# ESTONIA:

# COUNTRY REPORT TO THE FAO INTERNATIONAL TECHNICAL CONFERENCE ON PLANT GENETIC RESOURCES

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**Note by FAO**

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# CHAPTER 1
# Introduction to Estonia and its Agricultural Sector

The Republic of Estonia is one of the Baltic countries in the northern part of Europe. In the North Estonia is bounded by the Gulf of Finland and in the West by the Gulf of Riga. The Russian Federation in the East, the Republic of Latvia in the South and the Republic of Finland in the North (less than 90 km from the northern coast) are the three closest neighbours of Estonia. It extends from 57° 30' N to 59° 40' N and from 21° to 28° 15' E.

The area of Estonia is a little larger than that of Denmark and equals to 45,200 square kilometres. 9.2% of the territory is under islands and 6.1% is taken up by inland water bodies.

The country is largely a plain, which is on average only 50 m above sea-level; only 1/10 of the territory is above 100 m.

Estonia (January 1, 1994) has a population of 1.5 million. 70.3% live in urban and 29.7% in rural areas. The average population density is 33.3 habitants per square kilometre.

Estonia was an independent republic from 1918 to 1940. In 1940 it was occupied by the Soviet Union and Estonia became one of the 15 union republics of the Soviet Union. The democratic movement started at the end of the 1980s. The independent Republic of Estonia was reestablished on the 21st of August, 1991 (the official name since the 8th of May, 1990).

## 1.1 CLIMATE AND SOILS

In Estonia the average annual air temperature is 5°C. The air temperature in summer is somewhat lower than the average for the latitude, but considerably higher in winter. Nevertheless, the lowest air temperature recorded in Estonia is -43.5°C and it was registered on the night of January 16th to 17th, 1940. Severe winters (-30°C to -40°C) occur one or two times in 10 years. Thaws are characteristic of winter, but there can also be very stable cold spells, for example in some winters the air temperature (in inland) does not rise above 0°C during 90 or 100 days. The vegetation period generally lasts for 170-185 days, the period of active plant growth is 120-130 days. The annual amount of precipitation (550-650 mm) exceeds evaporation approximately twofold.

Nevertheless, there may be especially severe draughty periods in the western part of Estonia in spring and in the first half of summer.

The principal soils are soddy calcareous soils (26.3% of all arable lands) and soddy clay soils (32.3%). Soils influenced by erosion make up 18.9%. Bog soils constitute 7.7%. The major part of agricultural land needs reclamation, primarily drainage: 63% of the soils are excessively wet. 44% of the soils are acid.

One third of the total area of Estonia is arable land, one fourth is under cultivated meadows, pastures and other lands. 35%. of the area is under forest.

Main crops grown are barley, rye, wheat, oats, legumes, vegetables, potato, field grasses, annual fodder crops. The need of the country is to be entirely supplied from the local production. Higher quality wheat is needed for pasta (macaroni) products and white bread. 3/4 of the field production is used to feed livestock. Estonia does not produce any following minor crops of local diet: buckwheat, maize, millet and rice.

Fields and grasslands are sown with selected seed, chiefly with those bred at the (Estonian) Jýgeva Plant Breeding Institute.

Fruit is mostly grown in small backyard gardens and fruit growing supplies 3040 kg per capita consumption.

## 1.2 FOREST TREES

Coniferous trees are predominant (about 64%). The species composition is as follows: pine (Pinus sylvestris) 41%, birch (Betula pendula and Betula pubescens) 28%, spruce (Picea abies) 23%, speckled alder (Alnus incana) 4%, aspen (Populus tremula) 2% black alder (Alnus glutinosa) 1.5%, oak, ash and others 0.9%. In 1979 the percentage of forest stands on the Estonian territory rose to 38.7 as compared with 29% in 1958, and decreased to 35% in 1994.

In 1993 10.3% of the inhabitants were active in the agricultural sector, hunting and forestry. 37.7% of the workers were active in food processing industry.

## 1.3 RECENT TRENDS

The former (Soviet time) resource-constrained and centrally planned economy has been turned into demand-driven and market oriented economy. In the past years the economy was mostly based upon the cheap resources from the former Soviet Union and mostly supplied the Soviet markets. Now it is directed to western markets and broad participation in the world economy. The state ownership that dominated a few years ago has been substituted by private ownership.

Agricultural production has declined. For example 967,00 tons of grain was produced in 1989, in 1992 the production was only 399,00 tons. In 1993 the potato production declined from 864,00 tons to 539,00 tons.

The decline in the Estonian agriculture is due to the failure of the Russian markets. Some relief may be gained from the Free Trade Agreement with the EU. The restitution of property rights on land tends to produce a great number of small private farms. The use of mineral fertilizers and chemicals for controlling pests and weeds has declined dramatically because of low farm income and the rising prices of these chemicals. In 1992 the average yields per hectare dropped because of draught and, in the following years, due to the shortage of chemicals. It will take years to restore efficient and highly competitive private farming,

Local cultivars are less affected from pest and disease attacks and better adapted to the shortened use of mineral fertilizers and unfavourable winter conditions than foreign ones.

# CHAPTER 2
# Indigenous Plant Genetic Resources

There is a unique genetic diversity of economically important qualities in the wild of Estonia that has never been utilized in the development or improvement of the cultivated varieties. There are some wild progenitors or wild relatives of current or potentially important commercial agricultural (including pasture) plants among the natural vegetation of Estonia. They are still available in the wild and are not threatened by human activity. These species are the following:

**Gramineae**

| | | |
|---|---|---|
| From genus | *Agrostis* - | *A. canina, A. gigantea, A. stolonifera A. tenuis, A vinealis* |
| | *Festuca* - | *F. arundinacea, F. gigantea, F. pratensts, F. rubra* |
| | *Koelena* - | *K. glauca, K. grandis* |
| | *Phleum* - | *P. beriolonii, P. phleoides, P. pretense* |
| | | *Poa pratensis* |

*Papilionaceae*

| | | |
|---|---|---|
| | *Lotus* - | *L. corniculatus* |
| | *Medicago* - | *M.falcata, M. lupulina* |

They have outstanding winter hardiness and are adapted to different soil conditions, e.g. to superfluous soil moisture (*Agrostis* sp.), alkaline or acid soils, strong draught (*Medicago* sp.). Some above-mentioned species have been used in the Estonian breeding programmes during the last decades.

There is a cranberry species (*Vaccinium oxycoccus)* in the Estonian bogs. It has become adapted to the climate of Estonia and is already used in cultivar breeding, Some bogs have been demolished entirely but 760 samples of the Estonian cranberry have been planted into a collection at the Nigula Nature Reserve.

## 2.1 LANDRACES

There have been many "farmers' varieties" in Estonia but only a few are still maintained and very few are used by farmers at the present time.

In the 1950ies and 1960ies many farmers' varieties and old (bred 70 years ago) cultivars of the Estonian breeding programmes have for conservation purposes been given into the collections (elementary gene bank) of the N. Vavilov Institute of Plant Industry (St. Petersburg, Russia). Lately, the situation in Russia has changed so dramatically that the possibility to save the cultivars is getting threatened.

Fortunately, Estonia got the germplasm (seeds of old varieties) back from Russia (in 1994). Although the germination of the seeds is very low, there is hope to revive these cultivars and landraces during the forthcoming years.

Some landraces of apple, pear, plum, cherry and berry plants are still used by farmers because of their very good winter hardiness and good adaptation to the local soil and climatic conditions. At present the old Estonian grain cultivars are winning back their importance as the use of mineral fertilizers has decreased abruptly; the old cultivars can better be adapted to extensive farming than the newest.

There are still some unique old cultivars as the rye (Secale cereale) cultivar 'Sangaste' (120 years old), which has shown an extraordinarily good winter hardiness not only in Estonia but also in Canada and other places.

# CHAPTER 3
# Conservation Activities

*In situ* conservation is mainly used in the wild nature reserves for the conservation of biological diversity and in special landscape reservations (see Annex: Estonian forest genetic resources). Only in a few cases the agriculturally important species or their progenitors are taken for *in situ* conservation. The island Saaremaa is one protected area to maintain a natural grove of wild apple (Malus sylvestis). Some very old trees (for example Oti apple-tree) are being protected as single objects.

## 3.1 *EX SITU* COLLECTIONS

There is no national gene bank in Estonia. But the Estonian Plant Biotechnology Research Centre, EVIKA, situated in Saku, approximately 20 km from the capital city Tallinn, has a major *in vitro* collection of 350 potato cultivars of which 40 are Estonian. Besides 500 potato mericlones, this Centre has also an *in vitro* collection of chrysanthemum, carnation, plum, sweet cherry and various berries. The potato collections may be considered as global collections including many old cultivars. The Centre has excellent tissue culture facilities and offers to carry out contractual work on virus eradication for various crops. The staff of the centre has 15 employees, 5 of whom are researchers.

The other plant genetic resources collections are housed at the Jogeva Plant Breeding Institute (field, pasture, and vegetable crops), at the Polli Experimental Station (fruit trees and berry bushes), and at the Tallinn Botanical Garden (decorative plants).

The Jogeva Plant Breeding Institute was founded in 1920 and has 99 employees 25 of whom are researchers. The working collection of barley includes 620 accessions, there are 45 accessions in the wheat collection, 30 accessions in the rye collection, 190 accessions in the collection of oats, potato 320 accessions in the potato collection, 450 accessions in the collection of forage grasses and, vegetables 125 accessions in the collection of vegetables.

The Institute is very well equipped with modern specialized machinery for experimental plots. In the former Soviet Union, it was used as a training centre for the use of small plot machinery.

At the Institute the plant genetic resources activities have essentially been limited to the maintenance and replenishment of working collections by breeders.

A collection of wheat mutant lines is maintained by the Institute of Experimental Biology for their use in wheat breeding.

The Polli Experimental Station was founded in 1945 and has 15 employees 8 of whom are researchers. The working collection includes 250 cultivars and 150 "landraces" of apple, 50 cultivars and "landraces" of pear, 60 cultivars of plum, 70 cultivars and selections (mostly of sweet cherry), 90 cultivars of currant 95 cultivars of gooseberry, 30 cultivars of raspberry, and 50 cultivars of strawberry.

The Estonian collections mainly contain regional and global material of the major crops of the country, which are replicated elsewhere. But some unique material is also collected from local areas and it has great value in plant breeding. This is considered to be the most important factor for preferential treatment in the genebank.

Every year probably one third of the samples are used by plant breeders and researchers at the national institutes but the plant breeders of the national programmes in the other countries also use the Estonian gene resources. There seems to be a balance between the material that the Estonian breeders and researchers provide for the use outside the country and the material that we obtain from outside for our own use. The Russian, Byelorussian, Nordic, Latvian and Lithuanian collections are the main sources of material from outside.

The Estonian national collections represent the diversity in the field and orchard but the need is to replenish them with especially good disease resistant donors of high quality.

The collecting activities will prefer local gene samples and is mission-oriented (breeding objective). This material can be transferred to other collections but we must have the right of access to it.

Estonia has no special storage facilities for the conservation of collections, except from the above-mentioned EVIKAÍs tissue culture facilities. Generally the rooms and containers are not adequate to the internationally recommended levels of moisture content and temperature. At present the agricultural and science policy of the Estonian government is not clearly stated and there is no certainty that the conservation activities will be improved.

Ordinarily the basic collection material is not duplicated. A part of the potato and fruit cultivars, that have been bred in Estonia, are duplicated in two places: potato in EVIKAÍs tissue culture collection and in the field collection of the Jogeva Plant Breeding Institute; fruit and small fruit cultivars are duplicated at the Latvian horticultural institutions.

Estonia is a too small country with insufficient financing possibilities to have a national gene bank. Therefore an agreement with the Nordic Gene Bank to store our plant genetic resources is under consideration. The Nordic Gene Bank has initiated cooperation between the three Baltic countries to support the establishment of a computerized centre in Latvia and to train the Baltic researchers in the documentation of the material.

The Estonian collections are partly documented and mostly without a computerized data base. Only partial catalogues are available and a little or almost nothing is published systematically about plant resources. And in case some full inventories (Estonian apple cultivars, Estonian sweet cherry selections, Estonian small fruit cultivars) are published, they are only in Estonian. The Soviet occupation had a strong impact on breeding activities because all the disposals of this kind were centred in Russia (The Vavilov Institute of Plant Industry) or into a regional centre in Byelorussia.

We have card indices and simple lists of cultivars with uncomplete descriptions which are not yet on an internationally required level. They consist of characterization data, evaluation data, indigenous knowledge, and breeders' records. Up to now the Estonian researchers havenÍt got any international descriptors.

Nevertheless, the backlog in documentation will be surmounted in the near future. The documentation records are intended to be fully duplicated.

There are no special problems with documenting samples of wild relatives. If researchers cannot readily verify the naming of this material, a competent taxonomic expertise is courteously attainable.

We think that the evaluation data must be returned to the genebank and the increasing expenditures will be justified by the most effective use of germplasm. It is evident that international collaboration could help to achieve a better result in conservation activities and in breeding. The Nordic Gene Bank should take the leading role in our regional approach.

## 3.2 REGENERATION

The accessions to our collection will be regenerated according to the necessity, that is, for example by the results of laboratory analyses. If we are not able to regenerate the material then it is intended to store it somewhere were it can be regenerated. Some years ago it was the Vavilov Institute of Plant Industry but in the future we intend to collaborate with the Nordic Gene Bank. So far the regeneration procedures in our collections have been adequate to maintain the genetic character of the original samples. This activity is carried out or supervised by qualified plant breeders. A full and accurate regeneration history of every accession is available to the users of the material. In general, more than one generation of the same accession is maintained in the collections.

The Tallinn Botanical Garden which was established in 1961, has 8000 taxa of living plants, 2000 of which are tropical and are grown under glass. The Garden has 85 employers of which 12 are researchers. The Garden is essentially involved in plant introduction, having some additional limited activities in the field of the conservation of rare species. A computerized list of all the taxa present in the garden has been developed.

# CHAPTER 4
# In-Country Use of Plant Genetic Resources

The Estonian national collections of genetic resources are frequently used in national breeding programmes. During the last 3 years the main crops used for breeding are the following: barley, oats, wheat, rye, bean, pea, tomato, fodder plants, apple, pear, plum, cherry, strawberry, cranberry, and currant. There is only one institution per each crop requesting and being provided with material; in case of field and pasture crops it is the Jogeva Plant Breeding Institute, and in case of fruit crops it is the Polli Experimental Station. Only one professional breeder, in case of some crops two or three breeders use the genetic resources of a certain crop. They are all government-funded.

The samples of plant genetic resources used in breeding come from the Estonian own national collections (70 to 100%). The major external sources are the Russian (VIR, St Petersburg), Byelorussian, Finnish, Swedish, Danish, Latvian and Lithuanian collections of their breeding centres.

The Estonian farmers have access to the genetic resources of the country through seed producing farms. In case of urgent need the access can be direct.

The main function of the Estonian plant breeding programmes is to release the improved cultivars of local origin. They are widely used to adapt the imported germplasm through hybridization to the local needs, introducing pest resistance and other specific characteristics originating from foreign resources.

The ultimate objectives of the Estonian plant breeding programmes are to increase production and its quality, to meet national food needs, to increase export opportunities. Although some good cultivars have been bred, the amount and quality of scientific plant breeding does not meet the national needs. The main constraints are shortage of finances, over-aging of qualified breeders and modest laboratory facilities. It must be added that plant breeding activities are conducted only through government-funded programmes.

After the end of the Soviet occupation in Estonia the international transfer of genetic material conducted well (no delay in Moscow). Several new draft laws are waiting for their acceptance in the Parliament. The Estonian legislation is not complete yet, for example, the sale and distribution of seeds, the

Intellectual Property Rights, etc. need regulation. Every year Estonia amends the existing laws and formulates new ones.

The government policies and recent changes in these areas have a positive impact on our national genetic resources programme.

# CHAPTER 5
# National Goals, Policies Programmes and Legislation

In Estonia the activities in the field of plant genetic resources have not been organized into a National Programme. It is an integrated programme which is at the stage of starting and sponsored mostly by two ministries (Environment, Agriculture) and their research institutions. No commercial firms and farmers' organizations are involved in it.

Plant genetic resources collections are not protected by any law or national decree. Up to now their fate has been decided by ministers. Therefore the genetic resources national programme must be completed and the legal status of the collection must become secure.

The Estonian collections are managed by trained personnel: biologists, breeders, agriculturists. But there is urgent need for young trained specialists who have acquired their knowledge at the most advanced research centres abroad. The in-country training in the field of plant genetic resources does not meet the international requirements.

The broader agricultural and consumer community has had enough opportunity to learn about genetic resources to be able to communicate effectively with the specialists in the subject. The national policy-makers also understand the need of Estonia for a plant genetic resources programme.

As to the personnel the trained people are very persistent (no rapid turnover). Men and women and all the ethnic groups are equally involved in training programmes on all levels.

The locally produced cultivars are most valuable for commercial or semi-commercial types of farmers. The results of in-country crop improvement are easily and quickly made available to farmers. The farmers themselves are not involved in plant breeding. However, they are involved in cultivar evaluation on experimental farms, as well as in seed production.

Estonia has not directly benefited from its indigenous plant genetic resources. Nevertheless, providing material to the institutions of the other countries it benefits from obtaining improved stocks in return or from collaborating with other partners.

We regard the Estonian plant genetic resources as potentially valuable both in short and long perspective. Better co-ordination of policies and planning as well as closer integration to the genebank will certainly make it more profitable.

The following assistance could improve the utilization of plant genetic resources: Training of young breeders and researchers in the most advanced countries and better access to contemporary facilities. We prefer to obtain such assistance from the Nordic Countries.

# CHAPTER 6
# International Collaboration

Estonia belongs to the countries who have not yet adopted the UNCED Agenda 21. But Estonia is already member of FAO and intends to join in the European programmes of plant genetic resources conservation.

The Conventions on Biological Diversity and Climate Change were ratified by the Parliament on the 11th of May, 1994 and proclaimed by the President on the 26th of May, 1994. Estonia also signed the Resolution 2 of the Strasbourg Conference on the protection of forests in Europe at the Helsinki Conference in June, 1993. It is recognized by the Estonian Ministry of Agriculture that some areas need a stable source of funding and that plant genetic resources conservation is such an area, being a very important component of biodiversity.

Estonia is comparatively rich in biological diversity and has many protected areas, covering 12% of the national territory. The country has an extensive network of nature reserves but appropriate legislation has to be developed to take into consideration the reprivatization of land.

Among the Nordic Countries there is a well established initiative, the Nordic Gene Bank, that focuses on collaboration between the regional plant genetic resources programmes. The programme of Estonia is halfway to participation in this collaborative arrangement. We believe that there is further potential for regionally integrated plant genetic resources programmes between the three Baltic countries. In principle we support it, thinking that it should work in practice.

It must be stressed that in the near past there was an effective collaboration between Estonia and the N. Vavilov Institute of Plant industry (St. Petersburg, Russia).

During many decades Estonia has already had bilateral collaboration on plant genetic resources with Latvia and Lithuania. It has not been put into a formal agreement but it has worked on some other bases. This collaboration should naturally be turned into more official agreements between the collaborative countries. Similar sharing of resources has been arranged with Byelorussian, some Russian, and Ukrainian breeders, but that collaboration has come to an end now.

The goal of Estonia is to turn into a normal country that has adapted the main international agendas, conventions, and has joined the other United Nations/FAO global systems.

# CHAPTER 7
# National Needs and Opportunities

1. The full inventory of the unique genetic diversity of economically important qualities present in the wild of Estonia has to be made up. It is feasible that the Estonian specialists do the work.
2. All the cultivars and landraces (farmersÍ varieties) of the Estonian origin, as well as the threatened germplasm from the wild must be collected into national collections.
3. One part of the germplasm can be regenerated into the Estonian collections. If we can't regenerate a part of the germplasm it is intended to store it somewhere where it can be regenerated.
4. The Estonian finances are too short to build up a gene bank with contemporary facilities. Therefore there has to be collaboration between the regional plant genetic resources programmes. An initiative is well established by the Nordic Gene Bank.
5. The collections of Estonia are only partly documented and mostly without computerized data base. It will take some years to do it properly on an internationally recommended level.
6. The goal is to duplicate all the documentation on plant genetic resources.
7. There is urgent need to train (young) researchers in documentation abroad and to get support for the establishment of a computerized center in Estonia.

# ANNEX 1
# The Estonian Forest Genetic Resources

## INTRODUCTION TO THE ESTONIAN FOREST SECTOR

The composer's note: the percentage of the forest area used here by silviculturists doesn't coincide with the official statistics presented in chapter 1.

In Estonia the forested area is 2.02 million ha, i.e. 48%. The main part of it is state owned. The total growing stock is 277 million $m^3$, the average volume per hectare is 153 $m^3$. Softwoods make up the major part of wood (pine and spruce together - 65%, birch 27%). The total annual increment of forests is 9.0 million $m^3$ which means 5.0 $m^3$ per hectare. In Estonia the forested area and standing volume per capita are 1.3 ha and 178 $m^3$ respectively. The annual wood increment per inhabitant is 5.8 $m^3$. During the last half of the century the forested area has grown constantly at the expense of agricultural land and afforestation of drained peat land. The amount of harvested wood is small: 2.4 million $m^3$ in 1993 (0.9 % of the total growing stock, 1.2 $m^3$ per hectare). Nearly a half of this volume is harvested in the course of final cuttings and a half by thinnings and sanitary cuttings. The clear-cut areas are regenerated by planting of spruce or pine, birch gives natural regeneration. The use of regenerative cuttings is very rare. The modest volume of harvested wood is the result, of the fact that 1/3 of the Estonian forests are protected and the area of mature and premature forests is quite small. The cuttings have been less than one third of total increment for a long time. Due to that the stock of timber increases rapidly. The developments in the near future:

1. transition of forests to private ownership. Up to 40% of forests can be transmitted to private owners (farm forests),
2. the forested area increases 10% as a result of afforestation of agricultural lands,
3. the area of protected forests decreases from 30% to 20%. According to that the proportion of forest production increases from 70% to 80%,
4. felling outturn doubles as a result of improvement in age class proportion and increases in the area of production forests. Further, the felling outturn can be increased to 8 million $m^3$ per year mainly by final cuttings.

One can see the multiple use of forests in Estonia: besides the utilization as a wood source forests are used in environment protection and pollution control, recreation, hunting, picking berries and mushrooms etc. Wood processing industry has quite a high level of development but operates with low intensity today. A particularly high level has been achieved in furniture industry. Sawn timber is also produced. The activity in the field of pulp industry has stopped but will start again in the nearest future. The proportion of exported forest products was 9.3% of the total export of the country. The most important product exported was birch pulpwood. Before the World War II wood products made up 1/3 of total export. The import of wood products is very small (~ 1% of import).

## INDIGENOUS PLANT GENETIC RESOURCES

During the last 70 years the area afforested by planting and sowing is 520,000 ha which is 1/4 of the forest land of today. The main species planted are pine and spruce. This results in the fact that on better sites the major part of spruce and pine stands younger than 50 years are man-made. The plantation area of the other native tree species (silver and swamp birch, black and gray alder, oak, ash) is not remarkable, the stands of these tree species are of natural origin. There has been no extensive tree seed import from abroad during the century. But that was common in the previous century, particularly during the last quarter of the century. At the beginning of this century a great part of the stands planted with the material from these seeds was cut because of poor growth, poor stem quality and branchiness and/or frost sensitivity. Nevertheless, in 1951 it was estimated that ~ 1,000 ha of pine stands are grown from imported seeds. Until now these stands have been cut. Pine seeds were the most important among imported seeds. They were mainly brought from Germany, seldom from Belgium, Southern-France and Hungary. A few years ago seed importing in smaller quantities form Finland, Central-Russia and Latvia started.

Pine stands planted in the 20th century mainly originate (90%) from the seed collected in Estonia. But two mistakes have been made in seed collection. From 1918 to 1938 a large amount of pine seed was collected from pine stands of poor quality in South-Easter Estonia (Orava District) as it was profitable due to lower labour costs. 34 tons of seed was collected there and 15,000 to 17,000 ha of forest was planted with this seed (only a part of these plantations are of quite good quality). The second mistake was seed collecting from pine bog stands during the first ten years after the World War II. It was easy to collect seeds from trees not high. There are plantations demonstrating

both poor and satisfactory quality among the stands from bog pine seed. Only a small amount of spruce seed has been imported to Estonia and it has been spread to a small extent in Estonia. The proportion of plantations among spruce stands bearing seed crops can't be compared to pine stands. Due to that the regional features of spruce are expressed more clearly than in case of pine. The progeny tests have confirmed this statement. Supposedly the geographic differences in the characteristic features of pine will be restored as local seed is used in planting today and intensive natural selection takes place: mortality is 3/4 of planted trees until the age of seed bearing is reached in the plantations with high density of initial spacing. To avoid seed circulation/moving from one part of Estonia to the others. Estonia was divided into two spruce seed collecting regions in 1976. The rule is that only local seed can be used in the region. Later, Estonia was divided into two spruce seed regions and five pine seed regions. That division was based on the characteristic features of stands, site conditions (soil and climate) and progeny tests. As matter of fact the forest districts (there are 186 forest districts in Estonia) use the seed collected in the district: although seed extraction takes place in two big seed extractories it is done, separately and the seed is sent back to the certain district where the cones were collected.

Nearly all birch stands are of natural origin (all together 571,000 ha, less than 10,000 ha of these stands are planted but the local seed is used). All stands of gray alder (79,000 ha) and aspen (30,000) are of natural origin. There are a few plantations of black alder, oak and ash which are planted with local material. All the stands of hardwood species are in good condition and not endangered. In some places damages by local air pollution are detected in pine and spruce stands but this is not dangerous to the genetic resource as a whole.

To protect the genetic resources genetic reserves and clone archives repositories have been established in Estonia. Seed orchards, protected forest areas where only natural regeneration in permitted, and great supplies of the seed of coniferous tree species (spruce seeds are stored for 10 years) are the promoting factors in respect of conservation of genetic resources. The maintenance of stands of all species and thus of genetic resources of these species is guaranteed by the fact that the final cuttings have not exceeded the prescribed yield since 1961. There are no endangered species in Estonia among tree species important as forest stands. But such tree species as Taxus baccata (some 40 places of finding) and Crataegus palmstruchii (only some places of finding) are indicated in the Red Book as threatened species.

## NATIONAL CONSERVATION ACTIVITIES

The research in the field of forest typology and regular forest inventories over 100 years have enabled to get precise survey of the distribution of forest trees. Profound research has been conducted to study the influence of soil and climatic conditions on the distribution of forest trees. The human impact on the distribution of forest trees, the distribution of tree species during the last 10,000 years (palynology), and growth of trees in the past (dendrochronology) are also studied. Sufficient information has enabled our specialists to apply concrete means to protect the genetic resource of forest trees. The basis for that was laid down by the Decree of the Minister of Forestry and Nature Conservation No 183 of December 20, 1985. In this decree the following measures have been stated:

- establishment of genetic reserves;
- protection regime for certain noteworthy and rare stands and trees;
- establishment of collection plantations and clone repositories.

10 reservation areas of 3,540 ha (0,2% of the forest land) were established in 1985 to protect the economically best genetic resources of forest trees. Four of these are mainly pine stands (1987 ha), five areas are dominated by spruce (1136 ha) and one by birch (417), the other tree species are also represented in these areas. While establishing the genetic reserves of forest trees descriptions (passports) were composed in four copies which all are kept in different places. The following activities are forbidden in genetic reservations: use of chemicals for disease control and fertilizing, clear-cuttings, resin tapping, disturbances of the ground cover and soil, afforestation with use of seeds and/or planting stock coming outside of the reserve, all other activities affecting and/or harming genetic resources or making growth conditions worse.

Plus stands and plus trees are more essential objects among protected stands and trees. Several unique stands and forest areas are protected as Nature Conservation Objects. In 1959 the selection of plus trees was started in Estonia. Until now 443 pines, 135 spruces, 13 larches and 23 birches have been taken into account as plus trees. The major part of these trees are reproduced and grow in special clone stands, seed orchards or progeny trials. The detection and counting of plus stands, temporary and permanent seed production stands take place in the course of forest inventory. Final cuttings are not applied in plus stands, temporary seed-production stands are cut in seed years. Seed is only collected from standing trees in permanent seed-production stands because these forests are particularly valuable.

Several conservation areas have been established with a special objective. The oldest of them is the Nature Reserve Compartment in Järvselja (19 ha, untouched by human activity since 1923). Two nature reserves of memoral forests (Abruka Island with the area of 103 ha and one of the swamp pieces of the Virussaare Bog with the area of 40 ha) and one nature reserve of oak stand (Mihkli Oak Stand with the area of 91 ha, the age of the stand is over 200 years) have been established. Great forested areas are protected in national (all together 53,300 ha). There are other nature conservation areas having different protection regimes (nature of these regimes ranges from restricted cuttings to complete protection - visiting is prohibited) in Estonia. The area of forests protected in such nature conservation areas amounts to 38,100 ha. Thus, nearly 100,000 ha of the Estonian forests can be regarded as genetic reserves besides the nature conservation purposes. The maintenance of these forests is warranted by the Act of Protected Nature Objects (accepted by the Estonian Parliament on the first of June, 1994).

Among the plantations to protect and maintain the genetic resources seed orchards are the most important. Seed orchards are established according to the principles of clone archive - the origin of each graft is known, its location in the plantation is mapped. The establishment of seed orchards was started in 1965, the total area is approximately 250 ha today (180 ha of pine seed orchards and 32 ha of spruce seed orchards). Altogether, there are 503 pine clones and 178 spruce clones planted in the way that the same clone can be found in different seed orchards.

The seed of coniferous tree species is stored in two great seed stores: in Kilingi-Nomme and near Rakvere. These stores have freezing equipment (refrigerators) and seed is stored in airtight glass, metal or plastic containers. Since the seed years of pine are quite frequent, the pine seed supply is not great, the spruce seed supply is sufficient for more than ten years.

The protection of genetic resources is complicated due to the great intra-specific diversity (particularly in case of spruce). This problem has been investigated in case of pine, spruce, aspen and birch. The morphology of flowers, bark and cones and variation of time of budding was investigated. The main aim was to relate these aspects to growth rate and productivity. Only the budding time determinated genetically turned out to be significant. The study of the geographic variation of pine and spruce has given the best results. A great number of trials has been established, for instance 41 ha of spruce plantations during the period from 1970 to 1988. Some 460 seed consignments of different provenances and progenies are represented in these trials. On the basis of these trials Estonia was divided into forest seed regions. To obtain the up-to-date information on the situation of the objects related to forest tree breeding and genetic resources protection regular inspections are carried out. The first inspection took place in 1981, the second in 1988 and

the third from 1993 to 1995. The last inspection started with the Decree No 50 of May 18, 1993 of the Director of the State Forest Department. Records of inspections are kept in four different places (State Forest Department, Forest Tree Breeding Centre, Estonian Forest Research Institute and the Forest District of the location of the object).

In 1991 the Forest Tree Breeding Centre was established in Tartu. Main topics of forest tree breeding and genetic resources conservation are covered by this institution. The centre has tight cooperation contacts with the Estonian Forest Research Institute. The evaluation of the quality of the forest seed and planting stock is the main task of the centre. The centre also introduces the principles of forest genetics and tree breeding recognized internationally in forestry practice. The selection of plus trees and plus stands, genetic reserves and other objects, collection and documentation of information on the condition of these objects are carried out by the centre. Import and export of seed is arranged.

## IN-COUNTRY USE OF PLANT GENETIC RESOURCES

According to the Estonian Forest Act (accepted by the Parliament on the 20th of October, 1993) only the planting stock and the seed of genetically high quality can be used to plant forest. The genetically high quality of planting stock and seeds is warranted by the following means:

- sowings in nurseries are made with the seed from pine and spruce seed orchards;
- division of the country into forest seed regions and using seed from these certain regions only. If there is not enough seed spruce seed from the eastern region can be used in the western region, pine seed from the southeastern region can be used in other regions;
- collection of seed from the same Forest District where the sowing will be made. Seed collection is carried out in each Forest District. The collected seed is sent to one or two seed extractories that also have seed stores. Seeds are extracted and stored separately according to Forest District and later delivered to the district where cones were collected from;
- strict rules for the places (stands) of seed collection. Collection of seed from the stands of poor quality is not allowed. The network of seed-production stands is created and seed is collected primarily in these stands. Seed collection in plantations is not restricted because the proportion of them is very high in case of better growth sites of pine and spruce. Lack of

information on the origin of seeds used in plantation is not an obstacle to the collecting of cones if the plantation is of good quality.

It recommended to use more natural regeneration than earlier. Seed orchards need constant care. The extension of seed orchards is also needed.