FOREST SCIENCE IN LATVIA

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In the territory of present-day Latvia the forest has, already for more than ten millennia, been the prevailing ecosystem which follows the rules of its own. The distribution of forest lands as it exists now takes its origins in the history of the country and has especially been affected by two factors, the diversity of natural conditions and the man's economic activities, the farming in particular.

At first the man's impact on the forest was insignificant, but it increased with time. The forest was used as a source of timber and firewood, tar, resin, wood charcoal, bast, game, mushrooms, berries, honey and a number of other products. In ancient times it was a common practice to burn out forest lands to have fields and pasture lands instead. After repeated burning-out, a part of the areas under similar management practices paludified, while on another part the substrate lost its fertility and could no longer be used for farming. Just this situation made the man to start thinking how to manage the forest.

The earliest attempts to introduce some kind of forest administration and management date back to the early 17th century. The first laws concerning forest management were passed at that time. In Latvia the first ever published papers and books on forest management, predominately codes of directions and pieces of advice to foresters, appeared already at the end of the 18th and the beginning of the 19th centuries. The activities of the German-origin foresters A. Leviss and A. Bode in the early 19th century in this country are to be considered an important landmark in the history of Latvia's forestry, as they laid the foundations of science-backed approach to forestry issues. The Handbook of Forestry in Vidzeme by A. Leviss published in 1814 may also be regarded as the first manual in silviculture. The given work provides information on forest tree species, seed production, reforestation, basics of forest management planning, and a novel method for stock volume evaluation by using sample stems.

A regular research work in the field of forestry may be said to have started in 1867 when the Baltic Foresters' Society was founded, headed by M. Siverss the founder of the Skriveri Dendrological Park. The society incorporated the sections of silviculture, forest land drainage, forest utilization, forest protection and management planning. The society members appeared regularly to the public and in the press ("Lesnoj zurnal" (Forest Journal) published in St. Petersburg) with reports, articles and communications.

Eizens Ostvalds deserves here to be mentioned as one of the most eminent foresters and forest scientists who was the first to publish research data supporting forest land drainage as well as worked out the theory of ground rent as applied to forestry.

The forest science of Latvia has drawn from both the German and Russian traditions, as in the field of forestry until the post World War I period, there was no higher educational establishment or research organization located in the Baltics. The forestry on an academic level could be mastered at Tarandt and Eberswalde (in Germany) or at the St. Petersburg Forest Institute in Russia. The first research organization, the Latvian Forest Research Station, was set up in 1928, headed by the prominent Latvian scholar Kriss Melderis (1889-1942), who, prompted by the Russian professor G.Morozov, had, already during his student years in St. Petersburg, started a large-scale research work. K. Melderis is the author of over 50 scientific and popular papers and books on forestry, forest typology, entomology and reforestation.

The leading researchers of the Latvian Forest Research Station as E. Kalnins, L. Lazdins, A. Kundzins, K. Buss, V. Lange, I. Rozentals, were dealing with the most topical problems of practical forestry of that period: reforestation of sandy and low-fertility sites, promotion of natural forest regeneration, thinning, as well as introduction of exotic tree species and rational methods of timber harvesting.

Forestry research was also taken up by the teachers and the most versatile students of the Forestry Department of the Faculty of Agriculture of the Latvian University (1920-1939), which was subsequently transformed into the Forestry Faculty of the Latvian Agricultural Academy at Jelgava.

Among the most outstanding research workers in the field of forestry who were active during the interim between the world wars and even later we may mention Arvids Kalnins (1894-1981), the founder of the Latvian school in wood chemistry and the chemical processing of wood, R. Markuss specializing in forest land drainage and management planning, K. Kirsteins (forest biology), A. Kundzins (reforestation), V. Eihe (forest typology, forest biology), N. Zemitis (forest cultures), E. Kalnins (thinnings), L. Brammanis (forest entomology) etc.

Already in the late 20s the Latvian forest scientists were actively co-operating with the International Union of Forest Research Organizations (IUFRO). Likewise, during the 60s, when Latvia was under the Soviet rule, the Latvian scientists participated in the activities of some divisions of the IUFRO organization and delivered reports at its congresses. It was in 1980 that the Latvian Research Institute of Forestry Problems (now Latvian Forestry Research Institute "Silava") officially

became a full member of the IUFRO. A new period in the development of forestry and forest science in Latvia was ushered in following the annexation of Latvia by the Soviet Union in 1940 and the end of WW II in 1945.

The establishment of the Latvian Academy of Sciences in 1946 was accompanied by setting up with this organization of the Institute of Forestry Problems (its first director was Professor A.Kalnins). Among the most prominent researchers of the first decade of the Institute's existence one may mention M. Buss, R. Indans, J. Matuzanis, R. Sacenieks, J. Mezals, A. Eglite, J. Gailis, E. Mikitis and others.

By the late 50s the research problems dealt with embraced already a much wider spectrum: manufacturing of vitamin meal for fodder, (J. Abolins, A. Kalnins), drying of timber in large kilns (E. Mikitis, K. Upmanis), design of hand- and motor-manual saws, rationalization of logging operations (R. Indans, J. Mezals), the volumes of residue in logging operations and its utilization (J. Abolins, I. Ievins), pests attacking pine and spruce (G. Ozols), spruce breeding (V. Rone).

Since 1953, with the Forest Research Station "Kalsnava" set up at Jaunkalsnava (the Madona region in the central upland part of Latvia), the Latvian Institute of Forestry Problems, namely its silvicultural divisions, has its permanent research base.

In 1963, because of the restructuring of the Academy of Sciences, a number of institutes, mainly those oriented to applied research, were transferred under the administration of the respective branch of economy. On the basis of the wood chemistry laboratories of the said academic institute, the Institute of Wood Chemistry was founded, while the forestry-oriented divisions as well as the Forest Research Station "Kalsnava" were merged to form the Latvian Research Institute of Forestry Problems, in existence since Jan. 22, 1964 (director I. Ievins), under the supervision of the Ministry of Forestry and Forest Industries. As the institute was housed in a building unsuitable for research work and the laboratories were crammed for space, the construction of new premises, with the funding for science increased, was soon under way at Salaspils, in the vicinity of Riga.

Proceeding from the presumptuous ambitions of the integration of science and production in the one-time Soviet Union, the Latvian Research Institute of Forestry Problems was used as the base to set up in 1976 a gigantic complex - the Research and Production Association "Silava", by far exceeding the local needs and out of tune with the local conditions. It incorporated the Forest Research Station "Kalsnava", the Computing centre, the project and design organisations, an experimental machine-building plant and some minor support organizations. The principal objective for establishing the association, though never achieved, was to translate into practice the results of the research and development activities. During that period the Association "Silava" hosted a number of international symposia, conferences and workshops, the international prestige of the Latvian forest science increased, the scope of research work expanded, contacts with a number of countries all over the world were established.

A rapid growth and expansion was also experienced by the Institute of Wood Chemistry of the Academy of Sciences. In 1966 it was turned into a centre for co-ordinating the research activities all over the Soviet Union in the field of wood chemistry and the related branches, predominately impregnation of wood, technologies of wood chemistry, wood hydrolysis, man-made biologically active derivatives of pulp.

The restoration of the independence of Latvia in 1990 brought about an upheaval in forest science, too, dramatic and completely unpredictable at that. Fundamental changes in the political and economical life of the country, a turn to privatization and market economy crushed down the organizational framework of science created by socialism, including the Research and Production Association "Silava". These changes resulted in a number of private, research-oriented organizations emerging, including the non-profit state-owned organization - the Latvian Forestry Research Institute "Silava".

Unfortunately, Latvia, a country rich in forest resources, experienced a collapse of a number of institutions within the organizational set-up of the forestry sector, with the scope of research reduced accordingly. However, the forest science was successful enough to win legal recognition. The brainpower within this branch of science amounts to 108 doctors of science and 14 persons conferred the title Dr. Habilitus.

The Latvian Forestry Research Institute "Silava" still remains the hub of the research and development work in the forestry sector, regardless of the difficult situation with its material and technical base. Despite of the critical situation the Latvian Forestry Research Institute "Silava" managed to organize in the autumn of 1993 a IUFRO conference on Norway spruce provenances and breeding.

At present the institute is headed by Imants Baumanis, Doctor of Forestry, an expert in forest tree breeding.

In the course of time the Latvia's forest science has, in all the principal spheres of research, shaped standing traditions of its own.

FOREST ENVIRONMENT AND SILVICULTURE

The forest typology, in line with the local natural and climatic conditions, is the cornerstone of silvics in Latvia. It is the result of a gradual development with the contributions by such scholars as I. Gutarovics, K. Kirsteins, K. Melderis, A. Zviedris, P. Sarma, K. Buss. In this typology the forest site is described in terms of its salient features - stand, live ground cover and substrate. It is due to K.Buss that objective systems analysis methods were applied to identify forest types.

Both the scholars K. Buss and P. Zalitis have contributed significantly to forest hydrology. Under the conditions prevailing in Latvia, forest land drainage acts as an obstacle to exclude the transformation of high-productivity forest ecosystems into low-productivity marshy ones. Over 50% of

forest lands are affected by paludification and the groundwater table on these areas is dependent on the groundwater pressure discharge.

The conclusions inferred in the studies on forest typology and hydrology enable us to evaluate forest ecosystems as self-regulatory ones. The feature of natural self-regulation inherent to forest ecosystems validates the concept of end-use stand, laying bare the peculiar role in forest's life played by the chief tree species and pioneer ones.

Forest ecosystems display a number of precious traits: high stand productivity, the precedence of indigenous species under the growing conditions adequate for them, the diversity of habitat typical for the species making up these ecosystems and the successional diversity of tree species indicative of the forest types identified. The conservation of these inherent traits requires a constant attention of foresters and researchers, acting in partnership. These deductions worked out are based on a body of field data collected on permanent sample plots over a long period of time.

Apart from constant hydrological observations in 5 run-off basins, the post-drainage transformations of forest stands, as well as run-off, ground water table fluctuations, soil humidity, evapotranspiration and interception in diverse-structure stands have since 1963 been followed up at the Vesetnieki permanent sample plot with the Forest Research Station "Kalsnava".

The modes of final felling used in Latvian forestry are based on the successional types of forest tree rotation: clear cuttings (the average area below 3 ha), selected cuttings and select-group cuttings. Over 50% of cutovers are reforested by pine (by using two-year seedlings), spruce (3 to 4-year seedlings) or other principal species. The rest of the cutover areas are left to natural regeneration mostly by pioneer species, the principal species emerging in rare cases.

The main inferences about the forest fauna are very close to those for central and northern Europe.

The fauna of Latvian forests has been transformed by man. For some or other reason the indigenous species of beaver, red deer, wild boar, brown bear, auroch, glutton have been lost or done away with. We have succeeded in reintroducing the populations of beaver, red deer and wild boar. There exists a small population of brown bear, too. Regaining the moose population during the period between the 60s and 80s resulted in a conflict situation between forestry and game management as this animal inflicted damage to young stands of pine over large areas, including bark stripping of spruce stems.

In the domain of forest environment and silviculture, the problems identified and dealt with are as follows:
- structural model for the prospective forests of Latvia (J. Bisenieks, I. Tjarve);
- hydrotechnical amelioration of forest lands and their appropriate management (P. Zalitis, G. Gerkis, T. Gaitnieks);
- ecologically sound and economically feasible fertilization of forest stands (R. Sacenieks, E. Spalte);
- forest vitality and the ground cover vegetation as bioindicator (A. Abolina, M. Laivins, B. Bambe);
- game management as a part and parcel of forest management (M. Balodis, V. Gaross, G. Ziedins).

FOREST PLANTS AND FOREST PROTECTION

The Latvia's forests are made up of predominately indigenous tree species, the most important ones being Scots pine *(Pinus sylvestris)*, Norway spruce *(Picea abies)*, birch *(Betula pendula, Betula pubescens)*, common aspen *(Populus tremula)*, sweet willow *(Salix caprea)*, alder *(Alnus glutinosa, Alnus incana)*, ash *(Fraxinus excelsior)*, common oak *(Quercus robur)*, elm *(Ulmus laevis, Ulmus glarbra)*, lime tree *(Tilia cordata)*.

The regeneration of cutovers by pine is normally done either by planting or seeding, and, in rare cases, by natural means. The pine stands of today have, for the most part, been established by seeding. More than one generation of Latvian researchers have been working on the development of methods for seeding and tending the stands established like that (K. Melderis, E. Bakuzis, M. Buss, Z. Suna). However, the above practices for regenerating pine are on the decrease mainly due to higher prices for seed, spread of needle and shoot diseases, greater expenses for stand tending. For regenerating cutovers on coastal dunes, which is a process having peculiarities of its own, the research people recommended Scots pine *(Pinus sylvestris)*, mountain pine *(Pinus montana)*, some willow *(Salix)* species, while sand is fastened by spreading branches over the ground surface or by burying in the ground wattle fencing made of twigs (B. Jurkevics, M. Buss, K. Eihe, V. Kaposts). Developed is a science-backed method for afforestating dune areas and abandoned quarries by means of the container stock "Brika" (J. Broks, B. Pelse, M. Buss).

The regeneration of cutovers is also done by spruce, while an undergrowth of spruce is cultivated over the areas to be harvested in gradual felling. The methods of regenerating spruce have been evaluated and improved by E. Bakuzis, A. Zviedris, I. Mangalis.

The nursery methods for cultivating the planting stock of pine and spruce have been investigated by I. Mangalis. G. Igaunis has developed and recommended for practice an adequate method for cultivating conifer seedlings in plastic-covered greenhouses.

Ash, birch, aspen, black alder and white alder regenerate in Latvia by natural means. A project is under way for the most adequate methods of cultivating planting stock of oak, ash, birch, aspen, black alder including the most rational planting and stand tending techniques (I. Mangalis, J. Broks, M. Daugaviete). Another project is undertaken to evaluate the use of silt in sewage and waste-water treatment plants as a fertilizer in nurseries and forest plantations (I. Mangalis).

Some methods for site preparation for laying new stands or promoting natural regeneration are currently tested by using the TTS and Donaren Disc Trenchers (Z. Karins, M.Daugaviete).

In our research effort on forest regeneration the focus is not only on new theoretical conclusions but also on ecologically sound, technologically easy-to-use and economically feasible methods and processes, that could immediately be applied in practice.

In Latvia approximately 2,000 exotic tree species are found in collections, trial and amenity plantations, parks and gardens. Voluminous and ample are the collections *(arboreta)* of exotic tree species laid at the Forest Research Station "Kalsnava" (E. Smaukstelis, A. Kaskure) and the National Botanical Garden in Salaspils (R. Cinovskis). Beach, as well as some populations of larch and lodgepole pine *(Pinus contorta)* could be of some importance for the Latvian forestry. Under the local conditions the plantations of cork pine *(Pinus strobus)* and Douglas fir *(Pseudotsuga taxifolia)*, and the large-scale plantations of larch suffer from needle and branch diseases (D. Pirags, R. Cinovskis).

The forest tree breeding has evolved as an independent branch of forest science. Seed orchards of the total area 965 ha have been laid between 1957 and 1982: pine - 697 ha, spruce - 170 ha, aspen - 11 ha, birch - 5 ha, other indigenous and exotic tree species - 82 ha. The clones for seed orchards were chosen following the methods of phenotypical selection. The orchard seed crops of pine meet the country's annual demand - 1,000 to 1,100 kg on the average (J. Gailis, E. Ronis, A. Veveris, V. Bambe).

In order to assess the genetic value of traits, testing methods for the progeny of plus trees have been developed, clones and their progeny have been tested following a set of traits (V. Rone). For pine, over 400 combinations of clonal crossings have been done. In crossing experiments diallel patterns of 3, 6 and 10 clones were used.

The main deductions supported by the experimental data could be summarized in the following. For pine, the resistance to needle cast is hereditary and it can be evaluated in juvenile age. The height for sibs families at the age of 16 years is higher for interclonal combinations having enhanced general combining ability. There exists a relatively high correlation between the increment in height and diameter for the controlled and free-pollination progeny of clones, which is used for evaluating the clonal progeny and that of individual trees.

Provenance trials have been laid for seed coming from 64 places of origin in Germany, Poland, Russia and the local ones. Plantations of pine of diverse geographical occurrence were laid in 1975 in the western, central and eastern part of Latvia. In all the trials the local pine has turned out to show the highest degree of survival, exhibiting higher increment and better stem quality, except a trial plantation in Western Latvia, where the increment in height is by 5 to 8% higher for the Polish (Rytel) and German (Neubrandenburg, Jena) provenances. Different observations and field data suggest that for the purposes of forest tree breeding Latvia should be divided into two zones - eastern and western (V. Rone, I. Baumanis, J. Birgelis).

Starting with 1986, second generation seed orchards of pine are being laid - 100 ha in the eastern part of the country, 60 ha - in the western. In each of them 64 clones coming from the first generation orchards are represented after all-round testing and evaluation (V.Rone, I.Baumanis, J.Birgelis).

As to deciduous tree species, the breeding of aspen has been in the focus. A number of rot-resistant clones are identified, a clonal archive and seed orchard set up and a number of hybrids obtained (J. Smilga). The best clones and hybrids are propagated *in vitro* (I. Dubova).

The changeable climatic conditions in Latvia favour the spread of tree diseases and epidemics. The Institute "Silava" owns a small laboratory facility to meet the needs of forest phytopathology, as identification of pathogens, biological analysis of fungi, methods of disease recording and control.

Needle and branch diseases represent a major obstacle in nursery cultivation of pine. Here, *Lophodermium seditiosum* and *Graminiella*, and some others are the most dangerous pathogens causing the above diseases. An inventory of the species of pathogens causing tree diseases in Latvian forests is now under way. Nurseries are advised to apply such practices for cultivating pine and keeping it healthy that comply with local conditions.

The damage done to Latvian forests by needle and leaf pests has been on the increase during the last few decades. Mr. A. Smits of the Forest Protection Laboratory is doing research on the population dynamics of *Bupalus piniarius* L. and some other pests. An integrated method, adapted to local conditions, for the suppression of *Ips typographus* L. has been developed, providing for timely salvage of clear-cuttings and select cuttings in combination with the deployment in traps of the pheromone "Tipoferol" to evaluate the spread of the pests. Pheromone technologies are tested to control the number of *Panolis flammea* Den. *et* Schiff. and *Lymantra monacha* L.

To suppress *Hylobius abietis* L. in the planting stock of pine, a technology for evaluating the condition of the stock and its treatment by insecticides before planting has been suggested. An inventory of entomofauna of importance for forest ecosystems is now under way.

The first phase of the system of forest monitoring in Latvia is operating since 1989. The development of this system has by now entered its second phase which is to provide for the evaluation of the impact of the local sources of pollution and gathering of additional data at the points of observation.

In the sphere of forest tree species and forest protection, the problems identified and researched are as follows:

- exploration and protection of the indigenous forest tree gene pool (J. Birgelis);
- seed production of pine and spruce (A. Gailis);
- selection of larch species for a perspective cultivation in Latvia (J. Smilga, R. Cinovskis);
- cultivating forest tree varieties (I. Baumanis), a model for natural forest regeneration (I. Baumanis, J. Oslejs);
- introduction of Douglas fir and Sitka spruce (D. Pirags);
- tree nursery technologies (I.Mangalis, V.Kaposts);
- soil microflora and agrochemical characteristics of non-forest

lands; prospective afforestation of abandoned farmlands (T. Gaitnieks, V. Kaposts, I. Mangalis, J. Broks, M. Daugaviete);
- vegetative propagation of trees (A. Kaskure); microclonal propagation of trees (A. Ozols, I. Dubova);
- phytopathological inspection of forests (L. Sica); entomological inspection of forests and pheromone application in pest control (M. Bicevskis);
- dynamics of forest pests and forecasts of outbursts (A. Smits);
- forest monitoring (M. Laivins, L. Ziedina).

FOREST OPERATIONS AND TECHNIQUES

Despite of the tough command policies concerning the mechanization of forest operations in the former Soviet Union, the Latvian scientists dealing with these issues, nevertheless, managed to develop and implement technologies and machinery suitable for Latvian conditions, including the methods of rational evaluation of timber felled by applying either tree-length or assortment technology (I. Ievins, Z. Salins, M. Daugavietis, A. Dreska).

The machinery developed was tested in thinnings in different forest stands. Research was done on the following: the impact of the machine and the related technology, including strip-road spacing, on stand performance in the future; the frequency of damage inflicted on the remaining stand, the degree of soil compaction, etc.; the use of boom-equipped machinery and its optimum parameters depending upon silvicultural constraints (I. Ievins, T. Rozina, A. Epalts, A. Kazemaks).

The group of ergonomics has investigated and made an evaluation of work loads for forest workers of different professions, including the impact of forest machinery and tools, on their status of health. This effort has resulted in different forestry jobs ranked as to their degree of difficulty (J. Mezals, M. Snepste). In energonomic studies, co-operation has been established with Norwegian specialists.

In the sphere of forest operations and machinery the following problems are under investigation:
- diverse novel methods in timber harvesting, their evaluation and testing; operational availability and feasibility of diverse type forest machinery; evaluation of the test results in terms of silvicultural constraints (A. Epalts);
- operating efficiency of different groups of forest workers and the methods for protecting and improving their status of health (M. Snepste);
- mechanization of operations for stimulating the natural regeneration under conditions prevailing in Latvia (Z.Karins).

FOREST INVENTORY, GROWTH, YIELD, QUANTITATIVE AND MANAGEMENT SCIENCES

Forest management in Latvia was completed already before WWII. Now it is repeated on a regular basis by the specialists of the Latvian Forest Inventory Institute, undertaking inventory within an interval of 10 to 15 years, of all the forest lands, irrespective of their ownership status. The inventory records are gradually improved. All the data on forest resources are stored in the data base. Forest growth models and the regularities that go with stand parameters have gradually been developed and improved by P. Sarma, P. Murnieks, J. Matuzanis, R. Sacenieks, J .Taurins, K. Buss, J. Bisenieks, et.al.

The inventory work results in a forest management plan worked out, making provisions for thinnings, final felling and regeneration. Computer software for estimating the cut is available (J. Bisenieks).

The planning of game management is done along with the inventory work by a separate group of experts, who work for new methods for evaluating the situation in game management.

In forest inventory and the growth and yield studies the following problems are dealt with:
- shaping the forest stands and a follow-up of their course of growth (J. Bisenieks, I. Liepa, J. Matuzanis, P. Zalitis);
- forest inventory and forest management (I. Liepa, J. Bisenieks, P. Skudra);
- evaluation of feed resources for *cervidae* (J. Ziedins, A. Prieditis).

FOREST PRODUCTS

The wood processing and conversion in a variety of ways has so far been investigated by a number of organizations: the Latvian Agricultural University, the Riga Technical University, the one-time Research and Production Association "Gauja", the Institute of Wood Chemistry, the Latvian Forestry Research Institute "Silava". The developments of the post war period gave rebirth to wood chemistry in Latvia, with the main achievements as follows: the Riga method in wood hydrolysis (P. Odincova), glue for paper derived from resin (J. Zandersons, Dz. Svikle), preservation of wood (I. Luse), delignification of wood (V. Gromovs), utilization of pentosanes (S. Hillers), structure and utilization of lignin (P. Odincova, P. Streips).

The scope of research work and the range of problems covered increased considerably after the Institute of Wood Chemistry was founded in 1964. The theoretical conclusions in the sphere of wood chemistry were translated into practical solutions for utilizing wood and other vegetable material as a possible source for novel fibre and polymer materials.

In 1966 the Institute of Wood Chemistry was appointed the leading organization for research, on an All-Union scale, on the following problem: "The Chemistry of Wood and its Basic Constituents". Against this background the best results were achieved in refining of wood (T. Darzins), thermal processing of wood (J. Zandersons), wood conservation, etc. A process for recovering furfural from logging residues was developed (A. Kulkevics, A. Vedernikovs).

Of great theoretical and practical significance is the research work in this context done by the Latvian Forestry Research Institute "Silava", especially in the domain of the chemical composition of tree foliage, including the utilization of foliage products and the related technologies for their

recovery (A. Kalnins, J. Abolins, I. Ievins, A. Valdmanis, V. Geine, J. Kevins, M. Daugavietis). The success of the research work in this field has resulted in practical applications, as there have emerged a number of production units manufacturing a bewildering variety of biologically active foliar products for uses in medicine, cosmetics, perfumery, as feed additives and plant protection agents, etc.

Right now research is under way on recovering extractive substances from tree foliage, bark and other components of forest biomass (M. Daugavietis, O. Polis, J. Zandersons) as well as on a multi-component protective paint, including the related technologies, against decay of wood (J. Kravalis, B. Andersons).

In the sphere of forest products ultilization the following problems are identified and dealt with:

- multicomponent antioxidant protective paints and the related technologies to prevent decay of wood (J. Kravalis);
- drying of timber by flue gases and the related drying regimes (J. Kravalis);
- chemical composition of tree foliage and bark (M. Daugavietis);
- utilization opportunities of plant protection agents (fungicides and insecticides) derived from tree biomass components (M. Daugavietis);
- evaluation of wood and timber quality (H. Tuherms);
- delignification, celluloze chemistry, wood chemistry (J. Hrols, J. Zandersons, J. Gravitis, A. Treimanis, J. Dolacis, P. Erins, N. Vedernikovs).

SOCIAL, ECONOMIC INFORMATION AND POLICY SCIENCES

The first debate on the role of forest as an important constituent of Latvian landscape was started more than three decades ago when the Latvian Forestry Research Institute 'Silava" launched a study on the protection, convalescence and social functioning of forest ambience. The related research proceeded in two directions: one - the management of forests in urban amenity zones and around health resorts (Z. Suna); cadastral survey of recreation forests, their regeneration, improving amenities, laying out routes for recreational and educational purposes (I. Emsis, A. Melluma, J. Tuktens, D. Danilane); the other - systematization of nature conservation sites and areas in Latvia, including the foundation of the Gauja National Park; the stand structure and dynamics in slightly-impacted natural forests (M. Laivins, S. Laivina); identifying the location, protection and population vitality on sites with rare and endangered animal and plant species (A. Sulcs, I. Riekstins). As regards the Latvia's nature reserves (Slitere, Teici, Krustkalni), the supervision and research work is done by the research staff there.

With the computer-aided research making headway, the first classifiers were developed: a classifier for floral plants and ferns (M. Laivins, A. Rasins), subsequently revised and enlarged covering also the adjoining territories (Lithuania, Estonia, Finland). A classifier of Latvia's bryophyte (*A. Abolina*) and lichen (*A. Piterans*) vegetation has also been worked out. There exists a data base on Latvia's trees - monuments and trees under protection.

The long period of crop rotation typical for forestry requires a certain historical continuity in studies on forest economics.

The first land reform during the years of Latvia's independence (1918-1940) resulted in a majority of forests becoming state property. The forest economics of that period was built upon Prof. E. Ostwald's theory on forest land rent propounded already at the turn of the century in his monograph "Waldrentheorie" (1931, in German) and tested in practice.

The forests economics goes hand in hand with forest policy. Already during the years of independence in the 20s and the 30s, these issues, due to Docent K. Teikmanis of the Latvian Agricultural Academy, became a matter of much controversy.

Unfortunately, after Latvia was occupied by the Soviet Union, any research in forest economics ceased, and it was only in 1967 that the Laboratory of Forest Economics was set up with the Latvian Forestry Research Institute. The research of that period had a completely different orientation, mainly in line with the demands of centrally planned economy: working out norms, economic validation of new projects, forecasts concerning the forestry complex, etc.

Regaining the independence in 1990 resulted in profound changes in the country's economy, which started to develop on a free market basis. A reorientation in economic studies had to be undertaken with a 50-year long gap between the situation as of now and the forest economics proper as it existed in the 30s. So, in the foreground there emerged problems almost unknown earlier. They have shaped the contents and directions of the research projects in forest economics now making headway:

- inquiry into the results of economic research of the pre-Soviet period, updating the problems of forest economics typical for Latvia and developing the related system of economic studies for the forest sector;
- evaluation of the achievements in forest economics in the free-market countries with a view to developing a model in forest economics suitable for Latvia;
- place and role of the forestry complex in the country's macroeconomics, developing a flexible forest policy for Latvia.

The Scientific Council of the Latvian Forestry Research Institute "Silava" and the Expert Committee of the given branch have carefully assessed the present situation in the forest science and set the principal guidelines for the years to come.

Right now the forestry complex, including forestry, timber harvesting, processing and conversion, is one of the few branches of Latvian economy that is gradually growing with a significant contribution to the export balance and budget revenue. Apart from its economic significance, the forest plays an important role in keeping the environment

healthy not only in Latvia and the Baltics, but also in the whole Europe.

At present, the functioning of the whole forestry complex is backed by all-round and long-term research in forest ecology and typology, growth and yield, forest engineering.

Latvia, along with other countries enjoying science-based forest management and utilization programmes, has, in fact, adopted such an approach to the forest that is in line with the modern developments: forest regeneration by genetically enhanced and tested seed, end-use oriented and site-adapted cultivation of forest crops in line with forest typology, intensive forest management and exploitation practices, providing at the same time for forest diversity, following the principles of sustainability.

An international team of experts headed by Danish specialist (1992) appraised positively the merits of the Latvian forest science and in an overall appraisal of the science in Latvia, ranked this branch among the top ones.

There is no doubt that, unlike other branches as physics, chemistry, computer technology, etc., the forestry studies in Latvia can be performed in Latvian forests only on the basis of long-term and all-embracing field data. So, the forest science is to be considered a national branch of science. Complex and long-term research cannot be replaced by individual research projects done by some international organization. Of course, they contribute to our knowledge on Latvian forests, but, nevertheless, are politically oriented. The "import" of the achievements of forest science from abroad should go with methodology and equipment rather than results.

In view of the present situation, the Latvian scientific community in the given field takes a firm stand for the revival of the country's research potential and the proclamation of forest science as a national one. For the years to come the following principal directions for the scientific development have been identified:

1. Forest and environment: the functioning of forest ecosystems under varying ambient conditions (climatic changes, pollution, anthropogenic impact); forest monitoring, including forest ecosystem constituents; development forecasts and control over forest ecosystems; forest protection; increase in forest productivity.

2. Gene pool of forest flora and fauna: gene pool evaluation and conservation of its diversity, its purposeful utilization and regeneration.

3. Forest utilization: basics of multiple use forestry; forest products evaluation and utilization; theory and technologies of whole-tree biomass utilization; principal economic guidelines in forest utilization; forest utilization in terms of ecology; forestry and the regional development.

4. Land use and forestry: cultivation of forest crops on extensively used and abandoned farmlands; the basics for "rural" forestry; cultivation of short rotation plantation for energy needs, for pulp and paper industry; for having special assortments of timber, etc.; forestry as a means of landscaping, etc.

5. Timber processing and conversion: quality evaluation of wood; theoretical and economical feasibility studies in the fields of timber processing and wood chemistry; composite materials, extractive substances from tree biomass; theoretical background for product development.

The given problems, in compliance with the international commitments Latvia has undertaken, require both fundamental and applied research.

In dealing with the research problems identified, the Latvian scientific community is looking forward to a mutually advantageous co-operation on an international scale.

FOREST EDUCATION

In the second half of the 19th century Latvia experienced a rapid growth of economy. Following the expansion of timber trade, greater attention was paid to forestry and timber processing. So, a need for qualified specialists was created.

The earliest opportunities for getting professional education in forestry in present-day Latvia date back to 1835, when a forestry class was opened at the Jelgava Classical School, where A.Bode worked as a teacher.

The first ever in the Baltics school for forest rangers was started in 1898 at Vijciems, in the North of Latvia, it continued until 1929. Between 1929 and 1957 there was a number of Forest schools in Latvia (Raiskums, Cirava, Vilaka, Lubana) training forest rangers, senior rangers, timber inspectors, assistants of tractor operators, and partly also forest technicians to work in the capacity of heads of forest districts.

Right now there is only one school (Ranka) training the specialists of the elementary level of qualification in forestry, regardless of an urgent need for well-qualified forest workers well-versed in the basics of both forest biology and technologies, including the skills to operate forest machinery. An annual demand for forestry workers of high professional standards is estimated to amount to 150-200 persons at least. There is a need to have some four or five schools for forestry workers, one in each region. Enrolment conditions should require compulsory 9 year schooling.

The training of workers in furniture joinery and carpentry is quite adequate.

Furniture joiners are trained at six vocational secondary schools, while carpenters at 11 schools, distributed all over the country. Besides, artistic carving of wood is tought at four secondary schools (colleges) of art (in Riga, Liepaja, Rezekne and Daugavpils).

At present, the mid-career training of forest workers and workers in the wood processing industry (1 to 12 week-long courses) takes place at the Ogre Forest Training and Education Centre, catering for the needs of forestry sector.

Medium-level educational establishments (technical colleges of forestry) were started in the post war period. Until

1958, there were two technical colleges of forestry in Latvia, one in Ogre (oriented to wood processing), the other in Aizupe (forestry oriented). At present there is only one technical college of forestry in Ogre, housed in recently-built premises. The college is training medium level specialists in forestry and forest operations. It annually enrols 75 students in forestry and 25, specializing in forest operations.

The medium level process technicians in wood processing are trained at the Riga State Technical College. The qualification level of graduates in the above fields is believed to be adequate. The improvements needed refer mainly to practical training, process engineering and economic subjects.

The specialists with a university level of qualification in forestry are trained at the Forest Faculty of the Latvian Agricultural University. Right now there are three specialities: forestry (annual enrolment 25 students), forest operations or logging (25 students), woodworking technology (50 students).

The training of the university level specialists in forestry in Latvia dates back to 1920, when the Forestry Department at the Agricultural Faculty of the Latvian Higher School was established (a university since 1921). It became an independent Forestry Faculty in 1939, when the Latvian Agricultural Academy was founded in Jelgava.

The divisions of forest engineering and woodworking technology exist at the Faculty since 1949.

The studies at the Latvian higher educational establishment, including the Forest Faculty, are organized in two stages.

In the first stage, lasting 4 years, the students, on the basis of general background knowledge, master the chosen speciality on an academic level so as to be qualified for an independent work in the given field.

In the first stage (undergraduate studies) all the subjects are studied with a practical bias, and, with an equal amount of academic hours devoted to each, they may be divided into three groups:

- general subjects (humanities);
- general engineering subjects (biology subjects for foresters);
- special subjects and those with a professional bias (mainly in the 3rd and 4th year).

To provide opportunities for specialization, each group of subjects comprises compulsory (ca 70%) and optional subjects (ca 30%). For junior studies there are less optional courses, while in the senior years they constitute up to 40% of total amount of courses offered. In order to improve the situation during the junior studies greater attention should be paid in the future to such subjects as economy and marketing, computer science, as well as foreign languages.

After the four-year course of studies and the final exam before a state examination commission, the graduate is officially qualified as an engineer and may hold the respective positions in industries.

During the first stage of studies the student is also given an opportunity to graduate with the bachelor's degree in forest science. To this effect, the student's performance must be above the engineer's level, he has to take 2 or 3 additional academic courses, amounting to 100 academic hours, and work out a qualification paper. Unlike an engineer, the bachelor is to show both higher standards of knowledge and a capacity for research work.

The master's studies is the second and higher stage in the academic education (graduate studies). The studies last for two years and result in the Master's degree in forest sciences. The principal task of the master's studies is to train specialists for the key positions in industries, research and educational establishments, in research, development and design.

The candidates for master's studies must show certain performance standards already during the first stage of academic studies, display proficiency and have practical experience in the given field.

The specialization opportunities for the master's studies are as follows:

- forestry with a bias to dendrology and forest tree breeding; also, forest ecology; forest management planning;
- forest operations with a specialization in timber harvesting methods and machinery; also, the complex utilization of wood;
- woodworking with a specialization in woodworking technology and equipment; also, product development, the complex utilization of wood.

It is envisaged to widen the specialization opportunities in the future. Apart from the above specialization, already starting with 1994 the graduates of the engineer's level of all the specialities are offered the master's studies in forest business, involving an in-depth inquiry into such subjects as economy, management and business administration, marketing, foreign trade, qualimetry entrepreneurship, financing, crediting. accountancy, business ethics, etc.

When examining an applicant for master's studies, his knowledge of foreign languages and organizer's skill are among the decisive qualities. Irrespective of specialization, during the first year of master's studies the students take such basic courses as foreign languages, mathematics, information technology, general subjects in the speciality, while the second year of studies is devoted to special courses on an academic level and the qualification thesis for the master's degree. A correspondence course is also available for master's studies. The master of forest sciences may proceed with post-graduate studies for the Doctor's degree. The course of studies lasts for 2 to 3 years and results in the defence of the Doctors thesis. The Doctor of Sciences may continue his research career by becoming Dr. Habilitus.

Further training after the basic education in all levels is organized as follows:

a) for workers and medium level specialists - at the Ogre Forest Training and Education Centre;

b) for specialists of the University level of qualification - at the Forest Faculty of the Latvian Agricultural University or other universities.