigation of the technological variants of flax harvesting in Latvia

The topicality of research in this direction was stipulated by the fact that harvesting is the most labour-consuming stage in the flax growing technology (approximately 70% of all the labour consumption), which, in many ways, determines the prime cost and quality of the finished product and total consumption of energy. Due to the sharp rise in prices of energy in the 1990s, flax harvesting by combine harvesters became less efficient, and suggestions were needed how to improve it. In the recent years, the interest has increased in the application of a two-phase harvesting technology used in several countries of Western Europe by which flax is pulled, at first, and spread in ribbons together with the seedy pods for drying and ripening of the seeds under natural conditions. After that, 6-10 days later, the flax is lifted, the seeds are threshed out, but the flax straw is spread on the ground. Compared to the combine harvesting, this method presupposes approximately 2.6 times less consumption of energy for final drying of the seedy part of the yield, etc. The basic factor that restricts the introduction of this technology in Latvia is that it requires considerably more expensive machines and the risk is high that the seeds may be damaged in rainy weather. Studies were conducted to determine the limits of the efficiency of these two technologies under the conditions of Latvia. Figure 1 shows the prime cost of the flax stalks when the flax is harvested by means of combine harvesters and with a two-phase method on different backgrounds of yields.

The difference in the prime costs of the flax stalks using a combine harvester and a two-phase method of harvesting, decreases with the increase in the yields. Summary calculations show that introduction of self-propelled machines for the two-phase flax harvesting technology can be justified for the time being only on condition that the yields are more than 5 metric tons from a hectare and the annual output of one machine is more than 120 ha. According to the prognoses in a ten-year perspective, both flax harvesting methods will be applied in approximately equal proportions.

In the 1990s, the Institute was intensively engaged in the development of machines and implements for harvesting of flax which would ensure lower consumption of labour and losses of its quality. The most popular machines among the ones which are used for processing the flax stalks are the fluffers of the flax ribbons with which almost all the flax seeders in Latvia were equipped (many of them are still operating today). Investigations were conducted into the efficiency of various flax processing methods during its maturing.

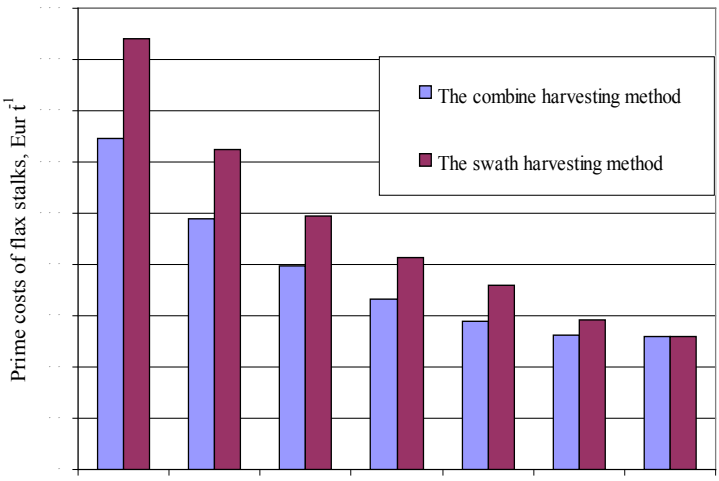

Fig. 1. The prime cost of the flax stalks according to the combine and the swath harvesting methods of flax.

The impact of fluffing on the quality of the product depends, to a great extent, on the crop capacity, i.e., the thickness of the layer of flax in the ribbon. In the experiments with flax the crop capacity of which was 2.8 t ha^{-1} and the maturing period was 19 days, application of single fluffing ensured an increase in the sort number not more than by 12% in contrast to the previously used maturing of flax without any special treatment; however, when the yield of the flax stalks exceeded 4.2 t ha^{-1}, even two-fold fluffing with a 10-day interval did not ensure uniform maturing (particularly in the bottom layer), and extra 5-8 days of maturing were necessary to complete the biological process in all the layers. When the ribbon of flax is turned over by 180º, it is separated from the ground and laid again on the surface of the field. In experiments with the flax, the crop capacity of which was 4.2 and 6.0 t ha^{-1}, application of two-fold overturning with a 9-day interval, in contrast to flax maturing without special treatments, ensured an increase in the sort number by 18.1 and 28.5%, respectively. It was established that, in case the yield of the flax stalks is higher than 3.0-3.5 t ha^{-1}, overturning of the flax ribbons must be included at any rate into the technology. The machines for the overturning process are considerably more complicated by their design and less efficient than the fluffers which slow down their overall introduction into the flax growing industry in Latvia. A series of practical recommendations have been worked out, and a book under the title "Flax growing and pre-processing technologies and machines" was published in 2007 (Ivanovs, Lazovska, 2007). Further investigations are aimed at the study of optimal technologies for growing similar technical crops – oil flax and hemp.

Investigations and development of a system of machines for growing of berries

During the last 10-15 years, interest has increased in the cultivation of berry crops. However, the unsettled situation with the technological and technical provision of agricultural farms of different sizes has hampered its implementation. On the basis of the investigations, a system of machines has been worked out for laying out plantations of cultivated cranberries, their cultivation and gathering. Investigations have been conducted, preliminary designs developed and specimens of machines made for sand and peat application based on a distributor of organic fertilisers, two types of a manual applicator for the weed control with a contact method, machines for the preparation (collection) and planting of sprouts, and implements for the water-level adjustment on the cranberry plantations (Ivanovs et al., 2007). On the whole, the total requirement for capital investments which are necessary to start the production of cultivated cranberries on a 10 ha area is approximately 180 thousand euro, including approximately 30 thousand euro in order to purchase the necessary machines and implements. In the pre-storage

stage, the most essential part of expenditure (32%) goes to the care after the plants and harvesting. Considering the great interest and scientific topicality of the issue, it is planned to continue the work in this direction.

As a result of the investigations into the harvesting processes of sea buckthorn berries, a technology has been improved and an equipment designed for the separation of berries from the stalks and their cleaning, machines have been worked out for the care after strawberry plantations, etc. (Лачгалвис, Эпро, 2005).

Investigations into the efficiency of the self-propelled field cultivation machinery

The direction of these studies logically developed in the middle/the second half of the 1990s. During this period there were more than 100 thousand land properties, the supply of various machines constantly increased, and from 1996 the government started subsidising technical improvement of the branch including the purchase of machines. However, often there were no criteria for their choice and estimation of the expected results of their application on the farms of various sizes and intensities. A computerised technological calculation method was worked out in the years 1997-1998. By varying the data, which characterise the technology (the performed operations, the machines used, the applied fertilisation and plant protection means, their prices, expected yields, and so on), this method allows to calculate the prognosticated costs per unit of product (Kopiks et al., 1998). In such a way, before starting the technological innovation it is possible to analyse various variants and choose the final one in the estimation of the expected economic results. Using this method it is possible to compare the costs of various aggregates (soil tillage, harvesting, etc.) depending on the cultivated area, and therefore to choose the optimal one for the farms of different sizes. By further improvement of this method, nomograms of profitability were drawn up for the production of the most important kinds of products (Kopiks, Viesturs, 2002).

The issues of energy provision of the farms were studied, namely, the capacity of the tractor related to the cultivated area within the context of development trends of the farms (Asejeva et al., 2003). It was found out that with the growth in the areas on the farms, the use of machines improves and the required energy supply in kW ha^{-1} decreases. On the farms with areas under crop over 200 ha, the energy supply is 1.2-1.6 kW ha^{-1}. According to the estimates by some authors, the specific energy supply, which would be necessary for an average farm in Latvia to do the work in optimum terms and quality, is approximately 2.50 kW ha^{-1}. These studies characterise also the trends of the development of the fleet of tractors. The comparative data about the changes in the tractor fleet on the farms of different sizes for the period of 2000-2007 are shown in Figure 2. As it is evident, the number of tractors is decreasing on the

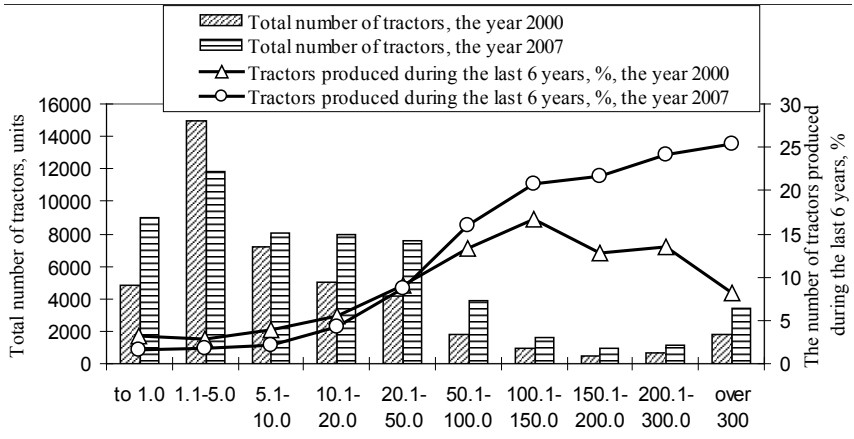

Fig. 2. The total number and percentage of tractors produced during the last 6 years on the farms with different areas under crop (the years 2000 and 2007).

small farms (except the farms with areas less than 1 ha and specialised in providing services) but increasing on the large farms with areas over 100 ha. It is typical that the number of tractors, which undergo technical checkups, is diminishing every year – in 2008 it made only 36%. This indicates aging of the tractor fleet, as well as advances an issue about the expediency of technical checkups. A conclusion can be drawn that, due to the concentration of production, the purchase of more powerful tractors will grow and the average specific energy supply in kW ha^{-1} of the farms will diminish. At the expense of the liquidated worn-out tractors, the total number of tractors will decrease, and after 5-8 years there might be 32-36 thousand operable tractors in the country (Asejeva et al., 2008).

A mathematical model has been worked out for the minimisation of the variable costs of the mechanised field operations using the MS Excel programme and handling it as an optimisation task of non-linear programming (Kopiks, Viesturs, 2008). By using this model it is possible to adjust to the area under crop of any individual agricultural farm a definite agrotechnical term for the execution of the work, the required working width of the aggregate, and the capacity of the tractor at the allowed loading, thereby ensuring minimal fuel consumption and minimal costs of the performed work. The developed model supplements the simulation methodology of the process management with a variant that can be used in agricultural production.

By developing the evaluation methods for technologies in 2009 and the subsequent years, it is necessary to start technological modernisation and assessment of the economic usefulness of the farms which are interested in the on-line mode ensuring calculations for concrete conditions of farming.

Investigations of the ecological aspects in the mechanisation of crop farming

One of the important tasks set for most of the many-sided investigations carried out by the Institute was the improvement of the ecological indices. In the perspective it is planned to aim this direction also at the improvement of the technical supply of the evolving biological crop farming (Vilde, 1995, 1999b).

Investigations have been conducted also into the aspects of ecological safety, mainly the issues of the working precision, uniformity, and longevity of the operating parts of field sprayers and distributors of mineral fertilisers. Several articles and a brochure (Vilde, 2002) have been prepared, as well as a summary (Pinnis, 2003) containing a motivation for the necessity to carry out periodic testing of the quality of field sprayers.

A research was conducted on the technology of ecological haylage preparation in rolls sealed in an elastic film, developed in the early 1990s. Recommendations were made on the improvement of this technology and application of the general-purpose machines existing on the farms for this purpose. These recommendations helped expand essentially the extent of the use of this progressive technology in Latvia. Together with the scientists from the Warsaw Agrarian University investigations were conducted seeking possibilities to reduce the prime cost of the haylage rolls sealed in an elastic film as well as to minimise the adverse impact on ecology. It is intended to continue the international cooperation started in this direction with an aim to solve together the scientific problems which are topical for those countries. A book was published under the title "Technologies and machines for the preparation of grass forage" that was intended for practitioners and students. Investigations were made in comparative economic efficiency of various technological variants of forage preparation, an algorithm was made for the calculation of economic indices on the computer, as well as studies on the improvement of the technology and technical means for the cultivation of the early sorts of maize to be processed into high-quality silage, etc.

There are studies in drying and storage of grain harvested by a combine in ventilated bins using the heat of the sun or a firewood furnace as the most acceptable solution for small and medium-sized peasant farms (Cesnieks et al., 2002). Implementing the market-oriented research project in cooperation with the Institute of Solid State Physics of the University of Latvia, computerised equipment has been created for constant control (monitoring) of the drying process. This enabled production of the highest quality food grain receiving twice as high remuneration for them than for the unconditioned grain from the combine harvester.

Research in the ecological safety of technologies and machines, which are adapted for biological farming, will be continued.

Rational use of the renewable energy

The aim of the research – to decrease the consumption of fossil energy resources in the stationary processes of agricultural production by using in a more rational way the power of electric heaters, regaining the heat flowing away through the ventilation systems, and acquiring the sources of alternative energy, including the heat of solar radiation, the heat of the outdoor air and biofuel.

Heat retrieval in the ventilation processes

High losses of heat arise in the ventilation process, which has a negative impact on the heat balance in cattle-sheds in the heating season. This is confirmed by the calculations of the heat balance in piggeries at various heat resistances and for all the main age groups of pigs (Ilsters et al., 2006). In the analysis of the heat balance of the piggery, the temperature T_d, at which it is necessary to start heating of the fresh air, can be determined in graphic way or calculated according to the following expression:

$$T_d = T_c - 2T_c \cdot (Q_{com} - Q_{sp}) (Q_{com} - Q_{sp} + Q_d)^{-1}, \quad (1)$$

where T_c – the air temperature in the piggery, ºC;

Q_{com} – the total power of the sources of heat, W;

Q_d – the losses of heat at a negative outdoor air temperature, the numerical value of which is equal to the air temperature in the piggery, ºC.

In order to decrease the need for energy resources for heating the air in the heating period, one of the solutions is heating the fresh cold air by means of a heat exchanger using the polluted air flowing from the piggery as a source of heat.

Analysis and laboratory experiments of various materials in order to clear up their suitability for making heat exchangers, showed that at the 60-80% moisture of air the intensity of the heat transfer through the wall made from hollow structure polyvinylchloride boards (PVC) sufficient heat transfer was possible. A technical design of such a heat exchanger was drawn up (Patent LV 13559 B). An experimental specimen of the heat exchanger and a factory-made heat exchanger WVT-120K (Germany) with surface areas 100 and 50 m^2, respectively, were tested under production conditions in a piggery with 500 fattening pigs. Figure 3 shows temperature variations of the flows of air and the capacity of the heat exchanger when the outdoor air temperature falls during the night

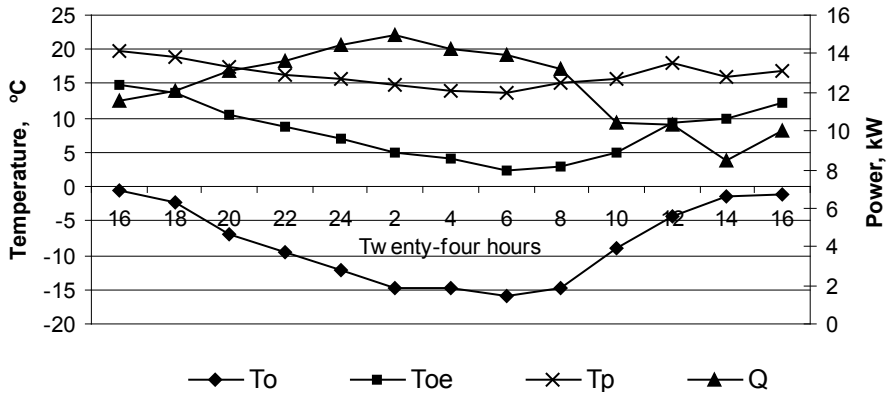

Fig. 3. The temperature variations of the air flows and the efficiency of the heat exchanger when the temperature of the outdoor air falls during the night hours: To – the outside air temperature, ºC; Toe – the inflow air ending temperature, ºC; Tp – the temperature in the pigsty, ºC; Q – the power of the recovered heat energy, kW.

hours. Depending on the outdoor air temperature, it would be purposeful to use 45-75% of the retrieved heat (Илстерс и др., 2007).

In the warm winters of the recent years when the mean temperature of 3 months was positive there was no heat deficit in the piggeries. Under such weather conditions, the heat retrieved by means of a heat exchanger with a temperature of 15 °C cannot be used in a direct way. At the same time, the energy resources are consumed to produce heat with a higher temperature.

In order to use the heat retrieved by heat exchangers more efficiently, a project is worked out about directing the heat warmed up in the heat exchanger to the evaporator of the outdoor air heat pump thus achieving a higher transformation coefficient of the heat pump (coefficient of performance – COP), which is essential when the heat pump is operated in the winter period (Patent LV 13726 B). An outdoor air heat pump Octopus IS 81 (Sweden) has been purchased and installed in a piggery with 96 farrowing pens to test the efficiency of the project under the conditions of production. Its rated power of heat is 17 kW at the driving power of the compressor 5 kW. The purchase of the heat pump and its operation, which started under production conditions in the piggery, is a foundation for further investigations into the acquisition of the sources of alternative energy for the needs of agricultural production.

The use of the energy of solar radiation

The common (classical) flat plate collectors of solar energy are built in such a way that the sun heats only one side of the collector absorber which faces the sun. The other side is covered with the heat insulation. In the period of several years, collectors have been created that follow the direction of the sun (Patents LV13371; 13516; 13549; 13696; 13711; 13712; 13713), including such in which, using mirrors, both sides of the flat plate collector absorber are radiated.

To specify the data about what part of the solar energy is used by the stationary collector and the collector which follows the direction of the sun, a mobile recording device MD-4 was worked out and made for the measurement of meteorological parameters. It contains two piranometer thermal batteries, one of which is placed in a stationary position but the other follows the sun so that the surface receiving its rays of heat is always directed perpendicularly to direction of the falling rays of the sun. Using this device for three years (2005-2007), from the 1st of March till the 1st of November, the air temperature, relative moisture and the power of the solar radiation were recorded at every 12 minute intervals (Fig. 4). The three-year average indices are the following:

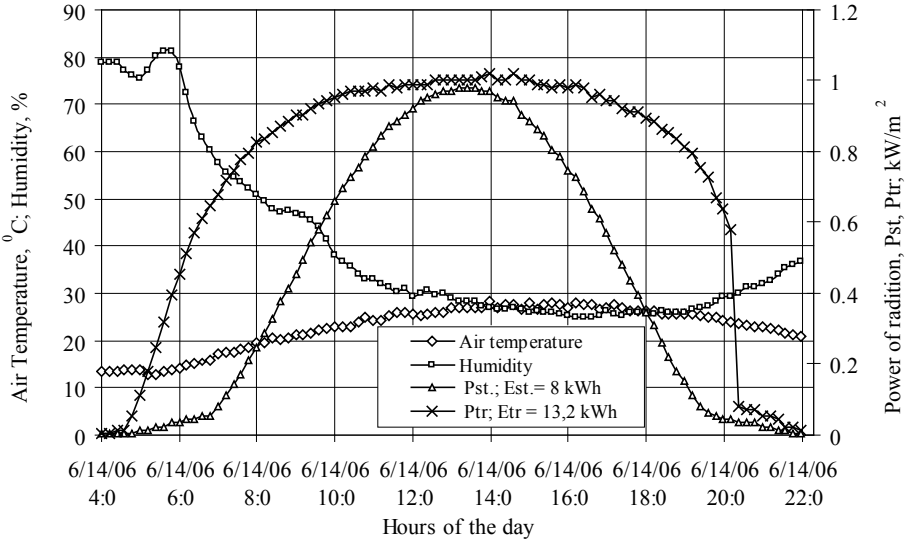

Fig. 4. The air temperature, humidity, and the power of solar radiation.

the average daily temperature – 13.7 ºC; the amount of the solar radiation energy daily received by the stationary to the south oriented surface – 1096 kWh m^{-2}; and the amount of the solar radiation energy daily received by the surface following the sun – 1538 kWh m^{-2}.

The results show that during the data recording season, the surface, which followed the sun, has received on average 1.4, but in the middle of summer – 1.65 times more thermal energy than the stationary southward oriented surface.

In contrast to the stationary collectors, the collectors which follow the sun have several advantages (Ziemelis, Kancevica, 2005). In the middle of summer, at about 6 o'clock in the morning, the rotary collector has already received 50% of the maximum radiation power. During the day, the collector, which follows the sun, uses the energy of solar radiation completely. Considering these positive features, as perspective can be regarded the work at the improvement of the design of the collector, which follows the sun, with an aim to create a compact individual water heater using solar radiation as a source of energy.

The use of biomass

The use of energetic wood is perspective. The main crops are osiers, willows, aspen trees, poplars, and reeds. The wood biomass is formed in a cycle of 2-4 years. The average growth of the biomass dry matter is about 10 t ha^{-1} a year. Also the dry matter of grasses can reach even 10 t ha^{-1} a year. According to the results of research conducted at the Institute and the calculations, from 1 t of the green mass it is possible to obtain approximately 200 kg of granules, 15-20 m^3 of biogas, and 0.6-0.7 m^3 of liquid organic fertilisers. Consequently, from 1 ha of the grassland area it is possible to obtain 40.3 MWh of energy carriers – granules and biogas (36 MWh and 4.3 MWh, respectively). Prospects are estimated for the use of solar radiation in the drying process of granules. An industrially built hothouse with a two-fold film cover should be regarded as economically most profitable. Such a hothouse can accommodate equipment for the production of granules (Зиемелис и др., 2008).

Direction of the further work

The research work is in progress at the combined supply of heat using the sources of renewable energy: biomass, the energy of the sun and the wind, heat pumps, heat exchangers, heat accumulation, and so on.

Conclusions

The strategic development plan of the Research Institute of Agricultural Machinery sets the directions for its further activity: studies in the technologies and equipment of competitive renewable energy resources replacing the fossil fuel; improvement of field crop growing technologies that are efficient in production, ecologically safe and safe resources for biological and conventional agriculture with the use of GPS technologies; participation in strengthening the intellectual potential of the nation by evolving engineering sciences and taking part in the implementation of national and international projects. As a result of the realisation of the strategic plan, the Institute is to be transformed into an internationally acknowledged research centre in the directions mentioned above.

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Research Institute of Agriculture: Scientific Activities of Last Decades 1990-2009

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Research Institute of Agriculture

Abstract. Latvia University of Agriculture Agency "Research Institute of Agriculture" in Skrīveri is the only place in Latvia where breeding of perennial grasses (both for conventional and organic agriculture needs) is performed, and cold resistant, productive and illness-resistant perennial varieties are introduced. In the course of recent years, producers have been offered new varieties of tetraploide red clover and alsike clover, and perennial grasses as well. The Institute scientists are engaged in production of selective perennial grass seeds; they uphold and study collection of genetic resources, arrange expeditions with the aim to collect the gene pool, and carry out economic evaluation of varieties, and check them, both within conventional and organic agriculture, assess difference, uniformity and stability among cultivated plants that will be included into the European Catalogue. The trial fields of Research Institute of Agriculture offer many practical ideas and ascertain the correct implementation of theory into the conditions of production: however, the Institute runs 117 ha of state land of which 43 ha are certified for the organic agriculture, in addition taking on lease 50-60 ha more.
Key words: Research Institute of Agriculture, breeding of perennial grasses, development.

Introduction

The history wheel relentlessly goes round changing generations and leaving behind numerous historic events, national changes, and completed and uncompleted works. The last, nearly twenty years have brought many changes both into national and the Agricultural Institute's life.

The principal activity directions of the Agricultural Research Institute during last 20 years were:

- scientific activities dealing with fundamental and constructive research within the field of agricultural sciences;
- selection of perennial grasses, the variety sustaining seed farming, and sale of variety seeds;
- maintenance of the national genetic resources, annually organizing expeditions and gathering perennial grasses of natural varieties, offering the collected material to the Latvian Gene Bank, and making research and describing these varieties;
- participation in educational work within higher education and doctoral study programs organized by the LLU Faculty of Agriculture;
- farmer, consultant and other agricultural specialist training, popularisation of scientific conclusions and research results;
- organic farming;
- offering the laboratorial and advisory service.

During this period we have entered the new 21st century. Slowly and implacable a new scientist generation replaces the old one lifting on the top new men who think progressively according to modern demands. New information technologies, mechanization, plant growing and selection methods enter our life and alter our thinking. Only crops remain the same, we grow them in order to bake our daily bread, to put something into the feed bunks of our cattle, to get milk.

Thanks to the reinstatement of independent Latvia and transition from a centralized management system to a market orientated economy, the state funds to research institutes have rapidly diminished, the land and production equipment were privatised implacably leading to narrowing of research work and decrease of scientist staff. During the years 1986- 1996 from the Institute lost Selection and Experimental stations, the housing facilities and public utilities went to the municipality, and more than three times has decreased the number of the Institute staff. The ten years brought to the Agricultural Institute quantitative changes and were concluded by the 50th anniversary of the Institute in 1996.

In connection with the anniversary we carried out a fundamental summarization of the 50-year scientific work of our Institute, and a book "50 years of research at the Latvian research Institute of Agriculture "Agra"" reflected this. Great work was performed, but the minds of our scientists and workers were preoccupied with concerned thoughts. *The 60th anniversary celebrated, but what about the 60th anniversary, and, if we live up to that day, what is the future of our Institute?*

It became clear that new change-winds blow, and to follow the rapid changes both on the national and agricultural level, our Institute beside quantitative changes had to go through qualitative changes as well.

The ideas of changes had to ripen in every scientist's mind first: if one is not aware of the necessity of changes, it is very hard to implement them. This factor influenced the Institute in a most direct way. According to the Law 'On Scientific Activity', all power of science institutions belong to a general meeting of scientists, and the council which is elected at the meeting. Certain time was needed until each scientist realized that his/her point of view and vote can influence all the essential questions concerning the development of our Institute – selecting the administration, the principal activity directions, the distribution of funds, elaborating the development strategy.

Most of our scientists, at these hard for the Institute times, think not only of the narrow interests of their research projects, but also of our Institute's development, therefore we could adopt many essential decisions permitting to distribute our scarce finances in a most optimal way: both to answer the research needs and to ensure the structures serving to science – procurement department, laboratory and administration.

Speaking about funds we would like to add the following: in the course of the last decade every new year brought to the Institute an empty purse since the actual financial order foresees funds to research projects mostly for one year, and the next year finances are allocated by tender procedures annually. Therefore during the first months of every year (until the first funds are assigned and enlisted) the entire collective has to tighten the belts. It is wonderful that our employees are patriots and have endured. The actually started base of the fund assignation, hopefully, will improve our situation.

Last ten years as heavy as poverty burden seem also our Institute scientists' minds because we have to choose the direction of our development and activities, and assume what legal status of the organization and structure would be the most adequate entering a new millennium.

Taking into account all the scientific experience of our Institute, the work of the past, the material and technical basis, and the good geographical situation as well, the scientist body decided that our Institute must carry on a leading national organization's position in the perennial plant breeding in the future as well, and basing of this, there should be established a regional centre for agricultural research and agricultural education, retaining our legal independence. Our right choice was confirmed by the fact that a system like this exists in all the Scandinavian countries: beside agricultural universities there coexist independent national research centres that collaborate both with higher educational establishments and agricultural consultation centres, agricultural organizations, and various enterprises as well.

Following a nationally approved education and science integration policy the Agricultural Institute was included into the Agricultural Faculty of Latvia University of Agriculture, as a national non-profit enterprise "Skrīveri Science Centre" in 1997. Starting integration, the Institute was to be engaged in study programs of Agricultural University ensuring their students a place for field practice and several study programs. Thinking about student needs our Institute renovated and furnished a dormitory, and restored a laboratory for agrochemical tests. Regrettably, LLU students spent in Skrīveri only two summers (1997-1998) since the field practice was moved to the LLU study and research centre "Vecauce". Involvement of our scientists into the LLU study programs was limited to several Agricultural Institute doctoral research works. Unfortunately, also our proposal to establish a LLU branch in Skrīveri was not heard by the Faculty of Agriculture.

Long-term field experiments play an essential role in understanding the complex interactions of plants, soil, pests and their management effects on sustainable crop production. Research institute of agriculture has three long-term field experiments. The aims of researches in long-term drainage field experiments "Sidrabiņi" (Dr.agr. J. Vigovskis, Mg. A. Jermušs) are to study the influence of perennial fertilizers and liming on yields of field crops and agrochemical parameters of soil and loss of plant nutrient throught drain water. Since 1982, long-term field trials were carried out under

crop succession with long-term grass, grain (rye, tritikale, spring wheat, barley, oat), potatoes and oilseed rape. The efficiency of mineral fertizers and liming on two different perennial grass swards are studied in long-term experiment "Līči" from 1974 to 2009 (Dr.hab.agr. A. Antonijs, Mg.agr. A. Švarta). The complex crop rotation experiments started in 1969 (Dr.agr. A. Lejiņš, Dr. agr. B. Lejiņa) and gradually expanded in time and space reaching five different structures of crop rotations sowings. The proportion of cereals in the crop rotation in different combinations reaches 50-100%, perennial grass – 16.5-33.3%.

However, involvement of Agricultural Institute scientists in educational processes goes on, thanks to close collaboration with Latvian Rural advisory and training centre (LRATC) Our scientists participate in farmer training organized by CEBC district offices, nearly everywhere in Latvia. The total number of lecture hours exceeds several hundreds, but total number of the audience counts several thousands.

Following the national agricultural development trends the Agricultural Institute during eight years introduced a few new directions of scientific work. PhD student of Latvia University of Agriculture A. Anševica started field experiments "The yield increasing of annual legumes in the green agriculture" in 2007. Dr.agr. L. Borovko investigated the influence of nitrogen and potassium fertilization and the use of growth regulators on yield and seed quality of spring oilseed rape in Latvia conditions (2005-2009), application of biological preparations in spring rape fields under ecological conditions (2006-2009).

Considering that the actual national control system of the field crop varieties will be reorganized, we decided to take part at the competition: to gain rights to control the field crop economical characteristics in Central Latvia region; we won. More than eight years here, in Skrīveri, we test the newest varieties meeting the needs of both the conventional and organic farming (Dr.agr. J. Vigovskis, Dr.agr. L. Agafova, Mgr. A. Švarta, Mgr. A. Jermušs) Tests on field crop varieties are a good basis for farmer summer seminars providing much valuable information to our scientists as well.

Interest in the organic farming recently in Latvia has increased; therefore we, on our own initiative, started research on the organic farming in 2003 (Dr.agr. J. Vigovskis) and formation of material basis for growing seeds, and simultaneously started new research "The providing of plant nutrient and weed limiting for barley in the organic agriculture" (Dr.agr. J. Vigovskis, Mgr. agr. A. Švarta). And it turned out that our initiative hit the jackpot: research on the biological agriculture, the demonstration and the seed growing roused really high interest both in farmers and agricultural specialists, and foreign scientists. We hope that developing and improving this research basis, Skrīveri can turn into a regional scientific and education centre in the field of organic farming.

LLU agency "Research Institute of Agriculture" in Skrīveri is the only place in Latvia where nowadays is performed the breeding of perennial *Papilionaceous* and *Culmifeour* plants and created cold resistant, productive, disease resistant and perennial varieties (Dr.agr. B. Jansone, Dr.agr. P. Bērziņš, Mgr. S. Būmane, Mgr. S. Rancāne, agronomist V. Stesele). In the course of the last years producers were offered new varieties: thimothy 'Varis' (2009), 'Teicis' (2008), red clover 'Skrīveru tetra' (registered in Lithuania in 2007), meadow fescue 'Silva' (2006), red clover 'Kaive' (2005), tetraploide red clover 'Ārija' (2004), buckwheat 'Aiva'. Our newest grass varieties are included into the variety catalogue of European countries rousing interest in scientists and seed breeders of several European countries, Canada and USA.

Research institute of agriculture is

- holder of breeders' right and maintainer of variety for varieties: red clover 'Skrīveru agrais', , 'Dīvaja', 'Skrīveru tetra', 'Ārija', 'Kaive', 'Jancis', 'Marita', 'Sandis', alsike clover 'Fricis', 'Menta', lucerne 'Skrīveru', 'Rasa', thimothy 'Teicis', 'Varis', perennial ryegrass 'Spīdola', meadow fescue 'Patra', 'Silva', 'Vaira', hybrid ryegrass 'Saikava', and buckwheat 'Aiva';
- maintainer of varieties: red clover 'Stendes vēlais' and 'Skrīveru agrais', cocksfoot 'Priekuļu 30'.

Our scientists established a wide collaborative net both nationally and internationally. Especially close contacts the Institute enjoys with our colleagues from Lithuanian Agricultural Institute in Dotnuva and Estonian Selection Institute in Jõgeva. On the regular basis we exchange various information and the seed source material, and meet at conferences and seminars. We have developed a friendly collaboration with Estonian

and Lithuanian breeders in the sphere of the usage of genetic resources. For this reason, two international expeditions have been arranged, where the researchers from all Baltic States have taken part.

Our *Papilionaceous* and *Culmiferous* varieties are tested in Czech Republic, Slovakia, Germany, Norway, Canada, the USA, Belarus and other countries.

A special activity field of our Institute is farmer and agricultural specialist training. During wintertime we arrange seminars and conferences on the seed farming of field crops, the newest varieties, growing technologies, biological agriculture; in summers – country-days and seminars on related themes. The events have gained popularity, are highly estimated and have grown into tradition. Our scientists and specialists, for their part, are often invited to read lectures throughout entire Latvia gathering, on average, 50 interested persons.

The scientists of research institute of Agriculture monitor master and doctoral research of students involved in our research work: Mg. agr. A. Jermušs "The optimisation of nitrogen fertilizers in spring wheat in two kinds of soil texture after different previous crop" (supervisor Dr. agr. J. Vigovskis). The Institute has gained the status of study practice place.

Our scientists every year attend international conferences and seminars offering 13-15 presentations, representing our country and introducing to representatives of other countries results of our scientific work. Both the experienced and new doctoral students attended international conferences in France, Bulgaria, Ireland, Spain, China, and Poland.

For national conferences and seminars our Institute offers 20-25 presentations. During last five years our scientists have written 3 books; the research results are reflected by 46 international and 90 local publications.

It is already our tradition to take part at various exhibitions. On a regular basis we introduce research results and new varieties to Latvian countrymen at agricultural exhibitions in Vecauce, Viļāni and Priekuļi, and these events are abundantly attended. We have participated also at Ķīpsala exhibitions "Regional development in Latvia 2006" organized by Latvian Development Agency and have received many positive references and acknowledgements. We try hard not to disregard minor events and use every opportunity to tell about ourselves, the direction of our activities, and new varieties and technologies.

Conclusion

The Institute team looks hopefully into future. We hope that by our 70th anniversary we shall have a modern centre of perennial grass selection in Skrīveri and seed production corresponding to the EU requests, ensuring the seed quality and the preservation of variety's identity both in conventional and biological agriculture. Our Institute should be a scientific research centre oriented to research serving to production of the biological agriculture and selection of perennial grasses, and offering advisory service, dealing with preservation of seed varieties and maintaining the field plants and genetic resources.

We hopefully look forward to such opportunities:

- introduction of new scientific work directions (biological agricultural projects, international projects in various agricultural fields etc.);
- long-term collaboration with LLU and regional higher education establishments within various adult education and lifelong learning projects on a district and national levels;
- participation in monitoring of doctoral and master study papers, arranging the student field practice;
- significant regeneration of the actual material and technical basis, more effective use in order to start various business activities.

We hope that the Agricultural Institute, in perspective, will be a many-sided scientific technologic centre concentrating science, production and sale – the educational and consultative centre.

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Development of the Research and Study Farm "Vecauce"

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Research and Study farm "Vecauce"

Abstract. The paper deals with the development of the Research and Study farm (RSF) "Vecauce" of the Latvia University of Agriculture (LLU), the last 20 years in particular (1990-2009). Since its foundation in 1921, the farm has been continuously in operation. After the 2nd World War, the well-developed farm was totally destroyed but thanks to the efforts of its staff it was renovated and high results were achieved in production and research. In 1967, the field research at "Vecauce" was interrupted because of the foundation of the research farm "Jelgava", which was situated closer to the LLU. After regaining the sovereignty of Latvia, "Vecauce" was not privatized owing to the efforts of the farm and LLU staff. In 1998, the "Law about RSF "Vecauce" of Latvia University of Agriculture" was passed by the Parliament of Latvia providing conditions for further development of the farm as a research and study base for all levels of students and staff of the LLU, and protecting the farm against privatization. The paper also covers development of the study subject "Practical Agriculture" which is realized at "Vecauce". The research directions in animal science, veterinary medicine, and farm mechanization are briefly analyzed. The conditions of the renovation of field research at "Vecauce" in 1993 are discussed, and the subsequent wide broadening of field research topics is analyzed. The importance of the agricultural exhibition at "Vecauce" (since 1995) and scientific-practical seminar "Harvest Feast at "Vecauce"" (since 2001) is described. A conclusion is drawn that the development of the RSF "Vecauce" provides further challenges for student and farmer training as well as for research diversity.
Key words: legal status, agricultural production, research work, training of students, "Vecauce" exhibition.

Introduction

The Faculty of Agriculture of the Latvia High School (later University of Latvia) was certain about the necessity for a research and study farm since the first days of its foundation. For that purpose, in 1921, after including all the land of estates in the State Land Stock, as the most suitable was recognised Vecauce. It was located side by side with town Auce and only 1.5 km from the railway station. The founder of the Research and Study farm "Vecauce" and its 1st director was the outstanding scientist, professor J. Bergs. The total area of the farm before the 2nd World War was 388.8 ha. Despite the necessity to purchase seed and equipment and renovate the farm, which was destroyed during the First World War, active research was started immediately after its foundation.

At the RSF "Vecauce", during first five years of its operation, scientific and training laboratories were established and equipped. Research was possible mainly in crop cultivation, beekeeping, fish farming, and agricultural management; also some pig and cattle feeding experiments were done. Testing of landraces and local varieties of a wide range of field crops, such as barley, rye, oat, potato, fodder and sugar beet, cabbage, Swedish turnip, carrots, red clover, orchard grass, tobacco plants, yellow lupine, etc., was started. In parallel, research on seeding rates, planting and cultivation operations (for instance, weed control), fertilizing and soil liming was done. Breeding of wheat, rye, and oat was carried out, which resulted in three new varieties: 'Vecauces skujiņauzas' (in Engl. 'Needle Oat of Vecauce'), 'Vecauces vienpusauzas' (in Engl. 'Single Side Oat of Vecauce'), and 'Vecauces rudzi' (in Engl. 'Rye of Vecauce'). The research results were reflected in the diploma works of students as well as in papers written by the teaching staff. The RSF "Vecauce" also took part in agricultural exhibitions, where it received awards and medals for its achievements (Bergs, 1926).

During the next 13 years (1926-1939), training and research work was activated. Students did their practical training in crop production from spring till autumn – they had to accomplish individual tasks in crop growing and study peculiarities of crop development. The research field then occupied 12 ha and was organized into eight smaller crop rotation fields, but the other farmland was used for crop production. Very different topics were investigated for the diploma works, only few examples: "Biology of

rye flowering" (student R. Eidemanis, 1935), "Fertilizing effect on yield and its chemical composition of different barley varieties" (student F. Villa, 1927), "Studies on field research methodology" (student O. Eiduks, 1933), "Investigations on meadow fescue seed production manner" (student J. Būmerts, 1937).

The teaching staff of the Crop Production Department studied field crop varieties within their research and afterwards advised farmers the best varieties. Also planting and harvesting time, first-stage processing of the yield (drying and cleaning), forage production for animals, different cultivation methods, and seed production was studied (Dermanis, 1940). In addition to the rich range of field crops investigated during the first years after establishment of the farm, later several other crops were studied: maize (a high fresh yield of whole plant of 50 t ha^{-1} was obtained), millet for hay (recognized as worse if compared with locally suitable legumes), buckwheat (should be sown at the end of May), beans (most suitable varieties were ascertained; fertilizing with N proved to be ineffective), mustard (high N demand; good for green forage; best type – white mustard), rape and turnip rape (risky crop due to low winterhardiness), poppies (varieties; N fertilizing; opium output), sunflower (good as silage crop; different N demand when grown for seed or for silage; some breeding work), caraway (increase in N rate increases also the seed yield), flax (more suitable varieties were detected and early sowing was recommended), hemp (fertilization with N is important; sowing in rows is better if compared with diffuse sowing), matricary (yield of flowers increased with increased N fertilizer rate; higher content of essential oils was noted during the first part of summer), valerian (autumn was recognized as the best time for planting, October – best time for harvest; rich N fertilization is needed), and peppermint (N fertilization; content of essential oils; stimulation of winterhardiness by compost top dressing in autumn) (Dermanis, 1940). Vulnerary plants were grown at "Vecauce" from the 1930s, where was the biggest nursery (10 ha) of vulnerary plants in Latvia (Jelgavas Lauksaimniecības …, 1941).

Some data are also found about animal research before the 2nd World War. For instance, the outstanding scientist P. Rizga organized a bee garden and a poultry farm at "Vecauce". He was an advisor of students' diploma works in this field and also made some very important innovations. P. Rizga designed a modern poultry farm building with four sections (later called "the Vecauce-type poultry farm design"): incubation of chickens, keeping of pullets, section for laying hens, and section for feed preparation. Besides, P. Rizga also designed new types of bee-hives, for instance, Auce's upright bee-hive. He organized a honey laboratory and the bee-keeping museum too, and a lot of research and advisory work was done in bee-keeping and poultry farming (Pēteris Rizga …, 1985).

The RSF "Vecauce" developed into a big, many-branched model-farm during the times of the first independent Republic of Latvia.

During the 2nd World War, the farm continued its work. After the war, "Vecauce" was totally destroyed again: all animal sheds, and hay and cereal barns were burned down, fixture equipment was dragged apart, and roofs of dwelling houses were shot up. The fields were ridged by entrenchments. Nevertheless, 25 highly productive Latvian Brown dairy cows and 12 horses were saved by the staff of the farm. Despite the heavy damages, "Vecauce" started its operation again in the spring of 1945.

Just after the war, dairy and pig farming as well as vegetable growing were chosen as the main branches of the farm. Later, in 1946, also sheep breeding was started. Owing to effective farming, renovation of buildings, amelioration of fields and research and innovations were undertaken again. The farm area increased incorporating the surrounding collective farms, and made approximately 1800 ha in 1954.

The main efforts in animal science at that time were connected with breeding and improvement of Latvian Brown dairy cow breed, Latvian White pig breed, and Latvian Dark-headed sheep breed. Research was carried out also into other topics: feeding of animals, keeping methods, pork production, wool production and quality, young stock breeding, etc. The most important task of crop production was forage providing (Rezevska u.c., 1954). The leading research directions were similar to those before the 2nd World War. Besides traditional crops and research directions, less known crops and topics were studied, for instance, senior lecturer A. Valainis studied vernalization of spring and winter crops, docent J. Lucāns studied maize, senior lecturer P. Freimanis – *Taraxacum kok-zaghiz*, senior lecturer M. Ozoliņa – soybeans, and assistant I. Holms – field beans. Research in grasslands was carried out by professor V. Tērauds (the

pastures arranged under his guidance were among the best in Latvia), but root crops were studied by the manager of research field J. Lauva. The political situation required that the researchers unconditionally surrendered to the ideas of T. Lisenko, but honest scientists tried to find the golden mean when reflecting their solutions to scientific problems (Lauksaimniecības zinātne …, 2000).

From 1957 up to the end of 1960s, students from the Faculties of Agronomy and Animal Husbandry were spending one year of their study time at "Vecauce", which included practical training as well as theoretical courses. The total number of field experiments carried out at "Vecauce" for the course and diploma works of students were some thousands. Since these years "Vecauce" is called "Mecca of Agronomists". Unfortunately, after complete formation of the Research and Study Farm "Jelgava" (in 1967), practical training of students as well as research work in field crops was interrupted at the RSF "Vecauce".

Nevertheless, this process did not affect the research in animal husbandry and exemplary farming. From 1960s to 1990, the total land area of the farm made up 2660-2797 ha, including 2323-2390 ha of agricultural land. A high average field crop productivity, which was high for those times, was obtained: cereals – 3.5-4.0 t ha^{-1}, potato – 19.0-25.0 t ha^{-1}, forage root-crops – 49.7-59.6 t ha^{-1}, and hay 5.1-6.0 t ha^{-1}. In 1961 the farm was acknowledged as a specialized certified seed grower (including maintenance breeding) for cereals (barley, later also winter wheat), peas, wetch, and potato (Vecauce …, 1981).

A lot of self-made innovations for practical farming were made by the farm staff, for instance, equipment for preparation of liquid N fertilizer, a 12-m-wide cultivator for high-capacity tractor K-700, a special bar sprayer for pesticides and liquid fertilizers, equipment for mechanization of field work in orchard, a hay drying facility, etc. Up to 1990, several new farm buildings for dairy cows, calves and pigs, a new grain drying and cleaning facility, a specific drying and cleaning facility for the seed of grasses and legumes, a mechanical workshop, facilities for storage of potato and fruits, a woodworkers' workshop, a vegetable and fruit cannery, apartment houses for farm staff, etc., were built. People from different parts of the former Soviet Union arrived there to learn. "Vecauce" received the breeder's certificates for breeding three new Latvian Brown dairy cow lines (BL-1 in 1979, BL-2 in 1981, and BL-3 in 1985). The average milk yield reached more than 5000 kg per cow per year at the end of the 1980s. Successful was also pig breeding work with Latvian White and Large White breeds, which resulted in development of several high-quality boar lines. As to sheep breeding, the wool quality of the Latvian Dark-headed sheep was exceptionally improved by crossbreeding with Argentina Corriedale sheep, and a new sheep line was established with ram Varis born at "Vecauce". In 1988, the total number of livestock included: cattle – 1843 (of which 670 were dairy cows), pigs – 1914, sheep – 250, and bee families – 60. Up to 1980, the farm had also poultry – 1000-2000 heads, mainly laying hens.

Such very strong, long-time traditions, necessity for students' practice, and scientific work of students and teaching staff as well as good results achieved in farming were the reasons why the farm was not privatized after regaining independence of Latvia in 1990.

The aim of the paper is to describe in detail the development and activities of the Research and Study farm "Vecauce" of the Latvia University of Agriculture in the independent Republic of Latvia during the last twenty years – from1990 to 2009.

Legal Status of the RSF "Vecauce", Specific Regulatory Documents Concerning the Farm, and the Main Tasks of "Vecauce" Nowadays

Starting from 1991 several regulatory documents were adopted concerning existence of the farm "Vecauce". In June 1991, the Supreme Council of the Republic of Latvia made a resolution about privatization of agricultural collective and state farms, and collective farms of fishermen. In December of the same year, a list of exceptional enterprises was published and "Vecauce" was included into this list. The resolution determined that the RSF "Vecauce" is not being privatized at the moment; the process, terms and peculiarities of its privatization must be set by a special decision. Consequently, part of the land was given back to its previous owners on 1 September 1997, and part was bought out from the previous owners by the Ministry of Agriculture of Latvia and further delivered over to LLU for management of the farm. It was very important to protect the farm against total privatisation. Owing to joint efforts of the farm staff and leaders of LLU

it was achieved that the Parliament of Latvia passed a special "Law about RSF "Vecauce" of Latvia University of Agriculture" on 30 October 1998. The main points stated in the Law were:

1) RSF "Vecauce" is the property of LLU and is not subject to privatization;
2) RSF "Vecauce" is the base of training and scientific work for students of all levels – professional, bachelor, master, and doctoral students.

The Rules of the farm stated: "The aim of RSF "Vecauce" of LLU is to secure the scientific, pedagogical and economical activities of Latvia University of Agriculture".

Since its first registration in the Company Register of the Republic of Latvia in 1991, "Vecauce" has changed its name and business type several times: from 1990 to 1999 it was a public enterprise, from 1999 to 2004 – a public, scientific non-profit organization, but since 2004 – a limited liability company. Studies, training and research are the main tasks of the farm nowadays. It should be pointed out that through the years the farm has survived mostly thanks to its own money earned in the production. The first European funds (for instance, SAPARD) were not available for public enterprises. On the basis of the first "Special Purpose Program of "Vecauce" Development 1999-2001" (worked out in accordance with the "Law about RSF "Vecauce" of Latvia University of Agriculture"), the first funding (78 730 LVL) from the state budget for research and study purposes was received in 1999 (Latvijas Lauksaimniecības …, 1998). Later continuations of this program were worked out on a regular basis (Latvijas Lauksaimniecības …, 2004). All the "Special Purpose Programs of "Vecauce"" emphasize three main interrelated directions of the farm work nowadays: 1) many-branched production of agriculture products, 2) teaching and practical training of students, advisory work, and 3) research in agriculture.

Agricultural Production at "Vecauce"

All three main directions of the operation of the RSF "Vecauce" have the same significance. For the teaching of students and advisory work with farmers, modern exemplary production is needed, but problems related to production can be solved by research. Such type of farm as "Vecauce" provides continuous linkage between studies, research, and production.

For its operation the farm has to earn the most amount of money by means of production. At the beginning of the survey period the farm was in good condition. Total land area on 1 September 1997 was 2.6 thousand ha, of which agricultural land was 2.3 thousand ha. High average yields of field crops were obtained in 1990: small grain cereals – 4.3 t ha^{-1}, forage root-crops – 50.0 t ha^{-1}, potato – 22.6 t ha^{-1}, hay – 5.8 t ha^{-1}. Certified seed of winter wheat, spring barley, oat, peas, several varieties of potato, red clover, and timothy was grown. Almost 1000 t of certified cereal seed was sold per year. Maintenance breeding of winter wheat, spring barley, peas, and potato was done. As mentioned above, since 1987, the milk yield per cow per year exceeded the 5000 kg border, and made up 5476 kg per cow in 1990. Milk and meet as well as pedigree cattle of all species were produced on the farm.

The succeeding 10 years were hard for the farm. Equipment and production infrastructure were gradually wearing out. During the first years of the independent Latvia "Vecauce" encountered difficulties in selling the products; usually payment for the products delayed for several months or even longer. At the same time, money was needed to purchase fuel, mineral fertilizers, pesticides, and electricity. Therefore, in 1993, small milk and meat processing plants were established. Nobody knew what kind of products will be needed the next year: one year certified seed was sold with good success, but the next year farmers did not buy it. "Vecauce" has survived inflation, replacement of the Soviet rouble by Latvian rouble (which, in its turn, later was replaced by Latvian Lats), and bankruptcy of the bank "Baltija". During the ten years concentration of production was made, operation of some branches was ceased and of some was changed, the staff number was reduced. In 2000, the pig farm was sold out due to the crisis and unstable situation in pork production in Latvia. In the same year, sheep breeding was interrupted. Glasshouses as a branch were liquidated in 2002; milk and meet processing was ceased in 2003. The years after 1990 were difficult and the staff worked self-denyingly for survival of the farm. Unfortunately, the high level of production decreased and was again reached only in 2004-2005.

As SAPARD funding and similar European funds were not available for public enterprises, "Vecauce" tried to attract investments from different projects in order to improve the material-technical basis of the production. During the last part of the

1990s, owing to the co-operation program with Nordrhein-Westfalen, state subsidies and farm-earned money, several modern agricultural machines were obtained, new cereal drying facility TORNUM was designed and built up, and four different-type milking equipments (Delaval, SAC, Stranko, and Larta-Stranko) were put up.

The land area decreased after 1997 (see the previous section), but at present it is varying from year to year since part of it is rented from the private owners – the total managed land area of the farm constitutes 1.8-1.9 thousand ha, but agricultural land 1.5-1.6 thousand ha. Up to now certified seed production has been maintained at "Vecauce", and during the last years the amount of realised certified cereal seed has increased (Fig. 1). Diversity of grown field crops has decreased due to economical reasons – mainly are grown winter wheat, winter and spring barley, winter oil-seed rape, maize for forage (in 2007-2008 also for biogas), and mixtures of clover or lucerne with timothy for forage. In 2008 the obtained yield for winter wheat was 5.1 t ha^{-1}, for winter barley – 5.7 t ha^{-1}, winter rape – 3.6 t ha^{-1}, and maize for silage – 30 t ha^{-1} of fresh matter yield (the season was too cool and dry for maize growing). Spring cereals (barley and oat) yielded less due to very dry conditions during establishment and tillering. At "Vecauce" there is also an orchard of 50 ha, but part of it is extensive with old big trees and should be renovated. New agriculture machines and tractors for field work have been purchased after the year 2000, but some are still urgently needed (for instance, maize and grass chopper*, manure sprayer, etc.).

New activities have been undertaken in the 21st century. In order to optimize the cereal harvest, feed grain rolling and preservation was done in 2004-2005. In 2005, 775 t of barley grain was rolled. Despite the big pressure from Polish apple and vegetable growers on the Latvian market, 71.3 t of apples were exported to Poland in 2005.

At present only two livestock types are bred at "Vecauce" – dairy and beef cattle. Great job has been accomplished advance the milk production branch. The breeding work, increase in the quality of heifer growing, balanced feed ration, and qualitative milking equipment have favoured increase in the milk yield. As a result, starting from 2004, more than 5000 kg per cow per year are milked again (Fig. 2). A new farm building was designed in 2005, and built up and equipped during 2006-2007. For milking of 120 cows, two milking robots have been assembled, but the rest of the cows are milked in a parallel-type milking hall. Up to now very high-quality milk (low amount of somatic cells and bacteria per 1 ml of milk) has been sold to cooperative "Piena ceļš" (in Engl. "Milk Way").

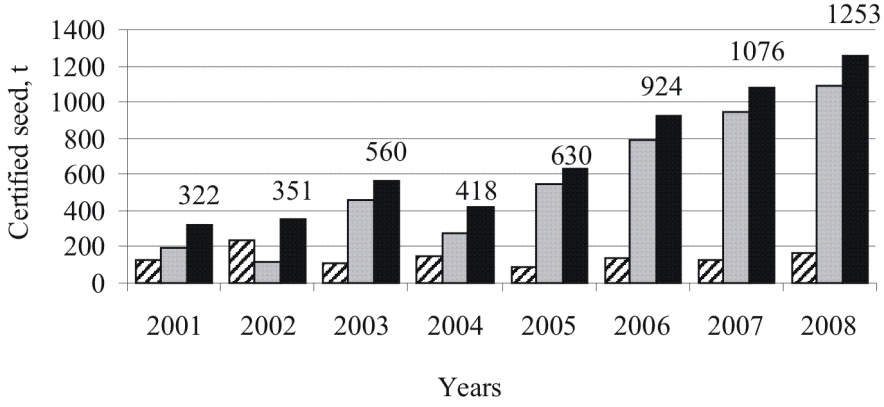

Figure 1. Realised amount of certified cereal seed (2001-2008): ▨ spring cereals, ■ winter cereals, ■ sold certified seed totally per year, t.

* – was purchased after writing the paper in June 2009.

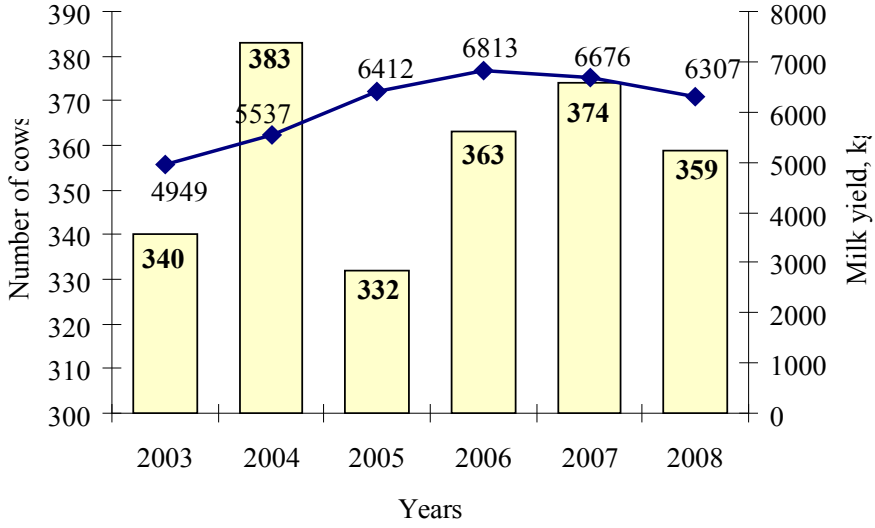

Figure 2. Changes in the average number of cows and milk yield per cow per supervision year (on October 1 of the respective year), 2003-2008: bars – number of cows; line – milk yield.

The beef cattle breeding was started with Hereford breed in 1995. Later also Limousin and Charolais cattle were added to the herd, and now the total number of cattle, depending on a year, is varying from 100 to 120 heads.

The most recent project realised at "Vecauce" was designing and building of the biogas production plant in 2007-2008. This is the first project of biogas production from manure together with plant biomass (silage from maize and other plants) in Latvia. Three biogas plants that use organic waste are operating now in Latvia, but in future the greatest potential of biogas production is related to agricultural sector: from 13 million m^3 of the biogas produced in 2011, about 64% will be produced using substrates from agriculture. The biogas produced at "Vecauce" is used for electricity co-generation; the planned capacity of the plant was achieved in March 2009.

The RSF "Vecauce" nowadays is a unique centre for studies and research, and is characterised by a great diversity of soils and relief. It is a many-branched farm where plant production with specialisation in seed multiplication and forage production occupies a stable place, but the main specialization in animal husbandry is milk production and beef cattle breeding. The new project – biogas production and electricity co-generation – was launched in 2008.

The farm "Vecauce", like Riga, is never finished. New plans, connected with increase in the biogas production capacity and improvement of the dairy farm with a room for veterinary services, already occupy the minds of the farm staff.

During this period, directors of the RSF "Vecauce" have been agricultural engineer L. Teteris (1986-2003), economist A. Aizsilnieks (2003-2008), and starting from May 2008 agronomist I. Grudovska. As head agronomists have worked D. Upmacis, I. Zaika, and A. Čapus, but as head zootechnicians – I. Brahmane, I. Klovāne, I. Eihvalde, and E. Guša.

Teaching and Practical Training of Students at "Vecauce"

The period from 1990 to 1998 was characterized only by students' practical training and practical work in the fields and farms. Get-together meetings of agronomists took place at "Vecauce" on a regular basis at that time. Constantly there were discussions about the role of the practical training of the new agronomists and other professionals who are engaged in agriculture or have some work in the countryside. The leaders of "Vecauce" considered teaching of students in real production conditions as vitally important, which was greatly supported by LLU rector V. Strīķis and vice rectors P. Bušmanis and

E. Bērziņš. As a result, completely new activities at "Vecauce" started in 1998 when the study course "Practical Agriculture" in the amount of 1 credit point was included into the 1st-year curricula of all faculties, and the course was accomplished at "Vecauce". The Training centre "Vecauce" was established under the guidance of the vice director, docent Dr.agr. I. Rūvalds who administered the centre and the study course "Practical Agriculture" until his sudden death on 22 September 2008. The aim of the study course until now is to introduce students to practical farming. "Practical Agriculture" provides insight into:

- operation activities and problems of a many-branched agricultural enterprise;
- technological processes of production;
- interrelation of different production branches;
- interrelation between one agriculture production enterprise ("Vecauce") and another;
- prosaic side of the rural life in general.

The course "Practical Agriculture" also helps students, who have chosen LLU for their studies and have arrived from villages, towns or Riga, comprehend what is agriculture, what and why people are doing in the countryside. Students are taught to be tolerant towards agriculture and to understand that the borderline of Latvia does not coincide with the borderline of Riga or any other town. During ten academic years, from 679 (in 2004/2005) to 928 (in 2002/2003) students per year have been studying this study course (Fig. 3). The number of students does not depend on the work of the Training centre, but on matriculation at LLU and on the quality of students – the number of students is dependent on university dropouts during the 1st year.

For one week the work is divided into lectures (in an auditorium of the Training centre) and practical training in specific production facilities: cattle-sheds, fields (during the season), cereal drying, cleaning and prepacking facility, orchard (during the season), fruit storage, mechanical workshop, woodworkers' workshop, Vecauce Palace, bookkeepers office, etc. The program was worked out in 1998 and till today is being improved and developed depending on the needs of the faculties and the changes going on at "Vecauce". In 1998, the study course had 14 sections and still has the same amount of sections (with minor changes in the 2008/2009 academic year). The content

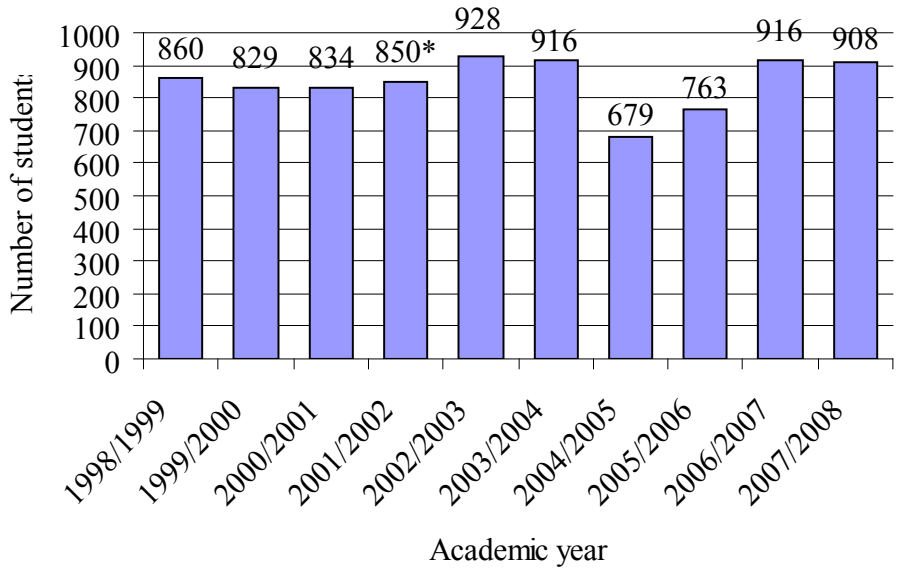

Figure 3. The number of students who studied "Practical Agriculture" at "Vecauce" during academic years from 1998/1999 to 2007/2008 (* – approximate number; the exact number of students in the 2001/2002 academic year is lost).

of separate sections within the possible limits is coordinated with the specific needs of each faculty. A one-week job concludes with a written report and a seminar covering the main topics learnt during the week. The teaching staff consists mainly of the farm professionals; the LLU teaching staff only rarely is engaged in delivering the study course "Practical Agriculture".

At the end of the week, 100% of the students fill in a questionnaire about the content and teaching manner of the course and the household conditions at "Vecauce". Estimation is made by a three-rank order: good, satisfied, and unsatisfied. Almost invariably the answer of more than 50% of students is "good", but hardly ever "unsatisfied". It is possible that after years, when more knowledge and life experience is gained, students change their initial opinion. In 2003, a study was carried out by Mg.agr. J. Kopmanis to clarify the opinion of senior students about the study course "Practical Agriculture". Students from the Faculties of Agriculture, Economics, Social Science, and Rural Engineering (totally 108 students, i.e. 6-32% from the group of 3rd or 4th year students) were surveyed. Some examples from this questionnaire can help understand the importance of the study course:

- Have the things and processes seen at "Vecauce" helped to form your comprehension about agriculture? Yes – 80% of respondents;
- Has a week spent at "Vecauce" helped you to better comprehend the further study program in your Faculty? Yes or partly yes – 60-90% of respondents from the Faculties of Agriculture, Economics, and Rural Engineering; and 18% – from the Faculty of Social Science;
- Has a week at "Vecauce" enriched your life experience? Yes – 40-70% of respondents.

In co-operation with the Ministries of Agriculture, and Education and Science, an agreement was made that also practical training of students from agriculture professional schools will be organized at "Vecauce" in order to use the farm potential better. Starting with the academic year of 2004/2005, students from professional schools had their practical training at "Vecauce".

Work with young and inexperienced students differs from that with university students. Therefore special programs were worked out paying the main attention to practical training, but theoretical lectures were delivered in an elementary manner. Much work has yet to be done for simplification of the program. Also professional school students are asked to fill in the questionnaire about the training course at "Vecauce", and the opinions are positive. Unfortunately, in 2009, due to the economic crisis, the existence of some professional schools is doubtful and such are also training possibilities for professional school students at "Vecauce" in future.

During the ten years of the operation of the Training centre, not only study programs were advanced, but also household conditions were improved according to the financial possibilities and students' needs. The computer class with the Internet connection was the main acquisition.

In addition to "Practical Agriculture", the Faculties of Agriculture, Veterinary Medicine, and Rural Engineering realize field practices at "Vecauce" also in other study courses. Besides, at "Vecauce" several students do their long practical training course (couple of months) which is required for obtaining a professional diploma. The quality of any practical training completed at "Vecauce" is highly appreciated.

Agriculture Exhibition at "Vecauce"

The first regional agricultural exhibition at "Vecauce" was organized in the post-Soviet Latvia in 1995. Since that time, regional agricultural exhibitions have taken place at "Vecauce" on regular basis – from 1995 to 2001 annually, but hereafter – once per three years (in 2004 and 2007). Approximately 80 participants offering products from Latvia, Sweden, Norway, Finland, Denmark, Germany, Belorussia, Russia, Poland and other countries have participated in the exhibitions. The offered products have included: machinery and equipment for crop production, equipment for cattle-sheds, feeding sources and supplements, agrochemicals, preparations of veterinary medicine, agriculture products' processing goods, spare parts for different kinds of equipment, seed and planting material for field and garden crops. Animal show, ploughing competition, demonstrations of different kinds of machinery (for crop production as well as animal husbandry) in production conditions, seminars, and advisory work have always been a part of the exhibition. In each exhibition a large number of demonstrated animals is

from the "Vecauce" herd; however, as since the year 2000 the farm has only dairy and beef cattle, the best animals of all other species are found by pedigree cattle breeding associations throughout Latvia. Field trials and demonstrations are inspected during the exhibition, and some advisory work is accomplished directly on the field.

The organizers of the exhibition are the "Vecauce" staff together with LLU and the Ministry of Agriculture. During the exhibitions, farmers have a possibility to meet the minister of agriculture and discuss the further development directions of agriculture in Latvia and in connection with common agricultural policy of Europe. The LLU staff participates in the organization of seminars, field demonstrations of machinery, and ploughmen's competition. The exhibition is financed mainly by the Ministry of Agriculture from the state subsidies, but some of the funds are always allocated by "Vecauce" and LLU.

In the last exhibition (in 2007), together with the Young Farmers Club of Latvia, an extensive program was organized for the new generation of farmers (students from secondary-level agriculture schools). Something new is always invented to make the exhibition more interesting and educational for the farmers and rural inhabitants.

"Agricultural Exhibition at "Vecauce"" is a traditional event during full bloom of a summer, where not only farmers, but everybody can find something of interest – young people can learn more about agriculture, and families with children can simply rest from their daily routine. At the same time, a lot of job is done – some contracts made, advice received, partners and friends met, and new directions of agriculture development discussed.

Main Directions of the Research Work Performed at "Vecauce" in 1990-2009

The RSF "Vecauce" is not a scientific institution, but a research base for all levels of students (bachelor, master, and doctoral) and staff of LLU. From 1990 to 1998 there were no researchers with a doctor's degree employed at "Vecauce", but in 1988 two researchers with a Dr.agr. degree were taken on: vice director responsible for teaching work, Dr.agr. I. Rūvalds with specialization in animal husbandry, and vice director responsible for research work, Dr.agr. Z. Gaile with specialization in crop production. The research has been carried out mostly by LLU scientists or by students under the guidance of their advisors from LLU. As to the technical staff, it has been provided mostly by the farm. Thus, the obtained results and the conclusions derived from them should be described by their authors. Further on are described: main research directions at "Vecauce" during 1990-2009, results of research which were important for the development of the farm or which were carried out by the researchers of the farm, and renewal and development of the research field. It should be pointed out that the possibility of carrying out experimental work in small plots and with experimental animals as well as to demonstrate achievements of agricultural sciences in production conditions is unique to "Vecauce".

Animal Husbandry. Research in animal husbandry has been carried out during all the years since the foundation of the farm owing to the high quality of the "Vecauce" herd of any animal species. Projects in animal science, veterinary medicine and animal farm mechanization have been implemented. "Vecauce" entered the survey period with three animal species: dairy cattle, pigs, and sheep (see above sections "Introduction" and "Agricultural production in "Vecauce"). Important was realization of some parts of the National Project "Improvement of productive animals and poultry breeds bred in Latvia using breeding methods approved in the world"; subtopic "Origination of a new type within dairy cow breed Latvian Brown" was realized using the "Vecauce" herd under supervision of professor J. Sprūžs. Within this project, Dr.agr. Z. Grīslis and L. Žuka studied the possibilities of evaluating the breeding value of Latvian Brown sires in sharply variable environment. The computer package PEST was used and data of the bulls' and cows' breeding value showed independency from environmental conditions, i.e. objective assessment was possible. Dr.habil.agr. L. Cjuk a and Mg.agr. D. Kairi a came to a conclusion that for the improvement of the exterior of Latvian Brown cow (especially the shape of udder) American Swiss is the best, but fat and protein content is higher if breed Angler is used (Latvijā audzējamo …, 1998). The heifers' breeding quality is important for milk yield increase, reproduction ability of cows, and prolongation of the productive life of dairy cows. In detail it was studied by Dr.habil.agr. L. Cjukša. Further the main directions of the research were as follows: improvement of milk yield of

Latvian Brown dairy cow using sires from different breeds, and evaluation of the exterior of cows with different pedigree and the exterior in connection with productivity and resistance of animals. Mg.agr. D. Kairi a and Mg.agr. D. Jonkus found out that for further improvement of the "Vecauce" dairy herd Danish Red sires should be used (Produktīvo dzīvnieku…, 1999).

Pig breeding was studied by Dr.agr. A. Veģe, Dr.agr. M. Jansone, and Mg.agr. Z. Bērziņa at the "Vecauce" pig farm "Pūpoli". Very topical in the 1990s was improvement of pork quality by decrease of backfat thickness of Latvian White (LB) breed pigs. The best result for obtaining F1 sows showed the crossing of Latvian White with German Large White (Deutches Edelschwein) (VD) breed, but for pork improvement mating with Pietrain (P) breed boars was planned (Latvijā audzējamo …, 1998). Pork quality evaluation with ultrasound equipment in live pigs was started at "Vecauce" owing to the efforts of Dr.agr. I. Rūvalds. Later, different crosses were made and pork quality was evaluated. Sometimes crosses of Latvian White breed with two foreign breeds (e.g. (LB×P) ×VD) gave pork with firm, wiry and rough muscle fibre (Produktīvo dzīvnieku…, 1999).

Up to destruction of the sheep herd at "Vecauce", the research on the improvement of Latvian Dark-headed breed using Il-de-France and Texel breeds was carried out by Dr.agr. J. Volgajeva, which improved fertility and precocity of sheep (Produktīvo dzīvnieku…, 1999).

Animal nutrition was studied by three doctoral students (A. Balode, L. Degola, and A. Trūpa) under guidance of Dr.habil.agr. J. Latvietis. Mainly new premixes for animal feeding were evaluated.

Later, in 2000, when work with pigs and sheep was finished at "Vecauce" only two kinds of animals were left for researching: dairy and beef cattle. This and succeeding improvements in animal keeping changed the research directions at the farm. Comparison of different breeds, beef quality improvement using different crosses, and economic efficacy of beef production were studied by bachelor and master students under guidance of Z. Grīslis and D. Kairiša.

When Latvia entered the European Union in 2004, and even before it, new demands for milk and meat quality and animal welfare were set up. Dr.agr. D. Kairiša studied new methods of milk quality assessment, but Mg.agr. D. Jonkus, for obtaining Dr.agr. degree, analysed variability of cow milk productivity characteristics (supervisor Dr.agr. L. Paura). Possibility of studying interesting topics on cow adaptability to changes in the keeping system (transition from tied system to free keeping system), which was provided by the new cattle farm built in 2007, encouraged the researchers to start new projects actively. Most recently (in 2008), I. Muižniece for earning her doctor's degree, under guidance of Dr.agr. D. Kairiša, started a study on comparison of milking technologies (milking by robot and in milking hall) and their influence on milk productivity and quality, and on reproductive ability of a herd. Urgent was the question about finding the milk freezing point. Such study was ordered by the Ministry of Agriculture, and now has been already accomplished, partly also at "Vecauce", by Dr.agr. D. Jonkus.

From the Faculty of Veterinary Medicine, the most active user of the research base at "Vecauce" was assoc. prof. V. Antāne. Before 2000, her research work was mainly connected with fertilization problems of productive animals and reasons for abortions, but later on she studied problems related to udder protection and mastitis. V. Antāne's most recent study, completed in 2008, was on the activity of humoral immunity and its regulation possibilities in udder pathology of dairy cows. As the new dairy farm provides novel challenges also for the researchers of veterinary medicine, Dr.med.vet. V. Antāne is going to start a new project in 2009 about cow udder health and milk quality problems in connection with the use a milking robot. In total, four studies for obtaining Dr.med.vet. have been carried out at "Vecauce", but still none of them has been defended – the authors are diligently preparing for their theses presentation.

At "Vecauce" the staff of the Technical Faculty has studied topics mainly connected with cattle-shed mechanization problems and designing. The work has been particularly activated during the recent years after building the new dairy farm and putting on the latest equipment (milking robot, milking hall, automatic stations for feeding of concentrates). Several bachelor papers and one research work for earning Dr.ing. have been carried out. Also grants of LCS and LLU internal projects on farm mechanization problems important for "Vecauce" have been realized. The supervisor for most of the projects and student research was professor J. Priekulis.

Field Crops and Horticulture. The research into field crops during the last 20 years can be divided into two periods: the first from 1993 to 1998, and the second from 1999 to 2009. Renovation of the research field and first investigations into different forage crops, mainly maize and lucerne from USA, characterize the first period. The second period is characterised by provision and development of the material and technical basis of the research work and by enlargement of the field trials, which was possible owing to mechanization of the most of the field work and later also the laboratory work.

As told above, during the late 1960s, research of field crops was interrupted at "Vecauce", and since that time has been performed mainly at RSF "Jelgava" but later – at "Pēterlauki". After regaining the independence of Latvia, several co-operation programs with different Western countries were launched. The research field was renovated in 1993 thanks to the enthusiasm of the RSF "Vecauce" staff and involvement in the "Co-operation program between Department of Agriculture of USA and Baltic States". Eight varieties of lucerne and twelve maize hybrids (mainly originated in USA) occupying ~400 m^2 were grown on the research field, and all work was done mainly by hands. The "Vecauce" staff were very interested in studying these crops as lucerne and maize were researched and produced on the farm already before the 2nd World War. Lucerne provides animals with cheap protein, but maize – with cheap energy. The responsible for investigations and renovation of the research field was agronomist Z. Gaile together with the staff of the Cereal and Potato Maintenance Breeding Department. Within the co-operation program with the USA Department of Agriculture, Z. Gaile several times visited the USA including also the Wisconsin University in Madison, where she improved her professional skills.

Later also other varieties were included, and the area allocated for trials and demonstrations was enlarged. Main research directions within the program (1993-1997) were suitability of lucerne varieties, their regrowth potential and winterhardiness. The research results showed that winterhardy-enough lucerne varieties bred in North America (USA and Canada) can be grown in Latvia with a success similar to that of local varieties ('Mežotnes' and 'Skrīveru' from Latvia, 'Birute' and 'Žydrune' from Lithuania, and 'Jegeva-118' and 'Karlu' from Estonia). At the same time, the introduced varieties were characterized with good stand persistence, faster regrowth after cuts and in spring, and with higher yield potential if compared with varieties bred in Latvia (Gaile, 2000a; Gaile, Adamovich, 2002). As mainly foreign lucerne varieties are sown in Latvia, winterhardiness of a variety is of high importance. Standard methodology of an accelerated lucerne winterhardiness test (during one winter) was adopted in Latvia. It includes exposure of lucerne plants to strengthened stress during the sowing year (thinned stand, cutting three times including a cut during closed time in September), and afterwards evaluation of the survived plants in the next spring according to a 5-point scale as well as rating comparison with the check varieties. A conclusion was made that the varieties from three most winterhardy groups and in addition also those from the fourth group which showed good results in yield evaluation trials are suitable for Latvia (Gaile, 2003).

Each year several field days and seminars were organized to demonstrate farmers the benefits of lucerne and maize as well as the growing technologies. Several variety demonstrations were arranged along the big roads labelled with posters to attract the interest of farmers. "Vecauce" was among the first farms which used the modern technology for haylage production – big bales wrapped in plastic. This was also the subject for organizing field days and seminars with participation of experts from the USA (one of them was D. Undersander, PhD, the outstanding scientist from the Wisconsin University in Madison).

Another research direction was evaluation of early-maturity maize hybrids and demonstration of a completely new growing manner aimed at prolonging the vegetation period (including late September harvest even after autumn frosts if they occur) and at obtaining the maximum possible dry matter (DM) yield at the soft dough till wax ripeness (DM content – 28-30% or at least 25%) stage. Totally, during five years (1994-1998), 63 different hybrids were tested; their cold tolerance during spring was observed, development during vegetative period was described, proportion of leaves, stems, and corn-cobs in the total yield were evaluated, and, for the first time in Latvia, yield quality was estimated by determining the neutral detergent fibre (NDF) and acid detergent fibre (ADF). The analyses were performed in the Tartu University laboratory (methods for NDF

and ADF analyses were not still adopted in Latvia in that time) (Gaile, 2000b; 2000c; 2000d).

During this period, student research with field crops was not carried out mainly due to lack of special small-scale research equipment for field work mechanization. The first field research work in the independent Latvia for earning the doctor's degree was performed during 1995-1997. Z. Gaile carried out the study "Evaluation of selection criteria for maintenance breeding of spring barley variety 'Klinta'" under supervision of Dr.biol. I. Belicka, and defended it in 1998. The research results showed the main selection criteria for elite plant selection (elite plant model was developed) and for selection in the nurseries of next pedigree generations (phenotype was noted as the main criterion) (Gaile and Belicka, 1998).

The main achievement of this period was renovation of the research field and gaining of assurance that "Vecauce" is a serious player side by side with the research institutions and is recognized by the farmers as a consultancy provider. It should be pointed out that this was acknowledged by foreign partners earlier than by Latvian side.

The second period of field research development started in 1999. The co-operation program with USA Department of Agriculture was completed, and foreign partners from Nordrhein-Westfalen noticed the accurate, hard manual labour by the staff of the research field. Within the frames of a co-operation program (concluded thanks to the efforts of Dr.agr. I. Rūvalds, and Dr. J. Weiss and Mr. P. Michel from Nordrhein-Westfalen), as a donation were received: a plot drill Hege-80 together with tool carrier Hege-75, and a small plot combine Hege-140. Later also other important field and laboratory equipment were obtained thanks to different research and infrastructure projects (especially starting from 2006) as well as co-operation agreements with commercial agriculture supply companies.

Another important event accelerating the development of the research field was "The Law about RSF "Vecauce"" and the funding received for studies and research in connection with this law and on the basis of the first "Special Purpose Program of "Vecauce" Development 1999-2001". It was the first additional money allocated for research purposes which was used according to a special program. As a result, many different-level student researches were carried out, and the number of research topics expanded mainly in connection with the needs and unsolved questions of "Vecauce" or farmers-visitors of the farm. By organizing the field days and seminars on the basis of the research field and together with the staff of the Faculty of Agriculture (most active were professors I. Belicka, I. Turka, D. Lapiņš, A. Bērziņš, M. Ausmane, B. Bankina) and by making use of the results obtained there, the research field gained the status of a reliable partner among the parties interested in field research: Faculty of Agriculture, Advisory Centre in Ozolnieki, farmers, commercial companies. Everything was prepared for the next step – research on the basis of contracts, which started in the year 2007. According to the contract, a customer pays for realization of a definite experiment or, in some cases, only for technical assistance. Thus, funds for research come from the Latvian Council of Sciences (LCS), Ministries of Agriculture, and Science and Education, The Latvian Rural Advisory and Training Centre, the State Plant Protection Service, and commercial agriculture supply companies. If critically needed, some field trials can be arranged for student research work without special financing.

Starting with 1999, the number of research topics and plots in the research field gradually increased. Initially, in 1993, one special field for research was allocated – field "Pils dārzs" (in Engl. "Garden of Palace"), 3.5 ha in area. When the number of studied field crops increased, the trials were arranged in different fields according to the appropriate crop rotation. It was not comfortable neither for the production unit of the farm, nor for the staff of the research field. Starting with 2003, another field was allocated mainly for research purposes – field "Aizaploki" (in Engl. "Behind the Pasture-Ground"), 50 ha in area. Besides, urgent was also research in organic farming conditions. Therefore certification process of a special organic research field (14.67 ha) was started in 2002. At present, the total area of special research fields in "Vecauce" makes 68.17 ha. However, some studies are still performed in big production fields due to the necessity to use farm-scale equipment (for instance, investigations in precision farming, some specific questions of growing technologies).

At the beginning, technical work of the research was performed by the Department of Maintenance Breeding, which step by step was reorganized into a department called "Study and research field". Six to seven full-time employees are engaged in carrying

out the research: vice director for research work (Dr.agr. Z. Gaile – 1998-2009, Mg.agr. O. Balodis – from 1 April 2009), manager of the research field (Z. Gaile – 1993-2000; Mg.agr. J. Kopmanis – 2000-2005; Mg.agr. O. Balodis – 2006-2009; agronomist I. Zaika – from 1 April 2009), technician, and three to four laboratory assistants. For soil tillage and connected jobs, tractor operators of the production unit are hired.

Main research directions during this period were connected with field crop breeding, variety evaluation, investigations into forage crops, soil tillage and sowing technologies, and the Internet-based decision support systems for integrated pest management. Recently research is being performed with crops regarding possibilities of producing alternative energy, and in precision farming.

During the second research period (1999-2009), possibility of using lucerne in pure stand and in mixture with timothy for pastures and for making haylage as well as cutting frequency effect on stand longevity and forage quality were studied. The research showed that foreign lucerne varieties bred nowadays can be used intensively also under Latvia's conditions if cut 3-4 times per season (during five years, a good high-quality yield was obtained). Choice of defoliation times per season depends on fall dormancy rating of a variety and on agro-meteorological conditions of the season (Gaile, Kopmanis, 2004). Growing lucerne in mixture with timothy gave higher yield, but pure lucerne stand provided higher crude protein content. If lucerne is planned to use in pastures, special purpose varieties should be sown (e.g. 'Karlu') (Gaile, Kopmanis, 2006).

Maize was investigated within a co-operation program with the Scientific and Production Farming enterprise "Company "Maize"" from Ukraine. The results confirmed the possibility of obtaining energetically dense silage from maize in Latvian conditions and for the first time showed the importance of the effect of the sowing and harvesting time on the yield amount and quality (Gaile, 2004). Further research on maize sowing and harvesting time was carried out by Dr.agr. Z. Gaile during 2005-2008. The obtained results showed that the best sowing time is the 1st ten-day period of May, and the best harvesting time depends on the maturity of maize – most frequently after 20th September or even in early October (Gaile, 2008b; 2008c). Also fertilization and weed control in maize was studied, and the conclusions were published in popular scientific journals for use of Latvian farmers. The recent studies (since 2008) on maize are connected with its use as a biogas substrate (Gaile, 2008a). These investigations are of high importance for the farm itself as well as for Latvian agriculture in general. A doctoral student under the guidance of Dr.agr. Z. Gaile is attached to these studies. "Vecauce" now is the only place in Latvia where maize is studied in detail.

Starting with 1999, the breeding nurseries of barley and winter wheat managed by Dr.biol. I. Belicka were relocated from the research farm "Pēterlauki" to "Vecauce". I. Belicka carried out a study according to the grant of the LCS, and later – a collaboration project in plant breeding also sponsored by LCS. Within this grant, part of the research "Agro-biological evaluation of hulless barley and its breeding perspective" was carried out by L. Legzdiņa for earning her Dr.agr. degree. The theses were defended in 2003, and the main conclusion was that initiation of a hulless barley breeding program in Latvia is useful. L. Legzdiņa also analysed the yield potential and the main positive and negative traits of hulless barley, and worked out selection criteria and main tasks for the breeding program (Legzdiņa, 2003).

Another group of researchers, which very intensively started research in 1998, was the whole staff of the Field Management Department under leadership of professor D. Lapiņš. Initially, different soil tillage and sowing technologies for spring barley and winter wheat were studied. Four different soil tillage modes were used (traditional mould board ploughing, ploughing very shortly before sowing, ploughing very shortly before sowing together with use of soil under the layer packer, and without ploughing). Also 4-5 different sowing technologies were used per every soil tillage treatment. The researchers found out that direct drilling and minimal soil tillage used in well-cultivated clay loam soils guarantee the same yield level as traditional soil tillage with mould board ploughing and at the same time provide economy of money. Use of soil under the layer packer and local fertilizing together with sowing was effective for winter wheat. Used sowing technology has less effect on high barley yield formation if compared with soil tillage technology and agro-meteorological conditions (Lapiņš et al., 2001). Later, a group of Field Management Department performed another research project connected mainly with soil tillage, sowing manner and weediness effect on cereal yield formation.

Weed control problems were studied for integrated pest management system as well as for organic farming. J. Kopmanis, under guidance of Dr.agr. M. Ausmane, carried out a research on weed control problems for earning his Dr.agr. degree – "Effect of reduced herbicide dosage on weediness of spring barley and on next generation of weeds". The research included investigation of reduced dosage (treatments – control without herbicide use, 1/1, ½, and ¼ from the registered dose) effect on weed control of six widely used herbicides for spring barley. Based on adopted herbicide efficiency for different weed species control, prototypes of "PC-P Weeds" (originally created in Denmark) computer program for Latvia was made, and the next generation of sprayed-with-reduced-herbicide-doses *Chenopodium album* was studied according to possible resistance development (Kopmanis, 2005). In 2004, Dr.agr. M. Ausmane started to study weed control problems in organic crop rotation after certification of the organic research field and establishment of crop rotation. The research demonstrated that crop rotation reasonable in organic farming system is one of tools for weed control thanks to different cultivation technologies that are used for different crops. Crop species diversity and crop diversity according to utilization in rotation can control spread of weed seeds. For *Elytrigia repens*, special agro-technical methods should be used, but annual and biennial weeds can be effectively controlled by harrowing (Ausmane et al., 2007).

Currently investigations of field crop management are carried out in precision farming under guidance of Dr.agr. D. Lapiņš. For this purpose, several production fields are used; the main winter crops investigated are wheat, barley, and oil-seed rape. In the investigations two doctoral students are participating and carrying out their research for earning their Dr.agr. degree.

The researchers from the Plant Protection Department (Dr.habil.agr. I. Turka and Dr.biol. B. Bankina) carried out part of research for the international project "Development and implementation of an Internet-based decision support system for integrated pest management in Latvia", subsections NegFry (connected with *Phytophthora infestans*) and "PC-P Diseases" (connected with winter wheat diseases) (1999-2002). Both models like "PC-P Weeds" were created in Denmark. The main conclusion was that use of the programs can decrease the number of sprayings or the total amount of used pesticides. Within this project, G. Bim teine under guidance of Dr.habil.agr. I. Turka carried out a research with field trials for earning her Dr.agr. degree – "Inventory of *Phytophthora infestans* population and optimisation of computer models for forecasting" (Bim teine, 2005).

Since 2006, oilseed rape including incidence and severity of the diseases has been studied. Particularly attention has been paid to rape *Phoma* stem canker (*Leptosphaeria* ssp.). Development cycle of disease and diagnostics of two agents (*Lepthospaeria maculans* and *L. biglobosa*) in Latvia has been studied (Bankina et al., 2008). The research on disease control of oilseed rape is being continued, and also control of cereal diseases for integrated pest management is currently being studied.

The Department of Plant Biology has not carried out big-scale experiments in "Vecauce". Some demonstrations of the efficiency of nitrogen fixing bacteria use for *Galega orientalis* and lucerne have been performed under guidance of professor V. Klāsens. Demonstrations clearly showed necessity to use nitrogen fixing bacteria, especially for new or seldom grown crops (such as *Galega orientalis*) due to non-being of specific bacteria in soil. Also the Department of Horticulture has not extensively made use of the "Vecauce" orchards for research. Some bachelor studies have been carried out there. For example, a very nice project was realised for the exhibition "Vecauce-2004" – arrangement of a small garden of spices and vulnerary and ornamental plants. The garden is being renovated and rebuilt in 2009.

The Department of Soil Science and Agrochemistry made use of the "Vecauce" facilities infrequently. Three standard profiles of the "Vecauce" soils were described in 2002, and the results of two descriptions were included into the newly published (2009) "Taxonomy of Latvia Soils" (in Latvian "Latvijas augšņu noteicējs") edited by professor A. Kārkliņš. In 2007, Dr.agr. R. Vucāns arranged a couple of field trials in order to develop a new method of phosphorus detection in soils; in 2008, Dr.agr. I. Līpenīte studied use of dairy cow manure as a substrate for biogas production, and use of digested substrate for fertilization of field crops.

Investigation into different topics connected with oilseed rape was started in 2006. The growing manner of winter oilseed rape has been studied by surveying 15 farms in Zemgale. Field trials have been arranged in "Vecauce" for testing the efficiency of foliar

fertilization and the disease control methods (Balodis et al., 2008), and lately also the influence of sowing time and sowing rate on the formation of winter rape yield. The last research theme is included in the study of vice director for research work O. Balodis for earning his Dr.agr. degree under guidance of Dr.agr. Z. Gaile.

These are only some of the researched topics. Besides them, a lot of field crop varieties have been tested in conventional and organic farming system according to the contracts concluded with the seed selling companies and the State Plant Protection Service (Official Test of Value for Cultivation and Use in organic conditions). Also plant pesticides have been tested according to the order of pesticide selling companies. Every year these results are demonstrated during the field days and seminars for farmers at "Vecauce".

Although "Vecauce" provides services for the whole LLU, all research activities are connected mainly with the Technical Faculty and Faculties of Agriculture and Veterinary Medicine.

The Department of Environment and Water Management has been carrying out monitoring of agriculture run-off in Latvia since 1996, and "Vecauce" is involved into this program as one of its research objects. The monitoring program is included into national and international research projects. The different monitoring projects have been headed by professors P. Bu manis and V. Jansons. Important for the development of the farm was the study "GIS application for management optimising of amelioration systems at RSF "Vecauce"" (2006), which was carried out by A. Dzilna for earning her MSc. degree.

Up to 1990, the Faculty of Economics extensively made use of the "Vecauce" facilities for bookkeepers training, but later in the survey period (1990-2009) only some diploma and bachelor papers were written using the farm as a research base. These papers were generally related to the analysis of farm management or accounting body of "Vecauce". Topics were important for the farm only at a specific moment. Academician A. Kalniņš and Dr.oec. M. Pelše within the frames of an LLU internal project (2008) analyzed profitableness of biogas production at "Vecauce".

The results of various investigations have been published in many scientific publications in Latvia and abroad. Also newspapers and TV sometimes report on topical events at "Vecauce".

Totally, during the survey period, researches for 12 Diploma papers, 30 Bachelor papers, 16 Master papers and 14 Doctoral theses have been carried out at "Vecauce" or at least partly at "Vecauce". Another six research projects for earning Dr.sc. degree have been started lately, and bachelor, professional and master students are involved in different investigations for writing their final papers._

Scientific and Practical Seminar "Harvest Feast in "Vecauce""

Field days and seminars were organised on the basis of the research field every vegetation season, but seminars also in winter in the Vecauce Palace Conference hall. Farmers appreciate visiting the farm where they can learn about the best and newest crop varieties, peculiarities of growing technologies, etc. The necessary advice can be obtained from the staff of "Vecauce" or LLU and from the partners of commercial companies. One of most important seminars is "Harvest Feast in "Vecauce"" which is organized in the first Thursday of November yearly since 2001. Originally, such event was organized in 1957-1967 when students were living and studying at "Vecauce" for one year and were carrying out their research for diploma papers. Then the autumn was the time to show what was grown during summer and to make a party. Nowadays a new idea is given to the bygone event: in the first part, a scientific and practical seminar is organized with oral and poster reports on the main activities during the gone season, discussions take place, and displays from the rich harvests can be viewed and tasted. The second part is relaxation, songs, dances and games. The renovators of this event, now already traditional and awaited, were vice director responsible for research work of "Vecauce" Z. Gaile, professor D. Lapiņš, and associate professor A. Bērziņš. Each year the seminar has another motto related to the season's topical issues. Initially, the seminar was intended only for the staff of "Vecauce" and Faculty of Agriculture, with invitations sent also to the partners from commercial companies. Later, since 2004, researchers from other agriculture scientific institutions were invited to participate with their reports and yield exhibits. The seminar as an important event has been acknowledged by the Academy of Agriculture and Forestry Sciences where a summing-up of the research season of agricultural sciences is made. Since 2004, a small brochure covering an

overall description of the season, abstracts of all reports, and descriptions of the main operations and activities of every institution-participant has been published. The seminar differs from large-scale conferences with a specific feature: the main discussion is about the currently ended research season, but not about fully accomplished studies. The last "Harvest Feast in "Vecauce"" (in 2008) was dedicated to the 145th anniversary of agriculture education in Latvia (Ražas svētki …, 2008).

The activities of RSF "Vecauce" have been presented to innumerable foreign and local delegations including Latvia's Presidents, representatives of the Parliament, the government, the Ministry of Agriculture, scientists of the Academy of Sciences and the Academy of Agriculture and Forestry Sciences, ambassadors of some foreign countries, e.g. USA, etc. To sum up, it can be said that RSF "Vecauce" with its old traditions and study and research facilities is a place for versatile student personality development.

Conclusions

1. The Research and Study farm "Vecauce" of the Latvia University of Agriculture (established in 1921) is not a self-dependent research institution, but a research and study base for all levels of students and staff of LLU. Therefore development of all three interrelated operation directions of the farm – agricultural production, training of students and advisory work of farmers, and research – are important. Production indicators after 1990 declined, and were again noticeably raised up and stabilised starting with 2004-2005.
2. Since 1998, the study course "Practical Agriculture" in the amount of 1 CP is successfully realised at "Vecauce" for all 1st year students of LLU. During the studies and after graduation, students evaluate "Practical Agriculture" as well-organized and important not only for their professional carrier but also useful for life in general.
3. Continuous research with animals has been performed at "Vecauce" since its establishment in 1921. During the independent Latvia, diversity of animal species has sharply decreased due to economical reasons. At present, only problems of dairy and beef cattle breeding, feeding, keeping and medical treatment are studied. The researchers are interested to have all species of animals on the research farm, but it requires large amount of financing. Each step further in modernization of the cattle-shed provides better research possibilities for the staff and students of the Technical Faculty as well as Faculties of Agriculture, and Veterinary Medicine. The obtained research results have always been important for further development of the "Vecauce" herd and for development of animal science and production of Latvia.
4. The well-appointed field research was interrupted at "Vecauce" during 1967-1993. In 1993, renovation of the research field within a co-operative program with the USA Department of Agriculture was started. Mechanization problems of field trials were mostly solved starting with 1998 owing to another co-operation program with foreign partners (Nordrhein-Westfalen country in Germany). Up to now, credibility of the research results obtained in "Vecauce" has been re-established anew. Starting with 1999, the field research has significantly expanded and the staffs of the farm and LLU have been carrying out studies on different topics and with different field crops. At present the priority is research in precision agriculture and studies of different growing aspects of energy crops.
5. Two traditional events organized at "Vecauce" are well known among farmers, researchers, etc., and are acknowledged as useful and needed: the Agriculture exhibition in "Vecauce" (since 1995) for farmers, researchers, commercial companies, students, and country-side people, and the scientific and practical seminar "Harvest Feast in "Vecauce"" (since 2001) which summarizes the season's agriculture research results in Latvia.

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Science at Latvia University of Agriculture –achievements and future perspectives

P.Rivža, I.Alsiņa

The beginnings of agricultural science in Latvia can be found in 1862 when Riga Polytechnic was founded. In 1863 the Agricultural department was created. Riga Polytechnic graduates Jānis Bergs, Paulis Lejiņš, Arvīds Leppiks, Pēteris Nomals and Jānis Vārsbergs were active scientists and later took part in the academic life of the University of Latvia and were the founders of Jelgava Academy of Agriculture.

In 1919 the University of Latvia was founded, and the Faculty of Agriculture was included in it. Some months later the Faculty of Veterinary Medicine was founded and in 1920 the Department of Forestry was created within the Faculty of Agriculture. In the academic year of 1938/1939 the Faculty of Agriculture had 19 departments: Department of Plant Science headed by J.Vārsbergs, Dept. of Plant Pests and Diseases –M.Eglītis; Dept. of Apiculture – P.Rizga, Dept. of Constructions – A.Raisters; Dept. of Horticulture – J.Sudrabs; Dept. of Crop Cultivation – J.Apsītis; Dept. of Agricultures Chemistry and Soil Science – P.Kulitāns; Dept. of Agricultural Machinery – A.Leppiks, Dept. of Agricultural Technologies – P.Delle; Dept. of Animal Science – P.Lejiņš; Dept. of Forest Biology – V.Eihe; Dept. of Forest Exploitation – A.Teikmanis; Dept. of Forest Organization and Taxation – R.Markus; Dept. of Forest Technology – A.Kalniņš; Dept. of Forestry – N.Zemītis, Dept. of Microbiology – A.Kirhenšteins, Department of Dairy-farming – F.Neilands; Dept. of Swamp and Peat Utilization– P.Nomals and Dept. of Management and Agrarian Policy – P.Kreišmanis.

At the same time there were several departments within the Faculty of Veterinary Medicine, such as the Department of Anatomy headed by L.Kundziņš, Dept. of Pathology and Parasitology – R.Grapmanis, Dept. of Inner Diseases – P.Apinis, Dept. of Surgery and Midwifery – V.Brencēns, Dept. of Infectious Diseases – M.Rolle and the Veterinary Clinic headed by V.Brencēns.

Up to 1939 the Agriculture series of the University of Latvia Proceedings had 4 volumes (144 printed sheets) with 51 publications of 25 authors. 11 promotions were held – 9 in agricultural sciences and 2 in forestry sciences. Only one promotion work was presented outside the faculty. Augusts Kirhenšteins was the first to get Dr. agr. at the University of Latvia. The first habilitation work was presented by Kārlis Pols. In total 25 habilitations were held at the LU Faculty of Agriculture, and 6 *Dr. honoris causa* were awarded, int.al. to J.Mazvērsītis (1928), P.Lejiņš (1932) and the prime minister K.Ulmanis (1934).

In the middle of 1930s it was decided to create a branch of the University of Latvia in Jelgava- a city with famous culture, knowledge and science traditions. Jelgava Palace was destroyed in World War I and renovation was suggested by the Jelgava Council. On 26th of June, 1936 the Cabinet of Ministers decided to transfer the Faculty of Agriculture and establish a new higher education establishment – the Academy of Agriculture.

On 23th December, 1938 the president Kārlis Ulmanis promulgated the law on the foundation of Jelgava Academy of Agriculture, which became effective on 1st July, 1939. Pāvils Kreišmanis was elected as the first rector. An intensive period of construction followed afterwards and the Academy was moved to Jelgava.

Academy has been visited by the president Kārlis Ulmanis, the Rector of the University of Latvia Mārtiņš Prīmanis, the Minister of Education Jūlijs Auškāps and the Minister of Agriculture Jānis Birznieks. Jelgava Academy of Agriculture began its work on 28th October, 1939.

The peaceful and creative academic and scientific work was ended by World War II. Many of the academic staff left to the West or suffered from repressions. Jelgava Palace was destroyed again and Latvia Academy of Agriculture returned to Rīga. The studies and scientific work were slowed by the lack of premises, books and inventory. Rector J.Pieve, professors J.Apsītis, A. Kalniņš, J.Bērziņš and P.Rizga contributed greatly to the restoration of academic life at Latvia Academy of Agriculture.

Professors A.Kalniņš, A Kirhenšteins, P.Lejiņš, P.Nomalis, J.Peive, P.Rizga became members of the newly founded Academy of Sciences. The professor of Latvia University of Agriculture Paulis Lejiņš was elected as the first president of Latvian Academy of Sciences.

At the end of 1950s and the beginning of 1960s Jelgava became an academy city once again.

During the whole existence of the LLA, 35-40% of the teaching staff possessed a scientific degree.

A notable research should be done in order to become a Doctor of Science. In 1946 the LLA obtained the authority to award scientific degrees in agriculture, forest management and veterinary sciences, later also in agricultural technologies and economic sciences. 10 – 20 dissertations (promotion works) of researchers from the university or other institutions were presented every year at the Scientific Council of Latvia Academy of Agriculture. At the end of 1970s councils dedicated to agriculture, engineering and economic sciences were established instead of the Scientific Council.

Research at Latvia Academy of Agriculture dealt with actual agricultural problems, agrarian policy and the agricultural development of Latvia. At the beginning of 1960s new state financed scientific laboratories were established: substantive scientific and problem laboratories: Plant and Insects Viral Diseases, Agricultural and Industrial Products Hydrothermal Treatment, Radiobiology, Milk Machine, Region Projecting and Territorial Organization, Agricultural Manufacture and Economy, Tractor and Unit Usage Laboratory. In 1968 the Agricultural Animal Feeding Microelements Scientific Laboratory was established.

Active research work takes place at the Latvia University of Agriculture (LLU). The priorities of the research work have changed in the course of time; nevertheless, they are all connected with the rural areas and agriculture of Latvia.

The priority scientific directions put forward by the LLU from 1975 to 1990 include:

- The development and introduction of technologies in the agricultural production;
- Land amelioration and chemicalization of the agricultural production;
- The economic problems of agricultural and forest management intensification based on specialization, concentration and rational utilization of funds and land resources;
- The automatization of the agricultural production;
- The prediction of the agricultural production development.

The teaching staff and scientists of all the faculties will take part in solving these problems. It was planned to increase the number of scientists in the problem and scientific laboratories. It is planned to turn two scientific laboratories into problem laboratories during the time period from 1976 to 1980, which has been accomplished. Accordingly, the Plant and Insect Viral Diseases Problem Laboratory and the Agricultural Products Hydrothermal Treatment Problem Laboratory have been established at the Latvia Academy of Agriculture.

At the early stage of Latvia Academy of Agriculture research was financed mainly by state, but at seventies - eighties the number of scientific contracts with resorts and enterprises increased.

Each year scientific- practical conference was held and regular scientific proceedings "LLA Raksti" was published

At 1991 Latvia Academy of Agriculture was renamed Latvia University of Agriculture (LLU). The year 1992 was a period of radical changes at the LLU. These changes were connected with the replacement of the Soviet system in all the fields of the country. Many normative documents were developed to reorganize and improve the quality of the studies, research work and other spheres. In 1992 six habilitation and promotion councils approved by the Latvian Council of Science started their work at the LLU embracing the sub-sectors of agronomy, animal production, and economics within the sector of agriculture; the sub-sector of agricultural engineering within the sector of engineering; as well as the sectors of veterinary science and forestry. In 1993 the habilitation council within the sector of engineering, the sub-sector of food product technology, processes and equipment, also started its work; and in 1997 – within the sector of engineering, the sub-sector of water management and land amelioration. At first the most important task of these councils was the equalization of the USSR academic degrees, i.e. candidate of Science and doctor of Science, and the newly adapted academic degrees of the Republic of Latvia, i.e. doctor and habilitated doctor. After the evaluation of the contents of dissertations as well as the scientific activities of the candidates following the dissertation defence, the LLU habilitation and promotion councils equalized the academic degrees of 358 scientists including 7 foreigners. 58 dissertations were defended at the LLU habilitation councils from 1992 to 1998; as a result, 21 scientists attained the habilitated doctor's degree while 37 – the doctor's degree. The teaching staff of the LLU

also defended dissertations outside the university (3 doctoral dissertations in 1996, 2 in 1997 and 1 in 1998).

In 1994 the LLU established an annually renewable regular exhibition *Science for Practice (Zinātne Praksei)* which was also exhibited in Ulbroka, Vecauce, Priekuļi and Viļāni. Since 1995 the annual agricultural exhibitions are organized by the teaching and research farm *Vecauce.*

On 7th November, 1995, based on the suggestion from the LLU, the Latvia Cabinet of Ministers adopted *The Regulation of the Conferment of the State Professor Emeritus Title*. The title is awarded for significant scientific contribution and entitles the recipient to a lifetime grant in addition to the old-age pension. On 13th March, 1996, the LLU Senate approved *The Regulation of the Awards in the Name of Scientists*; 7 awards were established, namely, of Jānis Bergs – in agronomy; of Aleksandrs Ņikonovs – in economics; of Jānis Āboliņš – in food products technology; of Vilis Skārds – in water management and construction; of Arvīds Leppiks – in agricultural mechanization; of Ludvigs Kundziņš – in veterinary science and of Eižens Ostvalds – in forestry science. Once in 5 years the award is presented to field scientists for fundamental research and unified subject-matter research work and discoveries which have significantly contributed to the development of Latvian rural areas.

The main research directions from 1990 to 2000 involved:

- The soils and waters of Latvia;
- The feeding of productive animals;
- Agrarian economics and the development of rural areas;
- The gene pool and breeding of plants and animals;
- The prediction of cultivated plants' pests and diseases;
- Renewable energy sources and the resources of raw materials;
- The research of technologic and construction materials;
- The development of food products and their quality;
- The mechanized technologies of crop farming and animal production;
- The precautionary and treatment methods of animal diseases;
- Ecologically and economically balanced forest management.

The prior research areas also change at the turn of the century. They are concerted with the priorities of the country:

- New materials and Technologies,
- Life Sciences and Biotechnology,
- Information technology,
- Ecology and environment protection,
  - Soil quality, conservation and protection,
  - Water resource management and quality,
  - Environmentally benign crop protection and nutrition,
  - Landscape conservation and multifunctionality.

The scientists of the LLU carry out research in the framework of the Latvian Council of Science (LCS) projects and programmes within the market orientated field (MOP), fulfil orders of public authorities and private companies, as well as attract foreign means to the research work by using 10 different funding channels. The total project funding is shown in figure 1. In 15 years' time the funding for science has increased 19.3 times. The amount of means for science has increased the fastest during the time period from 2005 to 2008.

Until the year 2003 the funding of the Latvian Council of Science constituted more than a half of the total funding for the Latvia University of Agriculture per year. The proportion of the LCS funding was particularly high during 2001 when it constituted 70% of all the science budget of the LLU (Figure 2). An average of 26-27 projects has been financed annually until the year 2000. Starting with the project of 2001, the number has risen to 33-35 projects per year. The funding amount of these projects has also been comparatively stable from 1998 to 2006; it has varied within 164 and 194 thousand lats.

The next great funding source is the subsidies from the Ministry of Agriculture (MA). Both the number of projects and the amount of external funding have changed throughout the years. The number of projects and the amount of external funding achieved their highest marks during the year 2006 when the funding uptake of 45 projects constituted 731.6 thousand lats. Owing to the funding from the Ministry of Agriculture, new and modern research equipment was purchased for many scientific and

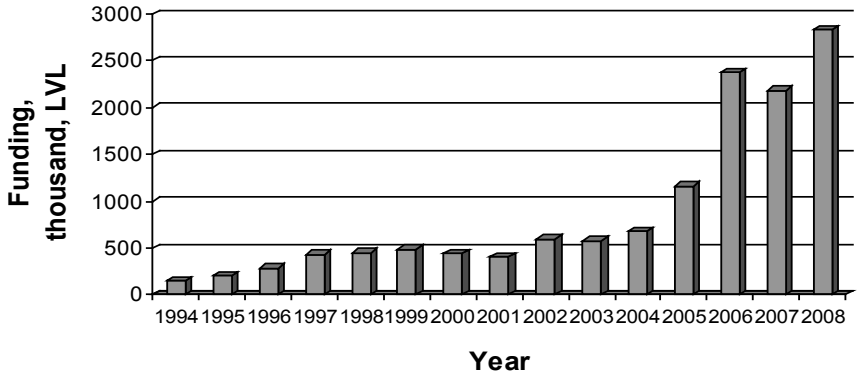

Figure 1. The Latvia University of Agriculture scientists' research funding uptake

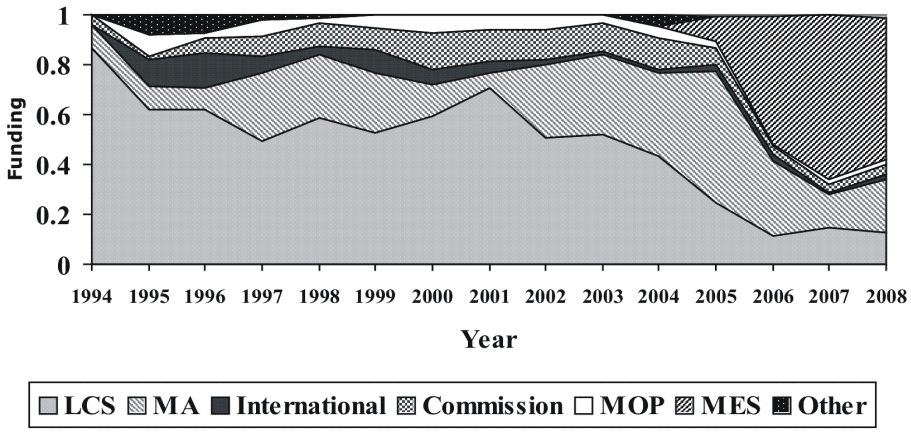

Figure 2. The distribution of science funding means by project groups

scholastic laboratories as well as new agricultural technology was obtained for scholastic and research management.

The international projects are comparatively small financially; however, very essential scientifically. The amount of external funding for these projects does not exceed 100 thousand lats. Two to three international projects are usually carried out annually. The number of projects was particularly high during 2006 when 7 projects were carried out. The amount of external funding for international projects until the year 2000 constituted 5–10% of the total LLU science funding amount. The scientists of the LLU take part in the scientific collaboration and programmes, e.g. the scientific collaboration projects of the Nordic countries, the programmes within the framework of the EU as well as various bilateral programmes and foreign collaboration projects.

The scientists of the Latvia University of Agriculture have also been collaborating with producers. 10-25 various commission projects are carried out annually at the LLU, the total sum being within 50 to 115 thousand lats.

A significant contribution to the development of science of late years has been provided by the base funding and means of the Ministry of Education and Science (MES) helping to carry out projects that facilitate the development of the university.

As a result of practical research, the lecturers of the LLU submitted and received 31 patents and trademarks of the Republic of Latvia from 1997 to 1999, 38 patents from 2000 to 2008. The main patent submitters include the teaching staff and the scientists of the Faculties of Food Technology as well as Engineering.

From 1996 to 1997 a preparatory work was done for the integration of the Scientific Research Institutes of Latvia Agricultural Mechanization and Power Industry (LVLMEZPI),

Latvia State Agriculture (LVZZPI), Latvia State Animal Production and Veterinary Science (LVLVZPI) and *Agricultural Polymers and Water Management* (LVZPILPŪ) into the LLU and starting from 1st January, 1998, these institutes acquired the status of legal entities within the faculties of the LLU, namely, LVLMEZPI as Ulbroka Science Centre at the Faculty of Engineering; LVZZPI as Skrīveri Science Centre and LVLVZPI as the Science Centre *Sigra* (Sigulda) at the Faculty of Agriculture and LVZPILPŪ as the Scientific Institute of Water and Land Management at the Faculty of Rural Engineering. At present these institutes function as LLU agencies.

The current research priorities defined by the LLU strategy are:

- Multifunctional agriculture;
- Agrobiotechnology: innovative, functional and environmentally friendly technologies of foodstuffs production and processing. Biomass biotechnology;
- Animal welfare and health, high quality, safety and heartiness of their products;
- Power industry – environmentally friendly forms of energy, energy supply safety and effective use of energy;
- Informatics – secure software, integrated information and communication systems and networks, electronic technologies in agriculture and forest management;
- Material science – the acquisition of functional materials, new generation composite materials;
- Forestry science – sustainability, new products and technologies;
- Environmental science – the conservation of natural resources, sustainable management and protection. The climate change regional effect on water ecosystems as well as adaptation, the Baltic Sea and inland waters environment protection;
- Sustainable development of rural areas.

The scientists' research exhibition *Science for Practice* (*Zinātne Praksei*) constantly functions at the LLU; furthermore, it is regularly renewed.

The first edition of the LLU research papers in English "Proceedings of the Latvia University of Agriculture" has been published. It is a reviewed edition that provides a new, wider range of opportunities for scientists; particularly, the new ones, to communicate with foreign researchers. The edition in English is a logical continuation of 294 research papers published starting with the first LLU collection of scientific papers in 1946 and ending with the ones published in 1999. A disparate continuation with prominent Latvian and foreign scientists on the editorial board.

The LLU Agronomical Analyses Scientific Laboratory is accredited and certified; furthermore, it is competent to carry out the testing of physical and chemical qualities of beer barley, malt, and feed.

With the aim to promote collaboration among scientists and enterprises or entrepreneurs, to protect intellectual property of LLU and commercialize results of research, the Technology and Knowledge Transfer Centre of the Latvia University of Agriculture started its work in November, 2005.

Summary

- The scientific activities, the work in domestic and foreign scientific projects and the participation in the activities of the Latvian Academy of Sciences (LAS) and the Latvia Academy of Agricultural and Forestry Sciences (LAAFS) are significant.
- The scholastic and research directions represented at the LLU correspond to all the main sectors of agriculture, forestry science, food science, agrarian economics, agricultural engineering, hydroengineering and veterinary science.
- 8 promotion councils function at the university. The existent scientific activity monitoring system of the LLU departments is productive and qualitative.

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Contribution of Agriculture Scientists in Scientific Academies of Latvia

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The contribution of Latvian agriculture scientists in the foundation and activities of the Academy of Sciences of Latvia, the Academy of Agriculture and Forestry Science of Latvia is significant.

The Latvia Academy of Sciences (LAS) has been founded in 1945, but it came into action on February 14, 1946, when members of the Academy gathered for the first general meeting. The scientists of the University of Latvia and the Latvia University of Agriculture (LLU) became the core of the Academy of Sciences and its institutes. The first full members of the Academy of Sciences included four scientists from LLU's academic staff, for example, the doctor of agriculture sciences, Professor Arvīds Kalniņš, the doctor of biology sciences, Professor Augusts Kirhenšteins, the doctor of technical sciences, Professor Pēteris Nomals.

It is worth noting that the first president (1946 – 1951) of the AS SSRL Paulis Lejiņš (1883-1959) was closely connected with Jelgava and the LLU. He, an outstanding agriculture scientist and expert in cattle-breeding, having graduated from the Agriculture department of the Riga Polytechnical Institute in 1907, was one of the organizers of the LLU and its Faculty of Agriculture. Since 1932 he has been a professor of agriculture sciences at the universities of Latvia, the Dean of the LLU Veterinary Faculty, the Head of the Study and Training Farm "Rāmava" (1922-1945).

As a result, according to the decision of the Senate of the LAS (October 15, 1992) the award of the LAS and the Academy of Agriculture and Forestry Science of Latvia in agriculture sciences named after Paulis Lejiņš was founded. The award winners include such prominent scientists as Jānis Latvietis (1995), Jānis Neilands (1996), Arturs Boruks (1997), Censonis Šķiņķis (1998), Sigismunds Timšāns (1999), Māra Skrīvele (2001), Aleksandrs Jemeļjanovs (2003) and others.

The first institute established in Latvia was the Institute of History. One of the first institutes in the post-war period was the Institute of Soil Knowledge and Agriculture that later was transformed into the LLU's agency "*The Research Institute of Agriculture*". While located in Riga, the scientific foundations were laid by such distinguished agriculture scientists as Professor Kārlis Bambergs, Head of the Department of Soil Science and Agriculture Chemistry, later the Head of the Department of Agriculture Chemistry, and Professor Jānis Sudrabs, who as a private assistant professor supervised practical classes in horticulture in Vecauce Study and Training farm. At that time Professor Jānis Peive, the merited scientist and the doctor of agriculture sciences, was appointed the director of the institute.

After the restoration of the Republic of Latvia, the general meeting on February 14, 1992 adopted the Charter and the Statutes transforming the LAS into a classical academy that unites elected members – outstanding scientists and other prominent personalities.

The main objective of the LAS is to promote the development of sciences and to support the process of studying and storing and transferring to the next generations the contribution of Latvia and the Latvian people to the world's science and culture heritage. The LAS has become a part of international scientific community, cooperating with other scientific academies and scientific organizations in Europe and overseas.

After the restoration of the independence of Latvia, the Academy of Agriculture and Forestry Science of Latvia (AAFSL) was founded on June 4, 1992. The delegates of the meeting represented more than 800 scientists involved in agriculture and forestry science. In the course of 17 years the academy has been functioning according to its statutes and it has proved to be a powerful institution with huge scientific potential. The idea of the necessity of such academy originated at the beginning of 1990 in the meetings and discussions of heads of mainstream institutions of agriculture sciences. The idea was especially supported by the following directors of scientific institutes: Aleksandrs Jemeļjanovs, Mārtiņš Belickis, Edgars Lāčgalvis, Jānis Zutis and others. Besides, the idea was encouraged by the Minister of Agriculture of that time Dainis Ģēģeris. The theoretical grounds and the basic principles of a new academy were outlined in the article "On the

Academy of Agriculture and Forestry Sciences of Latvia" written by Imants Gronskis, Aleksandrs Jemeļjanovs, Mārtiņš Belickis, Edgars Lāčgalvis and Jānis Zutis which was published in *Latvijas Lauku Avīze* (September 7, 1990). Professor Voldemārs Strīķis, the Rector of the LLU, was elected the first president of the AAFSL. The structure of then newly founded Academy was prescribed in its Statutes. The executive power belonged to the GENERAL MEETING, which delegated responsibilities to the PRESIDIUM. The first presidium was formed by such recognized scientists in agriculture and forestry as Voldemārs Strīķis, Aleksandrs Jemeļjanovs, Mārtiņs Belickis, Jānis Latvietis, Censonis Šķiņķis, Pēteris Zālītis and Jānis Tupiņš. It was the first presidium that initiated the tradition of having two general meetings annually: in May/June and December/January. The departments arrange seminars and visiting meetings all the year round. The AAFSL basically consisted of nine departments:

- Arable Farming; Head: Valdis Klāsens, Dr.habil.agr., Professor of the LLU
- Cattle-breeding and Veterinary Medicine; Head: Jāzeps Sprūžs, Dr.habil.agr., Professor of the LLU.
- Engineering and Power Industry; Head: Edvīns Bērziņš, a corresponding member of the LAS, Dr.habil.sc.ing., Professor of the LLU.
- Food Technology; Head: Uldis Viesturs, a full member of the LAS, Dr.habil.sc.ing., Professor of the LU.
- Economics and Agriculture Information; Head: Voldemārs Strīķis, Dr.h.c. of the LAS, Dr.oec., Professor of the LLU.
- Forestry; Head: Pēteris Zālītis, corresponding member of the LAS, Dr.habil.silv., Professor of the LLU.
- Forest Materials; Head: Henns Tuherms, Dr.habil.sc.ing., Professor of the LLU.
- Water Management; Head: Jānis Valters, Dr.habil.sc.ing., Professor of the LLU.
- Academic Education and Scientific Personnel; Heads: Juris Gunārs Pommers Dr.habil.sc.ing. and Pēteris Bušmanis, Dr.sc.ing., Professors of the LLU.

In terms of the size, the Departments of Arable Farming, Economics and Agriculture Information were the largest ones, the Departments of Cattle-breeding and Veterinary Medicine, Engineering and Power Industry were the next. The Departments of Water Management, Forest Materials, Forestry, Food Technology, Academic Education and Scientific Personnel were numerically small, but their research activities were versatile. The Department of Arable Farming has contributed greatly to field trial estimation in Latvia. The Departments of Food Technology, Cattle-breeding and Veterinary Medicine, Forest Materials have been efficient in cooperation with the producers. The Departments of Economics and Agriculture Information, Water Management, Engineering and Power Industry aimed their activities at interdisciplinary research and cooperation with the LAS. The Department of Academic Education and Scientific Personnel highlighted the evaluation of young scientists – doctoral students.

The scientists of the Academy were actively involved in the work of the Councils of the Science and Higher Education of Latvia as well as the State Commission of Scientific Qualification.

In 1999 Professor Baiba Rivža was elected the president of the AAFSL. The coming years proved expedience and the contribution of the AAFSL. The amount of members has increased since that time, and at present the AAFSL comprises 112 full members, 27 honorary members and 15 foreign members. The research activities of the AAFSL have become more closely linked with the LAS and the LLU. The core of the members is mostly represented by the LLU academic staff; they are eager participants of general meetings and presidium meetings of both the LAS and the AAFSL. The members of both Academies meet in visiting seminars, for example, the study of the area of Selonia etc. At present the Presidium of the AAFSL consists of the president, three vice-presidents (Prof. Daina Kārkliņa, Academician Aleksandrs Jemeļjanovs and Prof. Juris Skujāns, the Rector of the LLU), five heads of the departaments and a scientific secretary (Ieva Brence). In the course of time the number of departments has reduced to five departments (see Fig. 1).

The AAFSL is an active participant and supporter of the research projects. The priority is given to the following research areas: the genetic potential of plants and animals used in agriculture, the increase of plant and animal product quality, the creation of innovative products in various production systems and stages, the quality estimation of environmental resources used in agriculture, the development and monitoring of their sustainability criteria and indicators, agriculture and the ecosystem in the light of

climate changes. As regards food processing industry, the focus is on the development of innovative, environmentally friendly food resources and production technologies of new products, the research on the development and use of new functional food products, the research of food crisis. Concerning engineering science, the focus is on the technologies of the renewable energy, the use of biofuel, the production and use of biogas, the use of solar energy, including the research on agro-biotechnologies.

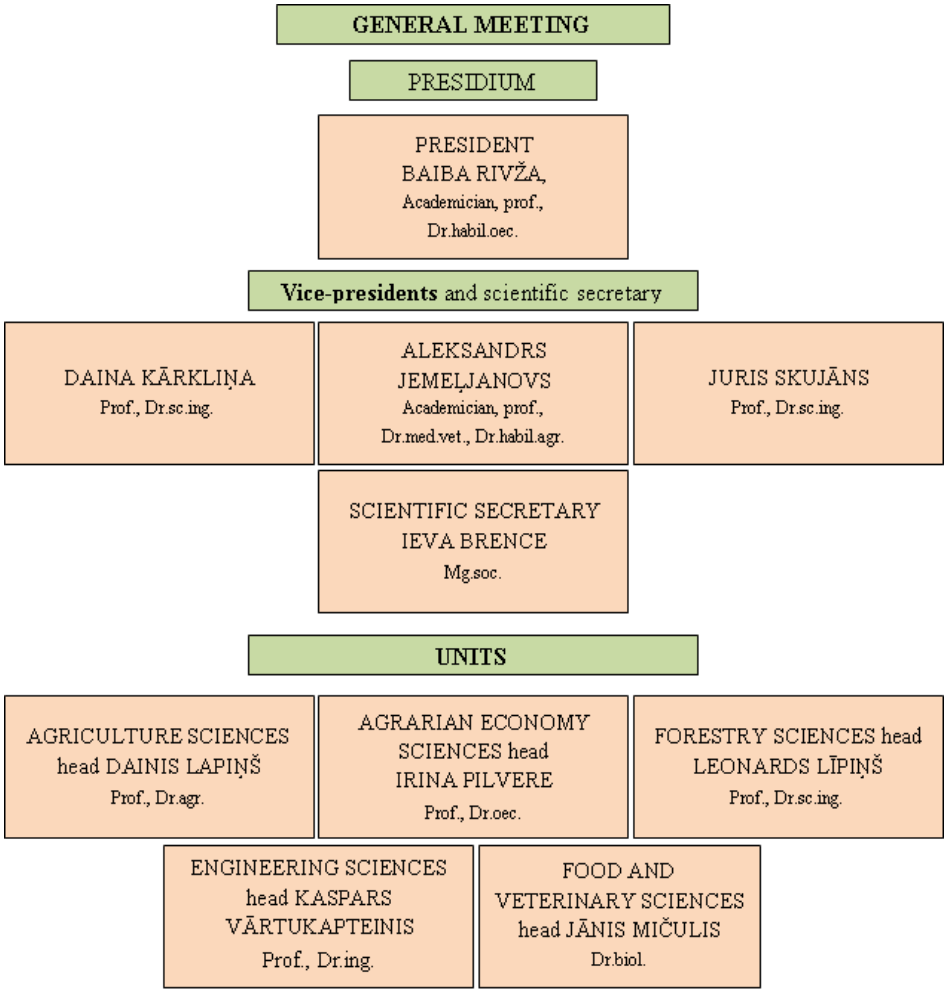

Fig. 1. The structure of the AAFSL.

In 2006 a new department was founded – the Department of Agriculture and Forestry Science (DAFS), affiliated to the LAS. The department consisted of outstanding personalities Mārtiņš Beķers, Īzaks Rašals,Uldis Viesturs, Aleksandrs Jemeļjanovs, Edīte Birģele, Edīte Kaufmane, Daina Kārkliņa, Aldis Kārkliņš, Jānis Latvietis, Arnis Kalniņš, Baiba Rivža, Kazimirs Špoģis, Bruno Andersons, Nikolajs Vederņikovs, Imants Liepa, Arnis Treimanis, Pēteris Zālītis and Aivars Žūriņš. The first head of the newly founded department was Baiba Rivža, the deputy was Arnis Treimanis. The close cooperation with the AAFSL facilitated the embracement of the department into the LAS. The new department received the support from the Academician Jānis Stradiņš, the Chairperson

of the Senate of the LAS, Academician Juris Ekmanis, the president of the LAS and Academician Raimonds Valters, the deputy Chairman of the board of the LAS.

The AAFSL and the Department of Agriculture and Forestry Science of the LAS was an eager participant of setting the priorities of Latvia's science for the time period of 2006 – 2009. Agro-biotechnology, forestry science, power industry and environmental science was added to the traditional priority science directions: biomedicine and pharmaceuticals, Information Technologies, the Latvian studies, material science, medicine. Agro-biotechnology envisages spacious, innovative, environmentally- and resource-friendly development of growing and processing technologies. Priority directions were realized in the state research programmes. Two of them were supervised by the members of the AAFSL. "Innovative technologies for the production of high quality, secure and healthy food products from genetically, physiologically and biochemically diverse plant and animal source material." (supervisor Prof. Daina Kārkliņa) and "The growth and efficient usage of foliage trees, new products and technologies." (Prof. Pēteris Zālītis).

— The AAFSL has submitted its proposals for the priorities of academic and applied research funding for the time period of 2010 – 2013. After tough discussions in the committees and action groups, the meeting of State secretaries (September 2, 2009) included "Local resources research and sustainable utilization (entrails of the Earth and forest resources technologies, food processing technologies)" among other priority directions. The researchers of the AAFSL will participate in such priority research directions as
— Energy and environment (renewable energy resources and utilization technologies, technologies of decreasing the climate changes and coastal biological diversity);
— Innovative materials and technologies (computer science, information and signal processing technologies, nanostructural multifunctional materials and nanotechnologies);
— National identity (the language, the history of Latvia, culture and social security);
— Public health (equipment and methods of treatment, diagnostics, methods of biomedicine)

The AAFSL actively participates in the international scientific discussions taking part in the international conferences and seminars, implementing the findings of the research, exchanging the experience with the researchers of different countries. Successful cooperation has been established among the member states of the Association of Academies of European Agriculture, Food and Natural Sciences that at present contains 18 countries. Along with the General Assembly of the Association, Latvia hosted the seminar "Renewable Energy Resources, Products and Technologies" in 2008 and acquired the status of the presiding state till 2010. In addition, the international conference "The Development of the Research in the Financial Crisis" was held in 2009 in Jūrmala, during which Ukraine was approved as the next presiding state of the Association.

This year, the fourth year in a row, the AAFSL has signed the protocol of intentions with the Ministry of Agriculture of Latvia (MA) and the LAS on the cooperation in a range of spheres, for example, in the development of draft laws on higher education and science, the implementation of joint research projects in agriculture, rural development and forestry science, in the information exchange among research institutions and experts, as well as the promotion of international cooperation in research and other significant activities.

The AAFSL cooperates with the Young Farmers' club that arranges various competitions for young people with the aim of giving the opportunity to rural youngsters and young farmers get involved in the informal and professional education thus strengthening civil society in the rural areas and developing entrepreneurship which is very important currently.

In cooperation with the LLU, the LAS, the MA and the Mortgage and Land Bank of Latvia and other supporters the AAFSL has attempted to carry on and financially support such traditions as granting awards that are named after the prominent scientists. "Paulis Lejiņš Award" is awarded once in two years to academic researchers who have contributed substantially to Latvia's rural development, "Arvīds Kalniņš Award" is awarded once in two years for the research in forestry and wood-pulp, "Jānis Lielmanis Award" is awarded once in three years for the outstanding achievements in plant-breeding and seed farming. The AAFSL, the LLU and the Mortgage and Land Bank of Latvia cooperate in organizing a competition for young scientists where the award is granted for the

contribution in the research of rural development twice a year. Young scientists get awards (usually three) for the participation and delivering reports in visiting meetings of the AAFSL. The awards are insignificant, but they serve as stimulus for young people to get involved in the research activities and concentrate on their final research projects at universities.

The media (printed, radio) offers a variety of opinions on the research activities in agriculture, food and forestry; their analysis shows that the research has a big potential since food and forestry industries are the major exporters of Latvia.

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Development of cooperation between agricultural science and research institutions in Latvia, Lithuania and Estonia

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Honorable doctor of Latvia University of Agriculture

Lithuania, Latvia and Estonia, for long centuries being near the Baltic Sea were friendly living together and never standing against each other, fought with the aliens from elsewhere if they were attempting to their freedom. Often they are called with one name - the Baltic Countries. It was of such historical periods when they weren't called the countries but carried the name of territories, regions or province. With great joy today we remember the Baltic way when people built 600 km length circuit connecting the three countries named "Baltic Way" firmly saying the whole world that we want to be free and self-build our future. This year is famous for us with various anniversaries and the jubilee: the recent mentioning of twenty years of unique phenomenon - the Baltic Way, Lithuania celebrates the millennium of the mentioning of it's name, Lithuanian University of Agriculture turns to 85 years old, and today Latvia University of Agriculture points out a worthy 70-year anniversary. This is a big celebration not only for all your University staff, students, graduates maintaining the honourable and beautiful traditions, but also for Latvia because University's graduates are spread all the country and working in agriculture and other strategic state economy spheres. It is also a big celebration for us - your neighbours. We welcome your work which commemorates the work done together and the pleasant moments spent together....

I would like to mention a few moments of our cooperation, which have been in the past and where I had directly participated. The increased cooperation began in the Soviet period. It took place among agrarian universities (academies at that period) of three Baltic countries, and was from a more massive scale. Regular meetings took place between related departments but the staffs of Faculties of Economics gathered in one place at the same time. The meetings of departments were held annually or biennially. Meetings were helpful in various aspects: methodological, scientific, communication, personal networking and even political.

I am a hydraulic engineer, in accordance with European classification attached to the trend of Environmental Engineering and Landscape Architecture. So we communicated at the Hydraulic departments' level. Cooperation between the departments of other specialties was a bit different but they were minor. The names of the departments were differ, but rather well met to the assigned subjects (they were coordinated from a centre in Moscow and was allowed only very minor deviations taking into account regional conditions), so the division of the methodological and scientific experience went very businesslike. During the Soviet period the intensive work took place towards the extending of material base, equipping of laboratories and the discussions during the meetings mainly contained the problems of design, construction and operation of research equipment and experience of daily work. The results were obvious learned from experience accumulated by neighbours and therefore turned to better equipping of home laboratories. Some tasks were performed by one party, some - by the other and the benefits were not one-sided. Communication was a win-win.

The benefits from communication and personal relations in the meaning of cooperation development were of the same importance as methodical or scientific one. We perfectly knew our counterparts in Latvia and Estonia, the meetings brought us closer together, and we made friends and have become a family of the international hydraulic specialists. The confidence in each other gradually gained, and colleagues of our three countries realised having unanimous opinion to one very important question - approach to the so called "strong centre" in Moscow. "Strong Centre" was very unpopular because it's dun and niggling regulation not only in the learning process, but in general was very unwelcome. It often became the object of criticism, perhaps more accurate to say ridicules jokes and the object of personal interviews at the receptions. Since none of us fall to the reach of KGB it can be argued that staff of our Hydraulic departments didn't include the agents

of Soviet intelligence services. Certainly, we didn't speak about the Ribbentrop - Molotov Pact and the secret protocols during the first meetings but later this issue has become topical. So the dawn of the Renaissance, when our countries decisively started to seek for independence and joined the live chain from Vilnius to Riga and Tallinn, we all rushed to joint it and felt handshake of our colleagues in the Latvia and Estonia.

A number of changes took place and many things have changed in our cooperation during the last twenty years that slide past after the Baltic Way. It was even a period of braked communication between some departments but willingness to cooperate never flagged. Some departments, such as Building Construction, continuing contacts for more than 30 years. Decrease in the intensity of cooperation resulted in a variety of reasons beyond our control but constructive and concrete cooperation of different nature has started again. During the Soviet period departments and faculties were mostly cooperated under private initiative. After Lithuania, Latvia and Estonia became independent states, the cooperation has risen to the inter-university level and accumulated experience at the departmental level. It led to the emergence of inter-university cooperation as after restitution of Baltic states independence the rectors of universities became the same members that from Soviet period meetings - Voldemārs Strīķis, Juris Skujāns, RIP Peteris Bušmanis from Latvia, Rimantas Urbonas from Lithuania, RIP Henn Elmet, Mait Klaasen from Estonia.

Development of inter-university cooperation was held in conjunction with the development of international relations in Western Europe and especially the Nordic countries. In 1995 the Nordic agricultural and veterinary university network NOVA rectors meeting was held at Lithuanian Agricultural Academy (University) and was attended by all rectors of universities of similar profile in the Baltic countries. At the meeting NOVA rectors decided to welcome universities of Baltic countries to the network and the joint cooperation network get a name NOVA - BA. Our high school in Lithuania was still academy while Latvian and Estonian agricultural academies several years ago had become universities and them direction have been attractive for us. Unfortunately, the period of name change of high school's have been passed and stopped at that period in Lithuania, so we were referring to your example when proving to our authorities and Seimas that Lithuania needs Agricultural University. NOVA chairman Bent Schmidt Nielsen, the rector of Danish Veterinary and Agricultural University - KVL, signed a formal letter stating that the Lithuanian Agricultural Academy is a university level school. For that time the study process at our Academy has been restructured under a Western model and the scientific work was sufficiently intensive, international relations were under active development, so the rest was just bureaucratic barriers for having the final result. They have been successfully overcome at the same year 1995.

NOVA meeting in Lithuania in 1995 was a result of the preparatory work done before. Even in 1989 the majority of Nordic scientists maintained contacts with scientists from Baltic "sisters". Professor Marten Carlsson, the architect of NOVA - BA strategy, stressed the Baltic "sisters" name in the edition published on the occasion of BOVA decade. The first time representatives of Baltic countries participated in NOVA meeting in Denmark in 1991 under KVL invitation. NOVA meeting held in 1993 took decision to intensify cooperation with the Baltic countries and the working group was formed to prepare a plan of cooperation. It should be noted that NOVA - BA start was given with the consent and active support by all NOVA University Rectors. International departments of partner institutions were actively working during the period of NOVA - BA construction. In particular, actively and enthusiastically worked NOVA secretary Astrid Holm-Olsen from Denmark, Lars Sjoflot from Norway, Markku Nygren from Finland, Monika Bengssont from Sweden and others. Of course, the most active part from the Baltic "sisters" side were people at international departments - Henn Tuherm, Ruta Zaleckyte, Antanas Maziliauskas, Minvydas Liegus, Ruta Skinkyte, Hardi Tullus, Aret Vooremae, Kylli Korgessar. .....

Under support of the Nordic countries one more step forward was quickly done – the Baltic agricultural and veterinary universities cooperation network BOVA was founded. It took place in Tartu 1996 at NOVA - BA Rectors' meeting. The fact of one coincidence has left in my memory. On the day of the discussions on how should be called the Baltic cooperation network we were taken by bus named Bova. I can't remember how much we were affected by these characters, but it was a coincidence and our cooperation network was named BOVA. This event was fixed in photo. The next cooperation stage crystallized

at two levels. The most intensive part was and still lasting at BOVA framework and linked to maintaining tight relations with NOVA. In the initial phase of NOVA - BA activity and from 1996 NOVA - BOVA activities were supported by Nordic Council of Ministers, later – by Wallenberg Foundation. NOVA - BOVA activities were very successful in various academic fields, particularly in study development, education of young researchers, communication, and website information. Expanded joint activities have formed general understanding of partner institutions that BOVA is a necessity. So now, although no longer supporting external funds, cooperation is maintained by all the universities jointly. Overall, I'm mentioned here only a very small part of the work being done, and only few NOVA - BOVA enthusiasts. NOVA - BOVA activities touched hundreds of people, has trained a number of excellent scientists, got the international experience, has helped to organize the world's recognized and widely cited scientific publications publishing.

On the occasion of this beautiful 70 - th anniversary we are proud by having such great neighbours - Latvia University of Agriculture. We together did so much important work during the whole period of existence, and now have friendly relations, good mutual understanding and goodwill. I wish LLU leaders, faculties, professors, and students the best luck, good health, patience and optimism. Long live the LLU!

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LZUU

Latvian and Estonian agricultural universities – a longterm mutually supportive co-operation

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Co-operation between the universities was started in the 60-ies of the previous century when the Estonian University of Life Sciences was called the Estonian Academy of Agriculture. At that time networking in different fields was started and is still going on. Meetings of academic and research staff are regular in veterinary medicine, civil engineering, forestry, field crop sciences, plant protection, agricultural economy and landscape architecture. For several years the leading initiator of meetings in veterinary medicine was Hiljar Pärn from the Estonian side. In 2004 an agreement was made between the universities for the intensification of joint research in milk production technology. In the framework of the agreement several meetings have been held. At present Arvo Leola and Vambola Veinla from Estonia and Juris Priekulis from Latvia are jointly preparing a textbook in grazing technology.

Different research projects have been carried out by both universities as partners. For example a project funded by the Swedish Institute (within New Visby Programme), *"Farm animal reproduction – reducing infectious diseases and preserving local genetic resources",* was carried out during the years 2001-2003 by the Estonian Agricultural University (Toomas Tiirats) and the Latvian University of Agriculture (Vita Antane). An integrated farming project for application of funding from the Baltic Sea Region programme is being prepared.

Organizing international scientific conferences in different fields jointly with our Lithuanian colleagues is also very common. Regular conferences take place in plant protection, forestry, civil engineering and rural economy – for example the annual conference *Economic science for rural development*. Every second year the Baltic conference in plant protection is carried out. Always the members of both universities belong to the organizing committees. Also joint publishing (together with Lithuanian colleagues) of the peer-reviewed scientific journals *Agronomy Research and Baltic Forestry* is very important.

In the training activities a good network between the universities has been developed by BOVA system, where both universities participate. This network is facilitating closer contacts between the partner universities and increasing the quality of postgraduate research training. Coordination of the activities between the partner universities is enriching the variety of special training courses and remarkably increasing the e-learning activities, also it is improving dissemination of high quality knowledge and experience in our region. In different topics several 4-5 days active courses for up to 20 postgraduate students from the member institutions are organised every year. Every course will include a module of distance learning, which will serve as a basis for the development of specific distance learning programs made available for students of member institutions via internet. In every course the professors from both universities are lecturing. With joint efforts of the lecturers of both universities the international master level course BIOLANDMAN has been prepared. At present a joint application is given for the project: *Supporting landscape architecture students labour market in Estonia and Latvia*.

Often the professors of both universities are opponents in PhD theses defences in the partner university. Just in June 2009 professor Kaspars Vartukapteinis and professor Gints Birzieties were opponents for a PhD thesis by Kalvi Tamme from Estonia.

It is possible to conclude that the co-operation between the Latvian University of Agriculture and the Estonian University of Life Sciences has strengthened research as well as training in both universities and this process should be continued.

Research in Veterinary Pathology in Latvia: from the Past to the Future

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Veterinary pathology as a tool for scientists. Veterinary pathology is a fundamental science which studies the mechanisms of a disease in animals, and the resulting changes in the body at molecular, cellular, and tissue levels. Research in veterinary pathology usually focuses on the study of morphologic changes – either visible at macroscopic level, i.e., those that can be seen with the naked eye or those that can be observed microscopically – with light or electron microscope, with routine (haematoxylin and eosin – blue and red stain) or by the aid of special stains. The aim of such studies is to diagnose a disease and understand pathogenesis of the disease, i.e., how the stepwise process leads to clinical manifestation of the disease. Science is intimately connected with practice, since one cannot exist without the other. Pathology is a special discipline in medicine as it stands at the crossroads between practice and science: on the one hand it is intimately involved in clinical medicine helping to answer a question "what is it?" and on the other hand it is intimately involved in the research trying to answer a question "why and how did it happen?"

Research in veterinary pathology in Latvia. Veterinary pathology as a discipline in Latvia emerged concurrently with the establishment of the College of Veterinary Medicine in 1919. The College was located in Riga, and existed as one of the colleges in the newly established higher education institution of Latvia. In 1920 Ernsts Paukuls established the Department of General Pathology which was the first academic home for a pathologist and later dean Rūdolfs Grapmanis.

There are several names that have dominated in the research of veterinary pathology in Latvia: R. Grapmanis, Milda Salmiņa-Skudiņa, and Oļģerts Parčinskis. Each of them has devoted their entire life to veterinary pathology: R. Grapmanis from 1920-1949; M. Skudiņa from 1926-1960, and O. Parčinskis from 1957-2009. Reviewing the past, it is apparent that during their service to the profession these Latvian veterinarians and pathologists have paid their attention to issues important in Latvia. A horse was the main animal species treated and consequently receiving most attention from the beginning to the middle of the 20th century; so it is not surprising that two significant publications of R. Grapmanis were devoted to this species – first his doctoral thesis describing the development of reproductive organs, especially ovaries in the equine fetus (1932), and later his study on comparing effects of chronic ossifying periarthritis treatment regiments on morphology of the tarsal joint in a horse (1939-1949). M. Skudiņa's doctoral thesis focused on the description of patho-morphologic changes in the stomach and intestines of horses having died from colic (1953). I am intrigued by the work of couple veterinary students, O. Kristiņa and G. Grudmanis supervised by M. Skudiņa and whose studies titled "Diagnosis and Prevalence of Malignant Tumours in Latvia" in 1952 is still worth mentioning in veterinary medicine in Latvia.

O. Parčinskis worked together with M. Skudiņa and later provided continuity in many aspects of veterinary pathology. Much of his research was devoted to study bovine enzootic leukaemia which was a rare disease in Latvia until 1960 when its prevalence started to increase consequently reaching the peak in the 1980s when ~76% of cows in Latvia were seropositive. Examples of O. Parčinskis research include a thorough description of gross and microscopic lesions characteristic of bovine enzootic leukaemia, and recommendations for elimination of this disease from dairy herds. Additionally, he has supervised research work of others leading to such publications as "Haematological Changes Characteristic of Bovine Enzootic Leukaemia" (A. Laizāns and P. Matvejevs, 1963); "Histological Changes in Organs and Tissues of Dogs Fed with Meat from Leukeamic Cows" (V. Bartenverfere and V. Bērziņa, 1970); "Correlation and Study of Mutual Connections between Bovine Enzootic Leukaemia Infection and Purebred Genetic Background, Meat and Milk Productivity" (J. Bojarunecs, L. Meijubere, L. Federe-Supruna, and B. Scopecs, 1977); and "Study of Factors that Promote Infection with Bovine Enzootic Leukaemia" (R. Jirgena, 1981). Bovine enzootic leukaemia is no

longer an issue after the implementation of eradication programme in the early 1990s but this review urges me to compare the knowledge and discoveries of veterinary pathologists and scientists in Latvia with the state of the knowledge at the same time in research labs free from the Soviet rule.

Research in veterinary pathology in Latvia in the past 20 years has produced numerous student publications, and Master's level scientific studies (47 publications between 1993 and 1999); although none of these has been published in peer-reviewed international veterinary journals. Re-establishment of modern pathology lab with good quality histology and immunohistochemistry capacity is needed to provide support for comparative pathology studies in Latvia. More importantly, for these studies to be competitive in the international arena, the studies have to be well designed and conducted considering the current state of knowledge in a particular area of research while applying that knowledge to the situation in Latvia. Therefore, fluency in English and access to international journals is the key. The return to disease studies in experimental animals would be also important; simultaneously remembering that there are famous success stories in the history of veterinary research in Latvia best shown by K. Helmanis and his studies of malleus. Lastly, collaboration with scientists of human research labs in Latvia and abroad should be actively pursued.

Concluding remarks. "Each case is a puzzle" says O. Parčinskis after 50 years of diagnostic work and hundreds of necropsies. I agree with him by 100%. The moment of surprise and ability to get closer to a definite diagnosis have attracted me to pathology. New discoveries and keeping up with them that keep me interested in this field. There are many "why" and "how" questions to be answered here in Latvia with the help of veterinary pathology and its basic tools – macroscopic and microscopic examination and immunohistochemistry.

Key words: veterinary pathology, R. Grapmanis, M. Skudiņa, O. Parčinskis, bovine leukemia.

"Contribution of Latvian scientists' to the development of dairy farming in the last 10 years"

D. Kairiša, D. Jonkus
Institute of Agrobiotechnology, Faculty of Agriculture

Dairy farming occupies the leading position among the cattle breeding sectors in Latvian agriculture. The research work within this sector has always been active and connected with solving the practical problems of dairy producers.

Institute of Agrobiotechnology of Latvia University of Agriculture and Research Institute of Biotechnology and Veterinary Medicine "Sigra" are the principal research institutions whose scientists conduct studies on dairy farming.

Research on animal adaptation to different keeping technologies has been launched alongside the studies on cow breeding and feeding as well as additional attention has been paid to the studies of factors influencing milk composition and quality features.

One of the topicalities of dairy farming is a precise evaluation of the breeding value estimation of cows and bulls. Initially D. Strautmanis contributed greatly to solving this issue.

The study of the linear statistic models was launched to determine those breeding bulls' evaluation models that would be the most appropriate for the conditions in Latvia. Both "sire model" and BLUP "animal model" were used in evaluating cows. Further studies of employing the linear models in breeding value estimation were connected with the necessity to cross over from the use of cow standard lactation data to the use of "test day model" data (L. Paura, R. Zutere, Z. Grīslis).

The studies of individual milk productivity commenced with the studies of lactation persistency. The study of milk production process analysed factors influencing the lysocime concentration, the aspects of milk production stability, milk productivity traits variation as well as the influence of calving interval on the individual productivity of cows. The milk freezing-point, the urea level and different indicators of milk composition and quality have been studied for the benefit of the production quality control (D. Jonkus, D. Kairiša, L. Paura).

The body of scientists from Institute "Sigra" under the guidance of A.Jemelanovs are working on the development of the scientific justification for the production of high quality, uncontaminated, safe and healthy food raw materials of animal origin. The research deals with the study of the genetic, physiological and biochemical features of animals, including dairy cows, as well as the application of up-to-date agrobiotechnology methods to cow feed preparation and the introduction of new feed preparation technologies in ensuring the wholesome feeding of cows.

Starting with the year 2007 Molecular Genetics Research Laboratory commenced its work at the LLU Faculty of Agriculture. The main objective of this laboratory is to store the biomaterial of agricultural animals' genetic resources, to extract DNA and to form a data base. Scientific research is also carried out at the laboratory; accordingly, in 2008 L. Paura and D. Jonkus studied the frequency of milk protein genes in the Latvian brown breed dairy cows. From 2009 a group of researchers under the guidance of senior researcher Z.Grīslis have launched a 4-year project to study the polymorphism of milk protein genes in Latvian cow populations and to prepare information for the transition to gene assisted selection (GAS).

The high productivity, health and longevity of cows can be ensured by their wholesome feeding. The research on grass silage preparation, storage and feeding, with the aim of reducing nutrition costs and the prime costs of the produced milk, have always dominated in the feeding of dairy cows. J. Latvietis, I. Ramane, D. Kravale, J. Mičulis, B. Ošmane, M. Beča and V. Auziņš can be regarded as the most important scientists of this research sphere.

Great work has been done concerning the development of the nutrients' energetic and protein evaluating systems and their introduction into cow feeding (U. Osītis); furthermore, an accurate supply of mineral substances in cow feed doses has been

studied (A. Trūpa). The computer programme "LĒDA" that manages the composition of cow feed doses for all the levels of productivity has been developed on the basis of these elaborations.

After launching the modern site of dairy cows at the LLU Teaching and Research Farm "Vecauce", opportunities arose to begin a set of scientific research on the adaptation of dairy cows to the new conditions, the influence of milking technologies on the composition and quality of the obtained milk as well as the reproduction and health of the dairy cows herd. The research spectrum is broad and the LLU scientists and doctoral students from the Faculties of Agriculture, Engineering and Veterinary Medicine are involved.

Soil Classification – Reflection of our Knowledge on Soils

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Similar to any branch of natural sciences soil classification deals with the systematic categorisation of soils based on distinguishing characteristics as well as criteria dictating choices in its use. We should admit that a uniform and generally accepted classification theory and systems are lacking for almost all natural sciences. Therefore we are under continuous development, discussions and proposals. Alternatively we are compromising between scientific and applied (practical) oriented approach. Marlin Cline (Soil Science, 1949) stated the basic rationale behind utilitarian classification. "The purpose of any classification is to organise our knowledge so that the properties of objects may be remembered and their relationships may be understood most easily for a specific objective. The process involves formation of classes by grouping the objects on the basis of their common properties. In any system of classification, groups about which the greatest number, most precise, and most important statements can be made for the objective serve the purpose best". To do so we need to have some basic knowledge on the object (soil) to classify, and objectives to satisfy (our utilitarian needs). Following the attempts to classify Latvia soils, studying the proposed and used schemes from the very beginning up to present, and analysing shortages of currently used systems we can follow the needs, functions and objectives we expect from the soil, (e.g. biomass production only or more complex segment of ecosystem) and extent of knowledge we have or we endeavour to reach.

Professor Jānis Vītiņš who developed the first schemes in 1927 is the founder of scientific soil classification for Latvia. Good soil science knowledge was obtained from the Russian soil science school and practical experience in Russia but since 1921 also in Latvia. The objectives were very understandable – development of Latvia Land Cadastre which included relevant soil evaluation and large-scale mapping.

The first scheme developed was rather simple (from the present point of view); however it gave a possibility for Prof. K. Krūmiņš to propose more extensive one in 1930. The third and fourth schemes (1936/37) already were the synthesis of efforts and collaborative work of soil scientists, and fit well for the set up objectives.

The period after World War II marked new objectives. Firstly, harmonisation and integration of Latvian classification into the USSR system following the governing Soviet theoretical concepts in soil science. Secondly, provision of the needs for ongoing large-scale soil mapping, supporting of soil drainage activities, and later on – also for soil evaluation and land cadastre. This period up to 1990 was characteristic with many practice-oriented investigations, methodological developments, and theoretical discussions. Many people (K. Brīvkalns, K. Bambergs, A. Boruks, H. Mežals, R. Skujāns, R. Stolbovs, I. Gemste et al.) contributing a lot for the data acquisition, map and survey production as well in soil research were involved in the development of theoretical and practical issues. Numerous soil data, publications, large scale soil maps covering all agricultural land area etc. were acquired during this period.

The year 1990 providing another economic situation and possibilities, and also other objectives was a new milestone. Firstly, we had to consider that soil is not only a resource where plants grow but the functions of land are more comprehensive. Therefore entirely agronomic soil classification was not the solution. It meant that soils should be studied, properties recorded, and interpretations developed more widely, comprehensively, and profoundly. New advanced soil parameters are under current interest. Secondly, incorporation of Latvia into the European and global information network requires the application of new (international) data standards. It means the use of non-traditional field and laboratory tests, new parameters, terminology, and interpretations etc., and possibility to use the internationally accepted systems of soil classification as well. If we want to tell somebody about our soils, we need to do it in a language the person understands. This is the new paradigm we are facing with. Consequently we need to reconstruct our soil research, classification, data archives etc. in such a way that they are still understandable und usable for traditional local users, while simultaneously

also applicable for external data needs. Thus we have to implement the international standards, approach, criteria, classification, and to find the compatibility possibilities for comparison of different data formats. We are not so powerful to loose (or make unintelligible) the huge amount of soil data accrued almost over the century, and to obtain the new ones instead. Nevertheless our objective is ambitious due to the fundamental differences between what we have and what we would like to have.

Key words: soil data format, compatibility studies, soil science.

Studies on Cranberry Cultivation of Historical Perspective

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The scientific research on the European or Latvian local cranberries (*Vaccinium oxycoccus* L.) was started in the 1970s by the Department of Horticulture of the Faculty of Agriculture, Latvia University of Agriculture. The studies show that the advantage of these cranberries lies in the growing season, since it is shorter. Besides, they require a lower sum of the effective temperatures than the large berry cranberries. The berries are better protected from autumn frosts, and the berry texture is gentler. It is impossible to apply mechanisation in harvesting this species of cranberries.

Productive wild clones were found not only in the bogs of Latvia but also in Karelia (Russia) and Estonia using both physical and chemical mutagenesis. Consequently 172 cranberry genotypes were covered by the study.

The research was carried out applying woody and soft wood cuttings, investigating planting density, substrates, morphological, and biological characteristics of the plant and other issues.

The main task of research is improving of less productive areas of cranberry bogs with high-value varieties as well as on recovering with the cranberry degraded bog areas. It was decided to continue selection on cranberry clone test conditions in order to breed crops, and to test their suitability in re-cultivated bogs. It was also decided to develop elaborated technologies for the propagation and cultivation of the specific genotype.

The most valuable clones were chosen in the selection work. Having analysed the organic harvest of the best cranberry genotypes, it can be concluded that the greatest number of inflorescence - 800 m^{-2} , the largest flower number 1420 m^{-2} , and berry mass were calibrated with the genotype V-63583 (Gronskis and Liepniece, 2004.)

The most valuable genotype seeds were sown in the re-cultivated cranberry bogs areas covering 40.8 ha of land and selected in different places of Latvia. The seed sowing was done by plane. Studying the re-cultivated cranberry areas it was found that cranberry growing was very uneven ranging between 10% and 30%. In some places it was associated with deep groundwater levels, sulphur spring diffluence and open places in the array as well they were damaged by frost.

The American large cranberry (*Vaccinium macrocarpon* Ait.) is relatively new cultures in Latvia. The first commercial cranberry plantations were established in 1985. Nowadays, the area of large cranberries covers approximately 100 ha and takes the third place in the world. The most popular varieties of cranberries are 'Stevens', 'Bergman', 'Ben Lear' and others, while 'Franklin', 'Pilgrim', 'Hoves' and 'Lemynion' are less popular varieties.

Due to the high costs involved to establish cranberry fields, most (65%) of the farms are small - with 0.1-5.0 ha of land, 21% of farms – with 5.1-10. 7% with 10.1-15.0, and 7% - with 15.1- 20.0 ha of land.

Three planting technologies are used for large cranberries in Latvia. First - in the prepared field, cranberry tendrils are evenly spread on the soil surface and imbedded in peat with a disc harrow. Second - imbedding tendrils by power harrow. The speed of the power harrow should be reduced not to damage the plants. Plants should not be imbedded too deep or too shallow. Third – manual planting using a planting stick. The drawback - a labour consuming process, yet it can be used for planting a small area.

Weed control as an essential part of cranberry management was done in two ways - manually and by using glyphosate pesticides as a replant treatment by weed wipers on bicycle wheels.

Sand, used as a mulching material, was spread with a specially constructed spreader, though there were problems with sand pH and weeds. Therefore, sanding is not popular. The breeders use high moss peat, while some - sawdust or sawdust mixed with peat especially those without a sprinkler irrigation system.

Up to 10% of the harvest was lost in autumn frosts on the farms of the Western area of Latvia from the analysed varieties of late cranberries in the autumn frost.

Maize in Latvia – Research during the Past Century

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Maize (*Zea mays* L.) as crop with a Southern origin is warmth demanding and one of the newest field crops grown in Latvia. The very first published data on maize growing and ensiling in Latvia date back to 1886 and 1887; however the results of first experiments carried out in Skrīveri were published 10 years later. After World War I Latvian refugees returned from Russia bringing some maize seed with them. Even good maize grain yields (2.5-3.0 t ha^{-1}) were obtained in Latgale region, but the production of maize on the farm scale was ceased after some failure years (especially in 1928). J. Bergs studied maize in Bērzmuiža research station and confirmed (1920) possibilities of maize growing for grain in Latvia. P. Rizga (1927) paid attention to maize use for forage. Large scale field experiments on maize growing peculiarities under the guidance of P. Dermanis were carried out in the research farm "Vecauce" of the Faculty of Agriculture (the University of Latvia) during the period of 1925-1931. Those experiments resulted in the main conclusions that growing of maize for grain in Latvia has no practical meaning, while its growing for forage is perspective, and during agriculturally favourable years maize can guarantee higher yield if compared with traditionally grown crops.

After World War II Latvia was incorporated into the Soviet Union, and consequently all regulations passed by the Communist Party were mandatory. Thus, during the September Plenum of the Communist Party in 1953 it was decided that maize growing area had to be expanded towards the North, including Byelorussia and the Baltic Republics. Large scale maize growing was enforced by authorities (including a leader of the Communist Party Nikita Khrushchev) despite the lack of suitable cultivars, experience and knowledge, and special machinery. From that time maize was called Khrushchev-crop, and even nowadays some people continue to consider maize as something strange. The first data on wider maize growing on the farm-scale date back to 1954 (8240 ha), however the beginning was not very successful due to the interaction of too late maturity cultivars with unsuitable meteorological conditions that supplemented the previously mentioned reasons. An expansive programme investigating different questions important for maize growing was launched in the middle of the 1950s and continued up to the 1970. The programme focused on the following aspects: research of maize growing and development, searching for best cultivars, later on – hybrids (even some breeding work was performed), soil suitability, liming and fertilisation, sowing time and mode, desirable plant density, importance of harmful organisms and possible ways for their control, harvesting time and desirable maize maturity at harvest, ensiling methods and forage quality, and maize growing together with legumes (field beans or lupine) for increasing crude protein content of forage. Some of the conclusions were useful only at that time, while the others have maintained their importance even nowadays. Mainly all the scientific institutions dealing with the research in agriculture were involved in this research. The study covered regions with different soil and meteorological characterisation. Even machinery system for mechanisation of all field works was developed by the constructors of Riga Agriculture Machinery factory.

During the period from 1970 to 1990 the research on maize was continued, though not on so big scale as before. New varieties were tested and a lot of studies of maize ensiling and silage quality improvement were performed. At the end of the 1980s thanks to the progress in breeding new early maturity hybrids were available and big scale investigations studying also agro-technology were performed in the Research Institute of Agriculture (RIA) in Skrīveri. In the 1990s, after Latvia regained its independence, contacts with different Western countries were established; particularly close collaboration was developed with the Latvians from the USA and Canada. As a result of the cooperation seed of new earlier maturity and at the same time high yielding hybrids were obtained for the research as well as production purposes. Again, new wave of investigations started and three main institutions were involved: RIA in Skrīveri, the Research Institute of Animal Science and Veterinary in Sigulda, and in 1993 also the research farm "Vecauce" of LLU. As land reform in Agriculture was performed, farmers again should be convinced on maize

growing possibilities and importance. New hybrids demand new growing technology and anew machinery did not satisfy the needs of the new technology. Those questions were solved by local researchers applying the experience from the Western Europe and America as well. Today a lot of studies are performed in the research farm "Vecauce" where also other way of maize silage use (for biogas production) is investigated.

Nowadays most of farmers appreciate the value of maize for animal forage and biogas production as well. Nevertheless they still have to learn a lot about this crop of a Southern origin, and therefore researchers shall provide the best ways for obtaining high and good quality yields.

Key words: climate suitability, cultivars and hybrids, sowing time and mode, control of harmful organisms, harvesting, forage quality.

Studies of Wood Resources Dynamics in the Faculty of Forest

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Annual values of wood volume current increase such as potential increase (PCI), volume debris (VD), natural increase (NCI), volume removal (VR), and real increase (RCI) have been used to assess wood resources dynamics at the forest stand and stand set levels. Appropriate methods for evaluation the above mentioned quantitative parameters have been elaborated and empirically proved at the Department of Silviculture of LLU. The main explanations: PCI is the summary result of physiological processes of forming the wood amount in the past year; VD indicates the common stem volume of trees, which ended the production of wood in the particular year; VR is evaluated as part of a stem volume cut during the past year; RCI indicates the portion of NCI after subtraction of VR. NCI yearly supplements wood resources of forest.

The practical estimation of the dynamic indices of forest is a complex problem in view of the exceptional variety of both the forest stands themselves and the conditions for their growth. The key aspect composes the evaluation of PCI, since the values of this parameter are not indicated by forest statistics. Especially it relates to the estimation of forest stand sets frequently growing on the extensive and varying areas. The following laboratory procedure is proposed.

PCI is expressed by means of equation (1):

$$PCI = G \cdot Z_M^{'} \qquad (1), \text{ where}$$

G -cross-section area of a certain forest stand set at the breast height, m^2;

$Z_M^{'}$ -reduced value of PCI produced by one square metre of cross-section area at the breast height, $m^3 \cdot m^2$. Our studies showed that the value of $Z_M^{'}$ depends on the wood species, age A and site index class B. This dependence is approximated by the expression (2):

$$Z_M^{'} = a_1 + b_1 B + c_1 B^2 + \frac{a_2 + b_2 B + c_2 B^2}{A} + \frac{a_3 + b_3 B + c_3 B^2}{A^2} \qquad (2)$$

All wood species have the following values of B for: class Ia B = 0; class I B = 1; class II B = 2; class III B = 3; class IV B = 4; class V B = 5.

a_i, b_i, c_i - empirical coefficients depending on wood species, for example, for the Norway spruce *Picea abies* Karst: a_1 = -0.10341; b_1 = -0.01785; c_1 = 0.007786; a_2 = 43.7988; b_2 = -2.5706; c_2 = -0.60422; a_3 = -430.820; b_3 = 26.968; c_3 = 5.5933. The values of coefficients listed above relate to the age interval 15≤A≤160 years.

The calculations of summary amount of potential current increase in volume PCI for the Norway spruce stands growing in the entire territory of Latvia are carried out as an example for the application of the proposed method. It is obtained that PCI amounted to 5.94 million m^3 on January 1, 2008.

Accuracy and labour expanses of laboratory method were checked empirically by means of the statistical evaluation of data obtained by the proposed method and the control method of sample areas. Control method is based on the measurement of the width of growth rings, and the equation (3) is used in monitoring of forest resources in Latvia.

$$Z'_M = 12732.4\psi H^{\alpha} D^{\beta \lg H + \varphi - 2}\left[\frac{Z_H(\alpha + \beta \lg D)}{H} + \frac{Z_D(\varphi + \beta \lg H)}{10D}\right] \quad (3),$$ where

H -average height, m ; D -average diameter at breast height, cm ; Z_D and Z_H -average diameter and height increase respectively; $\psi, \alpha, \beta, \varphi, a, b, c$ - empirical coefficients depending on the wood species, for the Norway spruce: ψ =2.3106·10^{-4}; α =0.78193; β =0.34175; φ =1.18811; a =-0.0256; b =1.693; c =5.794.

The sample areas were placed in separate forest stands with different soil, phytocenotic and morphometric characteristics. The results confirmed the adequacy of the proposed laboratory method.

Key words: wood volume, current increase, assessment method.

Reports and Articles – can They be Considered as a Successful Result of Research?

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Technical progress is the main way for the creation of prosperity. Everybody knows that the main lever of development lies in the intellectual field – both technical and artistic creation, and technology transfer of results in marketable products by innovative methods.

Besides, a part of the population (10–15%) must feel aspiration for creation (inventions, innovations). The task of universities is to foster this aspiration. The educational system, first of all, higher education system plays a considerable role in establishing the above–mentioned approach. We have to teach students to become not only skilled employees, but also innovative employers. Actually, we shall assure the continuity in the ERTDI(+I)P line, where: E – higher education; RTD – development of technologies/products/services; I – implementation; + I – special methods for commercialisation of RTD results; P – production.

The commercialisation of RTD results (I, +I, P steps) could be facilitated mainly by the interactions between the driving forces of progress: technology performers, private/public investors, independent experts (technological/financing auditing), the public, and policy–makers (state and municipal levels), keeping in mind sustainable development, especially environmental issues.

The interactions could be enterprise–driven, when the ERTDI chain meets industrial needs:

— the state, facilitated by the financial and legislative intervention at different steps of the chain, for example, the support of well-known instruments such as bioincubators, science parks/centres etc.;
— collaboration between universities and enterprises (very versatile relation).

In reality, the above–mentioned interactions at universities and research institutions are far from the ideal situation. Practically, the majority of research projects finish only with written reports, low quality publications, rarely found in widely accepted data bases, for example, in Scopus etc.; students do not tend to become entrepreneurs. We do not teach students of all levels to create, fix, and sell intellectual property.

The situation shall be changed. Especially important it is now, on conditions of the global economic and financial crisis. Universities should amend the study curricula, and improve teaching of students with the goal to develop creativeness and entrepreneurship. Students shall understand how to become employers in order to develop new/improved products and, consequently, incomes for ourselves and the society all in general.

Obviously, we have to start with ourselves. The following typical existing (A) and suggested (B) functions and activities performed by teachers, first of all, professors are suggested:

A – Professors and scientists, well known in the corresponding scientific field; authors of monographs, scientific articles etc.; leaders of scientific research projects.

B – Professors, high–quality specialists in a professional field. Experts and advisers in a profession, heads of professional associations and other leaders of practical projects. Owners of SME. Criteria for nominating to the post of type B professor: everything as for A, patents, certificates, licensing of IP, the spin–off process, IPO in the stock market, expertise in relevant branches of industry or other practical applications etc. An optimum is a combination of A and B.

However, competitiveness and globalisation are currently hot key words and reality in the job market. Therefore, extending of expertise (A + B) is very desirable. Consequently restructuring of study curricula is among the most important measures to ensure the continuity and working linkages from E to P. Therefore universities, firstly, have to reshape the competence and professional standards for the university (higher education institution) teachers. Secondly, the compatibility among graduates and also

the university teachers shall be a very strong concern. Thirdly, professors (all teachers) shall have an industrial (or other practical) competence. Of course, new additional duties seem rather unrealistic due to the specific Latvian situation (the current dramatic decline in wages).

In order to increase the compatibility on the university level, especially after graduating:

1. We have to start with amending the study curricula to teach creativeness; to teach entrepreneurship as well; to suggest/advise/teach students to become employers.
2. To change the attitude (climate) at universities, and to declare that their concern is the full formula ERTDI(+I)P, not only E and R, as it is, unfortunately, now in the majority of European universities.

As a result, we could expect an increase in new high–tech products, and simultaneously IPO and other innovative indicators.

Key words: higher education, RTD, innovations.

Challenges of Integration on the International Level of the Department of Wood Processing of Latvia University of Agriculture

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Taking into account the present situation in forest industry, it is necessary to look for new possibilities how to improve the study process, and how to create conditions and possibilities for the education of new specialists to recover the industry more efficiently exploiting the existing resources, and thus designing new technologies and developing products with higher value added. It is significant for the general development of the forest industry to foster the development of innovations which is possible due to motivation of more gifted students to undertake studies on Master level and doctoral level both in Latvia and abroad.

Hence a specialisation within the wood processing study programme is created and extended, and potential students when entering Latvia University of Agriculture (LLU) will have the possibility to choose the specialisation to acquire more extended knowledge:

— wood products and technologies;
— industrial design;
— wood product marketing and logistics.

In order to implement successfully the started scientific research as well as to multiply recognition the researchers from the Department of Wood Processing are actively involved in several scientist work-groups such as COST E 34 action "Bonding of Timber", COST E44 action "Wood Processing Strategy", and COST E53 action "Quality Control for Wood and Wood Products". These work-groups were established with the goal to unite scientific competences concentrating on workout of methods of disrupting and non-disrupting wood and wood material research and approbation of these methods as well as workout and development of innovative wood materials. The work in these scientists unions is a great possibility for researchers to be in touch with the latest tendencies in scientific environment as well as to establish contacts and develop cooperation possibilities with the leading researchers in Europe.

The Department of Wood Processing in cooperation with Forest and Wood Products Research and Development Institute is involved in the activities of technological platform the goal of which is to unite the opinions of the interested parties in order to define strategic research programme in several strategically important issues with high social significance where the development, competitiveness and long-term goals of European future depend on significant steps of research development and technologies in shorter and longer terms.

However, the international integration is ensured not only on scientific level but also in academic environment. Both the methodological basis and the material basis should be created in order to foster and develop the exchange of students on international level. The Department of Wood Processing has close cooperation contacts with several institutions of higher education in Europe, for example, Ecole Supérieure du Bois in Nante, France; Poznan Technological University in Poznan, Poland; and Kaunas Technological University in Kaunas, Lithuania. The countries that belong to small language group should implement study programmes in other languages to ensure their graduates with the best possibilities in international competition, since the European Union offers many cooperation programmes in the field of education. Recognising this, the leading European universities and professional university colleges create separate study modules in English thus involving young people of many countries in the environment of international education and research cooperation.

The project "The Improvement of Master Studies Programmes of the Faculty of Forest, LLU for Integration into International Educational Space" is worked out to foster the implementation of students' exchange programme both on the inter-disciplinary level and on the international level. In case of successful implementation of the project the updating and essential improvement of the content of Master study programme of the Faculty of Forest, LLU, could be carried out as well as ensured its involvement into international and inter-disciplinary educational space giving opportunity to undertake

studies in the Master programme not only to the Faculty graduates of Bachelor studies programmes but also to graduates of Bachelor programmes from related specialties. Thus the educational system would be improved, and competent specialists appropriate to the needs of the fast-growing and developing industry would enter the sector. At the same time a tight link between the studies and the industry could be created implementing the activities of improvement of study programme and research possibilities. Introducing study courses on interdisciplinary marketing and logistics, construction, and industrial design, and partly delivering them in English, students develop competences which are currently necessary for the development processes as new enterprises and services of the branch are developing exactly in these fields.

Key words: wood processing, wood products and technologies, international relationships, integration model.

Improvement of Scientific Qualification in Latvia University of Agriculture during 70 years

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In compliance with the Constitution (Satversme) of Jelgava Agricultural Academy (JAA) it was possible to obtain two kinds of doctoral degrees in the Academy – degrees in agronomy sciences (Dr.agr.) and forestry sciences (Dr.rer.for.). The Faculty Board awarded a scientific degree after a successful public defence of the doctoral thesis and then the Academy Council approved the degree. The degree paper was signed by the Rector, Dean of the faculty and Academy Secretary. During the existence of JAA a doctoral degree was awarded to nine people – eight in agronomy sciences (Dr.agr.) and one in forestry sciences (Dr.rer.for., Ernests Roze). Dagmāra Talce was the first to obtain a doctor's degree on April 3, 1940. The last doctor's degree in JAA was awarded on July 5, 1944. In the beginning of 1943 a positive reference on the thesis of Jānis Amtmanis was given by a commission of three people of the Faculty of Agriculture, but due to unknown reasons the thesis was not defended.

In 1944 after the Soviet occupation a two stage system of awarding scientific degrees existing in the USSR, was introduced also in Latvia – Candidate of Sciences and Doctor of Sciences. On March 6, 1945 the order of awarding scientific degrees was not yet specified in the statutes of Latvia Agricultural Academy (LAA) approved by the All Union Higher School Affair Committee of the USSR Council of People Commissars. It was only mentioned that the thesis should be publicly defended for obtain a Candidate Degree. By the Decision of the LSSR Council of People Commissars of April 19, 1945 postgraduate studies for 20 people were established within LAA for training of the new scientists. In 1946, the LAA Council obtained the rights to award the Candidate and Doctoral Degrees in agricultural, veterinary, and technical sciences. The first two theses were defended on May 8, 1947. Andrejs Rozēns, an assistant professor, obtained a Candidate Degree in agricultural sciences and Nikolajs Jansons, an assistant professor – a Candidate Degree in technical sciences. The first doctoral thesis in agricultural sciences was defended on June 20, 1952. Amālija Cekuliņa (November 27, 1959), the Head of the Department of Electortechnics, the former Rector of LAA was the first teacher of LAA to defend a doctoral thesis in agriculture. The Decisions of the LAA Council took effect only after the approval of the Higher Attestation Commission (HAC) of the USSR Ministry of Higher Education (MHE) in Moscow. Besides, the Candidate Degrees of Sciences awarded by the Council were approved by MHE (or sometimes not approved, or approved in accordance with an additional examination involving the so-called "black" opponents), while the Degrees of Doctor of Sciences were awarded by HAC in accordance with the proposal of the Council. Degree papers were prepared in Moscow, the degree papers of the Candidate of Sciences were signed by the Head of the Council and Scientific Secretary, while the degree papers of doctors – by the Head of HAC and Scientific Secretary. In 1963, the LAA Council was supplemented by qualified scientists from other higher education and scientific institutions of the republic, thus improving the scientific qualification of the Council. It was renamed the Scientific Council, and consequently it obtained enlarged powers. The Scientific Council of LAA obtained the rights to award a Degree of Doctor of Sciences in agricultural sciences and technical sciences in the fields of mechanisation of agricultural processes and electrification as well as a Degree of Candidate of Sciences in the fields of agriculture, techniques, biology, veterinary, and economics. The Scientific Council consisted of more than 50 people who participated in all kinds of evaluations of the theses. The Scientific Council of LAA existed until 1975. During that period of time the Council awarded 545 Degrees of Candidate of Sciences and 29 Degrees of Doctor of Sciences. In agricultural sciences 294 people have been awarded the Degree of Candidate of Sciences, and 20 – the Degree of Doctor of Sciences, in technical sciences – 176 and 7 respectively, and veterinary sciences – 17 and 2 people respectively. In economic sciences a Degree of Candidate of Sciences was awarded to 34 people, biology sciences – 24, and pedagogical sciences – one. The Council awarded the Degree of Candidate of Sciences to 212 teachers and employees of LAA, and the Degree of Doctor of Sciences to

15 teachers and employees. Other degrees were awarded to people working outside the Academy, including scientists from all neighbour republics of Latvia as well as Ukraine and Poland. During that period of time 15 teachers and employees of LAA obtained the Degree of Doctor of Sciences and 75 the Degree of Candidate of Sciences outside the Academy.

In 1976, no theses were defended in LAA, because the reform of approval of theses took place in the Soviet Union. In 1977, specialised field councils were established, which operated together with faculties until 1991. At that moment 23 doctoral theses were defended in the science of economics and 157 Scientific Candidate theses (55 agricultural science, 53 technical science, 47 economical science and 2 veterinary medicine science) were defended in the LAA councils. Eight teachers of LAA obtained the Degree of Doctor of Sciences outside the Academy (4 – engineering sciences, 2 – agricultural sciences and 2 – philosophy sciences), and 51 – the Degree of Candidate of Sciences.

In 1992, promotion and habilitation councils approved by the new Latvian Scientific Council started to operate in the University. Until 2008, 17 Doctor habil. theses (12 – engineering sciences, 4 – agricultural sciences, 1 – forestry) and 124 doctoral theses (50 – engineering sciences, 36 – economic sciences, 21 – agricultural sciences, 9 – veterinary medicine, 8 – forestry) were defended. Twenty-seven teachers of LLU obtained doctoral degrees outside LLU (10 – pedagogy, 6 – philosophy, 4 – biology, 2 – engineering, and one in architecture, philology, psychology, physics).

Key words: academy, doctoral theses, Candidate Degree, Doctoral Degree, council.

Professor Arvīds Leppiks – Founder of Agricultural Engineering in Latvia

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The year 2009 is the 120th birth anniversary of Arvīds Leppiks; however already 44 years have elapsed since he has passed away. In the course of time the most essential contribution has remained thus attesting Arvīds Leppiks as the founder of agricultural engineering in Latvia.

Being the son of a Čiekurkalns worker, he attended Čiekurkalns Elementary school, Biķeri Parish school, and in 1907 he finished Peter Real school. A. Leppiks studied in Riga Polytechnic Institute, and graduated it in 1913 as an engineer-technologist.

In 1913 A. Leppiks started working as an engineer at the Baltic Machine Testing Station in Priekuļi, Cēsis district, which should be regarded also as a starting point of his scientific activity in agricultural engineering. Already at the very beginning of his activity he organised machine testing on scientific foundations introducing elements of research into the evaluation of the operation of machines. In machine testing it is not enough simply to state the facts, though correlations are sought among the phenomena, their interpretations, new methods for the evaluation of the designs, and operation of machines. The brochures written by A. Leppiks and published in Petersburg during the years of World War I (1915, 1916) on testing and assessment of stump extractors, mineral fertiliser seeders, and potato sorters served as a witness of his activities.

In 1915, when mobilisation was over, A. Leppiks worked as the head of the design department at a horseshoe factory, he supervised the construction of a fortress near Tallinn, later he was engaged as a specialist in agricultural machinery in the Russian Ministry of Agriculture and the department of agricultural machinery.

In 1919 A. Leppiks returned to Latvia and started working as the head of the Chair of Agricultural Machinery in the Faculty of Agriculture, the University of Latvia (LU), where he remained in this office at the University of Latvia and afterwards at Latvian Agricultural Academy (LLA) till 1944. He organised again the work at Priekuļi Testing Station of Agricultural Machines and headed the Station till 1924 remaining after that as its consultant till 1939. A comparative assessment of the operation of machines, belonging to the same functional group, by their agrotechnical, energetic, and other characteristics is a characteristic feature in the machine testing of this period, which started already before the war. This allows a more unbiased judgement on the advantages or drawbacks of a particular machine in contrast to other machines and its suitability for the use on the conditions of Latvia. Along with the duties of a university teacher and the head of a testing station A. Leppiks carried out scientific research both in agricultural machines, as a whole, and particularly in their most significant operating parts. The subjects of studies carried out by him or under his guidance comprised: seeders of mineral fertilisers and grain, soil tillage machines (ploughs, spring-tine harrows, and cultivators), potato diggers and sugar beet lifters, and grain harvesters.

In 1923 A. Leppiks became an associate professor, and since 1924 he had worked only as a university teacher, expanding and deepening simultaneously scientific investigations in the operating parts of soil tillage machines. In 1934 he was conferred a Doctor's degree in agronomical sciences for the comparative studies of the tines of a spring-tine cultivator and a harrow and their operation. Later, in 1947, the State Attestation Commission conferred him for this work a Doctor's degree in technical sciences. In 1935 A. Leppiks was elected as a professor at the Department of Agricultural Machinery.

After World War II, having returned from Germany, the Professor worked at the Faculty of Agricultural Mechanisation of LLA as the head of the Department of Material Strength and Machine Elements. He was continually interested in the knowledge about the newest in agricultural mechanisation and machines from the literature and taking active part in the shows of the new machines as well as in the evaluation of their designs and operation. The Professor's opinions and conclusions on these issues are usually were perceived as the most authoritative ones.

In 1926 and 1947 A. Leppiks wrote the first extensive books on agricultural machines which were used as textbooks. Here the Professor described not only the structure and operation of the machines but also gave his own assessment on many of them, including the results of his research.

During the period of 1921 – 1940 the Professor participated with reports on agricultural machinery and mechanisation in several international congresses in Germany, Belgium, Italy, and Spain, which consequently resulted in publications in the materials of these congresses. Between 1930 and 1940 has been a member of the international commission of agricultural machines. After World War II the scientists of Latvia were practically deprived of such an opportunity.

Professor A. Leppiks has written more than 30 scientific publications. Most recently he was active in the Terminology Commission of Latvia Agricultural Academy and the Academy of Sciences giving more than 1000 Latvian names for the machines and their operating parts. Together with co-authors he has written textbooks on machine elements and strength of materials.

In general, when we evaluate Professor A. Leppiks' contribution to science, development of new research methods and equipment, training and education of the new specialists and scientists, he should be indisputably recognised as the founder of agricultural engineering in Latvia whose contribution has a yield even today.

Key words: Arvīds Leppiks, agricultural engineering, spring-tine studies.

Development of Agricultural Mechanics during the Past 50 Years

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Agricultural mechanics is a subdivision of the science on functional relationships of agricultural technological processes and machines. Particular knowledge provides a possibility to solve mechanisation issues of the agricultural production in a more motivated, economical and faster way. The development of agricultural mechanics during the past 50 years is connected with the problems and tasks of extension and perfection of mechanised agricultural production. It is developing in seven main directions:

— soil tillage mechanics (terra mechanics) and machines;
— mechanics of sugar beet diggers;
— mechanics of cutting devices for the beet tops;
— mechanics of sugar beet cleaning devices;
— mechanics of broad-grip machines and aggregates;
— mechanics of hydraulic drive and manipulators;
— mechanics of broad-grip fertiliser and chemical (pesticide) sprayers.

Approaches have been formulated and motivated concerning the course of soil tillage technological processes and energy requirement. In contrast to the previous views, a hypothesis was advanced and proved by A. Vilde that the draft resistance of the operating parts of the machines and the respective soil tillage energy requirement depend on the impact of dual forces upon them: the forces determined by the mechanical properties of soil (the mechanical strength (hardness) of soil which causes resistance to the penetration of the operating parts into the soil as well as resistance to its deformation), and the forces depending on the physical properties of soil (the forces of weight and inertia caused by the transferred mass of soil as well as resistance to friction and adhesion). Guided by this conclusion, relationships of the strength of materials and theoretical mechanics are applied for analytical determination of the forces acting upon the operating parts of machines and their elements. The obtained analytical relationships are used for the determination of optimal parameters of the operating parts of machines and the draft resistance in connection with the technological properties of soil and mode of working. On the basis of theoretical research a series of soil tillage machines and some devices were created for which 10 certificates of invention were granted. A computerised tribometric stand was developed in order to study the resistance of soil sliding along the surfaces of the operating parts.

Mechanics of sugar beet diggers, developed by A. Vilde, is a subdivision of terra mechanics. It is an explicit theory on functioning and energetics of one-share and two-share diggers. For the beet harvesters A. Vilde has designed a top cutting apparatus with adjustable correction of the cutting height that improves the quality of its work. A. Vilde has developed the mechanics of sugar beet digging, transportation and cleaning devices for the work in stony soils that increase their working safety on the conditions of Latvia.

A. Vilde, U. Pinnis, A. Cēsnieks, U. Bērziņš have established the main principles for efficient introduction and use of big high-power tractors, and have designed broad-grip high-speed soil tillage and sowing machines and aggregates for the work on uneven rugged terrain fields. The mounted machines and multi-sectional wide aggregates during the operation of which it is possible to transfer their extra weight (in order to perform technological operations) to a tractor using the automatic control system of the tractor hydraulic hitch-up device, hydraulic loaders or other similar means are the best machines on the conditions of Latvia. Therefore original designs and the modes of functioning of machines, couplings and aggregates have been created for which their authors have 12 certificates of invention.

A series of patented devices and schemes of hydraulic drives for loaders and manipulators were created in the Research Laboratory of Mechanics of Agricultural Machines for which 11 certificates of invention were granted (U. Dzintars, A. Mežs, V. Veidemanis, E. Kronbergs, V. Kolmakovs). Designs of a broad-grip fertiliser and pesticide sprayers were worked out (E. Kronbergs, V. Kolmakovs, I. Plūme et al.). Original

designs were created for their hooking on bars and manipulation for which 8 certificates of invention were granted. Under the guidance of A. Mežs and Z. Radziņš a machine for forestry (4 certificates of invention) was improved in cooperation with the Research Institute of Forestry. In the 1960s a lot of efforts was devoted to the analysis and synthesis of plane fore-link mechanisms (O. Ozols, V. Galvanovskis) and investigations of the dynamics of a jib in the lifting and lowering processes of loaders (V. Pūce).

Summing up, the investigations in agricultural mechanics and its achievements bear evidence of the development of agricultural mechanics during the past 50 years and its great importance for agricultural production.

Key words: agricultural mechanics, terra mechanics, hydraulic drive, optimisation of parameters.

Development of Rural Sociology in Latvia

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The country as a research object. Rural sociology is one of the fields of sociology having a rather long history if compared with the other fields. It firstly appeared in the 1920s. Several factors determined the appearance of rural sociology in the pre-war Latvia.

Firstly, for hundreds of years the Latvians have been a peasant nation, which has always had a disposition to land. Secondly, at that time the majority of Latvian population lived in the countryside, and the agricultural production was the main sector of national economy – the key producer of exports with which this country took part in the world market. Thus the farmers and the countryside served as the values of economic life. Thirdly, Latvia was not an isolated territory, but it was closely connected with the rest of the world.

Periods of research and main problems of research. From the present point of view it is possible to deal with several periods in the development of rural sociology in Latvia:

1. the period up to 1940;
2. the period of the 1970s -1980s;
3. the period beginning with the 1990s and continuing up to nowadays.

Each of these periods has its specific character as regards the organisation and the problems due to the change of political, economic, and social conditions. The structure of scientists, their fields of activities and readiness for carrying out research in sociology change as well.

Main research problems in the first period: 1) formulation of the rural life features by comparing them with the urban life; 2) groupings of land owners before and after the agrarian reform of 1922, which brought essential changes in the countryside of Latvia; 3) differences of inner groups of peasantry and also the peasantry situation in comparison with the other classes of the society; 4) additional work of farmers (smith, miller, craftsman etc.) and agriculture as an additional work too (income gained working in different state and municipal institutions, representatives of the so-called free professions, or works in commerce etc.); and 5) wage labourers in agriculture, considered as a special group of rural population.

Main research problems in the second period: 1) class and professional structure of the rural society, particularly the groups connected with agricultural production; 2) agricultural work (contents and conditions of work, organisation of work, professional orientation to agricultural work, professional training system, and other problems connected with this work); 3) analysis of living environment; 4) system of needs and the level of satisfaction are also to be investigated; and 5) at the beginning of the 1970s the work was started on development programmes for working collectives, also in the countryside, which were the first steps to consider the countryside as a holistic system.

Main research problems in the third period: 1) new social groups – farmers, craftsmen, entrepreneurs, wage labourers; 2) new social structure of the society, the centre of attention is peasantry (farmers); 3) processes of differentiation and stratification of the rural society; 4) more visible attention to territorial approach; 5) rural women, their role and status in the society and family – a more significant object in comparison with the previous period; 6) civil society formation process in the countryside – activities of local governments, non-governmental organisations, and other civic institutions; and 7) rural labour market and life-long learning problematic – one of the focuses of researchers.

Latvia University of Agriculture as one of the research centres. As regards the organising aspect, the time from the 1970s may be considered as the activity of small separate groups in Riga Polytechnic Institute, Latvia State University, and Latvia Agricultural Academy. However, Latvia Agricultural Academy gradually becomes the main research centre of rural sociology. Up to 1991 the guidance of the Rural section of the

Baltic branch of the Soviet Sociologists Association was located in the Academy. As of 1972 regular conferences dedicated to the problems of rural development are held in the programmes of which the reports having results of sociologistic research take an important place. During the Soviet time the researchers from Estonia, Lithuania, Byelorussia, and Russia met but during the years of regained independence – the researchers from the Baltic and Nordic countries, Germany, the Czech Republic, and Poland etc. In the years of independence the consolidation of people working on rural problematic (research groups and project teams) has taken place.

Research topicalities. 1. Development of rural concept, as the previous one is not any more connected with the real situation, while the new one has only the administrative and not the scientific meaning. 2. Rural territories are not analysed as a socially territorial totality having a whole problem range, e.g., through a space capital meaning. 3. Whole groups of population (working in medicine, education, communication, trade, building, melioration, social services, administrative departments etc.) living in rural territories have not been analysed. 4. The priority attention is still paid to the urbanization although in many EU countries the process of re-urbanisation or counter-urbanisation is expanding for at least five years. 5. The countryside begins to disappear as a constant research unit, as a complex system; it is often replaced by a regional aspect concentrated to the medium indices in the region.

Key words: research object, research periods, research problems, research centres.

Regional Higher Education Institutions and their Contribution to Economic Development Efforts

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Back in the past, colleges, institutions and universities worldwide focused on one main objective - educating students in different subject matters for different roles in the society. Higher education institutions taught students and awarded degrees based upon the programmes that had been in place for many years and that were driven by what the university wanted to teach and what students were interested in. However this approach has not been responsive to the needs of private sector employers. Regional policy in Europe developed in a period characterised by reconstruction and economic expansion, accompanied by trade liberalisation and economic integration. The transition from the agricultural to the industrial and knowledge society in the second half of the 19th century has brought enormous economic, social, and demographic upheaval. One key area where universities have been observed contributing to economic performance is their contribution to promoting innovation. Thus knowledge institutions are increasingly expected not only to conduct education and research, but also to play an active role in the economic, social and cultural development of their regions. The extent to which higher education institutions are able to play this role depends on several circumstances, like, the characteristics of the institutions, the regions they are located in, and the policy frameworks. The contribution of HEIs to developing their home regions is changing with the expansion of higher education, particularly in the non-university sector, which in some cases has aimed to address regional disparities.

Higher education institutions influence the society in a number of ways, and the research done in favour of rural development is one of them. Human and physical capital is considered to be determinants that stimulate economic growth and production output level.

In a globalised economy this role is growing in importance. Worldwide a typical example of regional universities refers to Oxford, Cambridge, Harvard, Uppsala, Tartu, Heidelberg, and Freiberg Universities: they all were established to promote regional development, and they still exist as regional universities or universities in the region. These universities are considered to be even better than those located in the capital cities. In case of Latvia this aspect shall be taken into consideration to enhance the development of institutions themselves.

The previous two decades have provided the onset of establishing regional institutions of higher education and branch campuses of existing institutions of higher education throughout Latvia. Although the term 'regional institution of higher education' cannot be found in any legislative and normative documentation, it is used to designate any institution of higher education that is not located in the capital city Riga. Regarding regional HEI, they are HEIs of an especial mission with the basic objective to implement scientific and research programmes necessary for regional development. In 2008 the sector of HEIs comprised 24 higher education institutions and 14 research institutions integrated into HEI, where scientific research was being carried out. Six higher education institutions have a status of regional HEIs: Liepāja University (founded in 1954), Daugavpils University (1921), Rēzekne Higher School (1993), Latvia University of Agriculture in Jelgava (1863, as an independent HEI from 1939), Ventspils University College (1997), and Vidzeme University College (1996). However only 3 of them provide doctoral studies and grant doctoral degrees: Latvia University of Agriculture, Daugavpils University, and Liepāja University. The study does not cover affiliates of higher education institutions established in the regions of Latvia.

The usual indicators of regional disparity are employment (working and unemployed), regional GDP per capita, growth rates, settlement structure, population density per square kilometre, and access to technical, social and infrastructure facilities.

The comparison of the indicators showing the socio-economic development and the number of students by regions leads to the conclusion that students also choose the

higher education institutions in more developed regions, where they see perspectives for future employment. It once again proves the urgent requirement for the necessity of a special support, including the aid for higher education, for the least developed regions of Latvia. Nevertheless two HEIs are located in Latgale region it is the least developed region, mainly due to low entrepreneurial skills of population and business depression governing there. It is difficult to conclude that exactly regional HEIs are the key driving force of the development, yet beyond doubt it is one of the factors stimulating economic growth.

Generally transfer of national economy to modern technologies, science-based production, and production of products with high value added was started in Latvia. Therefore the role of higher education, especially universities, as the producers, promoters, and supporters of the mentioned transfer is very significant for the today's society. Undeniably academic staff and research activities are the most important factor to ensure quality of education. Guidelines on the Development of Higher Education, Science and Technologies for 2002-2010 envisage restructuring of universities into the main scientific centres of Latvia, where high level scientific research, mainly fundamental one, would be combined with high quality academic and professional studies in sufficiently wide sectoral aspect.

Latvia urgently needs a special programme on the recruitment of young gifted specialists to research and teaching work at regional universities by noticeably increasing the number of doctoral students enrolled, and the volume of doctoral grants to those new researchers who devote themselves and their work in favour of rural development and particularly the regions they come from.

In summary, there are several ways in which a college or university can make significant contributions to regional, state, and national economic development initiatives. A higher education institution has to first have a desire to do so. Secondly, a college or university shall know its strengths and assets that can be leveraged to benefit its organisation and geographic area in which it can have an impact. Thirdly, the higher education institution entity shall have a vision of what it would like to achieve. Finally, the college or university shall have an implementable strategic plan. To maximise results for a region, state and country, the higher education institution shall be engaged with government, the private sector, other academic institutions, and the non-for-profit organisations. If everyone is working together to support economic development initiatives, everyone will benefit.

Key words: higher education institutions, regions, economic development, employment, studies.

Ecology of Education as a New Interdisciplinary Research Trend

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The semantics of the concept *ecology* for many scientists is still related merely to the research in the field of natural sciences, first of all, in the field of animal and/or plant ecology as well as to the solution of nature protection and sustainability problems nowadays. It has its substantiation, since the term *ecology* in the scientific terminology was introduced by a German zoologist E. Haeckel who was also the founder of the new interdisciplinary research trend *bioecology*. Thanks to the research performed by an American scientist Ellen S. Richards and her colleagues, at the end of the 19th century the USA became the grounds for the new interdisciplinary research trend — *human ecology,* which, alongside with *bioecology*, develops nowadays as an independent trend of ecology. During the 20th century there emerged and developed new scientific conceptions and theories, representing different sub-trends of human ecology**,** because the ecological paradigm became an transdisciplinary scientific paradigm. The new trends of human ecology began to develop on the basis of particular sciences, focusing the scientists' attention towards one or several environmental contexts. In human ecology we can distinguish *psychological ecology/ecology of psychology, economic ecology, politecology/ ecological politology, social ecology, cultural ecology, art ecology, family ecology, anthropological ecology, deep ecology/ecosophy as environmental ethics etc.* Human ecology is *the universal scientific* trend, which provides new — *ecological perspectives* — for the innovative, up to now unconventional research in different scientific disciplines.

The philosophical-methodological basis of the various trends of modern human ecology became also the grounds for the development of *ecology of education* as an interdisciplinary trend of human ecology. *Ecology of Education* is one of the trends of human ecology; the interdiscipline integrating natural, social sciences, and the humanities, which studies the interaction between a human being as individual and/or social systems and the multidimensional environment from the holistic perspective, viewing education as the facilitator of the sphere, process, result, and development of human activity in the aspect of human and environmental quality/trait. Due to the variety of the trends of human ecology, the varied explanations and interpretation of the concept *environment* are also transferred to educational ecology: 1) environment — it is *us* (social environment); 2) *environment is everything that surrounds us* and *is outside us*; 3) environment — *the totality of the reflections* of real things, phenomena, processes *in the human psyche*; 4) *environment is a multilevel ecological system (ecosystem), within which a human being is as an endosystem, sub-structure of ecosystem;* 5) environment is *a multi-component* and *multi-functional system* of interaction, *where a human being is an integral part of environment;* 6) environment as *an interaction process;* 7) environment as *the sphere of* human *activities*; 8) environment as *the field of semantics*; 9) environment as *a resource*; 10) environment as *a means for social stratification.*

Educational ecology possesses the significant potential for interdisciplinary research and several developmental perspectives, as a result of which through research it is possible to solve several modern topical problems: 1) promotion of human development, self-realisation in the educational environment; 2) studies and development of different human qualities and their totality (viability; competitiveness; competences; creativity; thinking, mental and emotional flexibility; attitudes etc.) in the educational environment; 3) education for: human socialisation and culturalisation; the successful human adaptation, integration and development in the changeable and multi-functional environment: social, cultural, different professions etc. environment; the development and improvement of home environment; 4) education for the development of human basic competencies for living on changeable conditions, in the rapidly changing human-built, including environment of information and latest technologies; 5) ensuring of lifelong learning in the varied educational environment for the development of knowledge society; 6) sustainable development of educational environment systems, including schools, higher education institutions, on the changeable conditions; 7) the development, experimental approbation and implementation into practice of conceptions and models of an open,

accessible, appropriate and developing educational environment which conform with the needs of modern society and each individuality, 8) education for the sustainable and balanced development of social, economic, and natural environment; 9) environmental values, career education as a over-content and the contextual approach to its integration into the study process; respecting of the balance principle *I – Ego* and *I – Eco* in the thinking and activity of a human being and the whole society, in the development of values and attitude systems for the sustainable development etc.

Research at the Institute of Education and Home Economics of the Faculty of Engineering of Latvia University of Agriculture performed in the field of educational ecology, has been acknowledged not only in Latvia, but also by the international level scientists from various countries.

Key words: ecological paradigm, ecological approach, educational ecology, educational environment, sustainable development.

Rural–Urban Fringe in Latvia after the Administrative Territorial Reform

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Polycentric development is one of the central concepts in the discourse of European spatial development since the publication of the European Spatial Development Perspective (in 1999) where sustainable and polycentric development is formulated as a strategic goal. Since that time a lot of research is focused on different dimensions of the polycentric development – polycentric urban regions on the European and national scale, hierarchies of cities and towns. Less attention is devoted to the analysis on the polycentric development in the sub–national scale – polycentric development of the regions. From this point of view a concept of functional polycentrism, defining polycentricism in terms of spatial organisation, simultaneously taking into account also the functional interconnectedness of settlements could be efficient. Polycentric development could be defined as a network of functionally interconnected cities, towns, and rural areas.

The National Development Plan envisages the polycentric development of the network of towns and cities as one of the main preconditions for the sustainable development in Latvia.

In accordance with the OECD classifications, which are based on such criteria as population density, in Latvia only Riga and its surroundings can be characterised as an urban region, the rest country is predominantly rural, where over 50% of the population live in communities in which the population density does not exceed 150 per km^2. The structure of Latvia's population density can be divided into four categories of habitation with different levels of urbanisation: the city of Riga; other cities of Latvia, which in the EU context would more likely be classified as medium–sized towns; and other towns, including regional centres that cannot be classified as big cities and rural areas.

Today there are 77 towns in Latvia. Depending on their size, towns play different roles in attracting and retaining people, and their residents have different opportunities for taking advantage of various types of services.

After the administrative territorial reform the new administrative division of Latvia consists of 9 republican cities and 109 amalgamated municipalities, in total 118 municipalities; and roles of towns and cities are changing. The previous socio–economic structure of Latvia was formed in the frame of administrative structure of districts. The new amalgamated municipalities differ quite a lot not only in size and number of population, but also in socio–economic potential of new district centres and impact on rural areas. The former district centres and towns benefiting from support for towns within the EU SF co–financed activity (for example, Smiltene, Līvāni) have become dynamic development centres providing wide range of good quality public services, while the development potential of some other new municipality centres is low. Some of the newly established municipal centres, such as in Tērvete, Rucava, or Rugāji municipalities even do not reach the criteria set by the legislation for these centres. Does it mean that new towns should be developed in areas with low density of population, weakly developed public transport infrastructure and in some cases far from larger centres to provide equal availability of public services? There is a risk of further widening of the gap between the central and peripheral areas, further disparities in the regional development.

In conclusion, consolidation of municipalities in the process of the administrative territorial reform should be continued to create preconditions for polycentric regional development – hierarchy of the settlements based on strong urban network and urban–rural partnership.

Key words: regional development, spatial development, polycentric development, urban-rural partnership.

Motivation of Students of Rural Vocational Secondary Schools for Studies in Latvia University of Agriculture

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Ongoing changes in the society, comprising its nature, institutions, behaviour, and relations of a community people, have a relevant impact on young people's motivation to be career-minded. Its successful development cannot happen without getting a qualitative education yet. The increasing internationalisation of economics, scientific and technological progress, particularly the rapid development of information technologies, fosters the formation of new ways of employment. Therefore education institutions should provide updated and qualitative getting of knowledge and skills. The quality of Latvia's countryside production and environment protection will directly depend on the rural young people education quality. Each education institution has to offer a possibility to comprehend and evaluate career prospects to the young people. It is vitally important for students of vocational education institutions to realise the significance of non-interrupted educational process after getting into the labour market. The implementation of the career education model at secondary vocational education institutions is a vital basis for the young people's career prospects, education kind, and level choice. One of the model functions is to help the young people to keep their learning motivation. Latvia University of Agriculture is a higher education institution of national and regional importance that promotes the rural young people to receive education.

About 30% of Latvia's population still lives in rural areas. Although in the process of urbanisation the vast majority of Latvia's population lives in cities and towns, still the countryside is not only the source of food and raw materials but also the environment which is important for the development of mentally healthy new generation. The intellectual potential of Latvia, protected and non-polluted environment, agro-climatic conditions and other factors are a precondition for competitive activities in the countryside. Its existence should be respected as a space for living and production. Therefore Latvia's countryside future vision is multisided business activities carried out by high qualified, educated, and active entrepreneurs.

Latvia University of Agriculture (LLU) is the only university type higher education institution in Zemgale region, and its mission is to educate intellectual potential for Latvia, and particularly for sustainable development of its countryside. LLU objectives are: to prepare academically educated specialists for national economic sectors, science, culture, education, and state administration; to prove itself as a significant education institution for preparing competitive new specialists; and therefore becoming a university with active involvement in the common European education and science area.

Teaching/learning process at secondary vocational school where students' knowledge, skills and attitudes emerge also from their self-evaluation based on a constructive approach is one of significant factors for motivation to continue studies at a higher education institution. Active interaction among the vocational school students, pedagogues, parents, and employers in career development fostering environment makes learning process more effective.

The following conditions have an impact on young people's education choice ideas:

- the choice to continue education in higher education institutions to a great extent is influenced by special subject teachers and parents;
- the most optimal time to motivate students for studies at higher education institutions is the third year at vocational school, since at that time a young person forms his/her view on the significance of learning binding together theory and practice in the chosen professional field;
- less than a half (41%) of questioned students of LLU who are graduates of rural vocational secondary schools recognise that they have been motivated for studies externally; it means that very close co-operation among vocational schools, labour market and higher education institutions is necessary;

— relevant obstacles for vocational school graduates to choose studies in higher education institutions are insufficient learning results in academic subjects and foreign languages as well as the lack of independent learning skills.

The objective of the Institute of Education and Home Economics of the Faculty of Engineering, LLU is to offer career counselling models to vocational secondary schools in the frame of scientific direction of career education to promote young persons' deeper comprehension of their abilities, knowledge, skills, attitude, interests, aims, actual possibilities, and significance of education in the labour market.

Key words: motivation for studies, rural vocational schools, higher education.

Main Tendencies of the Development of Small Towns

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Small towns play an important role in sustainable development of territories, however insufficient attention to their systematic investigation still is paid in Latvia. Therefore some investigations were done by the Department of Sociology together with specialists from the Faculties of Economics and Information Technologies during 2006 – 2008. The aims of these investigations were to ascertain the main problems of small towns and the way they are solved by local municipalities to provide sustainable development.

Twelve small towns were included into the investigation. There were four selection criteria: 1) they represent various regions; 2) they are located in a different distance from the centre of a region and Riga; 3) the number of population is less than 10000; and 4) they have an experience of positive changes. Investigations were based on the qualitative research method. Sixty semi structural interviews were done with the leaders and specialists of local municipalities and local employers.

The migration of population to the centres of larger regions as well as abroad is a serious problem of small towns not only in Latvia but also in Finland, the Netherlands and the United Kingdom. Therefore investigations showed objective and subjective fascinating factors applied by local municipalities, as the main factors being the following: maintained possibilities of work, attractive cultural environment, and sense of belonging.

Employment in small towns has a local character and is oriented towards satisfaction of local needs, local market, and consumption. Specialisation of production is necessary due to the limited number of jobs in small towns. But the level is still low. Traditional branches of production as wood production, food production, sewing, and tourism are developing in small towns. Metal processing and production of renewal energy were maintained as non typical branches of production.

Attractive cultural environment is an important fascinating factor not only for local inhabitants but also for inhabitants of surrounding territories. School is an integral part of this environment.

Relations between local inhabitants and the loyalty serve as basis for the sense of belonging. Local as well as emigrated inhabitants get together during a town's festivals and similar entertainments.

Strategies used by local municipalities to develop small towns as production and service centres were also ascertained during the investigations. Two groups of strategies should be mentioned in general: temporising and development oriented. The latter can be divided into traditional and innovative. The majority of small towns apply traditional strategies in their development.

The lack of a uniform definition and typology of small towns hinders investigations. Therefore investigations shall be continued. Such fields as social networks, social capital, social cohesion, and others are interesting for further research.

Key words: small town, strategy of development, fascinating factors, cultural environment.

Application of the Analytic Hierarchy Process in Education and Research in Latvia University of Agriculture

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The decision making is the final phase in the studies of any problem, and it is the most important part of this process. The technology used to prepare and adopt a decision has much to do with whether or not all of the information that has been collected during the process is actually used.

The Analytic Hierarchy Process, or AHP, is widely used in the United States, Japan, and in many other countries. In order to deal with certain problems and to take relevant decisions the AHP has also been used in Latvia and especially in Latvia University of Agriculture (LLU). During the past ten years, the AHP has been used in many decision activities in agriculture, economics, education, and regional development. The first time the method was used in LLU for evaluating the productivity and territorial placement of companies which were engaged in primary processing of grain. In the first (or top) level, the overall goal was "Location of a grain primary processing plant". The second level comprised eight criteria which contributed to the goal: total specific expenses, the project, territorial location, financial regulations, and development of the location place, skilled labour power, environmental protection, and grain primary processing system in the district. The third (or bottom) level included three candidate places which had to be evaluated in terms of the criteria in the second level. The experts estimated the significance of the criteria and compared the alternative locations of the grain primary processing plants in relation to each of the criterion.

Further on the AHP method was used in the decision making related to the development strategy of sugar production industry in Latvia, in assessing technical and technological aspects for choosing the appropriate agricultural machinery, and in the analyses of the models for integration of meet production, where six criteria were offered: development of meat production branch; mutual economic profitability of meat producers and processors; cut-down of expenses for the primary and secondary spheres; assurance of independent and constant quality; priority of sale prices; and increase of competitiveness for all participants of the integration. The alternatives included five integration model options of meat production, which had to be assessed in relation to criteria.

The AHP method in Latvia has been used in various fields, including education: "Development of Higher Education System in Latvia" and "Analysis of Structural Models of General Upper Secondary Schools" (Eglītis J., Rivža B., Rivža P., 2003), where the AHP algorithm was applied in the analysis of the structural models of general upper secondary school. The objective in this research was the accessibility of a qualitative general upper secondary education.

Another field of application of the AHP method is the analysis of various options for the administrative and regional structure and the development of vocational education in the regions of Latvia.

There are recent studies in the field of banking where the AHP method is applied in the research of the role of crediting in the development of Latgale region, the AHP method was used to ascertain, which kind of support (status of specially supported region, accessibility of loans, or accessibility of the EU structural funding) assures support for small and medium scale enterprises most effectively. Besides there is a research made in the sector of macroeconomics, where the AHP method is used for the evaluation of the economic stabilisation programme in the context of economic recession and a necessity to develop and implement a plan for an economic stabilisation and recovery. Here the AHP method was combined with the PEST method in aspect of setting up the criteria for the experts' evaluation. Three possible scenarios of economic stabilisation programme in Latvia where developed in the scope of the study. The research showed the highest ranking in the expert assessment for the third scenario *"Reduced costs considering priorities and the implementation of a progressive personal income tax rate",* which in this case was considered to be the best option.

The application of the AHP method in the study process. Students of Latvia University of Agriculture study the AHP method as a part of several study courses: "Quantitative methods in economics" and "Operation research". Doctoral students of the Faculty of Economics study the possible applications of the AHP method in the field of economics within the study course "Quantitative methods in the research of economics". It results in many successful applications of the AHP method in the doctoral theses and further researches.

Concluding remarks. The Analytic Hierarchy method can be used in the last stage of an evaluation of almost any problem, applying it at the point where a decision has to be taken or where one of many alternative options must be selected. LLU has an experience of applying the AHP method in the analysis of grain, sugar, and meat production, rural tourism, education systems, regional development, and macroeconomics.

Key words: AHP, agriculture, education.

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