AUSTRIA:

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

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Prepared by:

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Note by FAO

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Table of Contents

CHAPTER 1
Austria and its Agriculture

1.1 THE COUNTRY

The Republic of Austria - situated in Central Europe - is a federal state with nine federal provinces. It has 7.9 million inhabitants (94 inhabitants /km^2), 1.6 million people (some 20% of the population) living in the capital Vienna.

Austria has a surface of 8.4 million km^2; it is 550 km long and 50 - 300 km wide.

The country consists of 8 types of landscape corresponding to the Austria production areas:

1. High Alps,
2. Pre-Alps,
3. Eastern edge of the Alps,
4. Highlands of granite and gneiss,
5. Carinthian basin,
6. Alpine Foothills,
7. South-eastern flat and hilly country,
8. North-eastern flat and hilly country.

Among the Austrian landscapes the Alps, which reach altitudes of almost 3,798 m above sea level (GroBglockner), cover the largest area.

Across the shelve of the Alps Austria reaches into the Small Hungarian Lowland and there encircles Lake Neusiedel (116 m above sea level). The granit and gneiss highland north of the Danube reaches an altitude of 500 - 1,100 m above lea level. The area of the fertile lowlands along the Danube, in the Vienna Basin, in Burgenland, Central Styria, and the Alpine Klagenfurt Basin with its numerous lakes is far below that of the mountain areas.

Essentially, Austria is situated in the Central European climatic zone (moderate, humid), however, the eastern part and the eastern foothills of the Alps already have charact eristics of the more continental Pannonian climate (hot, dry). In elevated areas the central European climate turns into the cooler and more humid Alpine climate. Mean temperatures decline by 0.5 - 0.6° C per 100 m of altitude. Maximum precipitation in the Alpine area is 2,500 mm, in that area the inneralpine longitudinal vallies and basins and the eastern edge of the Alps are the driest regions (500 - 1,200 mm).

In the Alpine foothills precipitation is declining from west to east from 1,400 mm to 530 mm. In the east, which is influenced by the Pannonian climate, they drop down to 400 mm.

1.2 AGRICULTURAL PRODUCTION

The largest part of the country consists of farmland and forests. 46% of the total territory is covered by forests, 42% is farmland. 6.7% of the economically active population are working in agriculture and forestry; the share of agriculture and forestry in the gross national product is 2.3%. The area utilized by agriculture and forestry is managed by 267,000 farms of various sizes; the average size is 28 ha. In 1993 40% of the farmland was utilized as arable land, 57% as meadows, pastures and Alpine grassland, the rest consists of gardens, fruit cultivation and vineyards.

The major crops are wheat, barley, oats, rye, and maize; besides, sugar beet, potatoes, soybeans, sunflower, peas, rape, and field bean are important. 50,000 ha are used for viniculture, the area under fruits and vegetables is relatively small.

The mean self-sufficiency degree with food is 81%; in particular, substantial surpluses are produced of beef, milk and dairy products, grains and grain products. The self-sufficiency degree with fruits (41%) and vegetables (69%) is relatively low. By means of adequate promotive measures (EU programmes and national measures) a reorientation of production lines with surpluses is aimed at. In particular, a reduction of arable land and extensive measures in production are promoted. Programmes for landscape protection, in which agriculture and forestry are of great importance, are increasingly promoted by the public and private sectors.

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 WILD SPECIES AND WILD RELATIVES OF CROP PLANTS

The centres of origin and diversity of important crop plants cultivated in Austria are situated in different climatic zones. However, many crop and vegetable plants have relatives in the wild. Among the grassland plants utilized in agriculture, many grasses and fodder plants are an original part of the indigenous flora or there are wild relatives of the same species or variety. The fruit species cultivated in Austria also frequently have wild relatives, which belong to the forest plants. Thus wild forms of apple, pear or sweet cherry are indigenous in our forests; berries, such as raspberries or blackberries occur in our forests as brushwood zone.

Wild fruit species, (e.g. bilberry, cowberry, sea buckthorn, elder berry), vegetables (mushrooms), and the diversified group of medicinal and spice plants (yellow gentian, arnica, chamomile, juniper) are directly utilized.

2.2 LANDRACES AND OLD CULTIVARS

Landraces are varieties of cultivated plants, which have always or for a long time been cultivated in a certain area or originate from there.

In order to find out the possibilities of promotion according to EC regulation 2078/94, an expertise of "officially recognized, threatened valuable crop plants" was prepared in Austria in 1994.This list of varieties includes varieties of agricultural and horticultural cropplants, which:

- are threatened by extinction
- have properties worth to be preserved
- and are still of (mostly low) importance in present farming practice.

The above varieties are representatives of the categories indigenous varieties, elder selections of indigenous varieties, elder cultivars, exceptionally more modern cultivars with specific properties (e.g. naked oats).

Austrian landraces are found among all grain species cultivated in the country, maize and millet, potatoes, many vegetable species (onions, garlic, garden bean, lettuce, tomatoes, radish, cabbage, etc.) as well as among special crops, such as medicinal and spice plants. In particular in case of grains they are partly of local significance for biological farming and second generations. Landraces of vegetable and fruit species are found in farm gardens and scattered orchards - often for self-supply.

Apart from these varieties, which are still utilized, landraces of many species are stored in the Austrian genebanks, which in the future may not be important for direct cultivation, but for plant breeding.

CHAPTER 3
Austrian Activities to Preserve Genetic Resources

1. *In situ* conservation is guaranteed on the one hand by the conservation on the natural site of growth (wild plants, grassland plants) and by the cultivation and utilization of the respective species on farms (crop plants, fruit species) on the other.
2. *Ex situ* conservation.

There is a series of genebanks and collections in Austria, which are conserving genetic resources. Below a survey of the major collections:

Bundesamt und Forschungszentrum for Landwirtschaft, Wien

Versuchsstation Fuchsenbigl/Niederösterreich
Triticum, Triticosecale, Hordeum, Avena, Vicia faba
Versuchsstation Korneuburg/Niederösterreich
Medicinal and spice plants, oleaginous plants

Bundesamt für Agrarbiologie, Linz/Oberösterreich

Aegilops, Allium, Avena, Hordeum, Linum, Papaver, Pisum, Phaseolus, Secale, Triticosecale, Triticum, Vicia, Zea Malus, Prunus, Pyrus.

Landesanstalt für Pflanzenzucht und Samenprüfung, Rinn/Tirol

Triticum, Hordeum, Secale, Avena, Zea, Fagopyrum esc., Panicum/Sorghum, Papaver, Phaseolus, Linum, Vicia, Pisum, Brassica.

Landes/versuchsanlage für Spezialkulturen, Wies, Steiermark Medicinal and spice plants, vegetables, dyer's plants

Ad 1 to 4 compare: ÖGK (Austrian Genebanks for Crop Plants), 1992: Index Seminum Austriae. Ed. W. Kainz, Bundesamt für Agrarbiologie, Linz.

Institut für Obst- und Gartenbau der Universitat für Bodenkultur Wien

Malus, Prunus, Pyrus, Juglans.

Höhere Bundeslehranstalt und Bundesamt für Wein- und Obstbau mit Institut fürBienenkunde, Klosterneuburg/Niederösterreich

Malus, Pyrus, Juglans, berries Vitis (Division for Vine Breeding).

Bundesanstalt für alpenländische Landwirtschaft, Gumpenstein

Gräser, Leguminosen, Kräuter for Grünland und alpine Lagen.

Landesversuchsanlage für Obst- und Weinbau, Haidegg/Steiermark

Malus, Prunus.

Saatzucht Gleisdorf GesmbH. Steiermark

Vicia, Cucurbita, Panicum, Setaria.

Kärntner Soatbau GenmbH, Klagenfurt/Kärnten

Triticum, Hordeum, Avena.

Arche Noah, Schiltern/Niederösterreich

Triticum, Hordeum, Secale, Avena, various vegetables.

Predominantly, public institutions attend to the conservation of plant genetic resources. These are services at federal and provincial level and university institutions. Besides, there are collections held by plant breeding enterprises and privately organized groups as well as assortments of agricultural schools and botanical gardens.

The roots of the numerous collections are to be found in the diversity of agricultural and climatic areas and in the federal set-up of our country. Most genebanks were established amid specialized cultivation areas. For this reason, grain, fruit, and vegetable collections are found in separate regions; it is particularly underlined that each of these collections is unique. When public

institutions are in charge of specific crop species in their research, experimental or training activities, in many cases the storage of seed samples or the preservation of material suitable for vegetative propagation has developed at the same time.

Genebanks with material conservation in tissue cultures (*in vitro*) are being established for fruit and viniculture. Mostly domestic plant genetic resources with different breeding status are conserved (wild plants, breeding strains, landraces, breeding varieties). Emphasis is put on Austrian selections, which are withdrawn from circulation by plant breeding enterprises or struck off in the breeding record. Besides, landraces and abandoned foreign breeding varieties, which are important for Austrian cultivation areas, are collected. Active collection work in the field is done on a small scale only. However, individual landraces are frequently newly included in the assortments by interested staff members or other people.

In most cases the plant material is processed in the genebanks in line with the technical recommendation of the IPGRI. This comprises all steps of orderly propagation, investigation, and handling. The technical equipment required for this purpose is mostly available to a satisfactory extent. Basically it can be said that the Austrian genebanks are equipped with good drying and adequate storage facilities (cold-storage). In cases where storage is not in accordance with the IPGRI, free storage capacities are provided by colleagues from other genebanks. Besides the curator also the processing staff in the genebanks has good technical knowledge because of the country-specific specialization on individual crop species. Moreover, there are established long-standing technical contacts within the groups of crop species, such as grain or fruits.

From the collected material the usual small samples are delivered for breeding and scientific purposes. For more detailed information about the individual objects, interested persons may directly address the curator of the genebank However, there is no guarantee that individual varieties are not subject to current breeding rights; in such cases propagation and direct commercial utilization might be inadmissible, but the utilization for scientific purposes or as a crossbreeding partner would hereby not be restricted.

In case of grains and other field crops on the average 10 requests per genebank are dealt with annually comprising some 50 samples. About half of them are delivered to foreign genebanks and half to domestic university institutions and private breeders. In the fruit sector hundreds of grafts are delivered to hobby gardeners. As curators have to withdraw trees from the collection, since the arboreta are not large enough, this private interest is saving varieties from extinction. Also in the field of medicinal and spice plants the private interest is

great. The collection of objects in the individual genebanks is mostly computerized.

Deficiencies exist frequently as regards an adequate characterization evaluation of the available material. Records exist mostly over many years, but only in some cases they can be directly used for the identification of varieties. Frequently they need orderly working off and collection. The small personnel capacities are a limiting factor; in the public genebanks there is neither a curator nor one staff member, who is only in charge of the collection of varieties. Lists of the objects collected in the federal institution in Vienna and Linz, in the provincial institute at Rinn and in the provincial research institute at Wies are available since 1992 under the index seminum Austriae. This contains besides a short presentation of the genebanks all collected objects including passport data (number, variety name, country of origin, breeder or finding place, donor, donor number, status and remark). The institute for fruit cultivation at the University of Agriculture has taken initiatives to prepare a common list for the sector of Austrian fruit cultivation.

In 1991 with the establishment of the Index Seminum Austriae the Working Group "ÖGK" Austrian Genebanks for Crop Plants" was reactivated by several public collections. An expansion of this Working Group to all public institutions is generally welcomed. After a consolidation phase and the clarification of all basic questions it is planned to make it accessible to all collecting groups, in order to meet our responsibility to preserve the genetic diversity of our country. While conserving the uniqueness and sovereignty of the genebanks an increased cooperation and the establishment of smaller working groups for special crops is aimed at.

CHAPTER 4
Utilization of Plant Genetic Resources

4.1 UTILIZATION OF GENEBANK MATERIAL

Plant genetic resources from public genebanks are presently mostly utilized in the fields of basic research and breeding research. By the increasing use of biotechnological methods an increased use of plant genetic material from genebanks might in the near future gain importance also in practical plant breeding. This requires, however, a satisfactory characterization and evaluation of the stored material. Private and cooperative breeding companies mostly receive breeding material for the medium term, which they may immediately use in their programmes. In the private sector of the NGOs increasingly old cultivars, landraces or cultivars of rare origin are offered for private purposes (e.g. house garden).

4.2 PLANT BREEDING AND SEED PRODUCTION

Austria's plant breeding is characterized by a traditional cooperation between the public and private sectors. Breeding research, mostly carried out by public services pursues two major objectives. On the one hand the elaboration of new breeding methods under consideration of basic research and all neighbouring scientific disciplines of plant breeding, such as genetics, botany, biotechnology, plant physiology, and statistics, on the other hand it is the task of breeding research, to supply the plant breeder with new basic material for further breeding; i.e. plant material with a new and improved performance and quality character, resistance to diseases and other characteristics of value. Furthermore, it is responsible for the implementation of expensive long-term projects, such as the development of new crop plants from wild progenitors or interspecific hybrids, for the transference of quality and resistance characters or the mutating interference in the breeding structure of crop plants.

In Austria practical plant breeding is predominantly carried out by private and cooperative seed breeding forms. The breeding objectives of the private

breeding farms are geared to the demand and to the requirements of farmers, the processing industry and final consumers. Priority objectives are the improvement of quality and cropping capacity, improved processing qualities and resistance. Based on the legal regulations of the EC and Austria a national variety catalogue of agricultural plant and vegetable species is kept. The varieties listed therein are transferred to the common variety catalogues. The varieties included in these catalogues are marketable in the whole area of the EU.

The range of varieties bred in Austria is wide; the breeding intensity depends on the economic importance. The share of Austrian varieties in domestic seed production is high to medium with the grain species wheat (in particular durum and winter wheat), barley, rye, and oats as well as field bean and potatoes. Sugar beet is bred in Austria also by companies from other EU countries and also seed is produced. Crop species, which are cultivated in Austria to a larger extent such as grain rape, sunflower, soybeans and grain pea are not bred in Austria, the breeding activity of the leading crop maize has considerably decreased. There is slight breeding activity for vegetables, fruits and special crops (e.g. spice plants) as well as fodder plants. Vegetable seed (pepper, radish, lettuce, hot pepper, various brassica varieties, carrots, parsley, onions, beans, and tomatoes) is produced in Austria in modest quantities only but of high quality. The domestic seed production of small-seed leguminosae, grasses and California bluebell can cover the domestic demand only to a modest degree.

CHAPTER 5
Legal Basis for the Conservation of Plant Genetic Resources

In the federal constitutional act on comprehensive environmental protection (Fed. Law Gazette 491/84) the conservation of the natural environment as basis of human living and protection against harmful effects is laid down as an objective of the Austrian state.

On the legal basis of the regulations (EC) No. 2078/92 concerning methods of production which protect the environment and the natural living space and (EC) No. 2092/91 on ecological forming and respective labeling of agricultural products and food and the federal act, which stipulates measures for food security and the preservation of an efficient rural agriculture throughout the country (Agricultural act 1992 - LWG, Federal Law Gazette No. 375/92), the Federal Ministry of Agriculture and Forestry offers the support programme "ÖPUL". This programme, which comprises some 30 individual measures, encourages contributions to an environmentally-friendly, extensive agriculture that protects the natural living space. For instance, scattered orchards, the creation and preservation of biotypes, and the cultivation of rare crops is promoted.

For the conservation of plant genetic resources in a stricter sense there is no comprehensive legal regulation. Upon instruction of superior services or based on older statutes land races were collected and inventories made in public institutions already around the turn of the century; subsequently, a number of genebanks were established. According to the federal act on federal offices for agriculture and federal agricultural institutes, Federal Low Gazette No. 515/94 the federal Office and Research Centre for agriculture (Vienna,), the Federal Office for Agricultural Biology (Linz), the Secondary School and Federal Office for Vine and Fruit Cultivation (Klosterneuburg), the Federal Research Institute for Agriculture and Alpine Regions (Gumpenstein), and the Secondary School and Research Institute for Horticulture (Vienna) are entrusted with the preservation and processing of plant genetic resources in their respective fields. In most cases the federal agricultural research institutes were entrusted by virtue of the federal act on these institutes (Federal Low Gazette No. 230/82). Apart from these collections in the offices and institutes at federal level there are important genebanks at the regional provincial level.

These independently organized and acting collections cooperate within the framework of the Working Group "ÖGK - Austrian Genebanks for Crop Plants".

In the course of the implementation of the (EC) regulation 1467/194 on the conservation, description, collection, and utilization of the genetic resources in agriculture, the cooperation in this field will be intensified also at national level. This should extend to all public and private services dealing with the conservation of plant genetic resources. The following acts form the legal basis for Austrian varieties and seeds: the plant breeding act (1947), the variety protection act (1993), and the seed act (1937) as well as their implementing regulations, as amended. The plant breeding act constitutes an important part of the regulations concerning the approval of cultivars and seed certification of crop plants (except trees, shrubs, and vines). This act, and in particular its regulation on the approval of cultivars, secures the progress of plant breeding and the cultivation of varieties which are of high value for land improvement. The act on variety protection passed in 1993 codifies an intangible property right to protect the copy right property of cultivars, granting the breeder upon request the exclusive right to sell propagation material. Exempt from these breeders' rights is the use of the variety for the creation of a new variety (breeder's reservation), the production, handling, and use of farm-owned seed and plant material (farmer's reservation), the use in the private sphere and the use of propagation material for science and research. The seed act (1937) regulates the trade in seeds and plant material including approval, certification, and control. It is the objective of the act to promote the production in line with the quality and the supply of agriculture with seed and plants of perfect quality.

Sustainable plant production and a biological stability of the crop plants is only possible on the basis of a plant genetic diversity. The biological stability of the crop plants is founded in particular on a permanent resistance or tolerance against pests, which is possible only on the basis of a broad genetic diversity of the resistance properties. Scientifically supported intensive breeding of indigenous plants is the best guarantee for this. Free and unimpeded access to a broad diversity of plant genetic resources is indispensable for further breeding success.

The plant genetic diversity stored in the genebanks has to be scientifically processed, evaluated, and documented to become a useful tool for practical plant breeding on the basis of scientific breeding research. Apart from the establishment of genebanks and the documentation of the stored material:

- the free access to the genetic resources of the genebanks has to be secured,
- the genetic diversity of species and varieties has to be enhanced in plant production, and
- the utilization of the genetic resources by the breeders, in particular in resistance breeding, has to be intensified.

CHAPTER 6
International Cooperation

Austria is one of the signatory states of agenda 21 of the Convention on Biological Diversity at the UN Conference on Environment and Development in Rio 1992. With this signature Austria has committed itself to preserve and sustainably utilize the available genetic diversity.

Austria supports financially and substantially the International Plant Genetic Resources Institute (IPGRI), the successor organization of the International Board for Plant Genetic Resources (IPBGR), with the objective to enhance the preservation and use of plant genetic resources to the benefit of the present and following generations.

The country participates with its genebanks in the global system. Individual genebanks cooperate intensively with other international genebanks and organizations. The genebank of the Bundesamt for Agrarbiologie, Linz serves as security store for the important field bean collection of the International Centre for Agricultural Research in Dry Areas, Syria.

CHAPTER 7
National Needs and Opportunities

The substantial structural changes in agriculture entailed a considerable restriction of the plant genetic diversity. These developments have to be counteracted by suitable measures to preserve the plant genetic resources. In Austria genebanks are established and conserved to a satisfactory degree. Efforts to conserve the national resources have, however, to be strengthened in the following fields:

- complete survey of all collections and conservation activities (measures of *in situ* conservation, wild species, private individual measures, botanic gardens, agricultural schools,
- development of a collection strategy for the whole territory and monitoring of the diversity of species covered by the collections,
- greatest possible compatibility of the documentation of the species collections and the DP systems used,
- considerations concerning systematic security storage,
- improvement of the evaluation of the collections,
- frank and cooperative communication between the genebanks, and
- intensification of the cooperation at international level.

CHAPTER 8
Global Plan of Action

Precondition for the implementation of a global action plan is a better coordination between the international and supra-national institutions dealing with the preservation and utilization of genetic resources.

Measures at international level have to be harmonized with the objectives stated in Agenda 21 (Convention on Biological Diversity), chapter 14. Particular emphasis should be put on:

- the coordination of global activities for the preservation and utilization of genetic resources,
- the promotion of protective measures - in particular in areas with high genetic diversity - at political, financial, and technical level, and
- the survey and conservation of resources and information of presently neglected, potentially utilizable plant species.

ANNEX 1

Coordinator:
Ferdinand Muller

1.1 INTRODUCTION INTO AUSTRIA'S FORESTRY

Austria has a surface of 8.385 million ha, two thirds of which are situated in the Alps; further 10% are low mountain ranges north of the Danube. The lowland is restricted to areas in the east of Austria and the Alpine foothills.

Austria is situated in the sub-Atlantic, cool, humid central European climate, which gets increasingly continental towards east. The barrier of the Alps with its predominantly east-west running mountain ranges creates marked climatic zones in the Alpine area, which is Atlantic on the outskirts, while it is continental in the interior part of the mountains. The regional climate is overlaid by vertically successive climatic belts. Forest areas range from the lowland and hilly area over the sub-mountainous and mountainous zone to the low and high sub- Alpine area.

The total forest area of Austria is, according to the Austrian Forest Inventory of 1986/1990 3.88 million ha, i.e. 46.2% of the federal territory. Austria is thus the most densely forested country of Central Europe.

According to the Austrian Forest Inventory 19.1% of the forests are protection forests - these are forests, for which, because of their ecological sensitiveness, there are specific protection regulations.

11.7% of those forests are in hardly or not accessible positions and are stands with a very low growth rate by nature.

The largest part of the forest area is the commercial forest, accounting for 78.5%, 76.0% of which is high forest, 2.5% coppice forest.

The forests are not evenly distributed over the Austrian territory. The forest cover in the individual provinces (except Vienna) ranges from 32.0% (Burgenland) to 60.3% (Syria).

For decades the total forest area has continuously increased in Austria (on the average by 2000 ha/year, mainly due to the natural regeneration and by afforestation in the area of protection forests as well as of former farmland.

According to the Austrian Forest inventory of 1986/90 53.1% of the total forest area are small forests of less than 200 ha, 31% have more than 200 ha. 15.0% are managed by the Austrian Federal Forest Enterprise (state forests).

According to surveys made by the forest authorities in 1993, 400 forest enterprises with a forest area larger than 500 ha are managed by a forest organ. These forests account for a total of 1.5 million ha. As surveyed by the Austrian Forest Inventory, 42% of the isolated young forests are damaged by game, mainly the tree species fir and beech. Only in about one quarter of the forest a regeneration of all the species, desirable from the silvicultural viewpoint, is possible without protection measures. Damage caused by red deer occurs in 8% of all stems and 0.3% of the stems are newly gnawed every year. 11% of the stems are damaged by wood harvest and rockfalls In the medium term this leads to a deterioration of the protection effect of the forest. The Austrian Forest Inventory documents a highly unsatisfactory condition for the protection forests. Almost 1/4 of the protection forests is disintegrating, more than 1/3 is opened up or defoliating, the percentage of unstocked bareland and fail spots is above the average. The regeneration of overaged collapsing protection forests is frequently impeded or prevented by browsing. Some 11% of the damage is caused by grazing animals.

Examinations of forest damage show that both the condition of forest soils and the tree crowns as well as the increasing air pollution give rise to concern, Secondary acidification processes in forest soils, increased ozone and sulfate contamination as well as an increasing crown defoliation heavily burden the ecosystem forest.

On 12% of the Austrian forest soils secondary acidification processes were identified, to which the ecosystem has not yet adapted. Up to 20% of the forest soils are threatened by acidification. Lead and cadmium were found widely spread in increased concentrations, which gives rise to the fear that the Alps will become the large-scale deposit of European air pollutants.

In comparison to other European countries Austria has high ozone values. As regards the nitrogen oxides, mainly caused by motor vehicles, only a slight

reduction could be achieved from 1980 to 1992. Although the sulfur dioxide emissions were drastically reduced in Austria, the sulfate contamination in precipitation and its concentration in needles and leaves caused by pollutant imports are still high.

In 1993 45.1% of the trees examined showed losses of needles and leaves; in 8.2% of the cases it was medium to heavy defoliation. The worst crown condition was found among pines, only 37.4% of the examined pines had no defoliation. Likewise, fir, beech, and oak are heavily affected. Regional studies show that exposed protection forests are particularly damaged.

(Source: Österr. Waldberciht 1993, Federal Ministry of Agriculture and Forestry).

1.2 FOREST GENETIC RESOURCES

As concerns the distribution of tree species and their mixture, the present forest structure is marked by the natural site on the one hand and by forest management on the other.

The following natural forest associations occur:

- Larch - arolla pine forest: high/sub-alpine, predominantly inner - and interalpine.
- Carbonate - larch forest: high mountainous to sub-alpine, alpine carbonate sites in steep terrain.
- Low sub-alpine (1,500 - 1,700 m a.s.l.) spruce forest: predominantly inner- and interalpine, occasionally on alpine outskirts.
- Mountainous spruce forest: inneralpine; in other mountain areas with extreme local climate or edaphic conditions.
- Spruce - fir forest: subcontinental inner and inter-Alps, in other mountainous areas on edaphically extreme sites.
- Spruce - fir - beech forest: mountainous areas except inner Alps.
- Beech forest: sub- to low mountain areas.
- Oak - hornbeam forest: hilly-submountainous areas on the outskirts and outside the Alps.

- Pine - oak forest on acid soils: hilly submountainous sites with los nutrient content.
- Thermophile oak forest (pubescent oak Turkey oak): permanent associations on warm sites.
- European hop hornbeam - flowering ash: relict permanent association on shallow, steep, warm sites on the southern mountainous outskirts.
- Linden - mixed forest: hilly to low-mountain permanent association (450 - 700 m) on boulder-fields and debris cones.
- Sycamore maple and sycamore maple - ash forest: permanent association on specific sites.
- Sycamore maple - beech forest: fragmentary permanent association on high mountainous steep sites with abundant snow.
- Black older - ash forest: low to sub-mountainous permanent association on special sites with water surplus.
- Black alder swamp forest: sub- to low mountainous permanent association with high ground water level.
- Grey alder brushwood (river side forest): sub- to high mountainous permanent association on special sites with water surplus.
- Mountain pine (*pinus mugo var. rostrata*) forest: low to high mountainous permanent association on carbonate special sites in the western part of the northern outskirts or inter-alpine regions.
- Dwarf pine bushes:
    - Alpine dwarf pine bushes: mountainous to high sub-alpine areas on naturally unforested sites, frequently anthropo-genetic replacing association in the area of the sub-alpine spruce forest.
    - Dwarf pine swamp forest: sub- to high mountainous permanent association with high moor peat soils.
- Mountain white pine (birch)/mountain pine/swamp forest: low to high mountainous permanent association at the edges of high moors in the Mühl- and Waldviertel (Böhmische Masse).
- Carbonate fir forest: permanent association on dry, sunny carbonate sites, secondarily wide-spread.
- Silicate-pine forest: permanent association on shallow, sunny silicic special sites.

- Black pine forest: pioneer and permanent association at the eastern edge of the Alps and on the southern outskirts on dry carbonate sites; at the eastern edge of the Alps secondary forest.
- Riverside forest: various plant associations in the inundation area of the Danube and other major rivers.
- Green alder brushwood: high mountainous to sub-alpine small-scale pioneer and permanent association on sites with abundant snow.

Present distribution of tree species in the production forest: (Austrian Forest Inventory 1986/90)

	area (1000 ha)			%
Spruce	1870	+/-	32	56.1
Fir	82	+/-	5	2.5
Larch	150	+/-	6	4.5
Mountain white pine	193	+/-	9	5.8
Black pine	23	+/-	4	0.7
Arolla pine	17	+/-	3	0.5
Other coniferous trees	4	+/-	1	0.1
Total coniferous trees	2339	+/-	37	70.2

	area (1000 ha)			%
Beech	296	+/-	11	8.9
Oak	68	+/-	5	2.0
Other sclerophyll trees	195	+/-	8	5.9
Soft-leaved trees	128	+/-	6	3.9
Total broadleaved trees	687	+/-	18	20.6

	area (1000 ha)			%
Blanks	54	+/-	4	1.6
Fail spots	151	+/-	5	4.5
Bushes in stand	68	+/-	3	2.0
Brushwood area	32	+/-	3	0.9

In the past the percentage of coniferous trees was increased for economic reasons also in lower positions, mainly by introducing pine and spruce (secondary spruce and pine forests).

By exceeding the ecological tolerance of the sites this resulted in a deterioration of the soil, an increased occurrence of pests as well as in damage caused by storm and snow.

Austrian forest policy has therefore launched reorientation towards a more natural forest structure, mainly through extension and support, which is already reflected in the forest inventory results. Nevertheless, the percentage of spruce in the commercial high forest increased by 5% since the latest inventory period 1971/1980; this to the disadvantage of fir (-8.4%). However, in the protection forest the percentage of spruce declined by 9.1%, while at the same time the percentage of arolla pine, larch, and some broadleaved species increased.

According to the Austrian Forest Inventory 1986/90 33.6% of the forest area are stocked with pure spruce stands (more than 8/10 of spruce), in 1971/80 it was 45%. The percentage of pure broadleaved stands (more than 8/10 broadleaved trees) declined since 1971/80 from 9.5% to 5.2%, that of mixed forests increased from 22.0 to 35.3%.

While - according to the Austrian forest inventory - the percentage of broadleaved trees in the production forest increased over the last years, the percentages of fir and beech substantially decreased. The main reason for that is browsing of the young stand, which is particularly severe in case of these species. For example, the percentage of fir in the commercial high forest is dropping from 8.6% in the age-class of more than 140 years, to 0.9% in the age class of up to 20 years. At the same time the total percentage of fir decreased since the period of 1961/1970 by more than l/3 to 2.5% of the area. The percentage of beech in the age class from 101 to 120 years, viz. 14.1%, is the double of that in the age class up to 20 years.

A preliminary evaluation of the 1992 survey of the Austrian Forest Inventory on regeneration and browsing gives information about the regenerative potential of Austrian forests. 15% of the forest area shows natural regeneration, 2% artificial regeneration, and 83% no regeneration at all. The share of natural regeneration in the total regeneration, amounting to 87%, is high. However, in forests without regeneration there is a need to regenerate 21% - this mainly in old stands where the possibilities for natural regeneration have been heavily impaired by game and grazing.

The percentages of tree species in forests with regeneration are informative. Natural regenerations have three or more tree species in 52% of their area; in predominantly artificial regenerations the percentage is 36%. A comparison of the individual tree species in natural and artificial regeneration shows these

differences even more clearly: spruce regenerates in 72% of the natural regeneration area, 23% of which are pure spruce regeneration; in afforestations, however, spruce accounts for 98%, 45% of which are mere spruce cultivation. The share of beech in the natural regeneration is 36 in afforestations 20% - as natural new growth. Fir accounts for 24% in natural regeneration areas, in afforestations for 12%. The shares of tree species in natural and artificial regeneration are: larch 13% and 20%, resp. oak 10% and 4%, ash 22 and 14% maple 27 and 14%, birch 8 and 12%, and mountain ash 22 and 10%.

Various tree species, such as hornbeam, elm, sorbus and prunus species, bird cherry, and linden regenerate - according to the present partial results of the Austrian Forest Inventory - exclusively naturally. If we consider the stands, however, from the pole wood age onwards these ecologically important admixed tree species have been largely eliminated. This is partly caused by lack of light and by competition, but the factors game, forest posture, and also silvicultural treatment of young growth play an essential part in this admixing. (Source: Austrian Forest Report, 1993).

Threatened in their existence are populations of the tree species field elm and European white elm, of which, due to the die-back of elms (caused by the f*ungus Ophiostoma novo-ulmi*) only residual stands exist. Furthermore, wild pear (*Pyrus pyraster* Burgsd.) and crab apple (*Malus silvestris* L.) are tree species, the yields of which are increased by breeding and the cultivation of which is widely spread. Due to secondary immigration of the modern cultivars into the forest or by hybridization with the still existing wild varieties these species seem to be particularly threatened by supplantation of the original populations. Supplantation effects by cultivars exist also on natural black poplar sites in river- side forests.

In 1986, based on expert talks at the Federal Forestry Research Institute, a research project was commissioned by the Federal Ministry of Agriculture and Forestry entitled “Contributions to the Preservation of Biodiversity”. The project is unlimited and is jointly carried out by the Institutes of Silviculture and Forest Genetics in close cooperation with the services of the forest authorities and the forest owners.

The project comprises 3 groups of measures:

3.1 *in situ*: acceptance and attendance of gene-preservation forests.

3.2 *ex situ*: long-term storage of forest seeds (seed bank).

3.3 establishment of seed plantations and clone archives.

In situ and *ex situ* measures are linked in an overall concept and complement each other in their effectiveness.

1.3 ACCEPTANCE AND ATTENDANCE OF GENE PRESERVATION FORESTS

In line with the overall objective of gene preservation to secure the full genetic diversity of the tree populations,

- to guarantee their evolutionary development
- to preserve their full adaptability to changing environmental conditions
- to improve efficiency and chances of survival of forests in the future
- to comply with the ethical obligation to transmit without restrictions the heritage we have received to succeeding generations,

the *in situ* preservation strategy is to be given priority.

Moreover, due to their high efficiency, the *in situ* measures have proved to be less costly than other measures. They should therefore be applied wherever possible.

For the selection and silvicultural treatment of gene-preservation forests a concept was prepared (MÜLLER, 1993), the most important features of which are stated below.

By applying suitable natural regeneration procedures in gene-preservation forests, the genetic information stored in the stands is transmitted to the succeeding generations. When selecting stands criteria have to be considered, which have an immediate impact upon the preservation concept and the required silvicultural treatment.

As regards the economic utilization, it is distinguished between genetic preservation:

- (largely) without any logging and management activities (virgin forests, natural reserves, natural forest cells),
- with logging and management activities.

Due to the low number of virgin forests and natural forest reserves it is a matter of fact that genetic conservation under observance of certain requirements is practiced in forests which are integrated in the economic cycle. Depending on the size of the preservation unit we distinguish.

Genetic reserves; Large parts of forests (from 30/50 to several 100 ha). This size is deemed sufficient for mere *in situ* measures, since, given undisturbed development or adjusted anthropo-genetic influence, balanced, continuous evolutionary dynamics, independent of marginal impacts, is possible.

Preservation units are ecosystems, overall living communities or such of the dominating tree populations (e.g. elevation profiles of an Alpine area).

The required size enables the formation of characteristics of stand structure and texture, which secure the continuity of natural regeneration (overlapping tree generations) as a precondition for continuous adaptation processes. Gene-reserves should above all include those forest associations and complexes which may - due to their site conditions - cover large areas (e.g. sub-alpine spruce forest, spruce (fir) beech forest on Alpine outskirts).

Gene-preservation stands: individual stands of more than 3 - 5 ha. Objective of conservation are certain characteristic

- gentypical structures,
- ecotypes,
- small-scale forest association.

The size of the area is mostly insufficient for an independent or balanced development.

Undesired changes of the genetic composition occur in case of

- lacking isolation by pollen or seed flight from neighbouring populations
- isolation by genetic random drift or inbreeding

Owing to these influential factors there is an increased uncertainty that the genetic information is completely transmitted to the succeeding generation. The possibility of continuous regeneration of the preservation unit is limited, regeneration mostly occurs through separate tree generations.

Gene-preservation stands mainly include those forest associations which, due to locally limited climatic extremes or peculiarities, which may be caused by relief or soil, only rarely cover large areas (e.g. permanent associations, special

sites, such as sycamore maple in ditches/gorges, black alder swamp forest, mountain pine forests.

Specific small-scale silvicultural treatment, application of suitable natural regeneration procedures and creation of the preconditions for a permanent self-regulating balance enable a sufficient continuation of genetic information even in small preservation stands.

The following criteria are used for the selection of gene preservation forests:

Stocking in conformity with nature: composition of tree species and stand structure should be in conformity with the natural forest association possible on that site or it should at least be possible to create by means of normal silvicultural measures conditions which are similar to nature.

Autochthony: primary autochthonic forests, forest relicts or virgin forests are available for the selection of preservation units only in very rare cases, although they would be highly appreciated for the purpose of gene-preservation!

The anthropogenetic influence exerted for several tree generations (several up-rooting periods, exploitation, change of the tree species composition, transfer of reproductive material) has in many tree species led to a basic change of the original genetic structures also in the Alpine region. In particular in the commercial forest tree species, which are often artificially regenerated, are mixtures of various populations.

For the purpose of gene-preservation, apart from the valuable original (autochthonous) populations also those are of importance, which by their vitality and lack of deficiencies have obviously proved their suitability or adaptability to the given site conditions.

Representation: The question for the necessary dimension of preservation units to be collected corresponds to the question for the dimension and structure of genetic variations of the tree species and can presently not be answered. However, since the beginning of forest-genetic investigations numerous experts have been gathered to classify and define local races or ecotypes, which are currently supplemented by the use of biochemical procedures. However, these findings are not yet sufficient for a final judgment on the genetic diversity.

Since conservation methods cannot be postponed until a sufficient clarification of the forest genetic resources will be available, it was deemed expedient to use classification principles based on site/plant physiological findings, which serve for the delimitation of natural units of forest growth areas.

The selection of preservation units by growth areas and altitude and related to natural forest associations is presently considered as the most secure basis for the survey of the genetic diversity.

To which extent the natural area correlates with genetic structures, requires clarification in the future (see section on research requirement). Every natural forest association should be represented within the growth areas several times and as well scattered as possible.

In the first phase of work the characteristic forest associations (leading associations) are selected for each area of origin and each altitudinal zone. In a basic grid, covering the whole territory, each of this leading associations - possibly with its altitudinal variants - should be represented by at least one preservation unit. Only after achievement of this partial goal a more denser grid is aimed at.

Priority: Basically, we do not select and evaluate priorities by ranking the values of individual forest associations. An exception are forest associations, which, due to their rarity, their relict character, their position at the border of the area (border populations) or on special sites with extreme environmental conditions are worth to be preserved. Such stands are overrepresented in the preservation concept.

Preconditions for natural regeneration: The preconditions to secure the regeneration success have to be met or there must at least be the willingness to eliminate impediments of regeneration (fences against browsing, soil preparation, elimination of competitive vegetation, etc.). The principles of silvicultural treatment of gene preservation units are the following:

- permanent stocking
- preservation of mixtures of tree species according to the natural forest associations
- all-aged stocks
- all-aged structure also for small preservation units
- heterogenous development conditions

Among the natural regeneration procedures those are preferable, which enable long regeneration periods, utilization of several fructification periods, continuous regeneration and simultaneous reproduction of overlapping generations. When selecting the remaining trees in case of a reduction of the stem number and thinning, any selective loss of genetic variations should be avoided.

To realize the objectives public means are available according to a respective project of the Federal Forestry Research Institute.

The presently registered gene-preservation units (Table 1) are stored with their characteristics in data banks of the Federal Forest Research Institute. Forest owners and authorities are furnished with summaries (documentation sheets), which serve as a basis for the implementation of operational and silvicultural measures and as expertise for applications for support.

Within the framework of a project carried out by the Institute for Forest Genetics at the Federal Forestry Research Institute, part of the gene-preservation stands are examined by means of genetic-biochemical methods (project leader: Th. GEBUREK). The objective of the project is investigations of the genetic adaptation potential of domestic forest tree species based on micro and macrogeographic genetic variation patterns (genetic inventory), furthermore evaluation of post-glacial immigration paths, appraisal of gene centres as well as of evolutionary factors (selection, drift) for the gene pool, impact of silvicultural measures upon genetic structures and investigations into the mating system.

At present the international cooperation is limited to the exchange of information and the attendance of pertinent events. A strengthened cooperation in the European area would, however, be useful for the preparation of common guidelines for the selection and treatment of gene reserves as well as for the establishment of a data bank network. However, the importance of these international approaches must not be overestimated, since - apart from generally valid guidelines - regional approaches, which consider country-specific peculiarities, have to be applied.

Table 1 Gene-Preservation Forests

	Area	
	<30 ha	**>30 ha**
Larch - arolla pine forests	3	9
Carbonate - larch forest	4	1
Low sub - alpine spruce forest	17	16
Mountainous spruce forest	6	3
Spruce - fir forest	24	8
Spruce - fir - beech forest	39	21
Beech forest	6	-
Forests rich in oaks	17	1
Mixed hardwood forests on special sites	15	-
Black pine - (European hop hornbeam) forest	2	1

	Area	
	<30 ha	>30 ha
Yew sites	5	1
Carbonate - pine - forest	1	2
Mountain white pine - birch - mountain pine - swamp forest	3	-
total (units)	142	63
total preservation units:	124	

Total area: 5,900 ha
Average area per unit: 28.8 ha.

1.4 FOREST SEED BANK

The conservation of forest seed as a static element of the conservation strategy has not to be understood as an isolated measure, but is embodied in the comprehensive conservation concept. Storing seed primarily aims at bridging periods: periods of lacking or insufficient flower or seed production as well as periods in which natural regeneration is not possible for other reasons.

A complete seedbank would not only contain seed from seed-production stands but also from autochthonus or obviously adapted forest associations, which have been developed in conformity with nature, possibly with all their phenotypes - marked by site and altitude. It is, however, evident that despite all efforts only a part of the total population and only some typical random samples, which are considered to be of particular importance, can be stored. The seed quantity to be stored cannot reach the dimension of economic importance, but the stored sample should be big enough to survey the genetic structure of a tree species population.

The seed bank of the Federal Forestry Research Institute consists of 6 cold stores with separate air-condition (capacity: 260 m^3), in which at a temperature from + 5° to - 20°C up to 7 tons of seed can be stored.

The possible storage period for seed depends on the tree species and storage conditions. While mainly the small seeds of coniferous trees keep their germinating capacity for 15 to 20 years, the seeds of the most broad-leaved trees (in particular oak) live only for a few years. The preservation of a certain water content, which has to be in correspondence with storage temperature is of utmost importance. Optimum storage conditions are applied in line with national and international experiences. The germinating capacity of the: stored seed is checked by random sampling.

The storage capacity is considered to be sufficient; at present, part of the cold store is utilized by private companies for their accounts. A cooperation with seed banks of other countries would be possible but was so for not aimed at.

The characteristics stored in the data bank comprise descriptions of the seed source (seed-production stand, plantation), information about its external quality, and storage conditions.

(Source: LITSCHAUER, 1994).

1.5 CLONE ARCHIVES AND SEED PLANTATIONS

Tree species, which occur only as small-scale cells of a stand or individual trees, may be preserved by means of clone archives and seed plantations. The plantations consist of a number (mostly 50 to 100) of selected trees, which are established on the basis of regional, in particular vertical structure. Intensive mixing of all clones in the plantation enables a high degree of mating possibilities. In particular for dispersed individual trees the plantation helps to secure the preservation of the genetic diversity of the genetically developing progeny. In comparison to the seed production stands, forest preservation and seed plantations offer the advantage of obtaining seed beyond the life span of the original material (mother trees).

After a first planning of the plantation programme, within a period of 15 - 20 years 168 units of 1 - 2 ha each (partly parallel and in cooperation with the federal provinces) should be established. With the presently available funds and personnel it is foreseeable that this schedule can not be met.

The plantations presently established by the federal government, the provincial governments, the Austrian Federal Forest Enterprise and in cooperation with the Torrent and Avalanche Control Service for gene preservation comprise a total of 42 units covering 75.4 ha of plantation area (LITSCHAUER, 1994).

With this the demand for some important forest tree species for typical areas of origin and altitudes is met. In the future the plantation programme will concentrate on rare hardwood species and also autochthonous bushes will be considered. For the utilization of the plantations a draft contract between the Republic of Austria, represented by the Federal Minister of Agriculture and Forestry and forest seed procedures united in a Working Group

"ARGE-FORST-SAA" was prepared, which regulates marketing of the seed produced in the state-owned plantations.

Present *in situ* and *ex situ* preservation measures are not yet complete or representative. With the given personnel and funds a long-term continuation of the project will be necessary.

1.6 UTILIZATION OF FOREST GENETIC RESOURCES, LEGAL REGULATIONS

The gene-preservation measures described under section 3 almost exclusively serve the conservation (*in situ and ex situ*) and further development (*in situ*) of genetic information.

The seed stored in the seed bank does not meet the industrial demand. Seed plantations presently only start with fructification; its utilization for the domestic seed supply is planned.

The demand for forest plants for afforestations and replanting is largely met from domestic sources; 0.5% of softwood and 17.6% of hardwood plants are imported.

In line with the regulations of the forest act, forest seed is produced in forest stands and seed plantations approved for this purpose (see Table 2). Since 1980 Austria participates in the OECD Scheme for the Control of Forest Reproductive Material Moving in International Trade. The Austrian stands, in which harvesting is permitted, correspond to the category

Table 2 Approved seed stands (reduced area in ha)

Specie	Area	Specie	Area
Spruce	33038	Common beech	1072
Fir	1806	European white oak	242
Larch	2995	European oak	261
Mountain white pine	1660	Eastern red oak	12
Black pine	594	Little-leaf linden	32
Arolla pine	1905	Sycamore maple	109
Douglas fir	46	Ash	111
Macedonian pine	16	Black alder	20
Total			**ha 43919**

"selected reproductive material", seed produced in seed plantations to the category "untested seed plantations".

With Austria's accession to the EU the legal provisions of the Union will apply, which distinguish between 2 categories of reproductive material. At present the total domestic forest seed production corresponds to the EU category "selected reproductive material".

The requirements for the approval of stands destined for the production of selected reproductive material concern characteristics like volume production, timber quality, form properties, health, and resistance, which altogether are apt to secure valuable reproductive material to increase forest production.

At present, in the course of the amendment of the pertinent forest legislation changes at national level are intended, which, apart from adopting a new growth area classification to delimitate regions of provenance, also consider modern forest genetic results.

For instance, for sites with increased protection function, where the preservation of an unlimited adaptability of the tree population is more important than output, reproductive material with great genetic diversity will have to be provided in the future. For the production of selected reproductive material with the additional description "increased genetic diversity" in the future only registered basic material may be used, which meets the population-genetic requirements, from which we can expect better adaptability of the regeneration. Furthermore, in the future a higher minimum number of trees (in seed production stands) or of clones (in seed plantations) will have to be harvested for this category. In forest plant breeding stations sorting by size is not admissible. For the transportation of reproductive material from the EU-area, there are presently no traffic restrictions; however, recommendations regarding the provenance were prepared to advise the consumers.

Imports of reproductive material from Third Countries are subject to import license within the framework of quotas. The category "tested reproductive material is at present important in Austria only for vegetative reproductive material.

1.7 INTERNATIONAL COOPERATION

At the moment there is no institutionalized cooperation apart from an exchange of information. Austria's participation in the IPGRI/EUFORGEN programme is planned from 1995 onwards; likewise, a participation in the gene preservation research projects and concerted action in the European Union. The advantages of cooperation are mainly the harmonization of measures, the establishment of a data bank network, increased utilization of exchange possibilities and finding of gaps in the collections of reproductive material. In contrast to global approaches, regional programmes with their possibility to adopt to local peculiarities, should be given priority, if required by coordinating measures of neighboring countries.

1.8 NATIONAL REQUIREMENTS, RESEARCH DEMAND

There is a demand for research mainly in the following areas:

- Inventory of the structure of species by means of genetic, morphological, physiological, and biochemical characteristics, to create a secure basis for decision on preservation measures.
- Survey of changes in genetic parameters as a consequence of anthropogenetic influences.
- Examination of the impact of silvicultural measures in case of a formation of stands and tending of stands upon the genetic structures of the populations.
- Investigations into the reproductive capacity of the forest to survey impacts of climatic changes upon frutification and natural regeneration.
- Improvement of the preservation methods in seed banks and investigations to find potential changes of the genetic information during storage.