NORWAY:

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

(Leipzig,1996)

Prepared by:

Ministry of Agriculture

Oslo, June 1995

Note by FAO

This Country Report has been prepared by the national authorities in the context of the preparatory process for the FAO International Technical Conference on Plant Genetic Resources, Leipzig, Germany, 17-23 June 1996.

The Report is being made available by FAO as requested by the International Technical Conference. However, the report is solely the responsibility of the national authorities. The information in this report has not been verified by FAO, and the opinions expressed do not necessarily represent the views or policy of FAO.

The designations employed and the presentation of the material and maps in this document do not imply the expression of any option whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Table of contents

CHAPTER 1
Introduction to Norway and its Agricultural Sector

Norway is the northernmost country in Europe. The mainland extends from 58°N to 71°N, a total distance of about 1,750 km, which is greater than the distance between Oslo and Rome. The total land area, excluding Svalbard and Jan Mayen, is about 323,000 km^2, and the population is approximately 4.2 million. The population density is only 13 persons per km^2.

The total agricultural area of Norway is approximately 1 mill. hectares. This is 3 per cent of the total land area. Productive forests covers 7 mill. hectares, which constitutes 22 per cent of the land area. The remaining 75 per cent consists of mountains, glaciers, lakes and built-up areas.

The contribution of the agricultural sector to the GDP varies by counties from 1.4 per cent (Akershus) to nearly 10 per cent (Nord-Trøndelag), and is for the whole country about 2 per cent.

1.1 NATURAL CONDITIONS AND FARM STRUCTURE

Geographical location and climatic conditions play a significant part in the basic agricultural patterns. The country has Arctic and sub-Arctic characteristics. Agricultural production is limited by the length of the growing season, which is about 190 days in the southern parts and only 100 days in the northern parts of the country and in the mountainous regions. Climatic conditions have a strong influence on yields and increase the risk associated with crop production. Furthermore, the short growing season combined with rather unstable weather makes it necessary to have high capacity of machines and equipment during the spring farming and harvesting periods.

In addition, Norway has a long and severe winter. The indoor period is approximately 230 days a year in the south and up to 290 days a year in the north. Thus the livestock production requires isolated houses and good storing facilities for fodder.

A positive effect of the cold climate is less plant diseases than in southern countries.

The average farm size is about 10 hectares of agricultural land. The average size of forest properties is 56 hectares. 87 per cent of the farms has less than 20 hectares of agricultural land. However, mountains, lakes and forests divides the country's farm land into scattered and relatively small plots. The average field size is only 1.5 hectares. In addition, the farm land is partly very hilly. Nearly 20 per cent of the agricultural area has a gradient exceeding 1:5. These peculiar topographical conditions limits the advantages of modern agricultural equipment, and is also, in most parts of the country, a main obstacle for comprehensive farm amalgamation.

In milk production, there is 12 cows per holding on average. Also the average production units in sheepmeat, pigmeat, poultrymeat and egg production are relatively small. The average area in grain production is 11.3 hectares per farm.

1.2 AGRICULTURAL PRODUCTION AND INCOME

Agriculture is carried out in every of the country's 18 counties. Grass is the single most important crop and covers more than 55 per cent of the agricultural land. About 35 per cent of the area is used for grain production, and the remaining area is used for potatoes, vegetables, and other fodder crops than grass and feed grains.

In northern and western Norway and in the valleys of eastern Norway grass based livestock production is completely dominant. The main products are milk, bovine meat and sheepmeat. Cereal production is concentrated in the relatively flat regions of eastern Norway and some in southwestern (Rogaland) and Geographical location and climatic conditions location and climatic conditions play a significant part in determining the basic agricultural patterns. The country has Arctic and sub-Artic characteristics. Agricultural production is limited by the length of the growing season, which is about 190 days in the southern parts of the country and in the mountains regions. Climatic conditions have a strong influence on yields and increase the risk associated with crop production. Furthermore, the short growing season combined with rather unstable weather makes it necessary to have high capacity of machines and equipment during the spring farming and harvesting periods.

In addition, Norway has a long and severe winter. The indoor period is approximately 230 days a year in the south and up to 290 days a year in the

north. Thus the livestock production requires isolated houses and good storing facilities for fodder.

A positive effect of the cold climate is less plant diseases than in southern countries.

In northern and western Norway and in the valleys of eastern Norway grass based livestock production is completely dominant. The main products are milk, bovine meat and sheepmeat. Cereal production is concentrated in the relatively flat regions of eastern Norway and some in southwestern (Rogaland) and middle Norway (Trøndelag). The main crops are barley, oats and wheat. Potatoes are also grown, but no sugar beets. Most commercial productions of vegetables, fruit and berries take place in the southern and southwestern part of the country.

In terms of calories, the degree of self-sufficiency in farm produce reached 48 per cent in 1990. The number varies relatively much due to the substantial annual variations in the harvests and the quality of grain. Including fish, overall self-sufficiency was 55 per cent. Major import products are sugar, wheat, fruit, berries and protein feed stuffs.

In milk production, the degree of self-sufficiency exceeds 100%. The surplus is mainly exported as cheese and butter. For meat products the degree of self-sufficiency is about 101 per cent, and for grains produced in Norway the percentage is about 90. However, the degree of self-sufficiency of breadmaking wheat was in 1989-91 49 per cent, which is relatively high, and of rye only 6 per cent.

About three quarters of agricultural income derives from livestock production and one quarter from crop production. Milk is the single most important product, accounting for more than 35 per cent of the total value of production. Meat accounts for about 30 per cent, grain 15 per cent and horticulture 10 per cent.

According to OECD, in 1993 about 76 per cent of gross income in Norwegian agricultural production, except horticulture, came as a result of import restrictions and governmental budget transfers (PSE-calculations).

1.3 REGIONAL AND ENVIRONMENTAL POLICY

Maintenance of settlement throughout the country is an important political aim in Norway. In many areas, agriculture forms the main basis for economic activity and hence for settlement. In one out of four municipalities, agriculture directly and indirectly represents more than half of the employment. Especially livestock production is important. Thus, in Norway agricultural policy has been strongly tied to, and has been an important element within general rural policy.

In regional policy Norway has in recent year attached greater importance to the development of new activities and the creation of greater breadth in the economic base. Agriculture and the agricultural policy play an important role in the general regional policy. The Agricultural Development Fund and The Rural Development Fund are parts of the apparatus used to initiate such projects. However, a high level of activity in agriculture, processing industry and associated activities are essential for the development of many regions.

In many Norwegian rural communities, a decreasing percentage of women is an increasing problem. The situation for women is important both in relation to equal opportunities compared to men and to regional policy. To encourage more women to establish themselves in agriculture or farming-related activities, several initiatives for women were started in the last half of the 1980's. These initiatives - establishment grants and development of welfare facilities for agriculture - have been directed towards improvement of the potential for economic development.

Much effort is being made to limit the pollution from the agricultural production. Emphasis is given to reduce the soil erosion and loss of nutrients, and to optimize the use of fertilizers and pesticides. Laws, regulations, economical incentives and information are used to promote the aim of an agricultural production in accordance with local natural conditions. Other important objectives are to maintain the cultural landscape and to manage agricultural land so as to retain easily access to the countryside for recreation and leisure activities.

1.4 ANIMAL AND PLANT HEALTH

The health situation of animal and plants is of the best in the world. Norway is free from serious animal and plant diseases. The geographical situation

separated from the Continent, cold climate, small and scattered farms and a restrictive import regime are the major reasons for the present situation.

To prevent the introduction of infectious diseases, import of live animals and animal and plant products capable of transmitting infection are subject to zoosanitary and phytosanitary restrictions. Health certificates are required for all live animals imported, and the animals must be clinically tested for certain infectious animal diseases. Also for import of plants and plant materials health certificates are required.
To Norway it is most important to maintain the economical, environmental and ethical advantages of the existing animal and plant health situation.

1.5 INSTRUMENTS

A broad range of instruments have been provided to reach the objectives of agricultural policy.

The main agricultural policy guidelines are laid down by the Parliament. Particular policy instruments like product prices, regional support and environmental programmes are negotiated annually between the Government and the two nation-wide farmers' organizations, and laid down in the Agricultural Agreement.

Import regulations forms an integral part of Norwegian agricultural policy. Import of products, which are normally grown in Norway, are quantitatively restricted. However, supplementary imports to meet market demands are permitted at any given time. Import of products like sugar and tropical fruits are unrestricted.

Since 1982 the producers themselves have had the responsibility for overproduction, and the export costs are financed by marketing fees paid by the producers. Thus, the budget transfers to exports are insignificant.

The main responsibility for the operative element of market regulation lies with the nation-wide agricultural co-operatives. The co-operatives are responsible for evening out random fluctuations in supplies and prices, and maintaining stable supplies throughout the country during the year.

1.6 ADMINISTRATION

The differentiated set of agricultural policy measures necessitates an extensive administration to ensure that agricultural policy is carried out effectively.

In addition to the central government agricultural administration in Oslo, there are public Agricultural, Forestry and Land Consolidation Offices and veterinary services throughout the country. The Agricultural and Forestry Officer function in advisory capacities on county and municipal level. The local Agricultural Offices are essential in administering the agricultural policy. The Land Consolidation Services has a judicial function as well.

Norwegian agriculture compared to the agriculture in other areas

Agricultural area (mill. ha)

	Total land area	Agricultural area	Per cent
Denmark	4.3	2.8	65
Germany	24.9	11.9	48
Great Britain	24.4	18.5	76
EC 12	225.8	128.5	57
Norway	32.4	1.0	3

Source: Eurostat 1990, Central Bureau of Statistics of Norway.

Farm structure 1987

	Number of farms (1,000)	Agricultural area (mill. ha)	Hectar per farm
Denmark	86	2.8	32.5
Germany	671	11.8	17.6
Great Britain	243	16.8	68.9
EC 12	6,930	114.6	16.5
Norway	99	1.0	10.0

Source: EC Commission 1992, Central Bureau of Statistics of Norway 1991.

Farm sizes (per cent of total farms)

	< 10 ha	10-50 ha	> 50 ha
Denmark	19		17
Germany	50		6
Great Britain	31		31
EC 12	73		5
Norway	62		1

Source: Eurostat 1990, Central Bureau of Statistics of Norway.

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 MEADOW AND PASTURE PLANTS

There are now about 160 wild or naturalised grass species in Norway spread over 53 genera. In addition, there are about 15 species of legumes which may be of some importance in meadows and pastures. Many species of sedges and herbs also occur in grazed vegetation. Most species cultivated in artificial meadows and pastures have originally been introduced. On the other hand, many originally wild species and varieties occur in natural meadows and grazing land and sometimes in old, country farmyards and gardens.

Because the country spans many degrees of latitude, Norway has relatively substantial differences in day-length, temperature and precipitation. This has formed a basis for a natural selection of grass species into many different forms and varieties. For instance, varieties that are adapted to northern areas are more hardy than plants of the same species adapted to southern regimes. Likewise, northern types will stop growing earlier in the autumn and have less regrowth capacity. This also applies to species that have been naturalised or have become wild after being introduced into Norway. The genetic diversity in local populations of Norwegian grassland plants has been of great importance in the breeding of many varieties of meadow and pasture species, for instance, timothy, meadow fescue, cock's-foot, common bent and meadow grass.

For example, the two cultivars of timothy, Engmo and Grindstad, have been bred by selection among local Norwegian farm populations in, respectively, northern and southern areas. Norwegian cultivars are also partly based on individual plants collected in home fields and outlying fields in areas with different climate. There are, so far, few examples of Norwegian bred cultivars that are based on hybridisation through introduction of foreign material of southern origin.

The most important species of meadow and pasture plants that include Norwegian cultivars are given below:

Annual trade of seeds of meadow and pasture growths, and seed breeding in Norway of Norwegian varieties of the respective species

Latin name	English name	Trade (tons)	Seed breeding (tons)
Phleum pratense	Timothy	1,133	2,007
Festuca pratensis	Meadow fescue	392	506
Dactylis glomerata	Cocksfoot	118	296
Bromus inermis	Smooth bromegrass	87	6
Lolium perenne	Perennial Rye grass	384	-
Lolium mult.Ital. + West.	Italian ryegrass + Westerworth Ryegrass	873	-
Phalaris arundinacea	Reed canarygrass	9	
Festuca rubra	Red fescue	247* (25)	16
Festuca ovina	Sheep`s fescue	34*	-
Poa pratensis	Smooth meadowgrass	252* (25)	12
Agrostis capillaris	Common bent	31* (25)	1
Trifolium pratense	Red clover	146	280
Trifolium hybridum	Alsike clover	4	9
Trifolium repens	White clover	27* (10)	-
Medicago sativa	Lucerne	1	-

*: **Mainly for lawns, use in agriculture in brackets.**

2.2 CEREALS

Cereals have been cultivated in Norway for about 5,000 years. Until 60-70 years ago, all varieties of cereals were local strains. In the case of wheat, barley and oats, these consisted of a large number of pure lines with somewhat differing qualities. Growing them at one place for a long time had led to their adaptation to the conditions under which they were being cultivated, in the same way as with the grass species. The local strains were not given special names, but were named after the farms from which they came, for example Holleby barley, Børsum wheat, etc. These old local strains have long since

ceased to be used, but their genes have been used in the systematic cereal breeding that has taken place.

Four species of cereals, along with peas, are now grown in Norway. These are, wheat (cultivated area 39,000 ha), rye (1,000 ha), barley (H. *vulgare s.l.* convar. *hexastichon* and convar. *distichon)* (175,000 ha) and oats (130,000 ha). Both autumn and spring forms of wheat and rye are cultivated, but only spring forms of the other species. Peas are grown on about 1,000 ha.

Numbers of Norwegian and foreign cultivars of the various species cerealand peas on the official list of cultivars

English name	Latin name	Norwegian	Foreign
		Number of cultivars	
Spring wheat	*Triticum aestivum*	2	3
Autumn wheat		1	3
Spring rye	*Secale cereale*	0	1
Autumn rye		10	1
Barley	*Hordeum vulgare L.*	7	7
Oats	*Avena sativa L.*	7	6
Peas	*Pisum sativum L.*	0	2

2.3 OIL PLANTS

Both the oil plants cultivated in Norway, turnip rape *(Brassica campestris* var. *oleifera)* and rape *(Brassica napus* var. *oleifera),* belong to the brassica family (Brassicaceae). Turnip rape is chiefly a cross-pollinator, whereas rape is a self-pollinator.

Four cultivars of each species are grown, all Swedish in origin. The oil seed contains about 45% fat and 25% protein. Many countries use the oil from turnip rape and rape in the production of cooking oil and margarine, but in Norway the seed is exclusively used as fodder. Meal made from rape and turnip rape seeds is used in concentrates for various kinds of domestic animals. The oil may also be used in the chemical and technical industries, and as fuel. Based on the requirements for crop rotation and climate, the maximum area that could be used in Norway for growing oil plants would be around 50,000 ha.

2.4 POTATOES

The Nordic countries are far from the homeland and real gene centre of the potato, the highlands of South America. The potato *(Solunum tuberosum)* has no wild relatives in the Nordic countries that are currently of interest for preservation. The old cultivars in the Nordic countries and the rest of Europe descend from relatively few introductions and probably have a very restricted genetic basis. However, through more than 200 years, a more or less deliberate selection has taken place that has led to those varieties that remain being well adapted to Nordic growing conditions with long days and often short, cool growing seasons. Following a slow start just after the turn of the century, hybridisations between wild *Solanum* species and primitive, cultivated species have been increasingly used to transfer new genes for disease and pest resistance. All the cultivated *Solanum* species are from South America, but a few wild ones come from Central America. Most of the new varieties that have been put onto the market in recent decades originate from such interspecific hybridisations.

It is not known for certain how many different varieties have been under cultivation in this country. Just over 80 cultivars were registered in the Agricultural Census undertaken in 1968. The figure is probably substantially lower today. The list of varieties that are approved for controlled seed-potato production now numbers seventeen, nine of which have been bred in this country. Some other well known varieties are also grown here and there. Most of these are British, German or Dutch in origin, but some varieties are being grown that have been bred in eastern Europe or the USA. Exact figures are not known, but the total number of these varieties may be around 20-25. Most of these foreign cultivars are also in cultivar collections and gene banks elsewhere in the world and are of limited interest for the Nordic Gene Bank. A few Norwegian cultivars that are no longer on the official list of varieties are still being grown and will be considered for preservation.

Some old, local cultivars are also grown whose origin is not known. Some of these are probably only to be found in Norway now, others are also known in our neighbouring countries. Gullauge, which is still a common table-potato variety in northern Troms and Finnmark, is also grown in North Sweden, North Finland and Iceland. There are perhaps 20-30 of these old, local cultivars in this country. Some of them have probably been under cultivation for a very long time. In order that valuable genetic material shall not be lost, the Nordic Gene Bank has decided to initially place priority on work with just these varieties.

2.5 VEGETABLES

Very few of the other species of vegetable that are now cultivated here originated in this country. Many were imported in the Middle Ages and began to be used in the monasteries. In the 18th and 19th centuries, it was normal for government officials to have varied kitchen gardens, and most of the species that are now used entered the country at that time.

Some species have been cultivated for a very long time, right back to the Viking Period, for instance certain species of onion *(Allium* spp.) and cabbage *(Brassica* spp.). Species such as broccoli *(Brassica oleracea inalica),* Chinese leaves (B. *campestris pekinensis),* tomato *(Lacopersicon esculentum)* and paprika *(Capsieum* annuum) have, however, come into use during recent decades.

The use of vegetables began to be commonplace after 1900, and improvement by breeding through selection and seed growing had become an important part of this production. This was how many cultivars within the various species of vegetables came into existence and were adapted to the cropgrowing conditions in Norway. In 1921, nearly all cultivation of such species as swedes, sugar peas, turnips and early turnips was based on seeds produced in Norway. A few of the species that used to be widely cultivated are no longer grown. Examples are parsnip *(Pastinaca sativa),* black salsify *(Scorzonera hispanica),* purslane *(Portulana oleraceae sativa)* and horseradish *(Cochlearia armorica).*

The main vegetables now cultivated in Norway are carrots *(Daucus carota),* cabbages and cauliflowers.

Cultivated areas for the most important vegetables in Norway, 1989

Species	Area (ha)
Carrots	1,195
Cabbage	890
Cauliflowers	535
Common onion	425
Chinese leaves	195
Leeks	125

In important crop growing areas such as Rogaland and the Grimstad district in southwestern Norway, around Oslofjord, Toten (Oppland) and Trøndelag, extremely active development of cultivars and seed production for the

most important species of vegetables in Norway took place in the period from 1920 to 1950. For instance, many varieties of cabbage were bred in Rogaland which were in active use right up to about 1975-1980. As recently as around 1950, seed production for about 25 species of vegetable, and often several cultivars within each species, was being carried out on the southwestern coast of Norway.

Today, the situation is completely different. Using modern breeding methods, the plant-breeding industry in the large industrial countries produces a large selection of cultivars that have out-competed Norwegian varieties. Many of these are F I hybrids which, with their homogeneity and growing power, are preferred to the open-pollinated Norwegian varieties. Most species no longer have any alternative Norwegian cultivars.

Excluding potatoes, Norwegian cultivars of five species of vegetable are in practical use today. These are cabbage, swede *(Brassica napus* var. *rapifera),* early turnip (B. *rapa* var. *rapifera),* common onion *(Allium cepa)* and sugar pea *(Pisum sativum).*

Vegetable breeding now takes place under public auspices, that is to say at the Agricultural University of Norway and the Norwegian Crop Research Institute, and is limited to cabbages, swedes, Chinese cabbage and onions.

An active, deliberate effort has been made in recent years to protect the old national varieties. Some of the early vegetable cultivars have nevertheless disappeared but since new varieties are often developed from old ones through hybridisation and selection, portions of the genetic material have been passed on.

2.6 FRUIT

Fruit cultivation has long traditions in Norway and fruit production is of considerable economic importance in many districts. Strawberries and apples are economically the most important fruit species. A new type of pear, nashi (Pyrus pyrifola), has recently arrived in Norway and will be tested in the coming years. Many cultivars of each species have been tried and are more or less well known in Norway.

Almost all the fruit cultivars of any significance in commercial growing are of foreign origin. Breeding projects for apples, pears and plums are now in hand in Norway with the aim of developing cultivars that are better adapted to

Norwegian growing conditions. The cultivar problem is probably most serious with respect to pears, and lack of suitable varieties is leading to major difficulties for Norwegian pear production.
Peaches, apricots and grapes are grown in a few private gardens in climatically-favourable districts.

Cultivated and wild species of fruit in Norway

Cultivated species		Wild species	
English name	Latin name	English name	Latin name
Apple	*Malus domestica*	Crab apple	*Malus sylvestris*
Pear	*Pyrus communis*		
Plum	*Prunus domestica* *Prunus cerasifera* *Prunus insititia* *Prunus salicina*	Sloe	*Prunus spinosa*
Damson	*Prunus insititia*		
Sweet cherry	*Prunus avium*	Wild cherry	*Prunus avium*
Sour cherry	*Prunus cerasus*		
Strawberry (garden strawberry)	*Fragaria x ananassa*	Wild strawberry Wild strawberry	*Fragaria vesca* *Fragaria vesca sempervirens*
Raspberry	*Rubus idaeus*	Raspberry	*Rubus idaeus*
Blackcurrant	*Ribes nigrum*	Blackcurrant	*Ribes nigrum*
Redcurrant	*Ribes rubrum* *Ribes sativum* *Ribes petraeum*	Downy currant	*Ribes spicatum*
Gooseberry	*Ribes uva-crispa*		

Only five small-fruit species have had any great significance as regards cultivation in this country Cultivation experiments on the cloudberry (*Rubus chamaemorus*) have been going on for many years and show that it is possible to increase the yield significantly. Holt Agricultural Research Station in Tromsø has bred four varieties of cloudberry, two male cultivars and two female ones, for, respectively, mountain and coastal districts in North Norway.

At the moment there is a great deal of interest in bringing «new» types of small-fruit into cultivation, particularly the garden bilberry (American blueberry, *Vaccinium corymbosum*), cowberry (*Vaccinium vitis-idaeus*), common elderberry (*Sambucus nigra*), bramble (*Rubus fruiticosus*),

loganberry *(Rubus* spp.) and jostaberry *(Ribes nidigrolaria,* a hybrid of blackcurrant and gooseberry).

The small-fruit species, too, have a large number of cultivars and many have been tested in Norway. However, this varies a good deal from one species to another. The figures are based on estimates since no complete, precise information about this has been prepared. Only strawberries, raspberries and blackcurrants are to any extent cultivated commercially. However, a large number of redcurrant and gooseberry bushes are to be found in Norway but almost exclusively in small gardens. The number of varieties is also much greater in small gardens, because replacement does not take place so frequently, many garden owners preferring to stick to the «good old» varieties.

Number of fruit cultivars that have been tried, that are of commercial significance now, and the number of cultivars of the latter category that are Norwegian in origin (the figures are approximate)

Fruit species	Total number of cultivars tried	Number of cultivars commercially	Number of Norwegian cultivars commercially cultivated
Apple	480	15	
Pear	50	11	0
Plum	60	8	0
Sweet cherry	150	15	0
Sour cherry	60	4	0
Strawberry	120	6	2
Raspberry	40	3	1
Blackcurrant	70	6	3
Redcurrant	90	1	0
Gooseberry	40	0	-

2.7 LANDSCAPING PLANTS

Landscaping plants comprise trees, shrubs, perennials and lawn grass. About 2,000 species and cultivars of the first three categories of plants are in use as well as 10 species of lawn grass embracing about 40 varieties. Annuals and biennials (bedding plants and summer flowers) are also used in green areas. It will be impossible for the great majority of bedding plants to become part of the Norwegian flora. About 130 species, embracing a great many cultivars, are used. The total number may be two or three times as many if all the

varieties were included that are to be found in Norway in such genera as roses and rhododendrons, which are often of special interest to collectors. This group includes plants that are only being tested in Norway for a short period, because the material is not adapted to the local climate or soil conditions. The total number of plant varieties that have been planted in Norwegian soil will therefore always be higher than the number actually established in the country at any one time.

Plants obtained from the natural vegetation in Norway are included in the total number of landscaping plants. Virtually all native coniferous and deciduous trees in the Norwegian flora are used for landscaping, too, but special types are often selected for such use. For instance, four different provenances of downy birch *(Betula pubescens)* adapted to climate and day-length in various parts of the country are marketed. Selected clones, specifically adapted to conditions in North Norway are also marketed. In some cases, clones have also been chosen for some specific genetic character such as winter hardiness or ornamental value; one example is a double form of an ordinary guelder-rose *(Viburnum opulus* 'Tingvoll').

Norwegian green areas also contain numerous kinds of plants that derive from other parts of the world. Many clones are used that have been selected and propagated abroad, but separate selection work on these introduced plants has, in many cases, been undertaken in Norway. This is so both for plants propagated from seed and for vegetatively propagated clones. Selection may have been performed to develop plants that satisfy specific objectives, for instance wind load, salt tolerance or soil contamination. Taken as a whole, there seems to be a large, unexploited genetic potential in both Norwegian and introduced plant varieties. Examples exist of introduced trees and shrubs that have become naturalised in certain districts, thereby becoming part of the Norwegian flora, for instance the common silver fir *(Abies alba)* and dwarf serviceberry *(Amelanchier spicata).* Perennials such as Canadian goldenrod (*Solidago canadensis*) and black-eyed susan *(Rudbeckia hirta)* also belong to the group of plants that have become naturalised.

Numbers of landscaping plants of various types that are in common use in Norway (NLVF-utredning 126 «Planteskoleforskning", 1989)

Type of plant	Species	Cultivars	Total
Deciduous trees and shrubs	300	350	**650**
Conifers	50	80	**130**
Roses	10	350	**360**
Perennials	250	450	**700**

CHAPTER 3
National Conservation Activities

3.1 LEGISLATION

Norwegian environmental legislation is based on the «err on the safe side» principle so that the greater the uncertainty about the consequences of a measure or an action the stricter the regulatory control. Priority is being given to efforts to combat environmental crime, provide protection from pollution and other environmentally damaging encroachments, and protect the production basis and gene resources. Each ministry which, through its activities, influences the use of natural resources, is at present carrying out a systematic study of existing laws and regulations and how they are being implemented and applied, in order to propose changes which will support sustainable development.

The following Acts hold key positions in connection with protection and management of biological diversity.

- The Pollution Act of 1981 with revisions in 1989, covers all forms of pollution from permanent installations, whether they concern water or air pollution, noise and waste from industrial plants, agriculture, local authorities or continental shelf activities.
- The Planning and Building Act of 1985 with revisions in 1989 has as its main objective to pave the way for a coordination of state, county and local authority activity and to lay the basis for decisions concerning use and protection of resources and plans for development. It is also intended to prepare national guidelines for coordinating land use and transport planning.
- The Product Control Act of 1976 is intended to prevent products leading to health damage or environmental disturbance in the form of pollution, waste or noise.
- The Outdoor Recreations Act of 1957 establishes by law the rights of the public to stay in and move through the countryside (outlying fields and marginal land, rough grazing, the sea and watercourses) independent of who owns the land (the traditional «general rights»). The Act requires the public to respect the need for responsible movement and states how that shall be done.

- The Nature Conservation Act of 1970 aims to make it possible to utilise natural resources at the same time as consideration is given to the interdependence between man and nature and the need to conserve the qualities of nature for the future. The Nature Conservation Act is primarily concerned with individual acts of conservation. Firstly, it provides authorisation to protect areas according to four different forms of protection; national parks, landscape protection areas, nature reserves, and natural heritage sites. Secondly, the Act provides authority to protect species, in other words, protection of plant and animal life. Opportunity is, moreover, given for combining species protection and the conservation of areas in the form of what is called biotope conservation. Resolutions can, furthermore, be passed giving temporary protection when there is imminent danger of the destruction of areas or species deserving conservation.

- The Regulation concerning the Protection of the Natural Environment on Svalbard, dating from 1983, is intended to ensure protection of the nature of Svalbard and the surrounding territorial waters from pollution, waste disposal and other actions that can cause damage or inconvenience to people and the natural environment.

- The Regulation controlling Encroachments on Nature on Jan Mayen, dating from 1986, is intended to regulate activities or other initiatives that can lead to changes in the landscape or natural environment of Jan Mayen and its territorial waters.

- The Motorised Traffic on Marginal Land and Watercourses Act of 1977 regulates motorised traffic on marginal land and watercourses with the objective of protecting the natural environment and promoting well being. The overriding principle of the Act is that motorised traffic is not permitted on marginal land and watercourses.

- The Ancient Monuments Act of 1978 provides automatic scheduling of ancient monuments dating from prior to 1537, and the opportunity to schedule through individual resolutions. The Act gives authority to protect areas around scheduled ancient monuments.

Special measures must be implemented to protect agricultural landscapes that depend upon old farming practices. In accordance with regulations issued by the Ministry of Agriculture on 15.03.1991, funds will be allotted for extra areal and cultural landscape grants to manage agricultural landscape that is not maintained through ordinary farming operations. These funds will probably increase in the future and are intended to be used for measures to 1) provide the public with improved access to the agricultural landscape associated with farming by creating a continuous network of paths and tracks, so that their enjoyment of it may be enhanced, 2) look after ancient monuments and their immediate surroundings and improve access to these to

further their enjoyment, and 3) look after valuable agricultural landscape that has great biological diversity and a flora and fauna that are dependent for their survival on management in the form of grazing, traditional harvesting techniques and similar farming operations.

3.2 INTERNATIONAL CONVENTIONS

Norway has signed the following existing conventions concerned with the protection of various sectors of biological diversity (the year in which Norway signed is shown in brackets):

- The Ramsar Convention (Convention on Wetlands of International Importance Especially as Wildfowl Habitats) dealing with protection of wetland areas (1974). Norway has proposed 14 wetland areas, 5 of which are on Svalbard, for protection as Ramsar areas.
- Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats) dealing with the protection of European plants and animals, and natural habitats (1986). 21 species of Norwegian plants are listed in Appendix I of the Bern Convention.
- CITES - the Washington Convention (Convention on International Trade in Endangered Species dealing with international trade in endangered species of plants and animals) (1976).
- The world cultural and natural heritage convention (1977).
- Convention on biological diversity (1993).
- International Convention for the Protection of New Varieties of Plants (1993).

3.3 *IN SITU* CONSERVATION

Brief background

Publicly organised nature conservation began in Norway early in this century. The first nature conservancy legislation, «The Act concerning Nature Conservation measure concerning biological diversity in Norway, in 1911, when 52 species of plants on the lands of the Fokstua and Hjerkinn mountain lodges, on the Dovre highland plateau in central Norway were

awarded protection. In the course of the following decades, protection was given to several separate areas around the country with a view to their plant and animal life, but conservation work at this time took place in a rather haphazard manner.

There was more direction behind conservation work following the passing of a new Nature Conservancy Act in 1954, and the setting up of the National Council for Nature Conservation. The first national park (Rondane) was established in 1962, and in 1964 the National Council for Nature Conservation presented its «Report on a national plan for nature parks and national parks in Norway». Systematic work to preserve wildlife areas and plants and animals in their natural environment (*in situ*) started seriously after our current nature conservation legislation was passed in 1970, and posts of nature conservation and outdoor recreation officers were created at county level in 1971.

3.3.1 National Parks

So far, 18 national parks have been set up in Norway, with a total area of 20,767 km^2. Some huge national parks and reserves have been set up on Svalbard and the other Arctic islands. If these are included, the proportion of the land area of Norway comprised of protected areas is very substantially increased. However, it must be stressed that the protected areas in arctic regions include areas where conflicts with economic interests are almost, or entirely, non-existent.

Status for mainland areas protected pursuant to the Nature Conservation Act as of 1.1.96 and 1.1.97*. Number and area.

	Number		Area (km^2)		Proportion of land area (%)*	
Protection status	1996	1997	1996	1997	1996	1997
National parks	18	18	13,788	13,788	4.25	4.25
Nature reserves	1,220	1,293	2,210	2,289	0.68	0.71
Landscape protection areas	80	82	4,659	4,671	1.44	1.45
Nature monuments	87**	88**	2	2	0.00	0.00
Other types of protected areas	73***	75***	108	109	0.03	0.03
Total	**1,478**	**1,556**	**20,767**	**20,859**	**6.40**	**6.44**

* **Mainland of Norway excl. Svalbard (protection areas on Svalbard are established pursuant to the Svalbard Act of 1925).**

** **In addition approx. 190 trees/groups of trees are protected as botanical nature monuments.**

*** **Protection of species without protection of the biotope are established for some other localities.**

Overview of national parks in Norway, showing the percentages of the areas represented by various types of habitat

National park	Total area (km^2)	Productive forest (%)	Other forest (%)	Treeless (%)	Fresh water/ice (%)
Øvre Pasvik	66.6	49.5	12.9	17.0	24.0
Stabbursdalen	98.2	0.0	31.0	67.0	2.0
Øvre Anarjokka	1,398.7	-	49.0	47.0	4.0
Øvre Dividal	742.8	0.4	9.2	86.4	4.0
Reisa	803.0	0.0	12.0	82.0	6.0
Ånderdalen	69.0	-	30.0	65.0	5.0
Saltfjellet/Svartisen	1,850.0	0.3	5.3	*91.6	*2.6
Rago	167.4	-	12.0	83.0	5.0
Børgefjell	1,106.5	-	6.0	89.0	5.0
Gressåmoen	181.5	7.0	1.0	80.0	2.0
Dovrefjell	255.8	0.0	0.3	97.7	2.0
Femundsmarka	390.3	-	32.0	58.0	10.0
Gutulia	19.0	65.0	0.0	33.0	2.0
Rondane	580.6	0.0	1.8	97.3	0.9
Jotunheimen	1,145.4	0.0	0.1	96.0	3.9
Ormtjernkampen	8.5	62.0	12.0	25.0	1.0
Hardangervidda	3,422.0	0.1	0.1	90.0	9.8
Jostedalsbreen	1,230.0	0.0	2.0	0.0	98.0

-: Information lacking.

***: Treeless area, including ice (After Huberth Hansen, 1992).**

The National Council for Nature Conservation published a National Plan for National Parks in 1986 (NOU 1986:13). This proposes the setting up of 26 new national parks six of which would be combined with landscape protection areas. 14 new landscape protection areas, and three large nature reserves. In addition, it is proposed that nine of the existing national parks should be extended. Altogether, the new proposals cover an area of some 23,000 km^2. The majority of the existing national parks are located in non-productive or only slightly productive mountainous areas. Of the 29 physical geographical regions found in Norway, less than 50% are represented in the present national parks. The proposal for a new national plan for national parks and other extensive conservation areas is intended to ensure a representative selection of areas in the various physical geographical regions of Norway. The plan has been commented on by a wide variety of involved parties and has been re-considered by the Directorate for Nature Management and the Ministry of the Environment. A White Paper on the national park plan was published in June 1992, and a proposal is expected for the setting up 46 new, large conservation areas, including extensions to ten of the existing national parks, with a total area approaching 20,000 km^2.

3.3.2 Conservation Plans at the County Level

To rationalise and systematise the work on conservation of certain types of nature, work was begun in the individual counties early in the 1970's on conservation plans for wetland areas, bogs and broad-leaved deciduous forests. Work was subsequently started at regional and county level on conservation plans for seabird reserves. These types of habitat were given priority in a conservation context because a rapid conversion of such areas was taking place, partly as a result of draining and reclaiming of land for cultivation. Systematic registration of areas was started, and proposals for protecting areas from each of these types of habitat that had the greatest interest and conservation value were put forward through conservation plans drawn up by the individual country authorities. Work done on wetland areas shows that when the conservation plans are considered at the level where decisions are taken, very few (13,5%) of the areas registered are proposed for protection and the number actually achieving protection is further reduced (Eldøy 1991).

The selection of mire reserves is mainly based on hydrological and botanical criteria. Wetland areas are given priority first and foremost in relation to their function and significance for birds, whereas broad-leaved deciduous forests are selected primarily on botanical grounds. In the case of seabird reserves, the number of nesting seabirds has been the primary criterion, and the aim has been to protect nesting sites for at least 50% of the various populations of seabird through these reserve plans. During the last few years, an average of about 50 new nature reserves and other conservation areas have been set up annually, chiefly through these county conservation plans. By the end of 1991, the total number of nature reserves in Norway was 951, corresponding to 0,45% of the land area of the country. It is intended that work on the county conservation plans for mires, wetlands, broad-leaved deciduous forests and seabirds will be completed by 1995.

Number and total area of the various types of nature reserve in Norway (January 1st, 1992)

Type of reserve	Area (ha)	Number	Number
Coniferous forest	6,970	41	1
Broad-leaved deciduous forest	2,836	162	0
Wetland	41,801	180	14
Mire	40,993	219	5
Geological	24,102	57	10
Others	9,423	22	4

3.3.3 Other Conservation Areas

In addition to the county conservation plans, registration has been, or is being carried out in several counties with a view to conserving, among others, salt marshes, coastal heaths, occurrences of yew and holly, woodland on flooded ground and areas containing threatened plant species.

For all these types of conservation plan mentioned above, it is intended to implement conservation in accordance with the Nature Conservancy Act (in the categories of national parks, landscape protection areas, nature reserves or natural heritage areas). The Wildlife Act of 1981 can also authorise area conservation (§ 7). However, biotope conservation under the terms of the Wildlife Act has so far not been implemented on a permanent basis. The Directorate for State Forests and Land owns large areas, and has, on its own initiative, implemented administrative protection of some areas.

Reports and investigations which formed the basis for the thematical conservation plans of the 1970's and 1980's were largely concentrated around a few groups *of* plants and animals. The status of groups of plants and animals which were not investigated is therefore uncertain, even though some of the protected areas have probably functioned well for these, too. This especially applies to the large national parks in the mountains, such as Dovrefjell and Rondane.

3.3.4 *In Situ* Conservation Outside Conservation Areas

The implementation of the national park plan, the country conservation plans, the conservation plan for coniferous forest, and conservation plans in accordance with the Nature Conservancy Act (and possibly the Wildlife Act) will be the most important measures for securing Norwegian biological diversity. A number of species, however, have such scattered occurrences or such large territories, that traditional area conservation will be inadequate; habitat fragmentation may, moreover, lead to the natural flow of genes in populations of plants and animals being broken, and only small, isolated populations will be left on «islands» in a transformed natural landscape. It is therefore also important that measures are implemented for *in situ* conservation outside the traditional conservation areas, to preserve both relict biotopes, corridors and important elements in the areas in which the various species live.

In this context, the new Planning and Building Act from 1985 is an important agent in three main spheres. Firstly, it provides opportunities for regulating areas for nature conservancy purposes. Secondly, the planning and approval procedures for land use plans provide opportunities for remarks and

complaints to be made concerning nature conservation interests. And thirdly, provisions have been introduced stipulating the preparation of consequence reports in association with major development projects and changed land use.

Work has commenced on incorporating respect for conservation in relation to agriculture and forestry. This will be implemented through, for example, the wages and obligations agreement between the government and farming unions, various subsidy arrangements (for example, area and cultural landscape grants, and the termination of previous subsidies such as those for ditching of treeless bogs, and for spraying), and various legislations (for example, regulations about building of forestry roads). In general, increasing emphasis has been placed in recent years on incorporating respect for nature conservation and biological diversity (and the environment in general) in other sectors of society, including in relation to agriculture, transport, energy production, industry and defence.

3.4 *EX SITU* CONSERVATION

3.4.1 Activities of the Nordic Gene Bank

The Nordic Gene Bank for agricultural and horticultural plants (NGB) is a joint Nordic institution (Norway, Sweden, Denmark, Finland, Iceland) which answers to the Nordic Council of Ministers. The institution, which is located on the campus of the Swedish Agricultural University at Alnarp in Skåne, Sweden, started on January 1st 1979. The organisation is led by a committee with a representative (and a substitute representative) from each country.

The work of the gene bank is organised through Nordic working groups for the various groups of plants, and, in part, directly from the gene bank itself. The seven Norwegian working groups have responsibility for 1) Cereals, 2) Fruit and Berries, 3) Potatoes, 4) Forage Crops, 5) Vegetables, 6) Root Crops, Oil Plants and pulses, 7) Other plants. Each Norwegian committee comprises the Norwegian members of the various working groups of the Nordic Gene Bank, together with a representative from each of the following institutions: the country has its national advisory committee. The Norwegian Plant Breeding Council, the State Seed Testing Station, the Department of Genetics and Breeding (at the Agricultural University of Norway) and the Norwegian State Agricultural Research Stations.

The task of the Nordic Gene Bank is to preserve and document genetic variation in valuable material from agricultural and horticultural plants in the Nordic countries. In recent years, «... and their wild relatives ...», has in practice been added, without any formal decision on this being taken (NGB 1991).

3.4.2 Grass and Pasture Plants

In order to preserve the biological and genetic diversity in a range of Norwegian meadow and pasture plants, seeds of cultivars and populations will be preserved in the Nordic Gene Bank. Collecting has been undertaken since 1970 in North Norway and 1980 in South Norway. Seeds from a large number of populations of all the species mentioned in Chapter 2, as well as 15 other species, have been collected. The material has been reproduced and stored in the NGB. Parallel seed samples have also been stored at the agricultural research stations. which also carry out reproduction and evaluation of the material. Techniques have been evolved for drying, packing and storing the seed which provide secure storage. The material is chosen particularly with a view to carrying out improvement work. Preservation for aesthetic or related financial reasons, for example, preservation of flower-studded meadows in upland and valley settlements for the sake of the environment and tourism, requires other measures. Meadows that have been intensively cultivated will quickly take on the character of natural meadows in the course of a few years, when harvesting intensity and fertilising has been reduced. Conservation measures have also been used, for example in Heidal, to preserve a special type of cultural landscape consisting of pasture with juniper as the dominating species, along with grass and herbs.

3.4.3 Cereals

All relevant cereal material from Norway (that is to say, old cultivars) has already been collected. In future, only new cultivars that have been improved in the Nordic countries and breeding material of special interest will be added to the bank. In addition, catalogues have been prepared of collected barley and wheat. Work on a catalogue covering wheat, rye and triticale is currently being completed. The cultivars are carefully stored in freezers (at -25° C) at the Nordic Gene Bank. These now contain 31 cultivars or lines of barley, 25 oat cultivars and 33 wheat cultivars from Norway. Description and evaluation of the cultivating properties is taking place, at the same time as cultivar samples with reduced germination percentages are continuously being bred from seed.

3.4.4 Potatoes

Cultivar collections, including some of the old local strains, have been preserved for a long time in Norway and a couple of other places in the Nordic countries. Over the years, some of the strains have been abandoned because of disease, but others have occasionally been added, although no organised collecting of material has taken place. In 1979, the Nordic Gene Bank began securing genetic material from potatoes, and this task is now being organised by a working group with representatives from all five Nordic countries. The work so far consists of collecting, identifying and documenting the material, deciding on criteria for preserving it in the gene bank, testing its quality and resistance properties, and cleaning it of viruses and other pathogenes using *in vitro* methods.

Long-term preservation of a vegetatively reproduced plant like the potato is both work demanding and costly. The potato collection in the Nordic Gene Bank should therefore not be unnecessarily large, but should be concentrated around four groups: 1) Nordic strains (local cultivars of unknown origin); 2) cultivars produced at Nordic improvement centres; 3) material with particularly valuable qualities for improvement work (genitors); 4) old, foreign cultivars that have been very important in the Nordic countries and that are not being maintained in other gene banks. Important criteria for preserving material in the various groups are that the material is not being preserved elsewhere, is a distinct variety and can be documented, has one or more valuable properties related to cultivation, resistance or quality, and is valuable from a cultural historical viewpoint.

Nordic strains and foreign cultivars that have been extensively cultivated are considered for inclusion in the gene bank when they have gone out of general cultivation and are therefore no longer maintained through organised seed-potato breeding.

In 1982-83, more than 180 samples of old strains and local cultivars were collected from all over the Nordic countries. A few have been added each year since, and a few, old, little known varieties can still be expected to appear. Based on the established criteria, the working group has decided that between 30 and 40 of the old strains should be preserved in the gene bank. Between 8 and 10 of these originate from Norwegian material, and some new ones turn up each year in this country and are then investigated and assessed for conservation in the gene bank. The job of describing the material has started.

Utilisation of the gene bank material in improvement work presupposes good knowledge of the economically important qualities of the various cultivars. The qualities of the cultivars are already partly known, but there is still a need for control testing and additional evaluation. This is partly being

accomplished through testing of all the material at one place, and partly by the gene bank material from each country being included in the investigations being carried out through the improvement programmes of the various countries. In the case of potatoes, there are a great many characteristics that must be determined, and this work is still not complete.

The material belonging to the old potato strains was for the most part infected by a variety of viral diseases when it was collected. Cleaning has taken place using meristem-tip culture.

All the material will, by degrees, be preserved both *in vitro* and in the field. It is also planned to store botanical seeds of valuable cultivars in the permafrost store on Svalbard, and seed collecting has started.

The old potato cultivars of Nordic origin probably have a rather narrow genetic basis. Many of them also have small tubers, poor tuber shape and other primitive characteristics. That a few of the cultivars have been in cultivation for nearly 200 years is, nevertheless, an indication that certain valuable qualities must be present. Most of the old strains have poor resistance to several of the most important diseases suffered by potatoes in this country. Some exceptions occur, and a few strains have shown useful resistance to certain storage diseases. Some cultivars have extremely long dormancy time, which is important under Norwegian conditions.

The greatest value of this old material is probably to be found in the quality properties. That the strains have been used as table potatoes for a very long time alone indicates that they have good, stable food quality. Several of the old strains are also regarded as quality varieties in a number of other countries and fetch extra high prices. Organoleptic tests have also shown that certain cultivars represent a quality level that is rarely found in more recent cultivars and they are undoubtedly a source for intensified quality improvement through breeding. Preliminary investigations suggest that this material contains clones with nutritional qualities that may also be of value in a future programme for improvement through breeding.

The Nordic material for improvement purposes which is to be stored in the gene bank, and cultivars that may have some extremely valuable qualities but which for other reasons have not been marketed, first and foremost represent very good sources for resistance. Better resistance against several important potato diseases has been found in this material than in the well known, marketed cultivars. As new clones of corresponding value appear at the Nordic plant improvement centres, they will be evaluated for transfer to the genebank.

3.4.5 Vegetables

Most old Norwegian vegetable cultivars have been collected and preserved. The majority are being stored as seed, except for rhubarbs *(Rheum* spp., 24 cultivars) and shallots *(Allium ascalonicum,* about 10 cultivars) which are being maintained *in situ.* The seed store at present contains the following cultivars: 3 common onions, 1 leek, 19 swedes, 30 cabbages, 1 brussel sprout, 7 early turnips, 1 caraway *(Carum carvi), 1* tomato, 4 beans *(Phaseolus vulgaris)* and 6 peas *(Pisum sativum*). The qualities of the cultivars are now being described and information is stored in data banks that are available to those concerned with research, and with breeding for improvement. They are also being described from the viewpoint of organic cultivation, because it is thought that much of this old material has some extra resistance to diseases and pests, and other useful qualities.

3.4.6 Fruit

Norwegian literature contains descriptions and documentation of about 670 fruit cultivars. Of these, 470 are apples, 48 pears, 90 plums and 58 cherries. It must be assumed, however, that one and the same cultivar may have different names or that different cultivars may have the same name. Data sheets are being prepared for the most important species, on which all relevant information is noted. The information is stored in a form that is available to future users carrying on improvement breeding work and research. The filing system distinguishes between Norwegian and foreign cultivars. Norwegian ones are those that are known to, or are thought to, have originated in this country (local varieties), or that have originated as Norwegian mutants (varieties) of foreign cultivars.

The cultivar material that has been registered so far shows that the sources and background of Norwegian local cultivars vary and can be divided into the following five categories: 1) cultivars originating from methodical hybridisation; 2) colour mutants and variants of known and established cultivars; 3) cultivars that have originated from the sowing of kernels from a known cultivar; 4) cultivars that have been found and preserved by chance, or through natural seed dispersal; 5) cultivars that prove to be already known Norwegian or foreign cultivars.

The cultivars that have been registered represent a substantial range of quality and value for cultivation. This ranges from almost valueless ones (some types of sweet apple) and local varieties that are not known beyond an extremely limited area (a village or a cluster of farms) to well tried, nation-wide varieties with a long tradition of cultivation. The most important criteria for their future preservation are resistance to disease and winter hardiness.

Because fruit species can normally only be preserved by cultivation outdoors, it is expensive and time-consuming to look after the important cultivars. This has been solved through cooperation with local folklore museums (Bratberg, 1986). People connected with the museums who are interested in the project, assist by collecting cultivars and species in their local district. This provides secure storage facilities (clone shows), and the development of the trees can be adequately followed. The Norwegian working group now has contact with 7 or 8 of these museums and is attempting to develop the consent in other areas.

In North Norway, it has been common practice to take good, individual, redcurrant plants into gardens as ornamental plants and to produce berries. Several of these clones have proved successful in trials, compared with other established cultivars from the south, and some have been approved as cultivars in their own right. These have been in the breeding programme for state controlled plants, for example Kosma, Losvar and Syttinord.

Under the auspices of the NGB, wild populations of *Ribes* have been registered in Finnmark, North Norway (in the Alta valley, Posanger, Tana, Sør-Varanger, etc.). Individual plants and populations have been described, and around 100 individuals have been collected for comparative trials on the State Agricultural Research Station plot at Flaten in Alta. Corresponding work has also been carried out in the mountain areas of southern Norway where 173 individual redcurrant bushes from almost as many populations, 14 blackcurrants and 63 gooseberries have been described.

The northern Scandinavian varieties of *Ribes* are extremely interesting as hybridisation partners for resistance-improvement work, because, in that area, wild *Ribes* are resistant to, among other things, mildew. In North Sweden (Tornedalen), it used to be normal practice to take wild blackcurrants into gardens to use as berry bushes. A research project in North Sweden, which studied many of these clones, resulted in a selection of good ones becoming cultivars that are still used in northern districts. One of these cultivars (Øjebyn) was also an important variety in private gardens throughout Norway, because of its resistance to mildew. The Nordic Gene Bank has been interested in mapping and describing wild cherry (*Prunus avium).* Individuals with good edible berries have been selected and taken into plantations in many areas. The variaton in tree size was mapped and evaluated as landscape/farmstead trees, or as rootstock material. About 50 individual trees have been described from Sogn og Fjordane northwards. Some of these are in danger of being felled and to ensure that their genetic material is preserved, they will in due course be grafted and taken in to a secure clone show. When this is being done, attention will be paid to genotypes which are suitable for

timber production, using cherry as an alternative to tropical timber for the furniture and house fitting industries.

3.5 SECURITY STORAGE ON SVALBARD

At the initiative of the committee of the Nordic Gene Bank, a working group was set up in 1981 to consider the question of establishing facilities for security long-term storage of seed. It was decided to establish a store of this nature in a area with permafrost in order to have a stable, long-term, low-temperature store without being dependent on electricity and regular inspection.

After considering various alternatives and carrying out, amongst other things, some test drilling in the Jotunheimen in cooperation with the Norwegian Polar Research Institute, it was decided, in consultation with the Department of Geologi at the Agricultural University of Norway, to make use of an abandoned coal mine gallery on Svalbard. The gallery is about 300 m from the surface plant and has a 70 m thick roof. Following consultations with the Polar Section of the Ministry of Justice, which functions as the interdepartmental secretariat for Svalbard matters, a simple contact was signed with SNSK (Store Norske Spitsbergen Kullkompani - the state-owned coal mining company) to arrange the preparation of such a storeroom.

Measurements showed that radiation in the mine was insignificant. A specially constructed steel container with a volume of about 15 m^3 has been made to fit the gallery. An insulating wall was built between this gallery and the main one which takes in outside air which fluctuates in temperature. During a period of three years, the temperature in the storeroom gallery has fluctuated between -1 and -4^0 C. Inspections in June 1969 and November 1991 revealed rime formation on the container. This implies that the temperature in the gallery may exceed 0^0 C. However, no rime has formed inside the container. The relative air humidity exceeds 90%.

Staff at the Nordic Gene Bank prepare the most valuable material for placing in the security store. The seed is dried to a water content of approximately 4%, and about 500 seeds are placed in glass ampoules which are sealed by melting the glass. These are transported to Svalbard in polystyrene boxes filled which carbonic acid ice. So far, the store has received 3,429 samples consisting of 6 species of cereals, 30 grasses, 31 vegetables, 16 root, oil and tuber growths, and 2 seasoning and medicinal plants.

In 1986, the State Seed Testing Station at Ås began a 100-year long-term storage trial of seeds in connection with this store. Seed samples from 16 ordinary species of agricultural and vegetable plants were placed in the store. These samples were also put in glass ampoules and boxes, as in the case of the ordinary store material. During the first 20 years, samples are to be taken out every 2½ years, and thereafter every fifth year. The last samples will be taken out on February 1st 2086. The working of mine 3 is expected to come to an end in 1997.

CHAPTER 4
In-Country Uses of Plant Genetic Resources

The Nordic Gene Bank (NGB) is an institution which reports to the Nordic Council of Ministers, an executive assembly to promote cooperation between the Nordic countries: Denmark, Finland, Iceland, Norway and Sweden.

Initially the institution was called the Nordic Gene Bank for Agricultural and Horticultural Plant and its mandate was to preserve and document the genetic variation in Nordic agricultural and horticultural plants and their wild relatives. Nordic cooperation in plant breeding was organized by the Internordic Plant Breeding Institute (SNP). The two institutions merged on January 1, 1993.

This reorganization broadened the mandate of NGB. Along with the conservation and documentation mandate, NGB now promotes the rational coordination of plant breeding activities in the Nordic countries by funding cooperative projects to utilize plant genetic resources (PGR). Participation in international projects to conserve and utilize PGR is also stipulated in the statutes of the new institution.

Most material is preserved *ex situ*. Seeds are kept dry at -20° C. Fruit trees, berries and landscape plants are preserved in clonal archives (field genebanks) and potatoes are preserved *in vitro*.

Serious professional users have unrestricted access to NGB's material and information.

NGB's seeds are stored in three different collections:

- The active collection is used for the distribution and characterization/evaluation of material. When an accession is prepared for the active collection, the sample is divided into a number of small distribution bags and a larger bulk bag. It is multiplied when more material is needed for distribution.
- The material in the base collection is stored in tightly sealed glass bottles to maintain viability for as long as possible. Rejuvenation is performed when germination tests show that germinability has decreased below a minimum level. Special care is taken to maintain the genetic composition of an accession during rejuvenation.

- The safety base collection is a duplication of the base collection. The collection is stored in a container placed in a coal mine under the permafrost on the Svalbard Islands.

Information related to the material is stored in computerized databases. The computer system at NGB consists of personal computers (IBM and compatibles) connected in a local area network. The database management system dBASE IV is used to handle the information.

NBG has databases to manage the material and to document the characteristics of the preserved material. Catalogues for various crops are published to make the information available.

In 1993, NGB acquired seeds of 547 new accessions. 789 germination tests were carried out and seven rye accessions were rejuvenated. A comprehensive multiplication of forage crops has begun.

NGB received 101 requests for material. 47 were form the Nordic countries and 54 from abroad. 17 requests were forwarded to other genebanks from which 185 samples were received and carried over to users. 1,549 samples were distributed from NGB's seed store. 20 requests for catalogues or databases were received.

17 projects making use of PGR were sponsored during 1993. Six of these projects were finished in 1993.

Seed collections	
The ordinary seed collection	8,956
Special seed collections	15,197
Total	24,153
Safety base collection	3,780
Duplicates for other genebanks	3,761

	Number of requests for material (1993)
Africa	1
Asia	10
Australia and New Zealand	2
Denmark	13
Europe except Nordic countries	30
Finland	4
Iceland	1
North America	10
Norway	8

	Number of requests for material (1993)
South America	1
Sweden	21

The main concept of NGB's strategy is that NGB is a hub of a network of institutes and individuals engaged in conservation and utilisation of plant genetic resources in the Nordic countries. NGB will also become a Nordic information centre for Plant Genetic Resources.

This strategy will be the basis for the development of NGB until the turn of the century and will guide the management and staff in their daily work.

The board has recently decided to establish a temporary working group for wild plants.

The group will suggest to the board a list of species that should be included in the mandate of NGB and examine the need for specific preservation measures. The group will also submit a list of species that should be given priority in the inventory of useful genetic variation. The group will be NGB's coordinating body for the follow-up of the Convention on Biological Diversity.

CHAPTER 5
National Goals, Policies, Programmes and Legislation

Legislation has been dealt with in chapter 3.

The government intend to present a national action plan for the conservation and sustainable use of biological diversity during the spring of 1995. The action plan will include both plant and animal genetic resources and is primarily a follow up and implementation of the Convention on Biological Diversity.

To implement the action plan seven ministries will be responsible for measures to be taken within their mandate.

Essentially the planned activities will be government funded but cooperation is expected from sub-national authorities, research institutions and farmers organizations.

The sectorial approach to national actions is considered to be a key factor in the implementation of the national action plan. There is no hope of success if biodiversity is regarded as a responsibility of only one sector in our society.

The need for funding will be assessed continually in connection with the governments annual budget.

The government will receive regular reports and assessments of the situation concerning genetic resources and these reports are supposed to form the basis for Norway's reports to the Conference of the Parties to the Convention on Biological Diversity.

A crucial issue in the governments action plan is the need to focus on the sustainable use of genetic resources. Up to now conservation of genetic resources have mainly been defined as *in situ* conservation. These measures are important but they do not change the fact that the bulk of biodiversity and genetic resources is to be found outside of national parks and gene banks.

Consequently, biological diversity in large will have to be protected through measures for the sustainable use of its components. We shall have to integrate incentive structures and measures for sustainable use in all sectors of our

society such as developing mechanisms which reward the integration of sustainability efforts in major sectors, such as agriculture, forestry etc.

In this context, Norway consider the FAO process of re-negotiating the International Undertaking on Plant Genetic Resources as extremely important.

The action plan will reflect the need to acquire and make use of the best available scientific knowledge as a basis for setting priorities and taking actions.

Decisions must be based on the findings of the scientific community with due respect also for ethics and traditional knowledge and practices.

In this respect we also see the need for increased efforts at all levels of our educational system.

According to Norwegian legislation plants and animals are not patentable and in order to give some protection but still maintain the principle of Farmers Privilege Norway has submitted to the UPOV Act of 1978.

CHAPTER 6
International Collaboration

Estonia, Latvia and Lithuania have close links, both geographically, climatologically an historically with the Nordic countries and plant genetic resources of the Baltic countries and Nordic countries are of mutual interest.

The three newly independent states have not yet started a plant genetic resources programme of their own. The Board of NGB decided to establish contacts with local representatives. These contacts resulted in a two-year (1994 - 1995) project to promote the establishment of a plant genetic resources programme in the Baltic states. This project will be financed by the Nordic Council of Ministers.

Since 1989, NGB has been involved in a Nordic Development Project in the SADC-countries in Southern Africa (Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, Zimbabwe). The primary objective of the project is to establish a regional centre for plant genetic resources and a network of national plant genetic resources programmes. The first four-year phase of the project ended in 1992 but was prolonged a further year while the project was evaluated.

Following negotiations with the Nordic Development Aid Agencies, the board agreed that NGB will continue as Management Consultant in the project for the period 1994 - 1997. NGB will provide any backup required including financial administration and management of project funds.

The new SRGB building (SADC Regional Gene Bank for Plant Genetic Resources) was officially opened on 18 October 1993. The total cost of construction amounted to 15 million SEK. The total area of the complex is 1,400 m^2, including the genebank with a current storage capacity of 25,000 samples of base collection of orthodox seeds, in addition to 5,000 active samples.

The building which is situated on an 86 ha farm 25 km east of Lusaka, houses the seed bank, technical section, processing unit, library and administration block. All these units are served by a local area network of computers in a PC environment.

All this has helped SRGB to prepare its plan of operation for the second phase which began January 1994: installing the computer network and establishing administrative routines; starting the first 2 Regional Crop working groups,

and reorganizing and starting new national crop working groups in Zambia. The commissioning of new facilities enabled SRGB to process and store its first base collection samples during 1993.

The importance of international collaboration concerning plant genetic resources is clearly recognized by Norwegian authorities and Norway has from the beginning taken active participation in the European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR).

Norway has adopted Agenda 21, ratified the Convention on Biological Diversity (CBD). Norway is also a member of CPGR and has signed the Undertaking.

These instruments are all in harmony with Norwegian policy and are considered to be necessary in order to secure food production for future generations.

Future cooperation between CPGR and the CBD is essential. CPGR will be able to address sectors and problems which could hardly be satisfactorily solved by CBD. Renegotiating the Undertaking and the Code of Conduct into legally binding instruments represents a very important challenge for the near future.

If the Global system is to become a reality, international funding will be of vital importance. It is envisaged that a close cooperation between CPGR and CBD will make it more easy for donors to contribute to a financial mechanism.

Since June 1992 a country study of Norway's genetic resources (plants and animals) has been produced and in 1995 a national action plan for conservation and sustainable use of biological diversity will be completed.

The Nordic countries have also established a joint strategy group with the intention of monitoring the genetic resources within the Nordic area.

CHAPTER 7
National Need and Opportunities

Briefly the following indented paragraphs may illustrate some highly important elements in Norwegian policy for the conservation and sustainable use of domesticated genetic resources.

Administration of terrestrial areas shall be conducted in a sustainable way taking into consideration that these areas are the basis for life, health and well being for man, fauna and flora.

Several measures will be implemented in order to reduce the use of pesticides and herbicides. A prognosis program and monitoring and early warning system will be established and the efforts to implement integrated pest management will be enhanced.

Research activities will be given high priority. It is of great importance to analyse the interaction between various methods of farm management and eco-systems in agriculture. Continuation of our research programme on biotechnology will lead to enhanced knowledge of genetic variation and how to conserve and utilize genetic resources.

Implementation of environment and resources/planning on the individual farm will be an important component in the effort to raise the competence of the farmers.

Increased efforts will be made to characterize old genetic material which up to now have only been stored in the Nordic gene bank.

The present utilization of PGR consists mainly of PGRFA. The system behind conservation and utilization of PGRFA will be upheld through NGB and the active research and breeding institutions. In their mandate these institutions are supposed to stimulate enhanced utilization of PGR among breeders and scientists.

Import of PGR to Norway occur from time to time. Especially with regard to developing countries Norway will recognize the principle of Farmers Rights.

CHAPTER 8
Proposals for a Global Plan of Action

Every possible effort should be made to harmonize 1) The International Undertaking on Plant Genetic Resources, and 2) The International Code of Conduct for Plant Germplasm Collecting and Transfer with The Convention on Biological Diversity. The aim of this harmonization is to develop a new legally binding protocol under the auspices of CPGR.

The Conference of the Parties (COP) to the Convention on Biological Diversity is engaged in a debate on a possible protocol to the Convention on biosafety. Such a protocol will eventually become a very important instrument for safeguarding human activities in biotechnology. FAO/CPGR should be an active participant in this process.

To conclude the work with an international network of *ex situ* base collections under the jurisdiction of the FAO is to be considered very important. The development of the network need to be harmonized with the Convention on biodiversity.

Great effort should be made to reach an international agreement on systems to implement Farmers Rights.

The 96th conference should discuss the possibilities of developed countries using more of their financial aid to developing countries in the work with genetic resources.

It is of vital importance to reach a conclusion on how to manage Global Animal Genetic Resources. In principle Norway is of the opinion that the question of management should be solved by broadening the mandate for CPGR.

REGIONS AND COUNTIES IN NORWAY

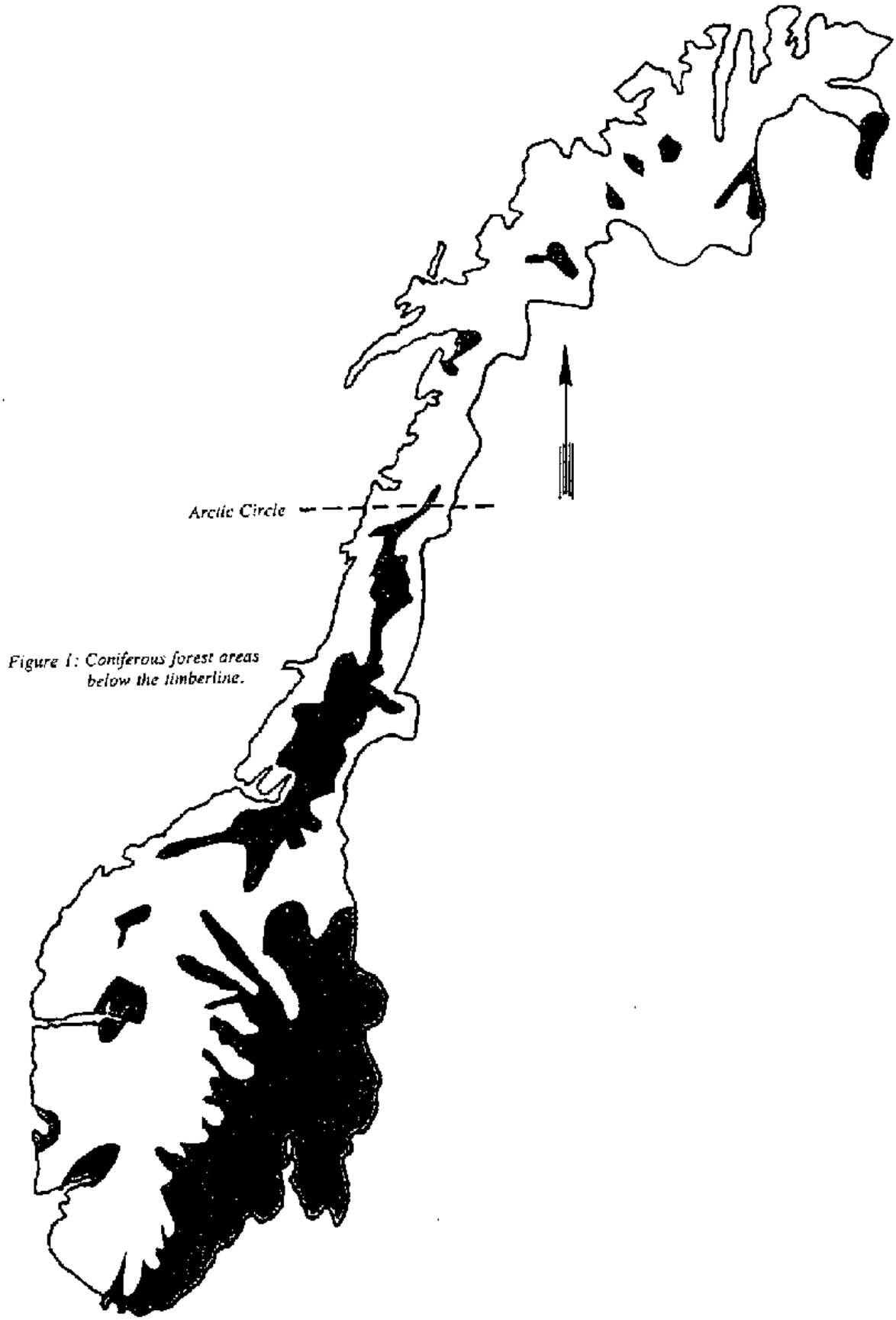


Figure 1: Coniferous forest areas below the timberline.

ANNEX 1
Forest Genetic Resources

CHAPTER 1 INTRODUCTION TO FORESTRY IN NORWAY

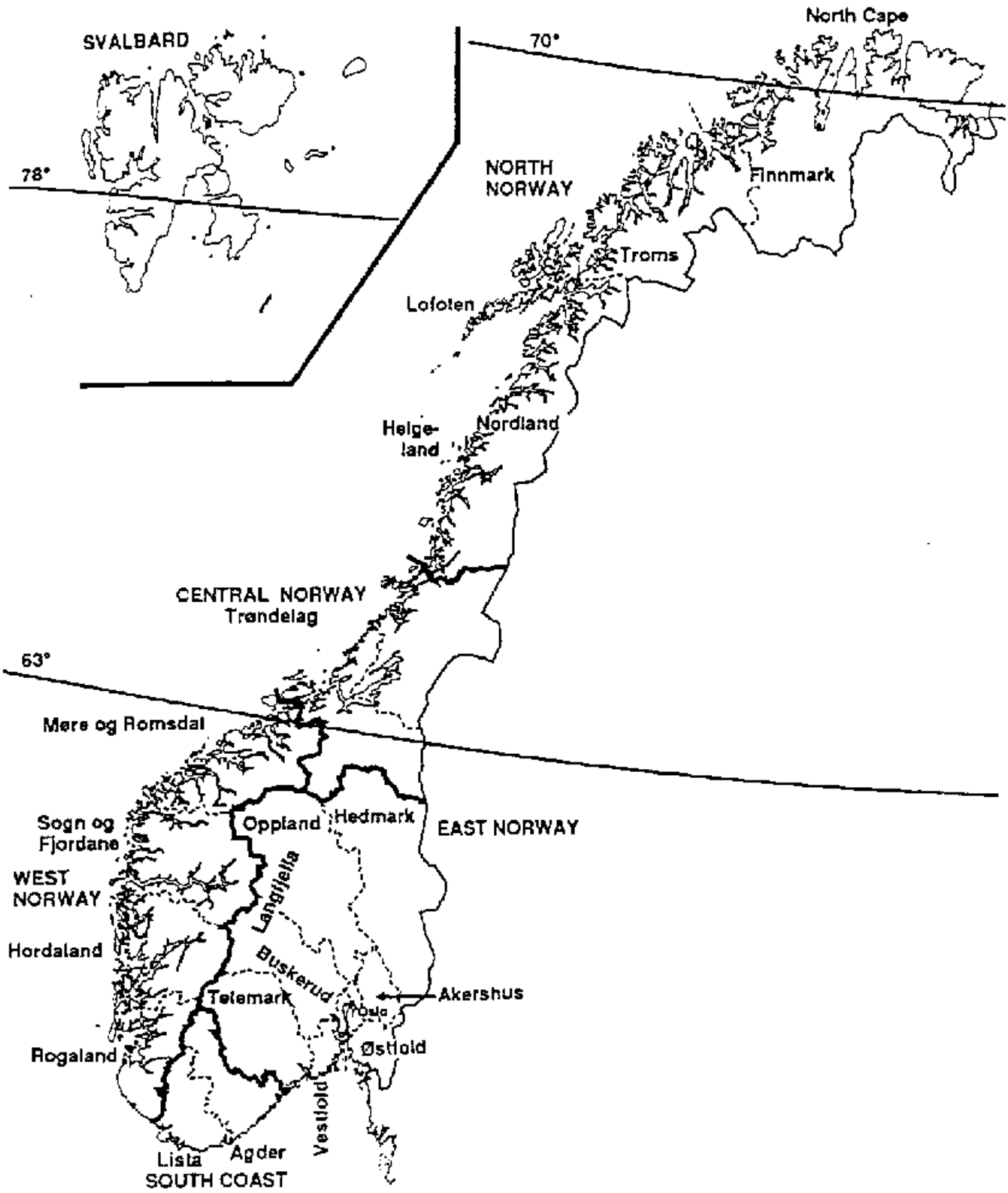
The forests of Norway cover a total of 12 million hectares, or 37% of the country's land area. Productive forests, defined as areas with an annual wood production of more than 1 m^3 per hectare and year, amount to 7 million hectars. Approximately 80% of that area is coniferous forest with Norway spruce as the dominating species. The largest parts of these forest are located to the southeastern and central part of the country, as shown on the map in Figure 1. Due to Norway's geographical spread climate, geology and irregular topography, ecological conditions for forestry production vary widely over short distances. The rotation age is 70-160 years.

The total productive forest area has hardly changed since the beginning of this century. The volume of growing stock, however, has shown a considerable increase since the start of the national forest survey in the 1920's. The volume of trees has grown from approximately 300 million m^3 to almost 600 million m^3. At the same time, the annual increment has increased from 10-11 million m^3 to approximately 20 million m^3. A main feature of the development during the last 50 years is an increase in young forest stands.

Eighty percent of the productive forest area is privately owned, mostly by farmers, with the average size of holdings being 30-40 hectares. The distribution is unbalanced, 90% of the forest owners have properties less than 100 hectares, own 40% of the productive forest and contribute 30% of the total harvest. These forests are generally farm forests and the owners earn their income both from agriculture and forestry. Only 12% of the forest area is State forest, of which a considerable proportion is remotely located and consists of low productive sites.

The total annual harvest is 10 million m^3, which is only of around 50% of overall growth. Norway spruce amounts to 70% of the harvest. Half of the annual cut is delivered as sawlogs and half as pulpwood. Directly and indirectly, forestry and the forest industries offer work to about 35,000 persons. The forest industries account for approximately 10% of total exports of non-petroleum goods.

FIGURE 1: CONIFEROUS FOREST AREAS BELOW THE TIMBERLINE



Regions and counties in Norway.

In Norway, the general public enjoys the right of free access on foot throughout the year to non-cultivated land provided that care and considerations are shown. This right has important health and social aspects and creates potential for multiple uses of the forests. It is therefore a main goal of the forest policy, as expressed in the Forestry Act, both to promote forest production and allow for the function of forests as sources of recreation and living environments for plants and animals. The principles of sustainable forest management are the basis for the commercial utilization of the forest resources, and the needs of both present and future generations should be met.

CHAPTER 2 INDIGENOUS FOREST GENETIC RESOURCES

Species composition and distribution of forest trees in Norway are largely determined by the following factors: the invasion of tree species after the ice age, subsequent climatic changes and human activities. The first tree species to establish after the ice retreated more than 10,000 years ago were birch (*Betula pubescens*), poplar (*Populus tremula*) and Scots pine (*Pinus sylvestris*). These species spread fast and to altitudes 200-300 m higher than the present timber line. During the warm and dry period that later followed high temperature demanding species such as lime (*Tilia cordata*), ash (*Fraxinus exelsior*) and oak (*Querqus robur, Q. petrea*) spread and formed forests in the southern and southwestern part of the country. Small remnants of these forests still exist. These and other deciduous tree species that occur as scattered trees in mixed stands with other species (e.g. *Fagus silvatica*, *Ulmus glabra, Acer platanoides, Prunus avium*) have their main distribution in warmer climates at more southern latitudes and occur in Norway today at the northernmost border of their natural range.

It was not until approximately 2,500 years ago, during a cooler and more humid period, that the at present most important conifer, Norway spruce (*Picea abies*) started its introduction into the Norwegian landscape. The Nordic spruce populations have their origin in the taiga in northern Russia and Siberia. During a period of 3,000 years the species spread through Finland and northern Sweden. The earliest identified establishments are from the years 500-400 BC in the border areas close to Sweden in Central Norway. The invasion of the southeastern lowland area took place during the following 1,000 years, but the migration up the valleys to the species' present altitudinal boundary was not completed until the period 1000-1500 AD. The coastal spruce forest in Central Norway established rather late (approx. 1300 AD). The species never established naturally in western Norway, except for a few

scattered populations, which have a late establishment and most likely are spread from the nearest source stands east of the mountain range. The present natural occurrence of Norway spruce is in southeastern Norway from the sea level and up to 1,000 m, and in Central and North Norway, north to lat. 67°N, at decreasing altitudes in the north. Outside this area the species has in this century been planted both in western Norway and north of its natural boundary in northern Norway. In both regions it has become an important timber species.

The distribution of forest trees along the coast, towards the mountains and in the north depends strongly on the climatic conditions. Decisive factors are the length of the growing season, minimum temperatures in the different seasons and the wind conditions. The high percentage of unproductive forest land is due to the fact that a large proportion of the forest is found near the climatic limits for timber growth, partly due to the altitude and partly due to the northern latitude. The soil is usually fertile enough, even though it is often thin. The climatic conditions can be characterized by the length of the growing season which is between 170-190 degree days in the south and only 100 degree days in the northern parts and in the mountainous regions. Fungal diseases may in on sites with unfavourable climate be a threat in young Scots pine stands, in particular in the alpine forest.

The Norwegian forests have been strongly influenced by human activities. The first serious disturbances probably took place more than 4,000 years ago in connection with the widespread early practising of swidden agriculture to provide arable land and pasture, and continued subsequently through ironmelting activities in upland forest and salt extraction on the coast. The heaths along the coasts are a result of felling, burning and winter grazing. Increased international trade resulted in more intense forestry activities between 1,000 and 650 years ago, with export of timber and clearing of forests to provide new land for cultivation. Early mining activities that started 400 years ago lead to deforestation in some areas. Some 300 years ago an excessive overharvest of the conifer forests began which strongly depleted the forest resources in some regions. An excessive international trade with timber and mountain dairy farming were the major reasons for this overharvest.

The exploitation period was followed by a period of unsuccessful methods in silviculture, where clearcuttings were not used, in the belief that regeneration could take place under the canopy of the maturing stands. Unfortunately, the soil temperature on the shaded ground was usually too low for germination. After World War II, silvicultural methods based on new principles were generally accepted, applying clearcutting followed by artificial or natural regeneration.

The present day productive forest is a mixture of old growth natural stands and younger stands, established partly by natural regeneration and partly by planting. Norway spruce is the commercially most important species as it amounts to 50% of the volume and 70% of the annual cut. The other important conifer is Scots pine which makes up 30% of the volume of the productive forest. The deciduous tree category (20% in volume) is dominated by the two birch species (*Betula pubescens, B. penduala*), with smaller mixtures of other species like alders (*Alnus incana, A. glutiosa*), ash (*Fraxinus exelsior*), lime (*Tilia cordata*), beech (*Fagus sylvatica*), oak (*Quercus petrea, Q. robur*), elm (*Ulmus glabra*), Norway maple (*Acer planatoides*) and wild cherry (*Prunus avium*). Even though emphasis is now placed on increasing the proportion of deciduous trees, nearly all artificial regeneration is made with conifer species. Norway spruce is the dominating species, making up more than 85% of all seedlings planted in the forest. However, of the annual regeneration area of approximately 60,000 hectares, 60% is naturally regenerated. The new forest will therefore be mixtures of naturally regenerated and planted stands.

No native forest tree species or provenances are considered to be threatened in any part of their native range in Norway.

CHAPTER 3 NATIONAL CONSERVATION ACTIVITIES

The gene conservation activities of forest trees in Norway are accomplished in four different ways: by nature conservation areas in national parks, protected landscape areas or nature reserves; by recently established conservation areas in productive coniferous forests; by materials preserved in clonal archives or seed orchards as part of the national tree breeding program and by seed in storage at the State Forest Seed Station.

In Situ Activities

The nature conservation areas are established to preserve landscapes and natural and scenic areas and to protect communities and species, and natural processes should be maintained in an undisturbed state. At present 18 national parks are established in Norway, covering a total area of 13,535 km^2. Of these areas 1,313 km^2 are forests, for the largest part non-productive. Most national parks are located far north and at high altitudes and do not sample representative areas of the Norwegian coniferous forest. Smaller areas conserved as nature reserves, altogether 951 localities at the end of 1991,

covering 6,970 hectares of coniferous forest and 2,836 hectares of deciduous tree forest. New proposals are being made for increasing the number of conservation areas. The nature conservation areas not established with the specific aim of conserving genetic resources and can only fulfill some of the gene conservation objectives. They can be considered as a supplement to other conservation programs, but cannot be considered to play a major role in the conservation of the forest tree genetic resources.

Based on a national plan to conserve coniferous forest, altogether 25,000 hectares of productive forest have been protected. Norway spruce is the main species in the larger part of these areas. The main intention was to preserve a nationwide selection of natural and, as far as possible, undisturbed coniferous forest that should include both typical elements and the more rare and threatened ones. Preservation of the biological diversity in Norwegian forests was the an important objective of the conservation plan, and conservation of the genetic resources was one of the motives. From localities classified as relevant candidate areas, 25,000 hectares have been chosen to be included in the conservation plan for the coniferous forest. In addition are 19,900 hectares of coniferous forest protected earlier. These areas are distributed in the different parts of the country and are stratified to be representative for major eco-geographic zones and sub-zones. The different areas vary in size, from ten to several thousand hectars. So far, no genetic studies have been made of the intra-specific diversity of the protected forests and to what extent they represent unique genetic adaptations to specific ecological conditions.

Plans have been made to increase the number of conservation areas in the productive forest and an enlargement will most likely be accepted by the political authorities in the near future.

Ex Situ Activities

A more active gene conservation work is performed *ex situ* by the establishment of clonal archives or seed orchards containing grafts of Norway spruce and Scots pine clones. Selections of plus trees have been made in natural stands covering the entire distribution of Norway spruce throughout the country, and to a less degree of Scots pine. More than 4,000 selected Norway spruce trees have been grafted, most of these at several localities. They were grouped in breeding populations according to the latitude and altitude of the origin of the natural stand. However, it was soon realized that progeny tests are necessary to assess the genetic value of a selected plus tree, and more than 2,500 of the selected spruce clones have been tested in family tests planted in trials at several sites. Traits that have been measured include height and diameter growth, annual growth rhythm characteristics, climatic damage

and stem and branch quality. In addition, a large number of families have been tested in artificial freezing experiments.

The grafted clones and their offspring in progeny tests is an important part of the gene conservation activities, as they are the only materials from which specific genetic information is available.

Smaller numbers of individual trees of commercially less important species have been grafted and kept in clonal archives, both of native (e.g. *Betula pendula*) and of introduced species (e.g. *Picea sitchensis, Abies lasiocarpa, Larix sibirica*).

The State Forest Seed Station is responsible for the procurement, storage and trade of forest tree seeds. Seeds of recommended provenances of both native and imported species are stored, with main emphasis on a wide selection of native Norway spruce and Scots pine provenances. A long term seed storage is needed as seed years are scarce at northern latitudes and at high altitudes. Seed lots are therefore kept as long as 20-30 years until new representative seed crops become available. The seed storage is an important component in the management of the forest tree genetic resources in the artificial regeneration program. Efforts will be made to characterize adaptive properties (e.g. growth rhythm, frost hardiness) of all the different seed lots in storage.

Characterization of Intra Specific Diversity

So far, no studies of isozyme or DNA genetic markers have been performed to characterize the genetic variability of Norwegian forest tree population. For the main conifer species Norway spruce, however, the variability between and within populations in quantitative traits is well characterized from genetic studies in provenance trials and family and clonal tests. The largest efforts have been made to characterize adaptation to the climatic conditions. Therefore measurements have in particular been made of annual growth rhythm traits: the timing and duration of the annual growth period, frost hardiness development in the autumn and dehardening in the spring. The survival and occurrence of climatic damage under field conditions are generally closely related to these traits. All studies demonstrate a clinal variation in growth rhythm characteristics of natural spruce populations from the south to the north and from low to high altitudes. The southern and low altitude populations have the longest duration of the growth season, and, as a consequence, the highest growth potential. They also show the latest development of frost hardiness in the autumn. The only well known characterizations of the adaptive process of spruce populations are the responses to temperature and photoperiod. Recent results from the genetic research indicate that the annual growth rhythm of the offspring may to some

extent be determined by climatic conditions during the generative reproductive process.

The genetic variation in quantitative traits is large within all natural spruce populations studied, also for traits that shown clinal variation at the provenance level. Norway spruce provenances show generally a large ability to being transferred. The success of such transfers depends to a large extent of how well the growth rhythm of the materials matches the climatic conditions at the planting locality.

Less genetic information is available for the other native tree species. Scots pine populations show similar clinal genetic variability in growth rhythm traits as Norway spruce. This species, however, seems to be much more specifically adapted to its region of provenance. Provenance transfers have been shown to be less successful, in particular when seed is transferred to more severe climatic conditions or from continental to more oceanic climate.

Genetic studies of growth rhythm and growth traits have been initiated with birch (*Betula pendula*) and alnus (*Alnus glutinosa*). In both species indications are given of large genetic variation both between and within populations.

CHAPTER 4 IN-COUNTRY USE OF TREE GENETIC RESOURCES

Natural regeneration is encouraged as a reforestation strategy after harvesting where it is a feasible and optimal regeneration method. Under certain ecological conditions, however, natural regeneration will not be sufficient for the establishment of a well stocked Norway spruce stand, and planting is necessary. At present, approximately 25,000 hectares are being planted annually. The volume of the plantings, at present 50 million seedlings per year, is only half of what is was 30-40 years ago when it reached its peak.

In addition to the planting in the southeastern and central parts of the country, new coniferous forest resources have been established in the western and northern parts in climatically favourable areas that were formerly covered by low quality birch and other non-commercial species.

More than 80% of the seedlings planted are Norway spruce, mainly of Norwegian provinces. Three sources of native spruce seed are being used: source identified natural stands, selected natural stands and seed orchards. Approximately 20% of the spruce seed is produced in seed orchards, in varying amounts for different regions. Seedlings from stand seed are primarily

used in the same region of provenance where the seed was collected. A large proportion of this seed is collected when stands are harvested.

The seed orchards are elements of a tree breeding program with Norway spruce that was initiated 40 years ago. Seven seed orchards are at present productive and five more are under establishment. The number of parents in the orchards varies between 50 and 200. The main intention with the breeding program is to produce seedlings with a well defined hardiness that will secure a superior yield and high quality. All seed orchard seed lots will be tested for frost hardness and annual growth rhythm and their use will be matched with the climatic conditions in the intended region of planting.

Norway spruce provenances from Central Europe, primarily from Harz, Germany, are to some extent being planted on sites with mild climate in western Norway where spruce does not occur naturally. Stands of these provenances show superior yield compared to stands planted with seedlings of Norwegian origin. Seedlings from seed collected in Norwegian stands of Harz origin show indications of being better adapted to Norwegian conditions that seeds collected in Harz.

Due to a lack of Norway spruce seeds of local origin seedlings of Central European provenances were planted in southeastern Norway during a 20 year period starting in the mid 1950s. In one county, Østfold, 35% of the total number of seedlings planted in the period 1960-80 originated from provenances in Austria and in Schwarzwald, Germany. It was thought that the high altitude of the seed stands, between 800 and 1,400 m, would compensate for the southern latitude. However, both practical observations and a recent survey in planted stands have shown that these stands are not well adapted to the northern climatic conditions. While 30% of the trees in 30 year old planted stands of native origins were classified as having saw timber qualities, only 7% of the trees in the Central European stands obtained the same classification. These provenance transfers had a negative effect on timber quality, particularly on sites were frosts commonly occur in late spring or early autumn. The stands established with seedlings from introduced provenances are in many cases mixed with stands of local seed origin and are often not recognizable. The seeds harvested in such areas, even in healthy stands, may partly be from local and partly from provenance hybrid crosses. Critical factors are the abundance of flowering in the stands of introduced provenances, the range of pollen migration and how fast the natural selection process proceeds.

Transfers of Norway spruce provenances from southern to northern latitudes and from low to high altitudes have also been made within Norway. Such transfers have in some cases resulted in plantations that show lack of adaptation to the climatic conditions. However, as these plantations in many

cases have failed and are rather scattered, they will in few cases produce pollen or seeds in large enough quantities to have any practical consequences, either for the natural regeneration or for seed collections.

Although as many as 50 introduced coniferous species have been planted in experiments and arboreta, only very few have been used to any extent in Norwegian forestry. In the coastal districts of West and North Norway, Sitka spruce (*Picea sitchensis*) from the west coast of North America has proven to have a substantial higher production than Norway spruce and has been planted from the beginning of this century. Along the coast in North Norway, the hybrid between Sitka spruce and white spruce (*Picea glauca*), *P. lutzii*, has in some areas replaced Sitka spruce. Specified provenances of seeds of these two species are imported from North America. Another non-native species that has been planted to some extent at high altitudes in eastern and central Norway is lodgepole pine (*Pinus contorta*), also from North America. Approximately 3% of the total amount of conifer seed sold in Norway are from these three species.

In addition, smaller quantities are being planted of other conifers, e.g. Douglas fir and larch. It has been estimated that 80,000 hectares of non-native tree species have been planted in the last 50 year period.

The procurement of forest tree seed, including the collection of cones, seed processing and trade of seed, is the sole responsibility of the Ministry of Agriculture. The Ministry is also responsible for the import of seed from abroad. The State Forest Seed Station performs the practical work and supervises work done by the local forestry administration. This institution also manages the national tree breeding program and is responsible for databases of all reproductive materials used. The Norwegian Forest Research Institute participates takes part in the formulation of tree breeding strategies and performs the genetic research with forest trees.

CHAPTER 5 NATIONAL GOALS, POLICIES, PROGRAMMES AND LEGISLATION

Norway has no laws or regulations specifically dealing with the conservation of the forest genetic resources. The Norwegian Forestry Act, however, provides general measures for the long term preservation and sustainable utilization of the forests, which also relate to management of the genetic resources. Special recommendations are given of forestry activities in areas which have such location, conditions or characteristics that they should be

managed with particular care. Where restrictions are deemed necessary, such areas may be classified as protection forest and subject to regulations. Protection forests comprise approximately 20% of Norway's total forest area and are in particular located at high elevations, along coasts or in the far north. The Forestry Act is administered by the Ministry of Agriculture.
The maintenance of genetic diversity is one of the main motives in the regulations for the classification, trade and use of reproductive materials in forestry. Specific recommendations are given for the transfer of provenances and use of vegetatively propagated materials. Seed from native Norway spruce stands should not be transferred more than 200 km in the northern or southern direction. Vertically, transfers should be within the range of 300 m. Close to the altitudinal and boreal timber line only local provenances should be used.

Special regulations apply for the use of vegetatively reproduced reproductive materials. Seeds from Norway spruce seed orchards should be tested for growth rhythm and frost hardiness, which should determine their regional use.

Norway participates in the OECD Scheme for the control of forest reproductive material moving in international trade and all import and export of materials are made according to the OECD regulations.

Two other components of Norwegian legislation, administered by the Ministry of Environment, have importance in the management of the forest genetic resources. These are the Building and Planning Act and the Nature Conservation Act. The first one provides fundamental principles for land management limiting non-forestry development and urban expansion on forest land. The Nature Conservation Act provides for the classification of specific areas which are to be protected as national parks, nature reserves, landscape protection areas and natural monuments.

The concept of genetic diversity of forest trees has not been an important topic in the public discussion in Norway. The introduction of Central European Norway spruce provenances has been criticized, but on grounds of the reduced timber quality in the planted stands and not so much due to a possible threat against the local spruce genetic resources. The introduction of spruce and its replacement of Scots pine and deciduous tree stands in western and northern Norway outside its natural range are debated locally. The negative voices are based partly on ecological considerations from naturalist groups as well as a general reluctance to changes in the landscape.

The public awareness of forest genetic resources and the considerations of their importance for the future forests are generally missing.

CHAPTER 6 INTERNATIONAL COLLABORATION

Norway participates actively in the international activities concerning the genetic resources of forest trees. The country has joined the European Forest Genetics Resources Programme (EUFORGEN), which is a follow-up action of the Ministerial Conferences on the Protection of Forests in Europe. The activities in this country will in particular be directed to the network focusing on Norway spruce.

A continuous and active cooperation on genetic resources of forest trees exists between the Nordic countries, both at the administrative level through the Nordic Forestry Council for Seed and Plants and in research projects supported by the Nordic Forest Research Co-operation Committee.

Norway participates in international research projects evaluating the genetic resources of forest tree species with a wide natural distribution. Such projects have been initiated by IUFRO Working Parties and may also be part of EU-research programmes.

CHAPTER 7 NATIONAL NEEDS AND OPPORTUNITIES

The general goal of Norwegian forestry policy is that the forest genetic resources should be managed by a sustainable forest management.

Topics that will be taken up in the near future include:

- Development of strategies for tree breeding to meet specific needs in different regions.
- An enlargement of the national plan to conserve stands in the productive coniferous forest to cover more representative areas in the different ecological zones.
- Information about forest genetic resources and their importance will be provided both to the practical forestry and to the public in general.