GERMANY:

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

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CHAPTER 1
Introduction

1.1 PLANT GENETIC RESOURCES: DEFINITION AND DELINEATION

At an international level, the term "plant genetic resources" (PGR) is defined in various ways. The term's definitions for the various activities are currently still being discussed by the Food and Agriculture Organisation of the United Nations (FAO) as well. International documents such as the "International Undertaking" (1983), the Convention on Biological Diversity (1992) and EC Regulation No. 1467/94 on the "Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture" are based on partially differing definitions of the term (see Annex 1).

The present German report is based on a definition of plant genetic resources derived from the current state of the discussion in the FAO Commission on Plant Genetic Resources (November 1994), however, slightly extended with a view to the definition of the Convention on Biological Diversity:

"Plant genetic resources represent plants or parts of plants which are capable of generative or vegetative propagation with actual or potential value including landraces, wild relatives and special genetic stocks."

In order to have a clear outline the present report classifies the plant genetic resources referred to according to eight groups, on the basis of the respective conditions for use and conservation:

a. **Agricultural crops:** plant species, mostly of one or two-year crops, for the production of foodstuffs (e.g. cereals, potato, sugar beet, leguminous crops and oleaginous fruits), fodder production (e.g. fodder beet, maize) and the production of raw materials (e.g. rape, flax).

b. **Pasture plants:** plant species of permanent grassland (meadows and pastures) for fodder production.

c. **Vegetables:** plant species of one or two-year horticultural crops for the production of foodstuffs.

d. **Fruit crops:** fruit species (fruit trees and shrubs, strawberries).

e. **Other permanent crops, special crops:** plant species of perennial agricultural and horticultural crops excluding fruit (vines, hop, tobacco, asparagus etc.) as well asplant species of perennial agricultural and horticultural crops for special purposes (medicinal plants, spices, aromatic and dyeing plants).

f. **Ornamentals:** plant species of horticultural crops for ornamental purposes (flowers, shrubs, ornamental woody plants).

g. **Forest plants:** tree and shrub species excluding fruit and ornamental woody plants.

h. **Wild plants of potential use:** non- commercially cultivated wild species, that were formerly used and currently are not being used commercially or for which a future use is expected.

Thus, plant genetic resources are part of our entire biodiversity whose importance goes as a natural basis of human life far beyond the current or potential value for mankind.

1.2 INFORMATION ON GERMANY AND ITS AGRICULTURE AND FORESTRY

1.2.1 Natural Conditions

Area: The Federal Republic of Germany comprises an area of 356,945 sq km (approx. 37.7m ha).

Position: Germany is situated in Central Europe and extends from the North and Baltic Seas to the Alps (latitude 5504' to 4716' N, longitude 552' to 1503' E, 0 to 2,962 metres above sea level).

Geographical Structure: From the north to the south Germany is broken down into three major areas:

- North German Lowland (North-west German Plain, North-east German lowlands, loess plains).
- Central German Uplands (Rhineland slate mountains, Upper Rhine's rift valley, eastern threshold of the lowland mountain range, southern zone of the lowland mountain range) as well as
- the foothills of the Alps and Bavarian Alps.

Climate: Germany is situated in a cool and temperate climatic zone characterised by frequent weather fluctuations. Altitude and the distance to the sea modify the prevailing climate. Winds from predominantly westerly directions and rainfall during all seasons are typical.

From the northwest to the east and southeast there is a gradual transition, influenced by topographical features, from an oceanic to a subcontinental climate; the amount of rainfall decreases and the variations in temperature between summer and winter as well as night and day increase. In the North German Lowland annual rainfall ranges between 500 and 700 millimetres, in the Central Uplands from 700 to more than 1,500 millimetres and in the Alps, up to and exceeding 2,000 millimetres. The annual mean temperature is approximately +9C. In the lowlands, average temperatures for January vary from -1.5C to +1.5C and in the mountains, depending on altitude, -6C and below. Mean temperatures in July are approximately 17C in the North German Lowland, in the Upper Rhine's rift valley up to +20C. In the mountains, temperatures continuously decrease with increasing sea level.

The vegetation period (mean daily temperature above 10°C) lasts for 150 to 180 days in the lowlands (in the Upper Rhine's rift valley even longer). It lasts for 120 to 160 days in mountainous regions (at higher altitudes the period can be considerably shorter).

Geology: The lowland mountain ranges predominantly date back to the Upper Palaeozoic Era, the Alps developed in the Tertiary period, and the North German Lowland as well as the foothills of the Alps were formed in to the Pleistocene.

Soils: There are many diverse soils in Germany. The soil types brown earth, podzol and leached brown earth are widespread. Additionally, in the North German Lowland there are black earth, marshland and moorland, in the mountains there are shallow soils such as ranker and rendzina. There are alluvial and gley soils by the riversides.

Potential natural vegetation: Germany's potential natural vegetation is classed with the temperate zone of the holarctic geobotanical region. Without human influence Germany would be almost completely covered by deciduous broad-leaved and mixed forests, only at high altitudes of some mountains and at special sites would natural coniferous forests grow.

Owing to the sites' conditions that vary from one small area to the next, a mosaic of different natural plant formations has developed in Germany. Mixed forests predominated by beeches represent the prevailing natural type of

vegetation in the plains to the lower mountainous ranges. Additionally, there are common and sessile oak and a number of other deciduous tree species. Furthermore, there are lowland and swamp forests, as well as pine forests on dry sites. In the higher mountainous regions there is a predominance of mixed mountain forest with beech, spruce and partly fir. Along the forest line grow spruce, larch and pine forests as well as dwarf pines. In the Upper Alps, arid zones, moorland, flood plains, and marshland there are natural vegetation types other than forests.

Compared to tropical forests the temperate forest does not have a rich variety of species, inter alia due to the climate-related predominance of tree species using wind pollination (which need higher population densities than species pollinating with insects). Compared with other temperate forests too, relatively few species live in the forest of Central Europe. This is due to the vast advance of ice into Central Europe (eccentric distribution of ice masses) and the extinction of many species and genera (Alps as a barrier to migration) during the Pleistocene. Moreover, the development of vegetation has been influenced by man, partly as early as during the remigration of the species after the last Ice Age.

Natural conditions of production: Due to the duration of the vegetation period of approximately 5 to 6 months, most of the agricultural and horticultural crops can be harvested once a year only. Exceptions are e.g. fodder crops that can be cut several times and fast-growing species of field vegetables. All kinds of land use and cultivation systems benefit from the lack of pronounced dry seasons. There are major differences regarding the quality of the soils. All in all, the natural conditions of production in Germany can be described as relatively favourable to agriculture and forestry.

1.2.2 Population and State

The Federal Republic of Germany has 81.2 m inhabitants (228 inhabitants per sq km in 1993) with a low growth rate due to immigration. The population density decreases from southwest to northeast. There are major differences between the rural regions on the one hand and the conurbations in the west and southwest on the other hand. Today, Germany has approximately 0.21 ha of farmland and 0.13 ha of forest per inhabitant. The number of people employed in agriculture, forestry and the fishery sector amounts to 1.25 m (3.6% of all people employed in 1993) and decreases annually by 3 to 5%. This sector contributes approximately 1% to the gross domestic product.

Germany is a democratic and parliamentary federal state encompassing 16 Laender (states, see Annex 2, Chart 1). Apart from the 13 large states (Baden-Württemberg, Bavaria, Brandenburg, Hesse, Mecklenburg-Western Pomerania, Lower Saxony, North Rhine-Westfalia, Rhineland-Palatinate, Saarland, Saxony, Saxony-Anhalt, Schleswig-Holstein, Thuringia) there are 3 city-states (Berlin, Bremen, Hamburg).

1.2.3 Land Use

Arable farming and animal husbandry and the related grazing management led to massive human interference in the natural vegetation. Due to this, more than two thirds of the forest area were lost since the Middle Ages. Furthermore, large forested areas were additionally integrated into agriculture by forest litter utilisation, intercropping as well as by use as woodland pastures (combined forms of land use) and were frequently subject to excessive exploitation. However, the herbaceous and grassy vegetation was able to open up new habitats and develop a greater variety. Owing to the introduction of sustainable forestry, the separation of forest and field as well as afforestation during the last 200 years, the forested area could once again be increased to approximately 30% and the productivity of the forest could be improved.

On the basis of the natural conditions (topography, local climate and soil conditions, deposits of water and raw materials etc.), human exploitation and their evolution throughout history, various man-made landscapes have emerged, almost completely replacing natural landscapes. This resulted in a loss of biodiversity in the forest ecosystems and an increase in diversity regarding agricultural ecosystems. Thus, typical grassland areas have developed (e.g. coastal area, foothills of the Alps, alpine pastures) as well as sparsely wooded regions with an intensive agriculture (e.g. fertile plains, glacial valleys), small-scale park landscapes (e.g. areas of an inferior soil quality, partly lowland mountain ranges) and areas with abundant forests (mountains, terminal moraine, former heaths). Approximately, half of Germany`s surface is used by the agricultural sector and one third is used by the forestry sector (see Annex 2, Table 1).

A major part of the crops that are important for today's nutrition was introduced by man (together with the accompanying co-adapted weeds). With the spread of agricultural management and coming from the Orient and extending to Central Europe, part of these species arrived as cultivated forms already during prehistoric times (barley, wheat, pea, lentil, flax, buckwheat, approximately 6000 years ago). Rye and oat presumably originated as field weeds and not until the Bronze Age did they acquire importance as crops

(approximately 3000 years ago). During antiquity the Romans brought along vines and some fruit crops (approximately 2000 years ago). In modern times, after the expeditions (as from 1492), further crops of current importance were introduced, particularly coming from America (tomato, potato, tobacco, maize, phaseolus bean, sunflower).

Interacting with the varying site conditions, several crops developed regionally adapted landraces which - together with foreign genetic material - have become the basis for an intensive plant breeding during the last 150 years. During the last few decades, due to the population's increasing tourism and travel activities, some neophytes migrated to Germany's wild flora. As to the forest area, due to the impact of forestry the percentage of coniferous tree species (spruce and pine) has increased to the detriment of the deciduous tree species (beech and oak, see Annex 2, Table 2). In some places non-domestic tree species from North America and East Asia have also been planted.

1.2.4 Farming Systems and Main Crops

a) Agriculture and Horticulture

In Germany, there are 17.2 m ha of agricultural area (Agricultural Area [AA], 48% of the total area). In 1993, approximately 68% of Germany's AA was used as arable land, 31% as permanent grassland, and 1% for permanent crops. During the last few decades, there has been a strong decrease in grassland.

Cereals are cultivated on more than 53% of the arable land. Wheat and barley cover the largest areas. Rye is predominantly cultivated for the production of bread grains. Oat and triticale are predominantly used as fodder. Field fodder crops (16%) and oil-plants (8%) are of major importance. Sugar beet (4%), potatoes (3%), hops and other commercial plants (3%), and vegetables, and other horticultural plants (1%) are cultivated on less extensive areas, but they are mostly of major economic importance for the farms.

The fallow land comprised 12% of the arable land. This trend is increasing, particularly as a result of the EC's set-aside programmes. This almost exclusively concerns rotational fallow, which - having been set aside for one to five years - can once again be used.

Germany produces approximately 36.7m tons of grain equivalents for vegetable foodstuffs and approximately 65.5 m tons of grain equivalents for animal foodstuffs (1992/93). The production value of agricultural products was approximately DM 64 billion, of which vegetable products amounted to

nearly DM 25 billion. The level of self-sufficiency regarding foodstuffs amounted to 89% (excluding imported animal foodstuffs). Many plants and/or their products are exclusively imported (rice, soybean, peanuts, cassava, sorghum, millet, citrus fruits, exotic fruits and vegetables, many spices and stimulants such as cocoa, tea, and coffee).

b) Forestry

In Germany, there are 10.7 m ha of forest (30% of the total area). The forested area is increasing - despite losses caused by settlements, industry and transport in the conurbations - and thanks to the afforestation of agricultural areas in rural regions and in regions that have abundant forests already.

More then 90% of the German forest is managed as age class high forest. Forest variable in age as well as coppice and composite forest cover a small area only. During the last few years the Laender laid down binding management rules for nearly the entire public forest, providing for an ecologically adapted forest management to equally maintain all forest functions.

In Germany, 30 million cubic metres of wood are harvested every year. Among the deciduous trees, the beech tree is the most important one, followed by oak (see Annex 2, Table 2). Spruce and pine clearly dominate the coniferous tree species. Germany imports predominantly semi-finished wood products (sawnwood, cellulose) and is not able to meet its demand with its own production.

1.2.5 Structure of the Holdings

In the area of the 11 "old" Laender, ownership rights to land are relatively constant. However, in the five new Laender, ownership rights and the structure of the holdings changed strongly after the restoration of German unity. Private property of land was restored as well as the power of disposal for property of agricultural and forested areas expropriated after 1949. Former state-owned agricultural and forested areas are predominantly leased on a long-term basis and are being reprivatised gradually under a long-term programme for the acquisition of land.

a) Agriculture

In 1993, Germany's agricultural area was managed by approximately 625,000 farms differing in size (see Annex 2, Table 3). The mean farm size varies strongly at the regional level, due to differences concerning the law of succession, topography and history. Thus, average farm sizes are between 13

and 18 ha in the Laender situated in the south and southwest, while they are between 20 and 40 ha in the northwest and between 190 and 360 ha in the east (new Laender). The number of holdings is decreasing by 2 to 3% annually. While the agricultural area remains almost constant in the former Germany, it has clearly been decreasing since 1990 in the new Laender.

The number of family farms amounts to the largest percentage among German holdings. 57% of the farms receive their main income from agriculture (full-time and supplementary income), 43% are part-time farms. In the new Laender a relatively high percentage of holdings are cooperatives or joint-stock companies. The re- established or newly founded holdings are especially supported during the transitional period, so that a productive, market-oriented and environmentally sound agriculture can develop. With a percentage of 53%, leased farmland has a major role to play in Germany's agriculture.

b) Forestry

Germany's forests are managed by approximately 447,000 enterprises. Approximately 40% are privately owned, 34% are state-owned (Federal Government and Laender), and 20% are owned by local authorities and other public corporations (see Annex 2, Tables 4 and 5). The Treuhandanstalt still needs to privatise 6% of Germany's forested area (however, in the new Laender only).

1.3 PLANT BREEDING AND SEED SUPPLY SYSTEMS

1.3.1 Breeding and Seed Supply in Agriculture and Horticulture

In Germany, plant breeding is predominantly organised by approximately 100 medium-sized enterprises. 70 operators have their own breeding programmes and 30 are distributors. They operate a total of approximately 3,450 ha of breeding gardens, 60,000 sq metres of greenhouse area of which 10,000 sq metres can be used for biotechnological studies. All in all, 2,300 permanent employees (300 of these are scientists) and additional seasonal workers work in these enterprises. Approximately 15% of the turnover in plant breeding is invested in research activities.

In addition to their own research and development activities and in the framework of the "Gemeinschaft zur Förderung der privaten deutschen Pflanzenzüchtung e.V." (GFP, association for the promotion of private German plant breeding) the enterprises participate in research projects subsidized by

public funds that are usually assigned to institutes either affiliated or not affiliated with the universities' field of research. The GFP contributes to the supply of a sufficient number of improved varieties (concerning the characteristics yield, resistance, and quality) for agriculture and horticulture as well as to securing the food supply.

Private plant breeding concentrates mainly on the few important crops (cereals, maize, rape, sugar beet, potato, fodder crops). Breeding activities relating to rare, usually economically less important species and the permanent and special crops are predominantly carried out by government-funded institutions or institutions that are part of universities. The same applies to the field of vegetable breeding, where only a small number of breeders has remained. Because of world-wide division of labour and international trade competition from abroad is stiff for the German medium-sized breeding enterprises.

The German supply with seed and plant material can be described as covering all areas and being very satisfactory for almost all crops. Today, most of the agricultural enterprises purchase seed and plant material - at least periodically. This results from the fact that, as regards agricultural enterprises, there is a lack of possibilities of processing seed, an insufficient or heterogeneous quality of their own harvest for sowing and the danger of diseases caused by re-use of farm-saved seeds. As regards vegetables, second generations are less frequently cultivated, because, on the one hand, in most cases the plants are harvested in the vegetative state and, on the other hand, very many vegetable varieties are hybrids a second generation of which would result in visible reductions in yield and homogeneity. Furthermore, plant breeders provide the agricultural and horticultural sectors with possibilities to benefit from genetic gain by supplying certified seed (high level of output, good resistance to diseases and animal pathogens, clear tolerances regarding stress), guaranteed and controlled quality (inner and outer form, identity of varieties) as well as increased efficiency. Nevertheless, during the last few years the importance of seed and plant material obtained from own harvests has increased in agriculture, particularly for those engaged in self-fertilisation (see Chapter 4.2).

The breeders themselves or German or foreign firms specialised in this field take the first steps to propagate one variety (pre-basic and basic seed). For most of the cultivars the last step of propagation (certified seed) is taken by practice-oriented holdings under the control of one of the authorities for seed certification organised by the various Laender.The seed and plant material is distributed in a decentralised way via agricultural trade and cooperatives.

1.3.2 Breeding and Seed Supply in Forestry

The genetic resources used in forestry are almost exclusively wild plants which are used by man to a limited extent only. Unlike the situation in agriculture, forest genetic resources are predominantly conserved in forest ecosystems for long term. Cleaning and thinning represent a wide-ranging instrument of selection with a view to a forest that can be used by man whose influence on the genetic structure of the stands has not been clarified yet. In the forestry sector, plant breeding is of a much more recent nature than in agriculture and is carried out almost exclusively by government institutions. Therefore, forest genetic resources - contrary to those in agriculture - have hardly been modified.

Using high-quality propagation material suitable for the respective site is particularly important in forestry, because this considerably determines productivity, stability, dynamism and quality of the stands during their entire life (50 to 300 years). Most of the propagation material for the artificial regeneration of the forests comes from stands. For some species material from seed plantations is increasingly being used (e.g. larch, pine, provenances from high altitudes), this applies to a lesser extent to material further processed by breeders (e.g. poplar). The importance of natural regeneration is growing. At present, approximately 40% of the area is naturally regenerated. In the framework of the increase in the percentage of deciduous trees that is currently commencing as well as the afforestation of agricultural areas, artificial stand establishment continues to play a major part for the time being.

In Germany, the forest owner is at the same time the proprietor of the forest propagation material produced in his forest. The same applies to owners of seed plantations. Regarding the forested area, government forests have most of and private forests have the fewest authorised seed crop stands and seed plantations. Corporation forests occupy a mid-position.

The forest owner or forest seed enterprises harvest the forest seed. In special cases (e.g. to conserve forest genetic resources) this is done by the forest research institutes. Approximately, 700 predominantly private forest seed and plant enterprises carry out the processing and storage of the forest seed, cultivation and seed trade. These enterprises are subject to a control by the forest authorities as regards the principal tree species.

Shrubs and rare tree species have not been bred for forestry or landscaping. Domestic provenances of many shrubs are not available in the seed trade and in nurseries. Furthermore, 80% to 90% of the seed of frequently used shrubs come from East and Southeast Europe as well as the Near East. They are predominantly used in landscaping where to date the provenance of the plant

material of the tree and shrub species used has hardly been taken into account. A market with domestic propagation material has been developing during the last few years. However, the supply with domestic seed does not come close to meeting the demand.

1.4 FRAMEWORK CONDITIONS IN AGRICULTURAL POLICY

Due to the European Communities' (EC) common market organisations that have been implemented since the Treaties of Rome (1957), the European agricultural policy - owing to nationally supported producer prices - resulted in a preference for European agricultural commodities to the detriment of third countries as well as in an intensification of agriculture in Germany, too. This entails the widespread use of high-yielding varieties and the respective necessary high input of energy, fertilisers and plant protection products.

Apart from reducing producer prices and quotas, the European Union's (EU) agricultural reform (since 1992) focuses on compensatory payments, inter alia on set-aside. A reduction of surpluses has been achieved particularly by reducing the cultivated area, but also by extensifying production.

Various measures accompanying the agricultural reform contribute to a diversification and extensification of agriculture. This includes, inter alia, promotion programmes for environmentally sound, extensive or traditional farming methods, the cultivation of regenerative raw materials andthe afforestation.

In the framework of their forest policy the Federal Government and the Laender promote in the private and cooperation forest the establishment of deciduous and mixed forests, measures to curb forest damage and to conserve forests. All in all, in German forestry ecologically adapted forest management concepts are increasingly prevailing - now being supported by the forest authorities. The Laender have the right to regulate and legislate in forestry matters.

1.5 TENDENCIES IN PLANT PRODUCTION AND FORESTRY

1.5.1 Tendencies in Agriculture and Horticulture

In agriculture the current structural change towards a decreasing number of full-time holdings and larger units will continue. The number of trainees in agriculture has been declining considerably during the last few years and many farms do not have a successor. In the new Laender there is a decrease in agricultural areas due to the transformation into traffic areas, enterprise zones and construction sites.

Because of the continuous intensification of competition, decreasing product prices and increasing prices for the means of production, savings in the latter field are gaining ground. On the one hand this results in a reduced and optimised application of plant protection products and fertilisers (extensification, integrated and ecological plant production), on the other hand in an increase in the collaborative use of machinery and joint storage capacities. Using certified seed and plant material has been on the decline for some time. Marginal sites (xerical grassland, moist grassland, steep slopes and high altitudes) are no longer cultivated, as they need a high input of labour. However, this is partially counteracted by the numerous landscaping programmes of the Laender .

In parallel with the above- mentioned tendencies the search for alternatives in cultivation and in marketing is being advanced. Supply contracts with firms of the processing sector are to be achieved in order to get quality-related prices for the agricultural products. This applies to raw materials for the food industry as well as to regenerative raw materials. The growing number of foundations of producer groups serves to make the risks equal for both parties of the contract.

Holdings engaged in direct marketing exclude intermediate trading and thereby the considerable price margin of the processing sector, thus usually being able to get higher prices for their products. In many cases, the farms engaged in direct marketing work according to the guidelines of one of the producer associations for organic farming. Currently, the area of the producer associations is still increasing every year. There is the danger that prices might decline too much due to an increasing supply that exceeds demand.

There are more and more discussions about the services agriculture provides by shaping and maintaining our man-made landscape. In some Laender national promotion of these services, under programmes focussing on man-made landscapes, has already started many years ago. Regional concepts of this kind

are supplemented by further programmes, financed jointly by the Federal Government and the Laender, in the framework of measures accompanying the EC's agricultural reform. Furthermore, it can be expected that respective programmes will be extended in future. At the same time associations for landscape conservation are developing on private initiatives, coordinating the implementation of regional measures and in doing so taking account of the interests of environmentalists, land users, and local politicians.

In Germany, framework conditions for horticulture vary widely. Contrary to the situation for most of the agricultural products there is an increasing demand for horticultural products but a decreasing domestic production. German consumers are more and more discriminating regarding the products they buy. They make special demands as to production as well as to the processing of agricultural products. High quality and freshness of the products play an increasingly important role in the decision whether to buy them or not. In parallel with that there is a trend towards environmentally-friendly cultivation and production methods.

1.5.2 Tendencies in Forestry

In forestry net returns have been decreasing for a long time, in some cases, they are showing deficits already. However, the forest's services for society and the environment keep gaining importance to the population. The same applies to demands on forest owners by society, particularly issues in the field of environmental protection. The forest damage caused by pollution, calamities of insects and the windthrows in 1990 also underpinned the importance of the forest's stability.

In Germany using ecologically adapted management methods is on the increase. This includes important aspects such as planting deciduous and mixed forests both from a suitable provenance and suited to their respective site, natural regeneration, selective use, prolonging circulation and regeneration periods, minimising clear cut areas and reducing the number of plants per area, also using pioneer species as auxiliary species. However, poor operating results force the forestry sector to further rationalise and mechanise (tree planters, harvester, skidding technology).

In the new Laender the setting up of a modern and efficient forest industry is making progress after the forest industry collapsed in the wake of German unity. Restitution or the sale of the German Democratic Republic's (GDR) former state-owned forest to public and private land owners will still take many years.

The structural change in agriculture results in an increase in afforestation of marginal sites and other areas no longer used for agricultural production. However, afforestation is facing stiff competition due to the promotion of other regenerative raw materials than timber.

In landscaping, too, using suitable and domestic tree and shrub species in the framework of environmental protection is getting ever more important.

CHAPTER 2
Indigenous Plant Genetic Resources

Indigenous plant genetic resources are those resources that are available for use in research, breeding, agriculture and forestry of the country. They normally fall into three categories:

1. Actual varieties that are presently grown (see Chapters 3 and 4)
2. Old cultivars and landraces of plant species that are or were grown (Chapter 2.1) and
3. Wild relatives and wild plants that are of potential use (Chapter 2.2).

2.1 OLD CULTIVARS AND LANDRACES

This chapter deals with the importance of old cultivars and landraces in the production of the different crops. The definition of the terms " old cultivar" and "landrace" depends on the status of each species concerned under the Seed Trade Act and the Plant Variety Protection Act (see Chapter 5.2). Old cultivars and landraces that are conserved *ex situ* in genebanks and botanical gardens are dealt with in Chapter 3.2.

Old cultivars have been subject to breeding efforts and are traded under a variety denomination. After the period of protection laid down in the Plant Variety Protection Act has expired these varieties are listed with the Federal Office of Plant Varieties as old cultivars. Varieties that require registration by the Federal Office of Plant Varieties in accordance with the List of Species annexed to the Seed Trade Act must no longer be traded after this period has expired. So commercial production of these species is restricted to registered varieties. For plant species which are not included in the List of Species of the Seed Trade Act and which are, as a rule, traded without variety protection, it is not possible to distinguish between old and actual cultivars.

In contrast, the term "Landrace" is used for varieties that are grown locally and which the farmer, over a long period of time, has selected and adjusted to the special requirements and environmental conditions of the site.

a) Agricultural crops

The marketing of seed and planting stock is subject to the provisions of the Seed Trade Act. Thus old cultivars were grown under certain conditions only; they were displaced by the registered high-yielding varieties traded commercially. As this almost exclusively concerns annual species, this displacement has had a major impact.

A number of farmers who manage their farms in accordance with ecological guidelines today pursue a persistent policy of re-use of farm-saved seeds to be able to maintain varieties meeting local conditions. The basic material consists, in the majority of cases, of varieties that the organisations of biological farming consider to be suitable. The main criteria is long-term security of yields based on adjustment to local conditions and on the existence of wide-range resistances plus low requirements in terms of fertilizers and pesticides.

b) Pasture plants

Marketing of seeds and plants of pasture plants that have been subject to breeding efforts is prohibited after the registration under the Seed Trade Act has expired. Old cultivars are of minor importance in farming as far as marketing is concerned; they may no longer be traded after the registration period has expired.

There is no definition of the term "landrace" in the case of permanent pasture plants as these are wild plants used by man. Selection takes place only indirectly as environmental and management conditions are changing. Populations that have adjusted to such conditions are called ecotypes. In Germany, only some of these ecotypes of pasture plant species have been lost through the ploughing-up of grassland or reseeding. So they are an important basis for plant breeding activities (as it is the case with landraces in arable farming).

c) Vegetable plants

All commercially important vegetable varieties are covered by the Seed Trade Act. A large amount of vegetable seeds is imported. Over the last few years new species and varieties of vegetables (like broccoli, various types of lettuce, zucchini) have been introduced successfully so the range of vegetables grown commercially has increased.

It is in very rare cases only that old cultivars are grown commercially. Landraces are grown in exceptional cases only. But still the genetic basis of commercially grown varieties must be considered to be substantially broader than that of agricultural crops as there is much more variation in the use and

the requirements as far as specific characteristics are concerned (differentation of products within marketing).

Also in the non-commercial production in kitchen gardens and allotments periodical buying of seeds and planting stock has more or less displaced the seed production on the spot. But for non-commercial vegetable production it is mainly old cultivars that are traded. After the normal variety protection periods under the Plant Variety Protection Act have ended a re-registration of the variety has to be applied for. Then commerical multipliers may maintain and propagate these varieties further on. This is why breeding progress has always, with a certain delay, also an impact on the non-commercial seed market.

One can assume that in the last few decades a large potential of genetic diversity has been lost in the vegetable sector. The crop genebanks have been trying successfully through appeals, to get old cultivars, landraces and even old vegetable species from hobby gardeners and thus save them from disappearing.

A number of commercial and non-commercial private groups run breeding programmes on old cultivars of vegetables to adjust them to local requirements and make them suitable for more extensive growing methods. In addition, old vegetable species that are no longer grown (like allgood (Chenopodium bonus-henricus), asparagus pea (Tetragonolobus purpureus) and salsify (Tragopogon porrifolius ssp. australis) are cultivated again.

d) Fruit plants

Marketing of seeds and plants of fruit species is subject to the provisions of the Seed Trade Act. A breeder only applies for variety protection under the Plant Variety Protection Act if he considers the variety to be of major market value. This is why the distinction between old cultivars and landraces in fruit-growing is difficult. But still the fruit from old cultivars and landraces have more or less disappeared from trade because of displacement processes.

Fruit plant varieties (old cultivars and landraces) that are typical of certain regions can still be found in Germany in old orchards, avenues, gardens, allotments, and several collections. Old meadows with scattered fruit trees are, however, increasingly abandoned and are frequently left to succession. Since fruit plants are mostly propagated vegetatively, one must assume that there is a relatively high homogeneity within varieties. But there should be great diversity between varieties. For non-commercial fruit growing and landscape gardening the demand for old cultivars and landraces has been increasing.

For short-lived fruit varieties the chance of finding old cultivars or landraces is relatively small. Raspberry and strawberry varieties often are of relatively high importance in the market and are thus subject to variety protection. In this case, however, it is very difficult to obtain them on the spot. There is no knowledge of surveys on the level on which the re-use of farm-saved seeds of old cultivars or landraces is carried out in practice.

e) Other permanent crops, special crops

In contrast to hops, medicinal plants, spices, and dye marketing of seeds and plants of vine, tobacco and asparagus are subject to the Seed Trade Act.

Many old varieties and landraces of vine have been improved by clonal selection. Others are no longer planted and were replaced by new varieties. Old cultivars are now and then to be found in old vineyards and on trellises of houses. But in the course of land consolidation activities the majority of them were eradicated. Few traditional varieties like 'White Riesling', 'Blue Silvaner', 'Blue Pinot Noir' continue to be of major importance in vinegrowing (55% of the grape-yielding area). If a variety continues to be commercially important its registration under the Seed Trade Act is extended by the Federal Office of Plant Varieties. The grape genebank started several calls for old cultivars and landraces.

In addition to new varieties bred old cultivars of hops continue to be of importance for hop growers. There might be landraces among them which because of decades of selection have been bred from wild species and later were protected as a variety. As hops is multiplied vegetatively by means of cloning diversity within the old cultivars and landraces must be considered to be relatively minor. Differences between various landraces are, however, relatively great. As only female plants are grown and the unfertilized flower is harvested, planting stocks are well separated, genetically, from wild hops. Since about 1925 there has been systematic crossbreeding in Germany. The basic material for that is, in addition to wild plants and varieties from abroad, both old cultivars and landraces .

Old cultivars and landraces of tobacco are no longer grown. Their decline was accelerated because of the requirements of the processing industry and the reduction of the acreage under tobacco in Germany.

Most probably no old cultivars and landraces of asparagus are grown.

In the case of medicinal plants and spices landraces, provenances and, more recently also non- protected and protected bred varieties have been introduced

into production. There are still few varieties of a small number of species that are protected at the Federal Office of Plant Varieties.
The cultivation of dye plants had a long tradition in certain regions (like wood in Thuringia). Because of the use of exotic dye plants (like indigo) and the manufacturing of synthetic dye the growing of dye plants was given up. In recent years dye plants (old cultivars and landraces) have started to be grown again, but only in small amounts.

f) Ornamental plants

Marketing of seeds and plants of ornamentals is not covered by the Seed Trade Act. In addition, the majority of ornamentals varieties and lines (many are obtained from a single plant by cloning) are traded without variety protection and often are on the market for a relatively short time. Variety protection under the Plant Protection Variety Act is, as a rule, applied for only for commercially very important plant varieties that are long-lived and traded for a long period of time (like ornamental shrubs, roses and hardy perennials). This is why the distinction between old cultivars and landraces of ornamentals is difficult. Old cultivars of these species are likely to be still traded and may be found in botanical gardens, parks and private gardens. There are, however, no known statistics on that.

g) Forest plants

Old cultivars of forest plants still exist for poplar and willow only. The term "landrace" has not been defined, like in the case of pasture plants as they are wild plants used by man in a limited way.

2.2 WILD RELATIVES AND WILD PLANTS

It should also be pointed out that in this paper it is only possible to refer to useful wild plants and wild relatives on the level of genera, even if crossing is made possible by technical progress. May be that in some cases not all species of one genus are crossable. The following enumeration is not complete, only examples are listed. For further details on the various species see Annexes 2 and 4.

Populations of wild relatives in Germany are included in the maps produced by the Federal Agency for Nature Conservation. Detailed mapping is finished only for some regions and few species.

a) Agricultural crops

The center of origin and diversity of the most important agricultural crops grown in Germany are in other climatic regions (Latin America, Middle and Far East, Mediterranean region).

- In the case of sugar and fodder beet (*Beta vulgaris*) there is a single stable wild beet population (*Beta vulgaris ssp. maritima*) on Helgoland Island. In addition, gold of pleasure (*Camelina sativa*) occurs in the wild.
- Oats (*Avena sativa*), rape (*Brassica napus*), black mustard (*Brassica nigra*), barley (*Hordeum vulgare*), flax (*Linum usitatissimum*), white mustard (*Sinapis alba*), potato (*Solanum tuberosum*), field bean (*Vicia faba*) and common vetch (*Vicia sativa*) have wild relatives within the same genera.
- For example bird rape (*Brassica rapa*), hemp (*Cannabis sativa*), sunflower (*Helianthus annuus*), Jerusalem artichoke (*Helianthus tuberosus*), white, yellow and perennial lupin (*Lupinus albus, L. luteus* and *L. polyphyllus*) and a vetch species (*Vicia villosa*) have become part of the indigenous flora, in some cases as wild populations of former cultivated plants.
- There are no wild relatives of buckwheat (*Fagopyrum esculentum*), phacelia (*Phazelia tanacetifolia*), pea (*Pisum sativum*), rye (*Secale cereale*), wheat (*Triticum aestivum*) and maize (*Zea mays*).

b) Pasture plants

All bred pasture plants can be found as autochthonous species in Germany, as a rule on old pastures.

- Indigenous bred pasture species in Germany are bent-grass (*Agrostis spp.*), meadow foxtail (*Alopecurus pratensis*), oat-grass (*Arrhenatherum elatius*), cock's-foot (*Dactylis glomerata*), tall reed, sheep, meadow and red fescue (*Festuca arundinacea, F. ovina, F. pratensis* and *F. rubra*), perennial ryegrass (*Lolium perenne*), thimothy (*Phleum pratense*), common meadow grass (*Poa pratensis*), yellow oat-grass (*Trisetum flavescens*) and also the leguminosae bird's-foot trefoil (*Lotus corniculatus*), black medic (*Medicago lupulina*), hybrid, red and white clover (*Trifolium hybridum, T. pratense* and *T. repens*).
- Lucerne (*Medicago sativa*), Egyptian clover, crimson and Persian clover (*Trifolium alexandrinum, T. incarnatum* and *T. resupinatum*) have wild relatives within the same genera.
- Italian ryegrass (*Lolium multiflorum*) and two species of lucerne (*Medicago arabica* and *M. x varia*) have become part of the indigenous flora and are found as wild populations of former cultivated plants.

c) Vegetable plants

The center of origin and diversity of the most important agricultural crops grown in Germany are in other climatic regions (South Ameria, Far East, Mediterranean region).

- Vegetable species like calariac (*Apium graveolens*), cabbage (*Brassica oleracea*), chichory (*Cichorium intybus*), carrot (*Daucus carota*), parsnip (*Pastinaca sativa*) and corn salad (*Valerianella ssp.*) are indigenous in Germany.
- Wild relatives within the same genera are known for onion (*Allium cepa*), leek (*Allium porrum*), endive (*Cichorium endivia*), lettuce (*Lactuca sativa*), garden cress (*Lepidium sativum*), radish (*Raphanus sativus*), and tomato (*Solanum lycopersicum*).
- Pursulane (*Portulaca oleracea*) and scorzonera (*Scorzonera hispanica*) have become part of the indigenous flora and are found as wild populations of former cultivated plants.
- Paprika (*Capsicum annuum*), cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*), fennel (*Foeniculum vulgare*), lentil (*Lens culinaris*), parsley (*Petroselinum crispum*), garden and kidney bean (*Phaseolus vulgaris* and *Ph. coccineus*), pea (*Pisum sativum*), and spinach (*Spinacea oleracea*) have no wild relatives in Germany's flora with wild species.

d) Fruit plants

Many fruit species are indigenous in Germany, but most of the cultivated species came from West Asia.

- Many wild forms of fruit species belong to the forest plants like the wild forms of apple (*Malus domestica*), pear (*Pyrus communis*), sweet cherry (*Prunus avium*), gooseberry and currant bush (*Ribes spp.*). In addition, wild forms of raspberry and blackberry (*Rubus spp.*) are indigenous in Germany.
- Beside of these species there are some indigenous wild fruit species that are rarely grown but harvested in the wild like hazelnut (*Corylus avellana*), sea buckhorn (*Hippophae rhamnoides*), common juniper (*Juniperus communis*), European dwarf cherry, rock cherry and bird cherry and sloe (*Prunus fruticosa, P. mahaleb, P. padus* and *P. spinosa*), and elder (*Sambucus nigra* and *S. racemosa*), as well as some semi-shrubs like blueberry and cranberry (*Vaccinium myrtillus* and *V. vitis-idaea*).
- Some other Prunus species (sour cherry, Syrian plum, plum) and strawberry (*Fragaria*) do have wild relatives in Germany.

- European chestnut (*Castanea sativa*), strawberry (*Fragaria x anassassa*), walnut (*Juglans regia*), cultivated plum (*Prunus domestica*), and cultivated pear (*Pyrus communis*) have become part of the indigenous flora and are found as wild populations of former cultivated plants.
- Some woody fruit species originate in Asia like apricot (*Armeniaca vulgaris*), quince (*Cydonia oblonga*), and peach (*Persica vulgaris*) do not have wild relatives in Germany.

e) Other permanent crops, special crops

Wine-growing was introduced to Germany by the Romans. Wild vines (*vitis vinifera ssp. sylvestris*) are indigenous only very locally in the riberanian parts of the upper reaches of the Rhine. In addition, wild populations of former cultivars (*V. vinifera*) and American vines (*V. riparia, V. rupestris*) occur as neophytes.

Wild hop (*Humulus lupulus*) is wide-spread in the wild, especially in riparian areas and at forest edges. The areas where hop is grown commercially, however, are, as far a possible, kept free of wild hop, to avoid the fertilization of pistillate flowers and thus the reduction in the quality of the crop.

Asparagus (*Asparagus officinalis*) can be found as a wild species in Germany, too.

Tobacco was introduced to Europe about 500 years ago from South America. The Nicotiana generus does not occur in the German wild flora.

Some of the medicinal, spice and aromatical plants used in Germany also are to be found in the wild. Of major importance are plants of the Compositae , the Labiatae and the Umbellferae family. Many spices have been traded traditionally and were of importance before colonial times already, like ginger, cloves, pepper, saffron, liquorice, and vanilla.

Many of the dye plants formerly grown or used occur in the German wild flora like wood (*Isatis tinctoria*). Few dye species have wild relatives, some were intoduced but did occur as neophytes (see list in Annex 3).

f) Ornamental plants

In more than 750 genera of the German wild flora one can find species which are used as ornamentals or represent wild relatives of non-indigenous ornamental plant varieties. This includes cut flowers, potted plants, bedders and window box plants, winter-hardy garden shrubs, ornamental shrubs, trees

for parks and alleys (see Annex 4). The wild relatives and cultivars of ornamental shrubs are considered to be forestry plants.

g) Forestry plants

In Germany, there are 196 indigenous woody species (excluding *Rubus* species). They were categorized into 59 tree species, 97 shrub species and 58 semi-shrub species as well as 7 climber species and 2 epyphytes. The vast majority of them are forest trees and shrubs which must be considered to be archeophytic wild species if they were not used for breeding.

- Indigenous forest species are silver fir (*Abies alba*), maple (*Acer spp.*), alder (*Alnus spp.*), birch (*Betula spp.*), hornbeam (*Carpinus betulus*), European beech (*Fagus sylvatica*), common ash (*Fraxinus excelsior*), European larch (*Larix decidua*), Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), poplar (*Populus spp.*), sessile and common oak (*Quercus petraea* and *Q. robur*), willow (*Salix spp.*), linden (*Tilia spp.*), elm (*Ulmus spp.*), the shrub species barberry (*Berberis spp.*), dogwood (*Cornus spp.*), hawthorn (*Crataegus spp.*), black dogwood (*Frangula alnus*) and snowball (*Viburnum spp.*) as well as the above-mentioned wild special and wild relatives of woody fruit and ornamental species (see Chapter 2.2 d, f).
- Important forest tree species of foreign origin are grand fir (*Abies grandis*), horse chestnut (*Aesculus hippocastanum*), Japanese larch (*Larix kaempferi*), some species of poplar (*Populus spp.*), Douglas fir (*Pseudotsuga menziesii*), northern red oak (*Quercus rubra*) and English tree (*Robinia pseudoacacia*).

Forest management measures, of course, include the selection of trees in accordance with forestry aspects but fertilization is not subject to specific criteria. Forest tree species show high and mostly natural diversity. The different species and provenances on more than 10 m ha of land represent a major genetic resource for forestry, fruit growing, horticulture and landscape gardening. The genetic resources of shrubs are tapped to a considerably lower degree.

h) Wild plants of potential use

The wild flora of Germany comprises an estimated 3,203 of ferns and flowers as well as 4,385 of Eumycota species. Out of these about 100 species have become extinct or are missing. About 30 per cent of ferns and flowers in Germany as well as 25 per cent of Eumycota are considered to be endangered. Annex 3 lists more than 900 wild plant species which are not used at present or for which a future use is expected. So the German names of many wild herbs indicate their historical use as medicinal plants (mostly collected from the wild): for example eyebright, loverwort, lungwort, comfrey, bloodroot etc. In total, more than 170 wild plant genera include species of known medicinal effect. Wild woody species of potential use are mainly treated together with the forest plants (Chapter 2.2 g).

CHAPTER 3
Conservation of Plant Genetic Resources

The national activities of Germany relating to the conservation of plant genetic resources are mostly carried out by public institutions or sponsored by the government. The private sector mainly performs activities relating to the *in situ* conservation of forest plants, wild species and old cultivars of crops and ornamentals.

The national activities for the conservation of the inter- and intra-specific diversity of agricultural and horticultural crops as well as of forest plants and wild species can be classified into two main groups with five sub-groups:

IN SITU	*in situ* conservation within natural habitats (Chap. 3.1.1)
	(wild species, forest plants, pasture plants, wild relatives of crops)
	in situ conservation on-farm (Chap. 3.1.2)
	(old cultivars and landraces of crops)
EX SITU	*ex situ* conservation in genebanks (Chap. 3.2.1) as well as in special and working collections (Chap. 3.2.2) as seed, pollen, tissue, field collections, seed orchards and clonal archives (crops and their wild relatives, forest plants, wild species)
	ex situ conservation in stands (Chap. 3.2.2) and botanical gardens or arboreta (Chap. 3.2.3) (ornamentals, forest plants, wild species)

3.1 *IN SITU* CONSERVATION MEASURES

The *in situ* conservation within natural habitats is a traditional priority area of nature conservation concepts. Nature should be protected against destructive interference by man. Only wild flora is affected (wild relatives of crops, pasture plants, forest plants, wild species). The conservation of cultivated forms (actual

varieties, old cultivars and landraces) in the production process is subsumed to *in situ* conservation ON-FARM (Chap. 3.1.2).

In situ conservation means that the species in efficient ecosystems are exposed to dynamic processes of evolution. Natural selection and the need for adaptation to changes in environmental impacts are thus ensured. The concept of integrating nature conservation and landscape management into agriculture and forestry has developed with the increasing awareness of the close links between former and current land uses and existing or endangered species diversity. Especially extensively used grassland areas and natural forests provide essential sites for a number of endangered plants. *In situ* conservation within natural habitats, however, is often possible only in connection with a use. The subdivision of the *in situ* conservation of plant genetic resources is therefore not quite clear.

3.1.1 *In situ* conservation within natural habitats

The activities relating to nature and landscape protection as well as to forestry are the most important measures for the *in situ* conservation within natural habitats. Nature and landscape protection developed, because men became aware of the ecological, socio-cultural and economic values of the natural resources, and the threat to species, biotopes and ecosystems became evident. The activities comprise on the one hand measures relating to species protection and on the other hand to area-related biotope protection. Genetic resources have not been included very often in activities for nature protection until now.

a, c) Agricultural crops and vegetable plants

There are no specific activities for the *in situ* conservation of the few wild species and wild relatives of agricultural crops and vegetable plants represented in the German wild flora. The resources of such plant species are normally covered by the measures of protection, tending and development in the designated protected areas (see also Chap. 3.1.1 h).

b) Pasture plants

There are still autochthonous grassland areas in Germany. These are naturally unforested areas (see Chap. 1.2.1) on the one hand, grassland areas resulting from management (forest pasture, clearing and pasture) on the other (see Chap. 1.2.3). Both categories are endangered by changes in use (conversion into arable land, afforestation, abandonment/succession), intensification (drainage, fertilization, high stocking density) or strains on the environment (immission, eutrophication). This results in a loss of habitats of adapted species and ecotypes. The designation of protected areas and other planning measures

(e.g. bans on afforestation for meadows in well-wooded areas) protects permanent grassland affected by it from further conversion and intensification.

In the 80s socalled landscape management associations developed in various parts of Germany. These are voluntary groupings of conservationists, land users and communes. In 1993, the landscape management associations joined up to form a federal association. The associations are mainly dealing with regional matters. Grassland management as relatively cost-advantageous landscape management and useful for nature conservation plays an important role in the associations' objectives. Grassland farming (especially in high and low mountain ranges as well as on moist meadows) is being promoted directly or indirectly by means of biotope management plans, contract nature protection and other programmes. These measures help maintain a wide range of habitats of adapted species and ecotypes.

Within the framework of Council Regulation (EEC) No 2078/92 (for details see Chapter 5.1.2) all non-city-state Laender have drawn up socalled cultivated landscape programmes. In the grassland sector, for example, the conservation of wet grassland, dry grassland and juniper heathland areas are promoted as part of a varied cultivated landscape.

Activities in connection with groundwater protection have an indirect effect on the species variety on grassland. Following the purchase of land, designation of protected areas or contracts between water supply companies and farmers extensive management methods are designed to avoid the discharge of chemical plant protection products and nitrate from organic and mineral fertilizers into the groundwater. Especially old types of extensive grassland farming (two-cut meadows, extensive hay pastures) maintain the habitats of plant species adapted to it.

Besides the conservation of species variety on grassland the conservation of intraspecific variety of important fodder crops is also considered to be important. Pilot measures for the *in situ* conservation of some populations of perennial rye grass (*Lolium perenne*) are under preparation. The interaction between the genetic composition of autochthonous populations and the environmental and management impacts involved must be known for the efficient conservation of intraspecific variety of fodder crops under human management. The conservation measures should therefore be accompanied by investigations of the distribution of genetic diversity in terms of time and space.

d, e) Fruit crops, other permanent crops, special crops

Specific programmes for the *in situ* conservation of indigenous wild fruit species are implemented by the Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" (see also Chap. 3.1.1 g). The conservation of wild vines in the Palatine riverain forest on the Upper Rhine is supported by the Research Center for Agriculture, Grape and Horticulture (in Neustadt/Weinstraße). As regards the wild relatives of non-woody plants from fruit, permanent and special crops the same applies as what has been said with regard to vegetable and agricultural crops (see also Chap. 3.1.1 a, c).

f) Ornamentals

Some wild species used as ornamentals are subject in their natural habitats to measures of nature and landscape conservation as well. Some endangered species (e.g. orchids, daffodils, cyclamen, primeroses) are subject to specific species protection.

g) Forest plants

In forestry the use of site-adapted and adaptable propagation material of tree and shrub species is of high importance for the conservation of the efficiency, stability and dynamics of forest ecosystems. Therefore, besides the provenance, a wide genetic basis within stands and seed orchards is important. Because of the complexity and longevity of forest ecosystems the conservation of plant genetic resources in forestry must be carried out at least as far as *in situ* conservation measures are concerned in the form of conservation of efficient forest biocoenosis. Apart from the life and ecological cycles necessary for economic use it should also be possible that co-evolutive processes take place. The activities for *in situ* conservation of forest genetic resources were greatly extended in the last 10 years.

Exploration of provenances and populations: The natural distribution of the major forest tree species after the Ice Age is known, inter alia, from pollen analyses. Studies of the physiological and ecological characteristics of tree species are available. Many forest tree species were intensively studied in the last 100 years with regard to their phenotypic variation. Studies concerning the delimitation of provenances and their genetic diversity were intensified in the last few years for example with the aid of isoenzyme analyses. Detailed results are now available for fir and spruce provenances; studies are going on for other species. The study results provide the basis for decision-making aids in delineating provenance areas in forest seed legislation and in assessing the type and extent of necessary conservation measures. The exploration of provenances of shrub species is still at the beginning. Initial results have come out in the last few years. It is still necessary to conduct further comprehensive studies of

diversity for tree and shrub species as a prerequisite for sound decisions on the necessary extent of conversion measures.

Sustainable forestry: The conservation of forest genetic resources through substainable use is the subject of Chapter 4.1.2. Ecological forestry, natural regeneration designation of seed stands play an important role in this respect.

Protected areas in the forest: The forest is the dominant type of vegetation in protected areas under nature conservation law (see also Chap. 3.1.1 h). In addition, there are protected areas under forest law and other protected areas, where forests are of importance. Table 7 in Annex 2 provides information about the number and area of the different categories of protection in Germany according to decreasing intensity of protection. It is not possible to add up the areas, because areas are partly overlapping. As a whole, about half of the forest area is subject at least to one of these categories of protection.

In many cases the measures taken in protected areas support the conservation of forest genetic resources. In isolated cases the objectives of protected areas can be an obstacle to gene conservation; for instance, if less competitive species or isolated populations would disappear without human assistance, autochthonous populations are eroded by foreign provenances already introduced or if no material may be removed for specific, effective conservation measures.

Specific activities for the *in situ* conservation of forest genetic resources: The Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" established in 1985 (see Chap. 5.1) had developed by 1987 a "Concept for the Conservation of Forest Genetic Resources" and a "Four-Year Programme" for its implementation. The work is focussed on *in situ* conservation. The following possibilities exist: conservation as a stand (group of trees, single trees), natural regeneration or *in situ* plantation.

Conservation stands are designed to adequately cover the existing ecological conditions under which the respective species occurs. The natural regeneration of old stands serves to maintain the natural selection and adaptation to the site. *in situ* plantation must replace natural regeneration if the latter is unsuccessful or has fail patches. The protection of groups of trees and single trees, also through freeing stands of oppressor trees, supplements the conservation stands for rare tree species and provenances (see Annex 2, Table 8).

The conservation of vitality and diversity of stands and, if necessary, the promotion of their natural regeneration are at the same time building blocks of preserving forest genetic diversity and sustainable use. The management of *in*

situ conservation stands and single trees is ensured by the forest district offices. Immissions and their implications as well as periodically occuring natural disasters are, however, a danger to the genetic diversity of conservation stands, too.

h) Wild plants of potential use

Parts of the territory of Germany are protected with legally binding effect as protected areas under the nature conservation laws of the Federal and Laender governments. In addition, biosphere reserves were designated within the framework of the UNESCO Man und Biosphere Programme (MAB) and wetlands of international importance under the Ramsar Convention. To be added to this protected areas under forest law (see also Chap. 3.2.1 g) which also play a role in protecting wild plants (see also Chap. 5.2). The areas of the individual types of protected areas are partly overlapping substantially. The reasons for it are to be found in the individual purposes of protection.

The area covered by protected areas is presently increasing. In addition, the networking of small-scale protected zones is increasing within the framework of integrated concepts of protection. This development takes account of the recognition that in the long run species protection can only be realized in the form of biotope protection. The conservation of the diversity between and within species is only possible by taking account of the dynamic processes in the ecosystems.

The observance of legal provisions, the implementation of protective and tending measures, monitoring and management of protected areas are tasks which are mainly ensured by the nature conservation authorities, universities, nature conservation associations and many honorary helpers.

Table 7 in Annex 2 provides information about the number and area of the various categories of protection in Germany. National parks, biosphere reserves and nature parks are large-scale protected areas which may be subdivided into zones of different intensity of protection.

The protective measures mentioned also serve to preserve the wild relatives of crops. A survey conducted in 1982 for the territory of the former GDR showed that wild relatives of fodder crops and pasture plants, medicinal plants and spices as well as fruit trees occur in protected areas. Similar investigations do not exist for the old Laender.

To conserve the agro-ecosystemic diversity of wild plants which is composed of many weeds co-adapted to crops promotion programmes were developed such as the field strips programme which gives financial assistance to abstaining

from using any herbicides on strips of land of a width of some meters alongside field edges to replenish seed stocks of weeds in the soil and to preserve these species. According to scientific research rare and endangered wild species of agro-ecosystems would occur much more regularly and could be conserved if there were organic management everywhere.

3.1.2 *In situ* conservation on-farm

ON-FARM conservation is ensured by cultivating and using the species concerned (e.g. formerly cultivated species) and varieties (also land races, old cultivars) on farms or outdoor museums of agricultural history, which distinguishes this measure from *ex situ* conservation, for example in genebanks. ON-FARM conservation is in contrast to the conservation in genebanks a dynamic conservation in the sense of continued evolutionary processes.

a) Agricultural crops

The conservation of current varieties authorized under the Seed Act which are usually not endangered takes place through their commercial production on farms. The inclusion of large reservations like the biosphere reservations into the on-farm conservation of agricultural and horticultural varieties has been under consideration for quite some time. A pilot project is currently being prepared by the Agency for Large Protected Areas(in Eberswalde/ Brandenburg). Within this project old varieties and landraces of wheat, rye, and potato are being conserved and propagated in the biosphere reservations 'Schorfheide/Chorin', 'Elbtalauen', and 'Spreewald'. For the most part, the seed and planting stock originates from the stocks of the genebank at Gatersleben. Cultivation and propagation of varieties by local farmers is assisted by the Land Agency for Large Protected Areas, and also includes the evaluation of the plants in the field.

In addition, in the new Laender cooperations exist between Museums of Agricultural History and the genebank. Landraces and crop-weed-complexes (e.g. cultivated oats - wild oats) were propagated in large museums in order to expose these to further evolution processes.

Under Council Regulation (EEC) No. 2078/92 specific promotion is granted for the cultivation of old cultivars and varieties of crops to be threatened with extinction. The Draft Programme on the Promotion of Pilot and Demonstration Projects in the Field of Alternative Production and Uses for Agriculture and Forestry of the Land of Thuringia aims, inter alia, to maintain or re-introduce historical land use types and to conserve the crops threatened

by genetic erosion. The programme also covers regionally developed landraces of crops. Concrete projects are, however, not yet known.

In the sector of NGO's, in particular, work is being done on the ON-FARM conservation of cereals in cooperation with ecologically managed enterprises belonging to recognized cultivation associations. Here, a relatively new approach is the development of dynamic populations of winter wheat and barley for food purposes on the basis of old cultivars as well as new varieties in order to further develop these into adapted "farm varieties" through re-use of farm-saved seed under the local environmental and production conditions of enterprises.

b) Pasture plants

Current grassland varieties are used on farms to increase the efficiency of grassland swards by new seeding and reseeding. It is not yet known, whether and to what extent these genotypes will survive in the long run in the grass swards and will thus be maintained *in situ* / ON-FARM.

c) Vegetable plants

Commercial cultivation ensures the conservation of current vegetable varieties. ON-FARM conservation of old vegetable cultivars takes place in home gardens and allotments. Trade also offers old cultivars, which are no longer protected and traditional varieties, which are permitted by the Federal Varieties Office without variety protection. They are propagated and marketed by specialist enterprises. Old vegetable cultivars are not included in the above initiative started by the Agency for Large Protected Areas (see Chap. 3.1.2 a) mentioned above. Some nurseries take part in the conservation, charakterization and propagation of species and cultivars of vegetables. The propagation and regeneration especially of cross-fertilizing vegetable species take place in individual cases also in Museums of Agricultural History.

d-e-f) Fruit crops, other permanent crops, special crops, ornamentals

Commercial cultivation ensures the conservation of current varieties and old cultivars. Until now in some traditional fruit-growing areas old cultivars were conserved by utilization in fruit-wineries and distilleries. ON-FARM conservation of fruit trees covers their maintenance (release cutting, pruning, replanting). Orchard programmes are an often practiced method of implementing Council Regulation (EEC) No. 2078/92. Some Laender have drawn up such programmes of promotion for the conservation of old orchards. Existing fruit varieties are, however, rarely recorded and documented. Rhineland-Palatinate has started to take an inventory of the old cultivars and

regional varieties still existing there with the aim of preserving them in the existing orchard systems.

Old varieties of fruit species and their use are also integrated into the above mentioned projects of the Agency for Large Protected Areas (see Chap. 3.1.2 a). Similar measures were also taken in some Museums of Agricultural History for various fruit species. Regionally typical varieties of fruit trees are gaining increasing importance for landscape management measures so that relevant material is offered again by nurseries.

The Federal Ministry of Food, Agriculture and Forestry (BML) is promoting a pilot project on the "Conservation and multivalent use of fruit genetic resources within natural habitats under the aspect of fruit growing, landscape management and landscape ecology" designed to record, evaluate and conserve in the long run the old fruit trees occuring in Greater Berlin and Frankfurt/ Oder and being unique in Europe (presumably over 1,000 varieties). The conservation measures are reconciled with the requirements of nature and landscape protection.

The conservation of old cultivars of permanent crops (e.g. rhubarb), special crops (e.g. medicinal plants and spices) and ornamentals is ensured in some cases by Museums of Agricultural History and socalled farmers' gardens.

3.2 *EX SITU* CONSERVATION MEASURES

The two major agricultural genebanks, the forest genebanks and the vine genebank, are the most comprehensive collections (Chap. 3.2.1). Plant genetic resources are also conserved in various specific and working collections, forest *ex situ* stands (Chap. 3.2.2) and in botanical gardens and arboreta (Chap. 3.2.3). The organization of *ex situ* collections is being reviewed in Germany and proposals for a new organization have been made (see Chap. 5.2).

3.2.1 *Ex situ* Conservation in Genebanks

In genebanks and collections more than 200,000 samples of plant genetic resources are being conserved in Germany which are available wordwide. There are two major genebanks for agricultural and horticultural crops at the Institute of Crop Science and Plant Breeding (Institut für Pflanzenzüchtung und Kulturpflanzenforschung, IPK) (A) and at the Federal Research Center of Agriculture (Bundesforschungsanstalt für Landwirtschaft, FAL) (B). There is an important collection for vine at the Institute for Breeding of Grapes of the

Federal Center for Breeding Research (Institut für Rebenzüchung der Bundesanstalt für Züchtungsforschung (BAZ) (C). The forest genebanks of the Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" (D) were established for the forest sector.

a) Genebank at the IPK at Gatersleben with field offices

History founded in 1943 as Emperor-Wilhelm-Institut for Crop Research at Gut Tuttenhof near Vienna; since 1945 at Gatersleben, until 1990 central genebank of the GDR at the Central Institute for Genetics and Crop Research; 1992 reestablishment as IPK and affiliation of field offices

Organization central genebank at Gatersleben, further collections in the field offices "North" at Gr. Lüsewitz, Gülzow and Malchow/Poel, "South" at Dresden-Pillnitz

Agency responsible and financing Federal and respective Laender governments (Saxony-Anhalt, Mecklenburg-Western Pomerania and Saxony)

Aims and approach collection, conservation, reproduction, characterization, evaluation and documentation; base collections; supply of material

Number of samples approx. 103,000 samples from some 1,800 varieties, from 70 families, of which: 74% at Gatersleben, 24% "North" and 2% "South"

Samples received according to crop groups cereals and maize (39%), potatoes (5%), Beta beets(2%), pulses (17%), oil seeds and fibre plants (7%), pasture plants (13%), vegetable plants (10%), fruit crops (2%), special crops (4%), ornamentals (1%)

Samples received according to stage of cultivation actual varieties and breeders' lines (33%), old cultivars and land races (48%), wild material (15%), mutants (4%)

IPGRI base collections lupin (*Lupinus spp*.; world-wide) tomatoes (*Solanum lycopersicon*; world-wide [= *Lycop. esculentum*])

Other important material barley (Barley Core Collection, Europe) onions (*Allium spp.* and relatives, Taxonomy Dept. of IPK)*Arabidopsis* (transfer of a collection from Frankfurt)

b) Genebank at the Institute of Agronomy (Institut für Pflanzenbau) of the FAL at Braunschweig-Völkenrode

History founded in 1970 as central genebank of the Federal Republic

Organization affiliated to the Institute of Agronomy of the FAL; integrated on a priority basis into the work area "renewable resources and industrial crops"

Agency responsible and financing Federal government

Aims and approach collection/taking over collections, conservation, reproduction, characterization, evaluation and documentation, base populations; supply of material

Number of samples approx. 57,000 from 948 species from 58 families

Samples received according to crop groups cereals and maize (53%), potatoes (6%), Beta beets (4 %),pulses (16%), oil seeds and fibre plants (7%), pasture plants (6%), vegetable plants (7%), special crops (1%)

Samples received according to stage of cultivation current varieties and breeders' lines (42%), old cultivars and land races (35%), wild material (15%), mutants (1%), samples without classification (7%)

IPGRI base collections oats (*Avena sativa*; Europe)
Beta beets (*Beta spp.*; Mediterranean provenances together with Greek genebank)
Abyssinian mustard (*Brassica carinata*; world-wide)
rape (*Brassica napus*; world-wide)
rape (*Brassica rapa*; world-wide)
brown mustard (*Brassica juncea*; world-wide)
white mustard (*Sinapis alba*; world-wide)
garden bean (*Phaseolus vulgaris*; cultivated species, Europe)

Other important material potato and *beta* beet collections together with CGN at Wageningen, NL

c) Genebank at the Institute for Breeding of Grapes (Institut für Rebenzüchtung) of the BAZ at Siebeldingen

History collection transferred in 1947 from Emperor-Wilhelm-Institut for Breeding Research to Siebeldingen; 1991 integration into BAZ

Organization an institute of the BAZ (others: see Chap. 3.2.2)

Agency responsible and financing Federal government

Aims and approach breeding/resistance research, evaluation, establishment of base collections. Collection, identification, evaluation of genetic resources of vines, international harmonization of descriptors, documentation

Number of samples about 2,500; from 32 species; (15,900 varieties are documented)

Samples received according to stage of cultivation current varieties and breeders' lines (67%, mainly breeding material), old cultivars and landraces (26%), wild material and samples without classification (7%; mainly wild material)

Important material world-wide important assortment of vines, leading role in international documentation of genetic resources of vines in cooperation with International Vine and Wine Office (OIV), Paris

d) Regional forest genebanks

History establishment mostly after setting up Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" (1985)

Organization coordination by Federal/Laender Working Group, at the forest research stations of the Federal and Laender governments; especially the regional forest genebanks of the Laender at Arnsberg, Escherode, Graupa, Hann. Münden, Teisendorf, Trippstadt and Waldsieversdorf

Agency responsible and financing Federal and Laender governments

Aims and approach measures to complement *in situ* measures (Chap. 3.1.1) and other *ex situ* measures (Chap. 3.2.2)

Number of samples about 68,000 from 50 tree and shrub species stored in genebanks: about 17,600 of these as seed 61%, pollen 37% and tissue (*in vitro*) 2% in seed orchards and clonal archives: over 50,000 genotypes in 404 seed orchards and clonal archives on 816 ha. some 20,000 genotypes as grafts and over 30,000 as cuttings

Samples received according to crop groups forest tree species 99% (among which wild fruit 4%), shrub species 1%

Samples received according to stage of cultivation almost exclusively pure wild provenances

3.2.2 *Ex situ* Conservation in Special and Working Collections and in *ex situ* Forest Stands

A selection of important special and working collections is to be found in Annex 2 under Survey 1. Information on forestry *ex situ* stands are to be found in Survey 2, in Annex 2.

Besides the collections listed in the Annex, ex situ collections of various types of fruit, some of which are very specifically aimed, are conserved by a large number of further institutions of the Federal Government and the Laender, universities, private research and breeding enterprises, as well as some societies and associations. These are for the most part working collections which are primarily for the purposes of research and development and often originate from genebanks of various Laender. The institutes responsible for preservation (generally IPK and FAL), once the corresponding research projects have been completed, take over working collections deemed valuable. Forestry working collections are kept at the research institutes and universities.

3.2.3 Botanical Gardens and Arboreta

Germany has about 70 botanical gardens and arboreta. Some have a very long tradition. The oldest German botanical garden is in Leipzig and was established in 1542 already. The gardens are mostly part of the universities and play a major role in taxonomic basic research and in teaching. In addition some cities have their own botanical garden. Botanical gardens also conserve exotic plant material beside of indigenous plant species. A great number of botanical gardens in the Federal Republic of Germany joined to form a Federal association. Various gardens are represented in the Botanical Garden.

Conservation International (BGCI). Cooperation in associations aims to improve the documentation of collections and to optimize the coordination of exchanges of plants. Some botanical gardens focus their work on specific technical areas. Examples are to be found in Survey 3 in Annex 2.

3.3 COLLECTING ACTIVITIES AND OTHER ACTIVITIES TO SUPPLEMENT COLLECTIONS

Collecting missions to the primary and secondary diversity centers of the most important crops pursue the aim of preserving the greatest possible range of traits and making it accessible for use. Another important aim is to ensure *ex situ* locally endangered diversity. Collecting missions were carried out primarily by genebank staff. In addition, valuable working collections were included by genebanks for long-term conservation. Appeals for search actions in scientific journals have led to retracing fruit, vine and vegetable varieties supposed missing.

The collecting missions of the genebank of today's IPK at Gatersleben already began in Vienna at the time when it was founded in 1943. When the Institute was transferred to Gatersleben in 1946 the collection comprised some 3,500 samples. Subsequently, important collections were included which were made by German scientists between 1935 and 1939 within the framework of international collecting expeditions so that the collections increased to over 12,000 samples. Around 1950 collecting missions were resumed after the breaks caused by the war. The main goal of the missions were diversity centers of crop species. They were increasingly planned in bilateral or multilateral cooperation and carried out with local people and native researchers. In almost all cases material of several plant species was collected at the same time. The main object of collections were landraces and material under cultivation, in the second line also wild relatives of crops. Collecting sites were primarily fields and plantations under cultivation. Samples of the whole material collected always remained in the country of collection. Great importance is always attached to the simultaneous collection of additional information on the material (aspects of use, indigenous knowledge). Originally, the collection of material suitable for breeding had been the main aim. Today, protecting endangered material is equally important.

Following the founding of the genebank at the Institute for Agronomy of FAL at Braunschweig-Völkenrode in 1970, older collections of varoius scientific institutions were taken over, such as from the Technical University of Munich-Weihenstephan and the Max-Planck-Institute for Breeding Research in Cologne. This was in line with the mandate given to the Institute by the Federal Ministry of Food, Agriculture and Forestry which included the

preservation of already existing old collections, the constant supply of plant breeding with basic material, and the safeguarding of endangered varieties and provenances. In the 80s in particular, the collection was mostly extended through international exchange. One priority was the procurement of material for the cultivation of industrial and energy crops. As from the mid-80s the genebank conducted its own collection expeditions, primarily within the framework of the German-Dutch Cooperation, in the field of the preservation of plant genetic resources. The goal of collecting material through exchange and active collection was the setting-up of geographically and taxonomically representative stands. Primarily, samples of the genera *Beta, Cichorium, Dactylis, Festuca, Lolium, Phleum* and *Solanum* were collected in the natural ranges. The collections are and were crop specific. Samples of the whole material collected always remain in the country of collection. The collection of the Institute is also continuously increased by taking over working collections from various institutions.

Within the framework of the Federal/Laender Working Group forestry collecting activities in Germany are undertaken on a priority basis according to surveying or mapping and an assessment of the risk and valence of *in situ* forest genetic resources. Collections focus on rare and endangered tree and shrub species and local species with a narrow genetic basis. Apart from conservation the aim is propagation and reintroduction into normal forestry. Forestry collecting missions abroad have concentrated on tree species of economic interest (Douglas fir, Sitka spruce, various fir species, Japanese larch and poplars) in North America and East Asia. But also for indigenous species (e.g. pine, spruce, beech and European larch) collecting missions were made to other parts of the natural range (former Soviet Union, Poland, Romania and former Czechoslovakia). The aim of the missions was to obtain valuable provenances for use in breeding to broaden the genetic basis. In most cases the collections were coordinated within the framework of the International Union of Forestry Research Organizations (IUFRO) or planned and carried out as bilateral or multilateral projects.

The aim of the few collecting missions organized by private breeding companies is to collect regionally adapted crop populations to enrich the trait and genepool available for breeding purposes. This is why mostly central European countries are the goal of collecting missions. Collections sometimes carried out by universities and research stations have mainly scientific objectives. Indigenous plants are often collected by staff from botanical gardens. This is always done in coordination with the competent nature conservation agencies. Collections in the countries of origin of exotic plants always carried out in coordination with the authorities involved are quite rare.

3.4 STORAGE

3.4.1 Storage Facilities

The storage facilities for the conservation of agricultural and forest genetic resources are decentralized in Germany. Coordination, however, takes place increasingly at national level. This type of conservation is based on the scientific, technical, personnel and physical capacities of the institutions mentioned in Chapter 3.2.

The genebank of the IPK at Gatersleben is storing seed material in cooling cells whose capacity of approx. 67,000 samples is presently exhausted. There is a hall for long-term storage. Expansion was postponed until a decision has been taken about the future organization of genebanks in Germany. Add to this 4,500 m^2 of greenhouse area and 75 ha. of experimental area. The branch office "South" in Dresden-Pillnitz has an experimental area of 16 ha. At GroßLüsewitz sufficient environmentally controlled and cold-storage capacities as well as experimental areas are available. The greenhouse area is not yet ensured. At Gülzow there are only environmentally controlled, however, no cold-storage chambers; experimental areas are available. At Malchow/Poel there are sufficient cold-storage capacities and experimental areas.

For the storage of the collection in the genebank of the FAL in Braunschweig cooling cells are available with a total capacity of 305 m^2 for 48,000 samples and a cold storage chamber with 65 m^3 for 12,000 samples. The storage capacity is entirely exhausted.

The present utilization of storage capacities of forest genebanks is estimated at about 50%.

3.4.2 Storage Methods

a) Conservation of seed by means of (deep) freezing

Seed of species like cereals, grasses, legumes, beet, fibre and oil-plants, pasture plants, almost all vegetable plants, hapaxanthous fruit species, wild vines, tobacco, many medicinal plants and spices, annual ornamental plants, small-fruited forest trees and shrubs as well as many wild plants are being conserved according to the classical method of (deep) freezing. The method is standardized to a large extent and unproblematic. The storage period depends on the plant species, seed ripeness, seed pre-treatment and various storage

conditions (Annex 2, Table 9). Efforts are being made to improve long-term storage.

b) Tissue conservation (*in vitro*)

The tissue culture is a method to improve the phytosanitary situation (e.g. for elemination of viroses). In addition, tissue cultures were established for the conservation of potatoes, onions and related species, fruit trees and shrubs, ornamentals with complicated genetic structure (e.g. triploids) and forest trees and shrubs which cannot be regenerated in another way. The cultural conditions for tissue cultures vary and depend on the one hand on the requirements of the plant species concerned, on the other also on the technical and spatial possibilities available.

Risks to the tissue culture arise from virosis transmission, somaclonal variation and the need for frequent regeneration. Efforts are therefore made to develop improved methods, for example, of cryopreservation (subfreezing storage of tissue capable of regeneration) inter alia, for potatoes and forest plants.

c) Field collections

Field collections serve to conserve purely vegetatively propagable as well as very long-lived and grafted plants like onion species, some medicinal plants and spices (e.g. peppermint), fruit trees, hop, vine, long-lived ornamentals (e.g. perennial plants) and some forest plants. Woody plants are propagated as grafts or cuttings.

3.5 DOCUMENTATION

In general, passport, characterization, evaluation and management data are documented of each sample. In particular the secondary evaluation activities are carried out by a great number of Federal and Laender research institutions as well as universities and private breeders. Different evaluation data are obtained, which are less documented and available. These data in particular are of main interest to most users.

The normal seed list (Index seminum) was replaced by EDP lists which contain upon request all available passport and evaluation data according to the interests of recipients. The data are made available in printed form and on discs.

a) Information Center for Genetic Resources (IGR)

The Information Center for Genetic Resources (IGR) established in 1991 in Bonn at the Center for Agricultural Documentation and Information (ZADI) has been dealing since its establishment, inter alia, with the development of a National Documentation and Information System for Plant Genetic Resources in Germany. All *ex situ* collections in genebanks and in other storage facilities as well as *in situ* stands of the whole Federal Republic are to be centrally recorded in that system. A prerequisite for such a documentation system is to collect the most updated and most complete data and databases available at the various institutions and their regular updating. A related information system must design structures to allow all users specific access to certain data by means of different algorithms. Apart from the quick access to certain samples in a storage facility or in several storage facilities one of the tasks of the IGR is to identify potential undesired duplicates. The verification of the results of databank analyses is the task of collections. At present, passport data are available of over 160,000 German samples (inter alia, of the IPK and FAL) at the IGR as well as first characterization and evaluation data on Phaseolus beans and on vine from the Institute for Breeding of Grapes of the BAZ.

b) Genebank of IPK at Gatersleben

The documentation of all information accompanying samples was recorded in field books and card indexes at the genebank at Gatersleben in the 80s. Since the mid-80s it was started to set up computerized documentation. Today, the data collection in the field is carried out partly with a portable collection device.

About 96% of the passport data documented in written are meanwhile available on database. The transfer of the other data having been recorded in written for about 50 years (mostly characterization and evaluation data) into digital form continues to be problematic because of the great labour input. These data are to be digitalized as from 1995, inter alia, within the framework of a project coordinated by the IGR concerning the collection of evaluation data. Within the framework of computerized documentation the data available are regularly duplicated in the form of a safety copy. The data available on paper are duplicated not at all or only partly. The duplicates are stored on the spot. A pilot data transfer project through the Internet is in preparation with the IGR.

Since 1981 every two years a seed list with names of varieties is published by the IPK. Another medium for documentation is the Institute's comprehensive herbarium which with over 300,000 samples is one of the largest herbaria specialized in crops and their wild relatives.

c) Genebank at the Institute of Agronomy of the FAL in Braunschweig-Völkenrode

All passport and evaluation data received and gathered by the FAL genebank itself and other relevant information are stored on a database (ORACLE system). Daily data safety is ensured automatically. This task is the responsibility of the FAL. In addition, monthly safety copies of the whole data base are made and stored for one year in a safe outside the Institute. The FAL genebank will also dispatch the enquiry results by E-mail.

d) Genebank at the Institute for Breeding of Grapes (IRZ) of the BAZ at Siebeldingen

In agreement with the International Vine and Wine Office in Paris a database was set up for vines at the IRZ. Passport data are available for over 15,000 grape cultivars; so far morphological descriptions are available for about 800 cultivars. The evaluation with regard to the resistance to fungi currently comprises about 800 cultivars. The data were published in "The Genetic Resources of Vitis, Genetic and Geographic Origin of Grape Cultivars, their Prime Names and Synonyms" (1992), "The World List of Grapevine Collections" (1994) and "Preliminary List on Resistance Genes in Vitis" (1994). The herbarium with leaves, shoot tips and seed samples comprised more than 1,200 varieties and is used for the identification of varieties.

e) Regional forest genebanks

Different documentation approaches and methods are used by the Laender for forest genebanks and the further *ex situ* resources and the *in situ* resources. The Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" has worked out a uniform minimum standard for documentation at the forest genebanks. Every two years a survey is made for the Federal Republic of Germany. A discussion is under way about whether and to what extent the data should be transferred to the central documentation system at the Information Center for Genetic Resources (IGR).

f) Federal Office of Plant Varieties

According to its mandate the Federal Office of Plant Varieties possesses very comprehensive data collections containing evaluation data on all lines to be registered as a protected variety or to be tested for their eligiblity in the field. These data are especially valuable, as they are collected mostly in standardized form on different testing sites. Varieties whose variety protection and registration have expired, are transferred to the genebanks together with the data gathered on those sites.

g) Botanical Gardens and Arboreta

Wild cultivars in botanical gardens are documented in the seed catalogues (*Indices seminum*) which are published every two years. The publication and exchange of these catalogues so far represented the information system between institutes. It provided the basis for the exchange and retrieval of material.

To rationalize work, the computerized information systems SYSTAX and DIDEA in particular were developed. Meanwhile they are used by many gardens. To facilitate the exchange of data it is planned to develop SYSTAX at the IGR further, to adapt it to the requirements of agricultural crops and to include it by means of additional functions of taxonomic, ecological, geographic, and threat-related data.

h) Mapping of wild flora

On the territory of the former GDR a survey was carried out in 1982 concerning the importance of nature conservation areas for the *in situ* conservation of crops and their wild relatives. A list was drawn up of 642 original forms of cultivated plants, autochthonous endangered forest plants, wild relatives of crops as well as potentially cultivable plants for the species occuring in the about 720 nature conservation areas investigated. On the basis of this work a database was set up at the IGR covering about 900 wild usuable species.

An encompassing mapping of the wild flora is carried out and continuously updated in Germany. This work is coordinated by the Federal Nature Conservation Office (BfN). The BfN keeps these data on a database which also contains information about the risk to individual species. Efforts and approaches are made to carry out point-precise mapping with the aid of new geographical techniques for certain species. A project launched in 1995 aims to optimize the coordination of the activities of the BfN and the IGR.

3.6 CHARACTERIZATION AND EVALUATION

In Germany, a distinction is made between characterization and evaluation according to the recommen dations of the IPGRI. The evaluated characteristics can, in addition, be subdivided into primary and secondary evaluation. The secondary features comprise features which can be ascertained only by means of specific knowledge or specialized techniques (e.g. resistances

to certain pathotypes of pathogens, quality properties ascertainable only in the laboratory, existence of certain genes etc.)

a) Genebank of the IPK at Gatersleben

90% of characterization is carried out by the genebank staff and with the assistance of the Taxonomy Department of the IPK. The data are almost entirely gathered in the course of field regeneration of samples. The primary evaluation of samples is also carried out mostly by its own staff and on its own premises. From 1974 to 1990 some 65,000 samples from the Gatersleben collection were characterized and underwent primary evaluation. For the description of samples special lists with minimal descriptors were developed which are less comprehensive than the IPGRI lists. The individual characteristics are usually comparable with those of the IPGRI.

Over 90% of the whole collection has been sufficiently characterized and has undergone primary evaluation. Secondary evaluation is carried out in cooperation with the institutes BAZ and with other partners like universities or breeders. It also includes biochemical and genetic information on the material. No information is available about the extent of secondary evaluation. Morover, the latter can never be described as complete, as the demands made on it may change with the development of new breeding methods and uses.

All the data accompanying the samples available at the genebank are made available upon request to users. Depending on the extent of the samples requested the information is provided on paper or disc. The return of the data on samples which users obtain from the genebank is not made a condition for providing the data. Research institutions provide all data collected on the material to the genebank. There is, however, an insignificant backflow of data from breeders with regard to valuable properties of samples.

b) Genebank at the Institute of Agronomy of the FAL in Braunschweig-Völkenrode

The methods for standardizing characterization and evaluation developed by the Institute of Agronomy of the FAL served the present IPGRI, inter alia, as a basis for the development of international descriptor lists. The data of the Institute, therefore, conform with a few exceptions to the international standards. For the primary characterization of the material characters are used which can be ascertained during seed regeneration. Work on the exact taxonomic description of the collection holdings or the structure of the collections cannot be carried out within the framework of basic funding of the Institute. Additional research funds, for example through German-Dutch cooperation, were made available for work on the collections of oats, potatoes, Beta beets and perennial rye grass.

The evaluation of the material, including the ascertainment of cropping properties and substances must be carried out for the most part within the framework of projects limited in time. Secondary evaluation data are collected in cooperation with breeders and other research institutions. Studies of the genetic diversity of some species and genera were carried out at the suggestion of the FAL at various universities.

The provision of material is not linked to any conditions. If large assortments are supplied, recipients are usually asked to provide evaluation data after completing their work. In order to be able to ensure a high quality of such data, close contacts must be maintained between genebanks and their users.

c) Genebank at the Institute for Breeding of Grapes (IRZ) of the BAZ at Siebeldingen

There exists a descriptor list coordinated with the International Vine and Wine Office in Paris, the UPOV and the IPGRI. 800 varieties have been described according to that list. The *Herbarium* with leaves, shoot tips and seed samples comprises more than 1,200 varieties and is used for the identification of varieties. About 20% of the vine assortment at the IRZ consisting of 2,235 varieties have been evaluated for important breeding characteristics. A list of the resistance of varieties to fungal diseases is available as a result of an investigation into literature (see Chap. 3.2.1).

d) Regional forest genebanks

The characterization and evaluation of forest genetic resources have to take the chiefly regional interest into account. A uniform descriptor list exists for the most important data and for the exchange of data. The Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" is implementing the characterization of the units ascertained.

e) Wild species in protected areas

There is no characterization and evaluation yet of plants conserved *in situ* in protected areas. However, there had been first talks between the IGR, representatives of the biosphere reserves and the MAB office.

3.7 REGENERATION

The intervals for the regeneration of *ex situ* stored samples are determined individually and depend on the viability of the stored material. Regular viability tests are carried out of seed samples. If a sample reaches values below individually fixed threshold values, a regeneration step is immediately introduced. Another reason for regeneration is a reduction of the seed quantity as a result of repeated seed withdrawls. *in vitro* conserved material must be regenerated more frequently, as otherwise there is a too great risk of genetic changes and losses. Work is under way on cryopreservation. Long-lived plants conserved in field collections are cloned when senescence of plants has been reached. The regeneration of short-lived plants vegetatively conserved in field collections is very costly.

a-c) Agricultural crops, pasture plants and vegetable plants Genebank of the IPK at Gatersleben

A reproduction volume of 12 - 15% of total stocks has been achieved at Gatersleben today. According to the experience gathered there this is a threshhold value. The new accessions, the reductions in stock due to deliveries and the continuous evaluation work should not fall below this value. 4,500 m2 of greenhouse area and 85 ha of experimental area with many isolation possibilities exist for regeneration purposes. Facilities for *in vitro* storage have been available at Gatersleben for some time only. Efforts are made to optimize storage.

Regeneration is almost entirely carried out on the premises of the genebank. Regeneration by breeders or institutions takes place in general only under the authority of genebank staff. The capacities in terms of space, staff and funds for regeneration work are still sufficient. However, if the stored material continues to increase, the regeneration capacity could soon become a limiting factor.

A reproduction system has been practiced at Gatersleben for five decades which has ensured the characterization (above all the botanical determination and elaboration of reference material in the form of collections of seed, ears, fruit and herbs as well as plant photo collections), primary evaluation and the provision of resources of 12 - 15,000 samples per year. The risk of genetic shift and limitation of samples during regeneration primarily concerns cross-fertile species. The genebank tries to counteract this risk by means of line formation. Heterogenous material is divided into groups of similar individuals and

regenerated in these groups in order to minimize the probability of loss of rare genes. Old and freshly regenerated material is generally conserved separately.

Genebank at the Institute of Agronomy of the FAL in Braunschweig-Völkenrode

Due to the relatively good storage conditions of a large part of the collection samples may be regenerated at longer intervals. Samples which are in frequent demand must be regenerated and propagated earlier. The decision about regeneration is usually taken according to variety-specific threshold values as well as on the basis of the results of regular viability tests. The collection of European potato varieties so far conserved *in vitro* is currently transferred to liquid nitrogen (cryopreservation) in order to reduce the amount of work.

The propagation work is carried out by the various departments of the Institute. The isolation area available is not sufficient for the necessary work. Therefore, breeding companies and other reliable institutions are also involved in regeneration work.

For cross-fertile species one regeneration covers up to 60 plants. Heterogenous original samples of cross-fertile species are only divided into subpopulations if there are indications at clear mechanical mixtures. After successful propagation the old material is usually discarded. The storage system allows no separate storage of original samples and the samples made available.

d, e) Fruit crops, other permanent crops, special crops

Fruit trees and many plant species of permanent crops (especially in the case of cultivated material or material influenced by breeding) are vegetatively regenerated in the form of cuttings and grafts. In the case of vines the material is virus tested. No somaclonal variation occurs. Strawberries are propagated by runners. For plants in special crops see above (Chap. 3.7 a-c).

f) Ornamentals

Ornamentals represent a very heterogenous group with regard to conservation and regeneration. There are long-lived ornamentals conserved in field collections, species stored as seed and ornamentals conserved in tissue culture (see Chap. 3.7 a-f).

g) Forest plants

The regeneration of forest genetic resources from seed requires several decades from the establishment of forest stands to fructification and thus often lasts longer than the storage of seed. The stored seed is regularly tested for its viability. It is sometimes necessary to overcome first germination inhibition or

seed dormancy. In the case of falling below a critical level, planting material is raised from the seed in nurseries which is used to establish stands and seed orchards. On the other hand, if basic stocks are still available, seed is harvested again for storage in order to replace the aged seed. Forest genetic resources can be propagated by means of cuttings, grafts or *in vitro*. Material conserved *in vitro* is regenerated at intervals of several years.

h) Wild species of potential use

Wild species are usually conserved *ex situ* as seed or regenerated accordingly. It is necessary to frequently carry out investigations on storage stability and viability. In the case of regeneration of wild species there is always a danger of unintentional selection for properties of cultivability (e.g. plants which ripen relatively simultaneously) and a genetic adaptation to the prevailing conditions (soil, climate) for regeneration. The regeneration of testaceous species and of material with physiological dormancy requires as in the case of forest plants the use of special techniques. Knowledge of properties unknown so far (like dormancy) are documented by the database.

CHAPTER 4
Use of Plant Genetic Resources

Plant genetic resources are an important factor of production in agriculture and forestry. The use of plant genetic resources as seed or planting stock in agricultural and forest production is, as rule, preceeded by breeding efforts and research activities to improve their characteristics. The following chapter deals with different objectives and methods of the use of PRG in research, breeding, seed multiplication and in cultivation to increase food security and to provide a basis for the agricultural and forestry industries.

4.1. THE USE OF PLANT GENETIC RESOURCES IN RESEARCH AND BREEDING

4.1.1 The Tasks of Research and Breeding

The use of plant genetic resources from genebanks and other collections almost exclusively takes place in basic research, breeding research and plant breeding.

In pure research plant genetic resources serve as a basis for studies of fundamental questions in the field of genetics, taxonomy, biochemistry, physiology, taxonomy and ecology. Forestry pure research additionally deals with provenance studies and research on ecosystemic interactions.

Breeding research has the role of a mediator between pure research, the bodies that conserve plant genetic resources and the plant breeding institutions. Its contributions consist in the development of breeding methods, the evaluation of genebank material that is relevant for breeding with regard to valuable characteristics (secondary evaluation) and preparatory breeding activities on the basis of primitive plant material for the production of basic material. It uses and transfers findings and methods provided by pure research.

The plant breeders first used the diversity of crops (landraces), that had developed in the course of millenia, to select lines and varieties. The gradually increasing demand for varieties with certain yield, resistance and quality

characteristics plus the extensive displacement of landraces resulted in the search for other sources of the desired characteristics. From the start combination and/or cross breeding used improved material from other countries (Europe, Russia; USA) and thus, more or less unknowingly, broadened its genetic basis. Breeders only use little primitive material in their variety breeding as it is rather far away, genetically, from their breeding material and, as a rule, lengthy back-crossing programmes are required to eliminate the negative characteristics that are bred in. In addition, in some cases cross incompatibility has a negative impact. The devlopment and use of biotechnology as well as progress in the field of plant genom analysis pave the way for the use of DNA markers as an efficient tool in selection. Genetic engineering is increasingly important for selective breeding, even among different species.

Plant breeding itself makes a major contribution to the creation of tensions concerning the conservation of plant genetic resources. Selection through breeding is bound to help the reduction of genetic diversity. Distinctiveness which is required for obtaining variety protection, in addition, has resulted in increasing demands concerning the homogenity within one variety. The strive for commercial success in the light of increasing competition among breeders on the German and European markets, moreover, encourages the spreading of a small number of high-yielding varieties which are suited to a wide range of environmental conditions in many regions. On the other hand the availability of sufficient genetic diversity is the major condition for further progress in breeding. The resulting problems for inter and intraspecific crop diversity has been known for a long time. It not only is the reason for the need for an adequate system of plant genetic resources *ex situ* conservation (in genebanks) but also increased efforts for their evaluation and use.

4.1.2 Use of Genebanks and Collections

The current use of plant genetic resources varies widely among the different crops, users and the conservation bodies. The are no complete data available on which plant genetic resources from genebanks and other collections were used in the breeding of registered varieties. There is only the exception of the government breeding system in the former GDR whose centralised organisation made it possible to gain an insight into the concrete use of plant genetic resources in plant breeding there. Breeders stated that for the period 1973 to 1990 basic material from the Institute of Plant Genetics and Crop Plant Research in Gatersleben was used for 56 registered varieties (33 barley, 13 wheat, 3 field pea, 6 food pea varieties and 1 lettuce variety). A breeding programme of the Federal Agricultural Research Centre (FAL) produced two

Jerusalem artichoke clones and two lines of gold of pleasure which can be registered. The complicated breeding systems of modern plant breeding make analyses in the use of plant genetic resources in breeding more difficult. The amount of material provided by collections may serve as a guide. The interest in the use of PRG for breeding was mainly directed to material from old cultivars of the main agricultural and horticultural crops.

The Gatersleben genebank (and its branches) over the last 40 years has provided an average of some 12,000 samples per year to about 400 different users (see Annex 2, Table 15). In recent years there has been a high frequency of demand for *Allium, Avena, Brassica, Hordeum, Lactuca, Secale, Solanum* and *Triticum*. In addition to crops primitive and wild plant material played a part.

The genebank of the Institute of Agronomy of FAL over the last 17 years has provided some 7,000 samples annually (see Annex 2, Table 15). In recent years there has been a high frequency of demand for *Beta, Brassica, Camelina, Chenopodium, Hordeum, Pisum, Solanum* and *Triticum*. This also included crops, primitive plant material and wild plant material.

There are no comparable data on forestry genebanks. But the exchange of material is considerably smaller. In forestry the conservation of genetic resources and breeding are closely linked as they, in the majority of cases, are carried out by the same bodies (Forestry Research Centres). This is mainly due to the, as a rule, regional use of forestry gene resources, the longevity of plants and the lack of private breeders. But material is provided for provenance trials and the establishment of seed orchards.

4.1.3 Breeding Aims

Public activities in the field of breeding and breeding research take place side by side with the activities and aims of private plant breeders. There is no government breeding programme with established breeding aims in Germany.

The Federal Ministry for Education, Research, Science and Technology (BMBF) promotes pure research on "Biotechnology and Plant Breeding " in a special programme up to the implementation level.

The Federal Ministry of Food, Agriculture and Forestry (BML)s Federal Centre for Breeding Research on Cultivated Plants (BAZ) deals with applied science in the field of plant breeding. Major tasks of BAZ are the evaluation of genetic resources and the development of basic material as a pre-condition for

an increase in genetic diversity in variety breeding. The research priorities of BAZ are:

- to produce basic material that is healthy in the long run and thus increase the genetic variety in breeding;
- to provide basic material of improved quality for use for food and industrial purposes;
- to work on the improvement of selection;
- to work on the establishment and use of genetic variability.

The aims of private plant breeding are orientated at exisiting needs in terms of yield, resistance and quality characteristics. The need itself is determined by the demands from farms (high yield, high level of resistance), the downstream industries and consumers (high internal and external quality of raw materials and products). Breeding is in line with the legal requirements for the seed to be registered as a variety (see Chapter 5.2). Private breeders have stated their aims to be the following:

- conservation and increase of genetic diversity;
- increase of resistance to stress and diseases;
- improvement of the ability for nutrient intake;
- increase of biomass production;
- improvement of the quality in both the food and the non-food sector;
- development of environmentally sound production methods.

a) Agricultural crops

New varieties of agricultural species are subject to the provisions of the Seed Trade Act (SaatG) and must have a "value for cultivation and use (VCU)" (landeskultureller Wert) to be registered. High yield is a requirement for the value of new varieties. Of increasing importance are resistances to fungi, bacteria and pests. And there are quality characteristics , for example for baking and brewing in cereals, starch content and spectra in potatoes etc. Testing of the suitability of existing varieties for less intensive methods of cultivation and further breeding for that purpose (multiple resistance, good rooting, high food quality) is done by some commercial breeders as well as by some private groups. Low-input characteristics, nitrogen efficiency and stress tolerance are of increasing importance. There are already some varieties with those characteristics that have been registered.

The provision of plants for the use as renewable resources requires the breeding aims to concentrate on a single ingredient (for example fatty acid) to make exploitation worthwhile. For the production of biomass, breeding mainly focuses on cereal and grass species for thermal use. These programmes include the reintroduction of displaced species like flax and hemp.

In addition, breeding methodology itself is studied in this context.While in maize and sugarbeet hybrid breeding has been routine work for a long time, rye hybrids have been on the market for a few years only. In wheat and rapeseed breeding, too, work is being done on the introduction of hybrid breeding. Methods like tissue and haploid techniques have been introduced in practical breeding. Marker-based selection and gene transfer are becoming more and more important.

b) Pasture plants

Breeding of pasture plants aims, in addition to higher yield (early growth and growthiness, aftermath regrowth) and improvement of the quality of the forage, also at the establishment of resistances to diseases and an increase in resistance to frost. Other breeding aims are important for species used for land reclamation (rapid greening and protection from erosion), lawn use (amenity and sports turf) and landscape management.

c) Vegetable plants

There are only very few breeders left in Germany who breed vegetable plants. The breeding aims for vegetable plants are (because of a very wide range of uses even within the various species) very numerous. Priority is given to commercially important species (cabbage, onions, leek, carrots and pulses). All vegetable species are subject to the provisions of the Act on the Trade in Seed (SaatG). Here, too, yield is an important factor that, in many cases, is increase through hybrid breeding. In addition, quality, harvestability by machines, uniform ripening, good storage and preservation characteristics as well as resistances are of importance for breeding.

d) Fruit plants

The breeding of fruit varieties is more or less done bei two institutes of BAZ (Ahrensburg, Dresden-Pillnitz). Some university institutes work on specific problems. Concerning the breeding of fruit trees resistances to pathogenes impeding the external quality (like apple scab) rank first. Other important factors are taste, shape and colour. The long-term aim is to link the largest possible number of resistance and tolerance characteristics with a high level of fruit quality. The plants serving as rootstock are intended to have and/or induce resistances.

e) Other permanent crops, special crops

Breeding efforts on vine in Germany encompass the improvement of the European cultivars by clone breeding and the breeding of new varieties. A special breeding aim is the combination of high biotic resistance to fungal diseases and high wine quality (interspecific breeding). Concerning the breeding of the rootstock varieties the development of phylloxera and virus resistant rootstock is the priority aim.

Hops breeding is done by a branch office of the "Bayerische Landesanstalt für Pflanzenbau und Bodenkultur". The brewing industry requires high-quality hops (aroma and bitter substances). The priority aim in breeding is the integration of resistances and tolerances in terms of pests and diseases to make hops growing environmentally-friendly. Activities focus on resistances to verticilium, downy and powdery mildew as well as aphids. In addition, agrotechnical characteristics like creeping capacity, harvestability by machines and suitability for drying are also important.

Breeding questions on tobacco are dealt with by the "Baden-Württembergische Landesanstalt für Pflanzenbau" in Forchheim. The most important breeding aims are taste and resistance.

Asparagus breeding is done by a small number of specialized breeders as this requires a particular breeding methodology. Asparagus is hermaphroditic-dioecius and is multiplied generatively through cross-fertilization. For cultivation the male plant is required only so that so-called "supermen" are used.

In the field of medicinal plants and spices demand for plants is almosts completely covered by imports from countries with more favourable growing conditions and lower costs. There is no private breeding with the exception of a few commercially and pharmacologically important species (for example camomile, cummin, poppy). Wild provenances from Germany and abroad are in some cases collected, multiplied and traded. The Breeding Institute for Vegetables, Medicinal Plants and Spices of BAZ in Quedlinburg does research on, among other things, the synchronisation of ripening, harvestability by machines, level of active ingredients and their composition, winter-hardiness, regrowth capacity and resistances.

f) Ornamentals

In the field of ornamentals, in addition to breeding efforts, the collection and introduction of new plant species for new shapes and colours is of great importance. Even potato and sunflower were brought to Europe as

ornamentals. In the breeding of ornamentals aesthetic aspects are the main breeding aims. These include, among other things, the variation of the colour of the flower, the form of growth, the size of the flower, the shape and the colour of the leaves. Induction of mutation is an important tool in this. In potted plants, moreover, a stocky frame obtained without the use of growth regulators is of importance. Only in species that last for longer periods (shrubs, roses, trees) do resistances play a part.

g) Forestry plants

Breeding is so important in forestry because of the fact that at the time a stand is established the production potential is tied down for the whole of the rotation period of in between 50 and more than 200 years. Compared with breeding in agriculture, breeding in forestry is rather ample. Priority is given to adaptable, vigorous and high-quality stands (selection of provenances and stands) or single trees (seed orchards). The seed for the establishment of stands of most tree species is mainly obtained from these phenotypically selected wild populations. In addition, controlled crossings make use of the specific combining ability as well as heterosis. In forestry varieties play a minor role because of their limited gentic diversity.

The aims of forest plant breeding are an increase in resistance (to biotic and abiotic damage factors), adaptability to unforseeable changes in the environment (by means of sufficient genetic diversity), quality (shape of trunk and crown) and biomass production (increment in height and volume). Hybrids are only important in larch, birch, spruce, poplar and aspen. By means of vegetative propagation the results of cross-breeding can be used more quickly in the case of some tree species (like poplar).

h) Wild plants of potential use

For other wild plants the trade in seed is very limited. There is some multiplication of wild plant to be able to rehabilitate surfaces (mining, ersosion in high mountains etc.) with autochthonous seed. Especially in cases of extreme conditions of site the use of autochthonous provenances is very important. The Institute of Agronomics of FAL did intensive research on the domestication of wild plants like spurge (*Euphorbia lathrytus*), hare`s ear (*Coringia orientalis*), penny-cress (*Thlapsi arvense*), Iberian dragonhead (*Lallemantia iberica*) and garlic wort (*Allaria petiolata*).

4.2 SUPPLY WITH SEED AND PLANTING STOCK

In Germany in 1993 seed and planting stock multiplication was carried out on 265,151 ha. This includes the propagation area of German varieties of sugar beet, fodder beet and maize, which are located within the southern European region by reason of better climatic conditions. Some 20,000 enterprises in Germany work as seed propagators. The rate of self-sufficiency in seed and planting stock varies in accordance with the type of plant. For some species Germany depends on seed and planting stock imports. But these figures also include re-importation of material obtained from German breeding lines that was multiplied abroad.

In Germany in 1992 more than 1,500 varieties of agricultural crop species and a total of 700 varieties of vegetable species were registered (Seed Trade Act). At the same time some 1,700 varieties of agricultural and 2,500 varieties of horticultural species were protected (Variety Protection Act; see Chapter 5). Since the introduction of the pertinent legislation in Germany more than 10,000 varieties have been protected. Since 1972/75 there have been European Community variety catalogues for vegetable species and agricultural crops. All varieties which are registered in one member state, may be grown throughout the European Union. Legal harmonisation in that field has not been finalized as yet.

The number of varieties registered has multiplied over the last 20 years (see Annex 2, Table 10). A large number of registered varieties in crops does not necessarily mean that in commercial growing there is a great genetic diversity. It is rather the number of varieties that are really grown and the genetic distance between them that are of importance. The use of registered varieties by other breeders which is permitted under the Variety Protection Act plus the high requirements to be met by new varieties have often resulted in a close genetic relationship of varieties.

Many farms react to decreasing profit margins with savings in the field of seed inputs. This is mainly possible with autogamic and vegetatively multiplied species. Farmers re-use of farm-saved seeds on their own land in Germany at present is, over all species, around 50% with a slightly increasing tendency.

With the single market in Europe the price fixing agreement for certified seed (see Chapter 5) was abolished. German seed prices must be expected to show a tendency towards approaching lower prices in other EU member countries. The impact of the abolition of price fixing on varieties grown and on changes in seed use cannot be forecast as yet.

a) Agricultural plants

For climatic reasons there is a rate of self-sufficiency of less than 20% in maize, sugarbeet and sunflower (sse Annex 2, Table 11). Although breeding mainly takes place in Germany seed multiplication for climatic reasons is done abroad. Re-use of farm-saved seeds on farm does not play a major part for these crops. Table 12 in Annex 2 shows the development of registered varieties, of multiplication sites and the share of the five leading varieties in the multiplication of the major arable crops.

There is important re-use of farm-saved seeds of wheat and barley (with an increasing tendency), self-fertilizing coarse grain pulses and planting stock of potatoes. For sugarbeet and maize there are almost exclusively hybrid varieties, for whom certified seed is bought for the whole acreage on a regular basis. In the majority of cases, there are only a few varieties that dominate production whereas many registered varieties remain unimportant.

b) Pasture plants

The use of pasture plant seed cannot be attributed to a specific field of application. At least in the case of some species, varieties are used for grassland sowing and for forage growing but also for the purpose of landscape management, greening, protection from erosision etc. Multiplication of grassland herbs is estimated to amount in Germany to some 6,700 ha, that of clover species to less than 50 ha (1990). The rate of self-sufficiency is around 60-80%. Re-use of farm-saved seeds does not play any part in the system of grassland and forage use.

c) Vegetable plants

There are no detailed data on the rate of self-sufficieny of seed and planting stock of horticultural crops. Many of the varieties grown commerically in Germany originate abroad. Probably a large amount of the seed and planting stock is produced outside Germany. These often are hybrid varieties. Most vegetables are used in its vegetative stage (lettuce, kale, beetroot, onions, spinach, celery) or as unripe generative organs (broccoli, cauliflower, cucumber, zucchini, pepper, tomato, green peas, garden beans). This is why re-use of farm-saved seeds in commercial gardening should be minor and seed, as a rule, be bought. Coarse-grain pulses that are used as ripe seed (dry peas and beans, lentils) may be an exception as the obtention of seed does not result in additional labour.

d) Fruit crops

Planting stock of all fruits is multiplied by horticultural holdings and tree nurseries. In commercial fruit growing especially actual varieties with major importance for the market are in demand. The rate of self-sufficiency in plantlets is about 20%. A major part of plants is importeted from the Netherlands and Belgium. For non-commercial fruit growing and landscape management there is an increasing demand for old cultivars and landraces. The rate of self-sufficiency in this sector is estimated to be almost 100%. Holdings mainly buy fruit trees and shrubs as the multiplication of fruit trees and shrubs as a rule is done by grafting scions to a large variety of rootstock. Generative regeneration of top fruit varieties and layering are not possible.

e) Other permanent crops, special crops

The production of propagation material of vine (cuttings from rootstock and scions) is done in parent plant stocks which are subject to registration under the Seed Trade Act. These parent plant stocks for scions are almost exclusively situated in Germany, while the parent stocks for rootstocks, in the majority of cases, are located in Southern Europe (Italy, France, Portugal). The production of root vines and grafted vines is done in vine nurseries. Table 13 in Annex 2 shows the parent vine acreage existing in 1990 and number of ready-to plant vines produced in vine nurseries.

The production of hops planting stock covers the domestic demand. Plantlets are propagated in greenhouses to keep them, as far as possible, healthy and free from virus.

f) Ornamentals

The rate of self-sufficieny in ornamental plants by seed prpoagation is estimated to amount to nearly 30%, that in young plants to 60% including production abroad by German companies. Most imports come from the Netherlands. The rate of self-sufficiency in ornamental trees and shrubs amounts to 60% for specimens produced from seed and to 80% for young plants. Most imports originate in other European countries.

g) Forest plants

In Germany, some 70,000 hectares of forest are estimated to be regenerated, about 40 per cent of which are reproduced naturally, 10 per cent are underplanted and 50 per cent are replanted. On top of that, there are some 10,000 hectare that are converted into forest land for the first time.

The propagation material for the artificial establishment of forest stands by seed or plantings is obtained mainly through harvesting stands and less from seed orchards, only in exceptional cases is it produced on the basis of vegetative reproduction or from material that has been produced by breeding efforts. Seed stands cover about 2 per cent of wooded areas in Germany. The Act on Forest Seed and Forest Planting Stock (FSaatG) registers seed obtention areas for 19 main tree species produced in all together 178 provenance regions. About 60 per cent of these stand are autochthonous. For other tree species the German Association for the Control of Forest Seed and Forest Stocking Material (Deutsche Kontrollvereinigung für forstliches Saat und Pflanzgut, DKV), a private association of holdings producing forestry seed and forestry planting stock, forest owners and forestry authorities, have approved so-called registered provenances (see Annex 2, Table 14).

More than 90 per cent of the planting stock is grown by private companies. The decisive factors for the selection of the suitable propagation material by forest owners are the provenance as well as increment and quality of the sources. Legislation only covers the 19 main tree species used in forests. Planting stock that is grown in gardens and in open landscape is not subject to the Act on Forestry Seed and Planting Stock (FSaatG). Many private tree nurseries produce both for forestry and for private and landscape gardening purposes. So it is more difficult to keep the material separate and to safeguard its identity as required under the Act. In the case of forestry plants, checking the identitiy at a later stage would hardly justify the time and money involved.

There are only estimates on the rate of self-suffciency in forest seed and planting stock. For indigenous species it normally amounts to more than 90 per cent. For non-native tree species, for common oak as well as a number of provenances of other tree species there is a deficit which is mainly made up for by imports from the countries of origin (North America, Japan), neighbouring countries or the Southeast of Europe.

The regional forestry genebanks of the Laender mainly are intended to make material available in the long run. This is achieved, above all, through the propagation of genebank material to establish seed orchards. These orchards are to provide seed of endangered species and provenances for planting. This already is the case for some species and provenances, for others it will be possible in the next few years or decades. Because if the increase of natural regeneration of suitable forests autochthonous forest stands for most of the provenances are conserved as a genetic resource.

As large parts of our forests are replanted with different tree species and as marginal farmland is afforested, planting will play an essential part in the decades to come although natural regeneration will continue to be promoted.

h) Wild plant of potential use

There is only a limited market in seed of other wild plants. A small amount of seed and planting stock of wild plants intended for landscape gardening and reclamation purposes is collected from the wild or produced in conservation stands. This is due to the asynchronous ripening of seed typical of wild plants and resulting , in many cases, in costly harvesting techniques. Botanical gardens offer seed of a great number of indigenous wild plants which they multiply themselves.

4.3 SUSTAINABLE USE OF PLANT GENETIC RESOURCES IN THE PRODUCTION

The principle of sustainabilty is of great importance for the conservation of plant genetic resources in the agricutural and forest production. To stabilize agricultural and forest ecosystems the conservation and the sustainable use of plant genetic resources is as important as the conservation of the rest of natural resources (soil fertility, climate, wood supply etc). The principle of sustainability also means that negative external effects must be avoided. It was at a very early stage that the sustainable use of plant genetic resources in forestry was recognized to be the basis for sustainable use of wood. And it is given more and more attention in agriculture and horticulture.

Sustainabilty of the use of plant genetic resources is, on the one hand, based on biodiversity in agricultural and forest ecosytems, and, on the other hand, on the high level of genetic diversity within the species used. For indigenous species requirements in terms of genetic diversity are based, among other things, on natural diversity. For species that have been introduced the diversity that has developed in Germany must be taken into consideration. The broad genetic basis within existing landraces, at the beginning, helped to prevent losing genetic diversity between varieties during selection too rapidly. The success, at a later stage, of relatively "wide" cross-breeds of improved landraces has most certainly also made a contribution to the broadening of the genetic basis. But today the wide-spread cultivation of only a small number of varieties, together with the advanced uniformity of production on different sites and in various man-made landscapes has resulted in a drop of the number of agricultural and horticultural crops, forest plants and wild plants.

The conservation of forest genetic resources in use is increasingly taken into consideration in forestry via semi-natural silvicultural techniques (see Chap. 5.4) so that the biological diversity of other wild plants is enhanced too. And in agriculture and horticulture more and more thought is given to the principle of sustainability. The Association for Intergrated Plant Production (Fördergemeinschaft Integrierter Pflanzenbau e.V.) intends to take account of plant species and of biocoenoses. Through the inclusion of new species like plants grown for energy or raw material use diversity is to be increased. Further reaching approaches are pursued for example by the Working Party on Ecological Farming (Arbeitsgemeinschaft Ökologischer Landbau, AGÖL). There are more Associations and Working Groups that are ecolgically orientated like the Association for the Conservation of Crop Diversity (Verein zur Erhaltung der Nutzpflanzenvielfalt, VEN), the initiative Plant Breeding Wernstein, the Society for Ecological Plant Breeding (Gesellschaft für ökologische Pflanzenzucht) at Werbellin, the vegetable seed initiative Flail (Dreschflegel) and the Pomologen Association (Pomologenverein).

a,c) Agricultural and vegetable crops

Genetic diversity in the field can be increased through the reintroduction of old and new varieties and species in the cropping pattern, varied rotation and regional recommendations on varieties well suited to the local site conditions. This helps to conserve, develop and multiply a wide range of plant genetic resources under various site and managment conditions. An increase in inter- and intra- specific diversity in crop production and the revival of various fields of production, especially in the renewable resources sector, is promoted by various programmes, mainly in Europe and several interested private groups.

b) Grassland plants

Phytocoenoses on autochthonous grassland are adapted to the site and its long-term management. As a rule, they produce lower but more stable yields, are more resistant to destruction by hoofs and have a higher bearing capacity as well as adjust better to changing environmental conditions. Sustainable use of gentic resources of autochthonous turf takes account of the manifold balances and interactions in the ecosystem. This mainly includes the adjustment of fertilizer application and stocking density, of grass cutting system and maintenance of the turf to local site conditions and natural productivity cycles.

d) Fruit crops

A number of farms that farm with an ecological mind are trying to grow a large number of old fruit varieties. They also aim at improved storage properties and wider gaps in ripening of different varieties to increase the season for home-grown fresh fruit. Sustainable use is also geared to the growing

or collection and processing of wild fruit species. Field experience is available on Japanese quince (*Chaenomeles lagenaria*), cornelian cherry (*Cornus mas*), sea buckthorn(*Hippophae rhamnoides*) fruit rose (*Rosa spp.*), elderberry (*Sambucus spp.*) and mountain ash(*Sorbus aucuparia*).

e) Other permanent crops, special crops

In viticulture diversity can be achieved through vegetative reproduction of vines via the cultivation of different grape varieties and an increase in the number of species grown in vineyards (for example by inter-row systems).

f) Ornamentals

The most important aspect of sustainable use of plant genetic resorces in the production of ornamentals is the conservation and proper managment of the reproductive capacity of wild species at home and abroad for the purpose of breeding and multiplying species that are cultivated.

g) Forestry plants

The sustainable use has a history of more than 200 years in German forestry. The term 'sustainability' over the years was widened not only to include the aspect of wood use but also other forest functions. In accordance with the Federal Forest Act forests shall be managed sustainably. The ministers for agriculture of the Federal and the Laender governments agreed in 1989 that proper forestry is a safeguard for the economic and ecological productivity of forest and thus the sustainability of its material and non-material functions. This type of management is, among other things, characterized by:

- safeguarding of sustainable wood production,
- conservation of forest ecosystems as a habitat for biodiversity through the encouragement of healthy, stable and varied forests
- selection of tree species suited to the site
- use of suitable seed and planting stock while maintaining genetic diversity.

After a strong decline in the Middle Ages and the early modern ages the wooded area has been increasing relatively steadily for more than 150 years. The timber stocks that were diminished during World War I and II and their repercussions have been rebuilt so that the average timber stock has reached some 270 m/hectare. The restocking was, however, mainly done with conifers like spruce and pine the seed of which was available in large quantities and the growing of which is possible, even on difficult sites (heath, large clear-cut areas, etc.), with less effort than in the case of deciduous tree species This restocking system resulted, in some cases, in instable forests not suited to the site.

This is why different Federal and Laender programmes promote the planting of deciduous trees suited to the site and suitable provenances, the management of forest fringes and the planting of rare tree species.

h) Wild plants of potential use

The collection of fruits, flowers and leaves of indigenous wild plants as well as mushrooms which is done to a limited degree, is another form of sustainable use as long as the reproductive capacity of the population is taken into account. It is, however, of minor importance in Germany and is done mainly on a non-commercial basis by private persons, infrequently by commercial firms specializing in this business. Other types of sustainable use of wild plants are bee-keeping and forest grazing (in Bavaria). The obtention of propagation material for the reclamation of damaged landscapes (like open-cast brown coal mining, ski slopes), for landscape gardening and measures of nature protection with indigenous material suited to the site is getting an increasing importance.

4.4 BENEFITS FROM THE USE OF PLANT GENETIC RESOURCES

Basic research uses plant genetic resources to study fundamental questions and problems from different fields of science. It is very difficult to assess the economic benefit of this work in terms of money. They rather consist of the continuous improvement of scientific knowledge and of the techniques used in the following, more application-oriented stages of research and breeding activities.

Breeding research uses the findings of basis research for application purposes. As it is mainly organized by the government it is possible to carry out new labour-intensive work. On the one hand, methods for the identification, isolation and transfer of new heridatary characteristics on the basis of any type of basic material with the help of culture material are developed without also transfering the negative characteristics of the source . And, on the other hand, the performance potential of "forgotten" crops and of wild species with particularly interesting characteristics are studied.

Plant breeders use both conventional and ready-to-use biotechnological methods. By improving evaluation and documentation as well as by research findings breeders are to be provided with a better chance to use plant genetic resources.

Progress in breeding has a direct or indirect impact on the crop yield. Higher and more stable yields are, however, also the result of advances in crop management so that it is not possible to judge breeding progress separately. In addition, many breeders, because of the competition among successful breeds on a European level, do not provide information on the source of beneficial characterisitcs. This is why the advantages of the use of plant genetic resources in breeding can only be shown by means of examples or via indices of breeding progress.

In rare cases the use of plant genetic resources can be reduced to a single effect- in most cases resistance. Selective resistance breeding efforts often produce additional side-effects or interact with other ecosystemic factors. One example is the future use of different mildew resistance genes in spring and winter barley. It impairs and delays the spreading of virulent fungi strains and thus guarantees the efficacy of the resistance genes. Efficacious resistance genes make it possible to reduce the application of agrochemicals which eases the strain on soil, water and the survival of wildlife.

The idea of sustainable use of plant diversity in forestry and ecological farming mainly aims at increasing stability, better exploitation of the site potential and thus at an improved input/output ratio (efficiency). In this context, biodiversity is of great importance in terms of adaptability to a changing environment and of resistance to new diseases and pests. In addition, an increase in immaterial values for society as such is expected (nature conservation and environmental protection, recreation, health).

a-c) Agricultural plants, pasture plants, vegetable plants

In addition to the advantages for the development of varieties that result from the improvement of yields, resistance and quality the relatively recent field of "breeding of raw-material-supplying plants" offers additional benefits of plant genetic resources. Also direct benefits of energy efficiency and, more or less, the production of raw material that is CO_2-neutral indirect benefits (expansion of the range of crops, reduction of food surpluses, income alternatives for farmers) must be mentioned. All this is based, on the one hand, on the search and manipulation of certain characteristics of crops that are already in use (like the quality of rape seed oil, starch content of peas and potatoes), and, on the other hand, the study of indigenous and foreign wild plants with regard to new characteristics (active ingredients, fats, proteins etc.). Table 16 in Annex 2 lists some examples of the integration of certain characteristics of plant genetic resources into varieties of crops and pasture plants and vegetables by breeding.

In Germany in 1992/93 some 383,000 ha were used to grow renewable resources. Of that, 133,000 ha were used to produce starch for processing into

paper and textiles as well as for biotechnology purposes. 250,000 ha were used for oilseed (110,00 ha of which were used for the production of bio-diesel). The growing of renewable resources, however, only makes a limited contribution to the interspecific diversification of the farming systems as it mainly concerns widespread crops. The introduction of new plant varieties into arable farming depends on the intensity of plant breeding activities and the competitiveness of the raw materials produced. Intra-specific diversification can, however, only be achieved through differing genetic patterns geared towards specific uses.

The benefits of the use of plant genetic resources for pastures frequently are based on the integration of autochthonous material by breeders. They are looking for resistances, well-adapted growth characteristics and characteristics suitable for certain purposes (grass cutting, pasturing, lawn). Autochthonous perennial pasture plants and variety material are genetically very close and can be crossed easily. As the autochthonous material is influenced by crop management it is only partly wild. Varieties are not extremely cultivated.

d, e) Fruit plants, other permanent crops, special crops

Wild relatives as well as old and regional varieties of table fruit species and permanent crops (hops, vine) are mainly used as carriers of resistance genes to diseases and abiotic stress factors. Breeders continue to use American wild vines to breed phylloxera-tolerant rootstock. In fruit plant breeding wild species and primitive forms from domestic and foreign sources are used especially to achieve resistance to certain diseases. Table 17 in Annex 2 lists some examples of the integration of certain characteristics of plant genetic resources into varieties of fruit and special crops and other crops by breeding.

f) Ornamental plants

Often wild material from domestic and foreign sources is used, but is not often used as a source of certain characteristics for already existing varieties; it is rather traded after multiplication as ornamentals without any breeder interference. Only if the variety is economically important (perennials, shrubs, roses) the characteristics of wild species are bred in. Novelty and quality are, in addition to production cost, of importance, so that the material traded is inter-specifically varied, but intra-specifically very homogenous. A problem exists with regard to the danger of extinction of rare autochtonous ornamental species at home and abroad.

g) Forestry plants

Forest genetic resources also serve the aim of basic research and the widening of propagation capacities. Basic research is, above all, to result in findings on genetic variation and its geographical distribution pattern (provenance research), the effect of resistance mechanisms and eco-systemic interactions. The Federal/Laender Working Group checked 185 stand and more than 14,000 single trees with biochemical-genetic methods. On this basis mainly seed orchards for the propagation of endangered species and provenances are being established. 404 seed orchards and clone archives of 42 forest tree species were established for maintenance purposes (see Chapter 3.2.1) by the Federal/Laender Working Group taking into consideration phenological characteristics, rareness and other criteria.

Using the suitable forest genetic resources characteristics like adaptability, health, vigour and quality, for example, could be substantially improved for spruce, oak, beech and Douglas fir, in some case, whereas the importation of seed of non-adapted provenances resulted in low increment, instable and patchy stands.

h) Wild plants of potential use

For further details on the use of characteristics of related wild species of certain crops through breeding see different crop categories.

CHAPTER 5
German Policy and Legislation

5.1 GERMAN POLICY REGARDING PLANT GENETIC RESOURCES

Under Germany's federal structure the 16 Laender have legislative competence. The Basic Law assigns differently important competences to the Federal Government for certain policy areas and partial tasks. Only the Federal Government has exclusive competence, inter alia, for external representation, foreign trade and development cooperation. Regarding the promotion of agricultural and forestry production and the trade with seed and planting stock the Laender have competence if there is no legislation by the Federal Government. Joint competences of the Federal Government and the Laender exist in the fields of nature conservation, agricultural structure and research. Agricultural training and forestry are mainly regulated by the Laender. Especially in the agricultural sector competences have been transferred to the European Community.

There is no own legal basis for the conservation and use of plant genetic resources. Different policy areas are concerned, in particular the agricultural, forest, nature conservation, environmental, research, education and development policies, for which a great number of ministries and institutions are responsible. The Laender are generally responsible for the implementation of the laws of the Federal Government and the Laender.

At the national level the conservation and use of plant genetic resources for food, agriculture and forestry falls within the responsibility of the BML. Activities in the field of plant genetic resources contribute to food security and to the improvement of the production conditions for agriculture and forestry as well as to the conservation of biological diversity. The BML considers it to be an important task for the future, for which international cooperation is required to carry out this task.

5.1.1 Agricultural Policy

A co-determinant for the essential features of national agricultural policy since the conclusion of the Treaties of Rome (1957) has been the EC agricultural policy. The agricultural policy is represented at the national and international level by the BML. The BML and the ministries of agriculture of the Laender are given support by various research institutions of the Federal Government (e.g. FAL and BAZ) and the Laender.

The most important objectives of the BML regarding plant genetic resources concern the ensuring and improvement of the natural sources of life and the protection of abiotic and biotic resources as well as the conservation of biodiversity, including genetic diversity.

Since 1957 common market organizations (CMO) have been adopted for a great number of agricultural products within the framework of market and price policies. Products of the European farmers covered by these common market organizations were purchased at subsidized prices exceeding sometimes by far the world market prices. In order to stabilize the markets in the member states, customs duties and quota restrictions were imposed on the imports of agricultural commodities from third countries. These measures were also designed to ensure Europe's self-sufficiency in foodstuffs and the continuation of peasant farming. The intensification of farming, promoted by European agricultural policy, with a high input of energy, fertilizers and plant protection products led to surplus problems for various agricultural products. Initially, these problems were met by storage and exports to third countries. Later, production quotas and guaranteed quota systems were introduced and a co-responsibility levy imposed if the fixed guaranteed quotas were exceeded.

The reform of the common agricultural policy of the EC led to a fundamental change in 1992. The reform decisions include, in addition to the changes in the fields of price and quota policies, socalled accompanying measures serving agricultural structure and rural social policies and environmental protection as well. The most important instrument of the reformed price and quota policies is to reduce price support via intervention in favour of direct compensatory payments and to introduce set-aside with area-linked compensatory payments. In Germany, about 14% of the arable land was set aside covering an area of about 1.6 million ha in 1994. Producer prices were declining, especially in the cereal sector because of cuts in intervention prices of the EC. These measures are designed to reduce surpluses by reducing the cultivated area and the intensity of cropping. The experience gained during the first two years of application confirm the effectiveness of the reform decisions.

As an accompanying measure to carry out the agricultural reform Council Regulation (EEC) No. 2078/92 on "agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside" commits all member countries to draw up appropriate programmes of promotion. The Regulation is implemented in Germany by means of regional programmes of the Laender. Under this Regulation there is also an extensification programme. The reduction of surplus production is to be coupled with an improvement of the environmental situation in agriculture.

Within the framework of the measures to adjust production to market requirements, to develop alternative products and to promote environmentally compatible agriculture as well as quality improvement Regulation (EEC) No. 2092/91 on ecological farming and the related certification of agricultural products and foodstuffs came into force in 1993. Regulation (EC) No. 1467/94 on the conservation, characterization, collection and utilization of genetic resources in agriculture is designed to coordinate the measures in the EC (see Chap. 6.2.1).

The structural policy in agriculture of the EC, the Federal Government and the Laender aims to develop efficient agricultural enterprises and marketing facilities and to improve the living conditions for the people in rural areas. The most important instrument are the aids under the Joint Task of Improving Agricultural Structures and Coastal Protection. In addition, regional economy policy measures are taken to promote rural areas whose development is lagging behind as well as labour market policy measures. Safeguarding the rural area as a place to work and live in is a prerequisite for implementing sustainable use concepts and at the same time for conserving biodiversity in the agro-ecosystem. The social policy in agriculture serves the social security of those engaged in agriculture, but also to mitigate the consequences of the structural change in social terms.

5.1.2 Forest Policy

Forest policy in Germany is formulated by the Federal Government and the Laender . Within the Federal Government it is the competence of the BML. The principal objective is "to preserve the forest because of its economic benefits and its importance for the environment, to extend it and safeguard its proper management in a sustainable way". The BML and the ministries of the Laender responsible for forestry receive advice in this respect from the forestry research institutions.

Appropriate overall conditions should make it possible for forestry to ensure, through proper forestry management, the manifold material and immaterial functions the forest provides for the environment, the population and the economy. Central points in forest policy are: safeguarding the natural bases and all forest functions, making efforts to reduce forest damage caused by immissions, improving the overall conditions for wood processing and timber sale, protecting the forest in planning projects, promoting ecological management methods and structural improvement through forestry associations.

In contrast to agricultural products, wood, which yields about 90% of the earnings of forest enterprises, is not subject to any common market organization and trade restriction. Within the framework of the Joint Task of Improving Agricultural Structures and Coastal Protection the Federal Government and the Laender promote in the private and corporation forest, inter alia, the establishment of broadleaved and mixed forests, forest tending, forestry assocations and measures to limit the new types of forest damage. The EC also provides financial assistance. The afforestation of agricultural land is promoted under Regulation (EEC) No. 2080/92 as an accompanying measure to carry out agricultural reform.

5.1.3 Nature Conservation and Environment Protection Policy

The aim of German environmental policy is to protect the natural sources of life also for future generations and to promote sustainable development compatible with the protection of resources according to the decisions taken by the United Nations Conference on Environment and Development in Rio de Janeiro (1992). In order to comply with these objectives efforts are made in Germany to integrate environmental protection into other action and policy areas, especially energy, transport, regional and agricultural policies.

Nature conservation, including biotope and species protection, fall within the responsibility of the Federal Ministry of Nature, Environment and Nuclear Safety (BMU). It is also responsible for the implementation of the Convention on Biological Diversity. The Laender give substance to this framework.

For nature conservation and species protection land use in particular is playing an important role in addition to keeping water, soil and air clean. The aim of nature conservation in Germany is to effectively counteract the decline in species and biotopes through nature conservation priority areas, consisting of linked natural landscape components as well as ecologically balanced types of management. Area-wide nature conservation in Germany is complemented by

the designation of protected areas (see Chap. 3.1.1). The Fauna-Flora-Habitat (FFH) Directive 92/43/EEC is important in this respect as well (see also Chap. 6.2.2). The Laender have started to implement the Directive. Special measures are taken to protect the Alps, the Wadden Sea and the Baltic Sea coast and biosphere reserves. A national strategy to implement the Convention on Biodiversity is in preparation.

The air pollution control policy in Germany could so far reduce the pollution of forest ecosystems in sub-sectors only. While stricter limits on emissions have reduced sulphur immissions, the discharge of nitrogen has become the greatest factor of pollution for forests and other ecosystems. The negative impact of nitrogen discharges on the genetic constitution of forest tree species has been proved several times. Special attention is also given to the ozone problems and the long-term climate changes.

5.1.4 Research and Education Policies

In general, the Laender are responsible for the research and education policies. The promotion of research and university financing are, however, carried out to a large extent jointly by the Federal Government and the Laender. Within the Federal Government it is the competence of the BMBF. The Federal Government and the Laender jointly finance the German Research Council (Deutsche Forschungsgemeinschaft), Max Planck Institutes (MPI), Fraunhofer Institutes and other research and service institutions ("blue list") of supra-regional and national importance, like IPK at Gatersleben.

The competences for school education rest with the Laender, for vocational training with the Federal Government. In the field of university education the Federal Government's participation is regulated by the University Outline Act which also provides for co-financing university building activities. Furthermore, the Federal Government is responsible for the promotion of training. Specific vocational and university education in the field of conservation and use of plant genetic resources does not exist. A complete overview of the manifold training and study courses dealing with these topics cannot be given at the moment. Thus plant breeding as an important instrument to use plant genetic resources belongs to the curriculum of any agricultural and forestry faculty. The post-graduate training on-the-job plays a central role to acquire specific knowledge.

In situ conservation measures like mapping, compensatory measures, recultivation and drawing up biotope management plans are mainly carried out by staff having undergone university education in the field of biology,

forest science, landscape ecology or nature conservation. The *ex situ* conservation of plant gentic resources is mainly carried out by scientists and engineers in agriculture, horticulture, forestry and biology. Programmers play an increasingly important role in documentation.

The vocational training for agricultural or biological-technical assistants also includes working techniques for the conservation and use of plant genetic resources for breeding purposes. Within the framework of vocational training, for example for the occupations of farmer, forester and gardener, theoretical knowledge is conveyed about seed law, plant breeding and genetics.

Seminars, workshops and symposia on issues relating to the conservation, use and evaluation of plant genetic resources were and continue to be organized and held by various institutions and scientific societies.

Chapter 6.1.4 deals with the training of partner skilled staff being provided within the framework of German development cooperation at various institutions in Germany or under development projects abroad.

5.1.5 Development Policy

Measures to conserve and use plant genetic resources for agriculture and forestry have been of great importance for many years in the bilateral and multilateral development cooperation of the Federal Republic of Germany. At the national level, responsibility lies with the Federal Ministry of Educational Cooperation and Development (BMZ). The programmes and measures are described in Chapter 6.1.

5.2 GERMAN CONCEPT ON PLANT GENETIC RESOURCES

In Germany, first collections of plant genetic resources were established from 1927 on at the Kaiser-Wilhelm-Institute of Plant Breeding Research and from 1943 on at the Kaiser-Wilhelm-Institute of Crop Plant Research. This material provided the basis for the crop plant collections and was incorporated into collections of the IPK, the MPI for Breeding Research, FAL, IRZ of the BAZ and the Teaching and Experimental Station for Integrated Plant Cultivation Güterfelde registered association. In the former GDR collecting activities were continued in connection with government plant breeding activities, inter alia, at today's IPK. The iniatives taken by FAO in the 60s which were supported

by German scientists and private breeders in the Federal Republic of Germany led in 1970 to the foundation of the genebank of the FAL. In response to the new types of forest damage the Laender began in the 80s to intensify their activities for the conservation of forest genetic resources. For details about individual institutions see Chapters 3.2.1 and 3.2.2.

The central importance of plant genetic resources not only for plant breeding, but also for nature conservation and environmental protection caused the BML in 1986 to entrust a project group with the elaboration of a concept for the conservation and use of plant genetic resources for the Federal Republic of Germany. On the basis of programmes and acitivities existing partly for decades and an encompassing situation analysis the project group submitted a concept in 1990 for which the BML elaborated measures for implementation.

The concept analyses the problems of genetic erosion for the Federal Republic of Germany, outlines the reasons for the need for more extensive national and international measures and recommends priorities for research, conservation and use of plant genetic resources. Because of the great number of institutions involved in the conservation and use of plant genetic resources an improved coordination of measures was requested at national level. *In situ* conservation measures were primarily proposed for grassland, forestry and wild plants, *ex situ* measures for the other agricultural and horticultural crop plant species and for the supplementation of *in situ* conservation. The availability of genetic diversity for breeding should be improved as well. For this purpose greater research promotion and an intensification of European and international cooperation were requested. A decentralized system under central coordination was proposed to implement the national and international activities consisting of an Expert Council for Plant Genetic Resources, an Information and Coordination Center for Genetic Resources with central documentation and crop species-specific technical committees (see Annex 2, Fig. 2). The technical committees were supposed to draw up crop species-specific concepts and problem solutions by concentrating competent institutions and experts in species and groups of species with different problems involved.

The German concept on PGR was implemented until 1994 in individual elements only. The reasons for it are the changes in preconditions due to German unity and the costs of implementation. The establishment of an interdisciplinary expert council is in preparation. Information provision was realized by establishing the IGR at ZADI in Bonn. At the IGR the central German documentation is being established at the moment and the further conceptual and advisory tasks performed within the framework of the present possibilities. The further extension is highly necessary and requires further efforts. The planned technical committees do not exist yet. Only for forest

genetic resources there is the Federal / Laender Working Group on the "Conservation of Forest Genetic Resources". The work performed by the Working Group so far regarding the implementation of the national concept in coordinated Laender specific programmes shows the need for such committees also for the fields of agriculture and horticultural crops.

The concept for the conservation of forest genetic resources elaborated in the Federal Republic of Germany in 1987 is a component of the overall concept. According to the Resolution of the Federal Council (the Upper House of Parliament) concerning measures to conserve the genetic diversity of forest tree species (1985) the Federal / Laender Working Group on the "Conservation of Forest Genetic Resources" was established in which the Forestry Experimental Stations and their genebanks are represented. The Working Group elaborated the concept for the conservation of forest genetic resources and a four-year programme for its implementation.

While initially account was primarily taken of the main tree species (beech, spruce, fir and others), rare tree and shrub species are increasingly incorporated into the conservation measures. Special importance is given to the *in situ* conservation of forest genetic resources. The *ex situ* conservation should not only take place in genebanks. Rare and scattered species and provenances should also be concentrated in seed orchards to ensure the capability of propagation and safeguard a broader genetic basis. Especially provenances from areas and stands greatly endangered by immission are to be ensured through planting or seeding in *ex situ* stands. The measures are planned by the forestry testing stations and, if necessary, implemented in cooperation with the forest districts.

The concept for the conservation of the diversity of wild species is mainly laid down in the Federal Nature Conservation Act. The scientific bases for the concept of nature and species protection were mainly elaborated by the Federal Agency for Nature Conservation (Bundesamt für Naturschutz) as well as by the Laender and their scientific institutions. Instruments are, inter alia, the establishment of biotope network systems and the consideration of nature conservation requirements in all use areas.

The German concept on PGR had to be developed further due to the technical and political developments resulting from German unity in 1990 and UNCED in 1992. In the wake of German unification the agricultural partial collections of plant genetic resources which were spread over the breeding research institutes in the former GDR were merged at the IPK and are supported jointly by the Federal Government and the respective Laender

governments. In addition, various institutions of breeding research on agricultural crops of both German states were merged at the BAZ.

To review the genebank organization an organization analysis was worked out in 1994 concerning plant genetic resources in the field of crop plants in Germany. The analysis reveals the duplication of work of parallel institutions and a lack of coordination. It is intended to extend the national genebank to a service institution financed by the Federal Government and all Laender which should also include the genebank of the FAL (see Figure 3). The speeding up of evaluation and the improvement of documentation and information as well as the strengthening of national and international division of labour and cooperation should promote the provision of genetic resources for research and use. The IGR is to be upgraded to assume coordination functions as well.

The objectives of the activities of research, evaluation, conservation and use of the institutions of the National Programme were fixed by BML and BMBF as well as other advisory bodies like the "Genebank Advisory Council" of the IPK, the Working Group on Genetic Resources of the BAZ and the Genebank Commission of the GFP. The great number of bodies, their overlapping work areas and their organization by institutions and not by crop species do not take the German concept into adequate account.

5.3 GERMAN LEGISLATION

As the competence for plant genetic resources is not in one hand because of the federal structure of Germany, there is no common legal basis for all aspects relating to the conservation and use of plant genetic resources. When dealing with the relevant legal basis, priority treatment is given to federal legislation. Regulations under Land law, e.g. forest and nature protection laws, cannot be dealt with in detail. German legislation is influenced by regulations at European and international level to which, if necessary, reference is made.

5.3.1 Nature Conservation and Forestry Legislation

The decisive legal basis in Germany for the conservation of biodiversity is the Federal Nature Conservation Act (Bundesnaturschutzgesetz). The aim of the law is, inter alia, to protect, tend and develop nature and landscape in populated and not populated areas so as to ensure the efficiency of the ecosystem, the productive capacity of the natural resources as well as animals

and plants as the basis of human life. It is a framework law which is given substance and is concretisized by the Laender nature conservation laws.

In its third section the Federal Nature Conservation Act regulates interference with nature and landscape, which substantially or sustainably affects the ecosystem or the appearance of the landscape. One must refrain from avoidable interference. Otherwise interference must be compensated for by the person responsible for interference. Proper agricultural and forestry land uses are, however, not regarded as interference.

The fourth section of the Federal Conservation Act defines area protection categories:

Art. 13: Nature reserves primarily serve the preservation of an indigenous stock of animals and plants encompassing as many species as possible.

Art. 14: National parks are large-scale protected areas which are to remain in a state which is not or only slightly influenced by man and for the most part are not used.

Art. 15: Landscape protection areas are subject to less stringent protection, mostly in cultivated landscapes.

Art. 16: Nature parks are large areas in which recreation and nature conservation have priority. They are often divided into development and recreation zones.

Art. 17: Natural monuments are protected single creations of nature (e.g. old trees)

Art. 18: Protected landscape components are parts of the landscape which are subject to individual or genus protection.

The necessary amendments to the Federal Nature Conservation Act to implement FFH Directive No. 92/43 EEC are in preparation (see Chap. 6.2.2).

The fifth section of the Federal Nature Conservation Act describes the tasks of species protection. They include, inter alia, the protection and development of biotopes of species of wild fauna and flora, as well as the introduction of fauna and flora of displaced wild species. In addition, this section of the Nature Conservation Act contains regulations concerning the protection of wild fauna and flora, especially from human interference. In connection with the Federal Species Protection Ordinance (Bundesartenschutzverordnung) we find there bans on disturbance, withdrawal, possession and trade with regard to species of

animals and plants which are especially protected or threatened with extinction. Trade restrictions in particular are also contained in Regulation (EEC) No. 3626/82 which serves the implementation and uniform application of the Washington Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Federal Species Protection Ordinance extends the number of protected species compared to the CITES Convention and the EC Regulation. According to the degree of risk about 40,000 plant species are listed in the annexes to these regulations. In addition, various rare biotope types are protected according to Art. 20c of the Federal Nature Conservation Act.

The provisions under species protection law are of particular importance for wild plants. Crop plants are normally not subject to specific species protection. Exceptions are individual wild relatives of crops like wild vine (*Vitis Vinifera ssp. silvestris*), endangered grassland species on marginal sites, some medicinal plants and some rare tree and bush species like dwarf and bush-like birch (*Betula humilis* and *B. nana*), daphne (*Daphne spp.*), ilex (*Ilex aquifolium*), rhododendron (*Rhododendron ferrugineum* and *R. hirsutum*), dwarf azalea (*Rhodothammus chamaecistus*) and taxus (*Taxus baccata*).

The Federal Forest Act (Bundeswaldgesetz) does not explicitly mention the aim of "conserving the genetic resources of forests". But it can be derived from the purpose of the law "to protect the forest because of its economic benefits and its importance for the environment". Under the Federal Forest Act and the forest laws of the Laender there are further protected categories like protection and recreation forest and natural forest reserves (see Chap. 3.1.1) in addition to the area protection categories of the nature conservation law. The large-scale designation of different protected areas in the forest can, however, not prevent the danger posed by immissions and climate changes and their implications for forest genetic resources.

5.3.2 Regulations Governing Trade in Seed and Planting Stock

For the trade in seed and planting stock in Germany the Seed Trade Act (Saatgutverkehrsgesetz) is applicable to agricultural crops and vegetables, the Act on Forest Seed and Planting Stock (Gesetz über forstliches Saat- und Pflanzgut) is applicable to the most important forest tree species, while for wild flora the provisions of nature conservation law are applicable. In addition, the Genetic Engineering Act (Gentechnikgesetz) and the Plant Inspection Ordinance (Pflanzenbeschau-verordnung) are of importance.

The Seed Trade Act of 1985 regulates the trade in agricultural and horticultural reproductive material to protect consumers (farmers, gardeners, processors etc.). For the trade in seed and planting stock, variety registration under the Seed Trade Act is required which also implements the EC Directives concerning trade in seed and planting stock.

At present, 68 agricultural and 32 horticultural crop species are subject to the Seed Trade Act. The seed and planting stock of varieties of these species may not be offered for sale unless the variety has been licensed by the Federal Office of Plant Varieties or registered in one of the "Common Catalogues of Varieties" of the EU. For the registration of a variety for the trade in seed the criteria distinctness, homogeneity, stability must be met. Agricultural crop varieties must, in addition, have a VCU. This means that the variety with regard to its quality characteristics compared to approved comparable varieties allows us to expect a distinct improvement for plant cultivation, the processing of the material or the products derived from it. The registration is granted for 10 years (for grape vines 20 years) and can be extended upon request for another 10 years (for grape vines 20 years) in the case of importance for the market. Varieties whose registration ends and/or is not extended may not be brought on the market after expiry of an expiry period fixed by the Federal Office of Plant Varieties.

The Seed Trade Act distinguishes between three categories of reproductive material, the varietally pure pre-basic seed provided by the breeder; the basic seed produced from it by contract firms and the certified seed produced for on-farm production by seed-growing firms. This should ensure the quality, varietal purity and stability of the characteristics.

The Act on Forestry Seed and Planting Stock of 1979 and the regulations issued by the Federal Government and the Laender for its implementation are based on Directives 66/404/EEC, 71/161/EEC, 74/13/EEC and 75/445/EEC. The Forestry Seed Act serves to promote forestry and to improve the productive capacity and the environmental effects of the forests. Focal points of the Forestry Seed and Planting Stock Act are the approval of the basic material (e.g. purety), certification, identity security and control of the reproductive material in the trade in reproductive material of 19 forestry main tree species. The reproductive material of these tree species must be separated, marketed and labelled according to 178 provenance areas which were delimited due to the ecological conditions as well as the phenotype and genetic properties of the tree species and be separated, traded and labelled according to whether they contain autochthonous or non-autochthonous basic material. The conservation of biodiversity is taken into consideration for the authorization of the basic material. For this minimum size of seed stands and

the minimum number of clones for seed orchards are determined. The trade in seed and planting stock of all other tree and shrub species, the natural regeneration as well as the use of forest propagation material for landscape management, within the own enterprise or for scientific purposes is not subject to the provisions of the Forestry Seed Act.

The trade in wild plants is subject to the species protection regulations of the Federal Nature Conservation Act (see Chap. 5.3.1).

The Genetic Engineering Act contains regulations on the trade in genetically engineered modified organisms, including seed and planting stock and is based on Directive 90/220/EEC. Under these regulations a special permission is required for trade in order to protect man and the environment.

The Plant Inspection Ordinance of the Federal Government especially applies to the trade in living plants, plant products etc. Certain plants subject to the Ordinance may be marketed in the EC with a plant passport. For the trade with third countries an officially issued health certificate is normally required. A special licence can be issued for the import of material from collections for the genebanks. The plants are then placed under quarantaine by the institutes and testing stations and examined for diseases.

5.3.3 Commercial Property Rights

The Plant Variety Protection Act (Sortenschutzgesetz) of 1985 serves to protect the rights of breeders in their varieties and to promote plant breeding. Varieties of all plant species may be protected. The effect of the property rights has so far been limited to the national territory.

The holder of variety protection has the exclusive right to market a protected variety for commercial purposes or to produce it for sale and to realize profits from sale. The Federal Office of Plant Varieties grants variety protection for a variety if it is new, distinct from other varieties, homogenous and stable and designated by a denomination suitable for registration. Variety protection under the Plant Variety Protection Act is granted in general for 25 years and cannot be extended; in the case of hop, potato, vine and certain tree species the duration is 30 years. After expiry of variety protection these varieties may be obtained, propagated and marketed by everybody. A precondition for it, however, is a prolongation of variety registration according to the Seed Trade Act for species which are subject in addition to that Act. Such a prolongation is to be justified by an appropriate cultivation and market importance.

The Plant Variety Protection Act grants the socalled "breeding reservation" which allows any breeder to do breeding work with varieties protected under the Plant Variety Protection Act and to utilize the new varieties for commercial purposes. Due to the restriction of the scope to trade for commercial purposes farmers may use the harvested crops of protected varieties as seed on their own farms ("re-use of farm-saved seeds") and within the framework of neighbourhood aid.

These regulations are based on the International Convention on the Protection of New Varieties of Plants of 1978 (UPOV '78) which was revised in 1991 (UPOV '91). On the basis of UPOV '91 the Regulation (EC) No. 2100/94 on Community Variety Protection was adopted (see Chap. 6.4). Accordingly, it is intended to apply for the protection of a variety for the whole EU. For the re-use of farm-saved seeds a regulation on fees is planned, whereby small farmers are excempt from paying fees. It is envisaged to adjust the national variety protection law to the new regulations of UPOV '91 and EC Regulation No. 2100/94.

The variety protection under the Plant Variety Protection Act and the registration under the Seed Trade Act (see Chap. 5.3.2) are not linked with each other in principle, but both procedures are carried out by the Federal Office of Plant Varieties according to the Procedure Ordinance of 1985 according to uniform principles. A breeder normally also files an application for variety protection for a variety subject to registration in order to obtain the exclusive right to propagate and sell. An application for variety protection is filed only for varieties of species not subject to approval if a great and continuous market importance is attached to the variety and the protection granting procedure is worth the financial expenditure.

For the protection of intellectual property there is protection under the Patents Act in addition to the specific protection of breeding performance under the Plant Variety Protection Act. In view of the increasing importance of biotechnology for plant breeding the Patents Act is playing an increasingly important role at the international level. The attempt to bring about a uniform regulation for the patenting of biotechnological inventions for the EU as a whole, has not yet materialized. Decisions by the supreme court, on the present legal basis, have not yet been made concerning the patenting of living beings. The so-called TRIPs Agreement (Trade Related Aspects of Intellectual Property Rights) under international trade law (see Chap. 6.4) is based on the principle that patents must be obtainable in all fields of technology. For plant varieties a sui generis protection system is also admitted instead of patents.

Under the German Patents Act like under the European Patent Convention to which Germany acceded all inventions are accessible to patent protection which are new, inventive and susceptible of commercial application. Plant varieties and biological procedures for breeding plants cannot be patented. However, microbiological procedures are patentable. A patent for a product covers any use of the product, also those uses not yet known at the time when the patent was granted. Patent protection for procedures also covers the products directly produced with such procedures.

The use of material protected under patent law for commerical purposes is not permitted unless the patentee agrees. The use for research purposes continues to be permitted. Special conditions apply with regard to access to the material if the patent applicant deposits this material with an independent depository in addition to a written description of the biological material in the application for a patent. The accessibility of samples of the material deposited corresponds to the accessibility of the written description. Until the publication of an application for a patent (within 18 months after the priority date), files do not lay open to inspection and access is not opened unless the patent applicant agrees expressly. After the publication of the patent application or the grant of a patent access is free and the depository is obliged to hand out samples to any interested person. All depositories have specified the types of organisms which they accept. The depository for microorganisms and cell cultures is the German Collection of Microorganisms (DSM).

5.4 ACTIVITIES OF NON-GOVERNMENTAL ORGANIZATIONS

The focus of work of NGOs was on questions relating to general environmental and nature protection and on species protection. In contrast to the international level (see Chap. 6.3), specific questions regarding the conservation and use of plant genetic resources have so far played an unimportant role for most German NGOs.

As a follow-up to UNCED many NGOs grouped together in 1993 to form the Forum Environment & Development. The main aim of the Forum is to jointly speed up the implementation of the United Nations Conference on Environment and Development (UNCED) decisions. Eight working parties, e.g. on biodiversity, sustainable agriculture and forests were set up for this purpose. A government-sponsored project agency located at the German Nature Conservation Union (Deutscher Naturschutzring) is responsible for the coordination of the Forum. Unter the title "... years after Rio - a stocktaking"

the state of implementation of the decisions of Rio is analysed every year and the need for action set forth.

In addition, there is a great number of groups in Germany which is specialized in the conservation and sustainable use of plant genetic resources, such as the "Association for the Conservation of Crop Diversity" (VEN), the "Society for the Promotion of Goethianic Research" (Gesellschaft zur Förderung Goethianistischer Forschung e.V.), the "Initiative for Plant Breeding Wernstein" (Pflanzenzucht Wernstein), the "Society for Ecological Plant Breeding" (Gesellschaft für ökologische Pflanzenzucht), the Vegetable Seed Initiative "Flail" (Dreschflegel) and the "Pomologen Association" (Pomologenverein).

Since the foundation of the Federal Republic of Germany the Association for the Protection of German Forests (Schutzgemeinschaft Deutscher Wald (SDW)) has supported especially the re-establishment of forests as well as measures to protect forests against the new types of forest damage. It has also launched the "Tree of the Year" initiative which draws attention every year to a tree species worth of protection. The SDW in Saxony-Anhalt is especially active in the field of conservation of indigenous provenances of rare tree and shrub species.

The Working Group on Natural Silviculture (Arbeitsgemeinschaft Naturgemäße Waldwirtschaft (ANW)), established in 1950, based its activities on the idea of mixed forest and permanent forest. The ANW advocates site-adequate tree species mixtures within the framework of natural forest management. In recent years, aspects of species diversity and forest genetic resources are also taken into consideration. The ANW is the German group of the Association of Ecologically Minded Foresters in Europe (PRO SILVA; see Chap. 6.3).

CHAPTER 6
International Cooperation

6.1 GLOBAL COOPERATION

6.1.1 Global Political Initiatives

a) UNCED process

Germany took an active part in the preparations for the United Nations Conference on Environment and Development (UNCED) and during UNCED in Rio in 1992 where, inter alia, the Convention on Biological Diversity and the Framework Convention on Climate Change were signed and Agenda 21 and the Forest Principles were adopted.

Already before UNCED, activities on the conservation and sustainable use of plant genetic resources (see Chap. 2, Chap. 3, Chap. 4) were initiated and carried out in Germany. The UNCED process played an important role in sensitizing politicians, media and the public. From the German point of view, especially the need for speeding up the implementation of the national concept and for coordinating the existing activities at the national and international level became evident. The Rio decisions provide the framework for manifold national and international activities.

The mandates to act for the next millenium in conjunction with Agenda 21 comply with the objectives of German environmental and development policies. Although Agenda 21 is not legally binding, the Federal Government attaches great importance to it for its own policy. An important prerequisite for sustainable global development in demographic, economic, social and ecological terms is mankind's adequate nutrition and education. The Federal Republic of Germany is therefore especially active within the framework of the UN Commission on Sustainable Development (CSD) which was established for the follow-up process to the Rio Conference. It will orient its national activities and its international cooperation in accordance with the requirements of Agenda 21. The conservation and sustainable use of genetic resources through the implementation of Chapters 14 and 15 of the Agenda is therefore of great importance also for other objectives agreed upon in Rio.

The Global Environmental Facility (GEF) is a funding mechanism which is jointly managed by the World Bank, United Nations Development Programme (UNDP) and United Nations Environmental Programme (UNEP) and supports developing countries by taking over the additional costs which arise from the implementation of environmental protective measures of global interest. The GEF was restructured in 1994 and is funded with a volume of US$ 2.02 billion effective until 1997. The Federal Government regards the GEF as the central funding instrument for all UNCED follow-up activities, especially for the implementation of the Rio Conventions.

The Convention on Biological Diversity was ratified by Germany in 1993 and has meanwhile entered into force. It takes the globally accelerating decline of biological diversity into account and supports Germany's policy to combat the causes of this decline at the national and international level. A German strategy for the protection and conservation of biological diversity designed to state the planned measures of implementation is being worked out.

With the Forest Principles of Rio, also supported by Germany, a global consensus was achieved for the first time on the management, protection and sustainable development of forests. Its further development into a forest convention binding under international law is being discussed within the framework of CSD. In the forestry sector Germany plays a particularly active role at the international level (e.g. International Working Group on Global Forests, Montreal Process), at the regional level (see Chap. 6.2.1) and within the framework of forestry development cooperation (Chap. 6.1.3 b).

b) FAO - Global System

Germany and German experts have participated and are participating in many ways in activities of FAO, e.g. in expert groups on forest genetic resources (1968) and plant genetic resources (1972) as well as in the establishment of the International Board on Plant Genetic Resources (IBPGR) of FAO/CGIAR (Consultative Group on International Agricultural Research). Germany is a member of the FAO Commission on Plant Genetic Resources (CPGR) and takes an active part in its working group. In 1983, Germany acceded to the International Undertaking on Plant Genetic Resources with the reservation regarding the plant genetic resources which are at the private disposal of breeders. Germany supports the establishment of a global system with *ex situ* networks in cooperation with CGIAR and the individual states, the establishment of an *in situ* network and a "Global Information and Early Warning System" for plant genetic resources.

c) Initiatives of UNESCO

Germany attaches great importance to the MAB Programme (Man and Biosphere Programme) adopted in 1970 within the framework of the United Nations Educational, Scientific and Cultural Organization of the United Nations (UNESCO) which also comprises projects for the conservation of biodiversity and genetic material in a network of biosphere reserves. In order to coordinate the German activities within the framework of the MAB Programme, the MAB National Committee was set up in 1972.

In Germany, 12 areas covering a total area of 11,589 km^2 have been recognized up to now by UNESCO as biosphere reserves designed to develop scientific bases for the conservation and ecologically compatible, sustainable use of natural resources (see Chap. 6.1.2).

The World Heritage Convention adopted within the framework of UNESCO entered into force in Germany in 1976.

d) International nature conservation agreements

The Ramsar Convention on the conservation of wetlands of international importance adopted in 1971 entered into force in Germany in 1976. The plant species adapted to the wetlands are protected under this Convention as well. Germany has filed an application for 29 protected wetlands as being of international importance to be included in the protected area system NATURA 2000 of the FFH Directive (see Chap. 6.2.2).

For details about CITES see Chapter 6.4.

6.1.2 International Cooperation in Research

a) International agricultural research

The research centers of the Consultative Group on International Agricultural Research (CGIAR) have been a focus in German promotion of international agricultural research since 1972. The conservation, use and improvement of genetic resources is an important field of research of the CGIAR for the decades to come. The programmes focus on the cooperation with agricultural research centers in developing countries.

The International Plant Genetic Resources Institute (IPGRI) promotes and coordinates the activities of the CGIAR regarding the development of a system-wide conservation strategy, the development of integration strategies for the *ex situ* and *in situ* conservation and the establishment of an intersectoral

PGR information system. An ad hoc committee of experts is dealing with the political aspects regarding plant genetic resources. Germany takes part in the discussion on concepts for increasing genetic diversity, on improving the conservation and sustainable use of plant genetic resources as well as on developing a common policy regarding access to plant genetic resources, including patent rights. Germany, as the third largest national donor, makes an annual contribution of DM 29 million and thus takes part in the financing of the CGIAR in the form of unrestricted core, restricted core and special project contributions.

The unrestricted core funds are made available every year as non-earmarked funds by the BMZ to the centers. Germany supports with these funds, inter alia, the work of the IPGRI as well as the conservation and use of the collections of global importance at the International Rice Research Institute (IRRI) and International Maize and Wheat Improvement Center (CIMMYT).

The restricted core funds are made available for defined research programmes designated for specific uses by the Federal Ministry for Economic Cooperation and Development through the German Agency for Technical Cooperation (GTZ). In 1993, four restricted core programmes were promoted designed to conserve and use plant genetic resources at the IRRI (rice), the International Potato Center (CIP, root crops and tubers), the International Livestock Center for Africa (ILCA, fodder crops) and the International Council for Research in Agroforestry (ICRAF, multipurpose trees).

The earmarked funds of special project financing are also made available by the BMZ through the GTZ. They are used for projects limited in terms of time and subjects regarding cooperation between international agricultural research centers and German research institutions. In 1993, five special projects, especially oriented towards plant genetic resources, were promoted as a cooperation between IPGRI and CIP on the one hand and German institutes on the other hand (see Annex, Table 18).

In addition to the financial assistance, the support in terms of staff for CGIAR programmes is provided in the form of experience and knowledge of German scientists and specialists to the strategic development and efficiency of the CGIAR.

BMZ and BML have entrusted the Council for Tropical and Subtropical Agricultural Research (Arbeitsgruppe für Tropische und Subtropische Agrarforschung (ATSAF)) with the task of monitoring of and giving scientific support to programmes and cooperative research projects with CGIAR centers. Scientists especially nominated for these purposes are in continuous contact

with the centers and pay regular visits to them. In addition, workshops between staff members of the centers and German scientists are organized in order to identifiy specific research areas and interests and to initiate appropriate programmes.

Germany also supports international agricultural research outside the CGIAR centers regarding plant genetic resources. Assistance was given for example to the German-Israeli research cooperation (GIARA) and other international agricultural research centers such as the Asian Vegetable Research and Development Center (AVRDC) in Taiwan.

The independent international crop species-specific network organizations are supported by Germany as well. The aim of these organizations is to jointly conserve and utilize collections of plant genetic resources in a network of decentralized collections. These network organizations are coordinated by means of international crop species-specific databases. These databases can be used as well to develop core collections. A core collection contains with a minimum of redundance a maximum of genetic variation with regard to the collection as a whole. Core collections are to facilitate the access to genetic properties in large collections. German scientists played an active part in developing a European, later on an international core collection for barley.

Through German-Dutch cooperation the Netherlands and Germany could make a decisive contribution to establishing the World Beta Network (WBN). The Institute of Agronomy of the FAL is presently responsible for the WBN Secretariat and the International Data Bank on Beta (IDBB) (see also Chap. 6.2). The German-Dutch Potato Collection (GDPC) and the potato collection of the IPK at GroßLüsewitz support international cooperation of potato genebanks (Association for Potato Intergenebank Collaboration (APIC). Databases on passport, characterization and evaluation data were developed within the framework of APIC and are being continuously complemented.

b) International forestry research

The International Union of Forestry Resarch Organizations (IUFRO) was established in 1892 on the initiative of the Prussian Forest Experimental Station in Eberswalde. Today, scientists from all German forestry experimental and research institutions, as well as forestry faculties, are represented. In 1981, a Special Programme for Developing Countries (SPDC) was drawn up designed to specifically promote forest research capacities within the framework of IUFRO in developing countries. German scientists take part in elaborating, inter alia, concepts for the sustainable use of forests and in the IUFRO Working Group on the "Conservation of Gene Resources".

Within the framework of the CGIAR (see also Chap. 6.1.2 a) Germany promotes, in addition to IPGRI and ICRAF, in particular the Center for International Forestry Research (CIFOR) as an International Forestry Research Center.

The BMZ is financing an independent programme to promote tropical forest research which indirectly also concerns forest genetic resources. At present, regional promotion is focusing on tropical humid forests on Borneo and on tropical dry forests in Latin America.

German forest ecosystem research undertaken at the research centers in Göttingen, Kiel, Bayreuth, Eberswalde and Tharandt is incorporated through the Terrestrial Ecosystem Research Network (TERN) (see Chap. 6.1.2 c) into the International Geosphere-Biosphere Programme (IGBP) and recognized within the framework of the MAB programme.

c) International environmental research

The ecosystem research centers of the TERN of Germany take part in the IGBP. TERN was established in 1988 by the BMBF which also provides support. Issues of biodiversity and genetic resources are also investigated while exploring forestry and agricultural ecoystems. With the Solling project, in existence since 1969, the Center for Forest Ecosystem Research (FWZ) in Göttingen has incorporated the globally oldest ecosystem research project of such a dimension into the network.

International cooperation in the field of environmental and ecosystem research was decisively influenced by the MAB Programme of UNESCO (see also Chap. 6.1.1). Within that framework interaction between man and environment are explored. The activities increasingly cover studies dealing with the importance of biodiversity for natural and anthropogenous ecosystems as well as with the effects of man's action on biodiversity. Since 1989 projects of German ecosystem research centers, e.g. of the FWZ, have also been recognized by UNESCO as MAB pilot projects.

The Accompanying Ecological Programme for the Tropics (TÖB) financed by the BMZ since 1992 promotes research on interrelations between and within ecosystems with the aim of their integration into development policy.

6.1.3 German Development Cooperation

a) Agriculture and horticulture

Within the framework of bilateral development cooperation, in addition to its support given to international agricultural research institutions for measures to conserve and use PGR, Germany has promoted for more than 20 years the *ex situ* conservation in genebanks and living collections.

Since 1976 Germany has given support to the Ethiopian genebank in Addis Abeba (Plant Genetic Resources Center Ethiopia; PGRC/E). This genebank contains collections of wheat, barley, maize, teff, sorghum, grain legumes and oil crops. The genebank's laboratory is being enlarged to carry out comprehensive quality analyses in order to use gene material more effectively for breeding and research purposes.

Since 1976 Germany has also supported the genebank in Turrialba (Costa Rica) sponsored by the Tropical Agricultural Research and Higher Education Center CATIE. The area of the mandate of the sponsoring agency covers Central America and the Caribbean. A great diversity of fruit trees, dye and fibre plants, spices and fodder crops as well as maize, root crops and tubers are being conserved. An important proportion of collections covers coffee and cocoa. Trees and shrubs are being conserved in living collections on about 50 ha.

Since 1980 promotion has been given to the Kenyan genebank by the Kenyan Agricultural Research Institute (KARI) acting as sponsoring agency. KARI is mainly active in Kenya itself, provides the national research and breeding institutions with gene material and receives in return collections of wheat, barley, maize, sorghum, grain legumes and oil crops. Add to this a significant collection of tropical and subtropical fruit trees.

In addition, Germany supports supra-regional projects such as "Small-scale seed production", "Network on vegetable growing in Africa" and "New methods of seed production". NGOs receive support with the aim of making a contribution to conserving local gene material in addition to ensuring food. Breeding as well as seed and planting stock propagation programmes of many African states which are not fully effective also provide an opportunity, by mobilizing self-reliance, to make once again greater use of landraces and other local resources in addition to breeding varieties and thus to counteract the loss of such resources.

b) Forestry

Germany supports with many projects the sustainable management of indigenous forest resources. Some projects are focused on the improvement of the supply with seed and planting stock of indigenous tree species (e.g. in China, Malaysia, Korea, Nepal) or on the natural regeneration of adapted, but overexploited forests (e.g. in India, Nepal).

Germany has supported for some years the establishment of forest seed supply in Morocco. For this purpose stands and residual resources of tree species are evaluated, seed collection stands selected, institutions established for the storage and processing of seed as well as a pilot nursery set up. In Kenya, promotion was given to the establishment of forest seed supply, the delimitation of provenance areas and the drawing up of provenance recommendations.

In Nepal, capacities for plantlet production with indigenous tree species were established and the natural regeneration of forest resources promoted. In the Chinese province of Shanxi, a center for forest tree breeding is being established. Its tasks also includes the breeding of tree species for the large-scale establishment of mixed stands and shelter plantations. In Malaysia, a programme on seed supply with indigenous species is under way designed to elaborate also the scientific bases for indigenous seed and planting stock.

c) Environmental protection and nature conservation

International cooperation in the field of environmental protection and nature conservation has gained momentum because of the global extent of environmental destruction and has increasingly been incorporated into development policy. The nature conservation projects promoted by Germany aim to preserve and restore the efficiency and utility of ecosystems by means of a protection of species, biotopes and landscapes. From the great number of bilateral and multilateral projects, some projects serving as an example are outlined below.

In 1991, Germany and Israel signed a government agreement on a joint nature conservation project. Germany supports Israel in connection with the registration of the Karmel mountains as a biosphere reserve. An important component of cooperation is to establish permanent ecological monitoring in the Karmel mountains.

In the tropical forest of the Brazil federal state of São Paulo, the decline in habitat and thus the reduction of variety diversity is proceeding particularly

drastically. Germany supports Brazil's efforts to preserve the Atlantic coastal forest and to secure its ecological and economic functions in a sustained way.

Together with the World-Wide Fund for Nature (WWF) Germany supports an environmental action plan for Madagascar designed to protect natural forest reserves in conjunction with the management of peripheral zones. The local population should be sensitized for environmental questions at the same time.

6.1.4 Training in Development Cooperation

In addition to the financial and staff promotion of international research and the implementation of specific measures, advanced training measures for skilled partner staff constitute an important component in German development cooperation. The measures support, inter alia, the conservation and utilization of plant genetic resources through advanced training regarding a more efficient management as well as organizational, technical and scientific aspects from the collection to the use of plant genetic resources, organization of seed and planting stock programmes. The development of biotechnology aids, such as micropropagation and related techniques for the conservation and use of plant genetic resources, are to be developed as well.

Germany gives promotion to such projects through the GTZ, the German Foundation for International Development (DSE), the German Development Service (DED) and other institutions. There are also programmes of the BMBF and projects which are implemented by the German Academic Exchange Service (DAAD).

Within the framework of the genebank projects, training programmes are implemented, at suitable institutions in developing countries (especially CGIAR research centers) or in industrialized countries. Various training programmes and workshops are offered focusing on the development of new varieties, the conservation of varieties and biotechnology.

Academic promotion is also of relevance, for example, the post-graduate study courses supported by the DAAD and GTZ and the specialization on "Plant Genetic Resources Management" within the framework of the diploma studies at the Agricultural Science Faculty of the University of Zambia (UNZA) which offers a Master of Science Programme in crop science for the whole Southern African Development Community (SADC) region.

Training measures concerning different aspects of plant genetic resources conservation, documentation and use for staff from developing countries are

also offered by the DSE in Germany. Three courses are dealing with specific topics concerning plant genetic resources:

- conservation and use of plant genetic resources (duration: 1 month)
- use of plant genetic resources as a contribution to food security (duration: 13 months)
- biotechnology: micropropagation and related techniques for the conservation and use of plant genetic resources and improvement of plant crops (duration: 4 months)

The Carl-Duisberg-Association (CDG) carries out, inter alia, training courses on the integrated development of natural resources and environmental management in the field of nature conservation. Within the framework of a programme on the management and conservation of biodiversity training and managerial staff is being trained in the field of species protection.

Tropics and subtropics related education and research have been gaining momentum at the agricultural and forestry faculties and research institutions in Germany. Field trips and research visits to Germany, partly financed by the Federal Ministry of Food, Agriculture and Forestry, were carried out for research workers and practicians from central and eastern European countries. German private plant breeding supports advanced training and the exchange of foreign experts.

6.2 EUROPEAN COOPERATION

6.2.1 European Political Initiatives

In 1989, the Council of Europe established an expert group on "biological diversity and its conservation" dealing with the protection of wild relatives of our crop plants. In cooperation with Kew Gardens a list was drawn up for the Council of Europe of the most important crops and their wild relatives.

Within the framework of the Protected Area Programme of the Council of Europe the registration of biogenetic reserves can be applied for. Up to now Germany has integrated one area near Bremen into the programme. Since 1967 the Council of Europe has awarded the Europe diploma to 8 areas in the Federal Republic.

At the Ministerial Conference on the Protection of Forests in Europe held in Strasbourg in 1990, Germany signed Resolution S2 "Conservation of forest genetic resources" and Resolution H2 "General Guidelines for the conservation of the biodiversity of European forests" which took place in Helsinki in 1993.

Resolution S2 commits Germany to take measures at the national level to conserve forest genetic resources. This work was started in 1986 already by the Federal / Laender Working Group on the "Conservation of Forest Genetic Resources". An international follow-up committee, in which Germany plays an active role, carried out a preliminary study of the status of and risk to forest genetic resources in Europe, legal framework conditions and appropriate conservation programmes. The European Forest Genetic Resources Programme (EUFORGEN) was drawn up for the further implementation of Resolution S2 (See Chap. 6.2.2).

Resolution H2 has brought about suggestions of international importance for forestry in particular with regard to the implementation of the decisions of Rio. Germany has committed itself to promoting the biological diversity of the forest, inter alia, through forest policy measures and continued forest ecosystem research. In this respect, international cooperation should be strengthened.

The Convention on the Conservation of Wildlife and Natural Habitats (Bern Convention) was adopted in 1979. This Convention is applied by Germany and increasing importance is attached to it for species protection regulations which are coordinated at the European level and for an all-European biotope network system.

Environmental protection in Europe and outside Europe increasingly carries the stamp of the environmental policy of the EC. It is based on the relevant legal provisions of the EC Treaty.

The EC Conference on "Biodiversity - a challenge to science, industry and society" - held in Dublin in 1987 within the framework of the FAST Programme (Forecasting and Assessment of Science and Technology) was the first initiative taken by the EC. The report was not published.

The FFH Directive No. 92/43/EEC is considered by Germany to be an important step towards an all-European biotope network system (see Chap. 6.2.2).

In 1990 the EC Commission was requested to submit a report on the conservation and use of plant genetic resources. This report contained a

proposal for a Community programme for the conservation of plant genetic material in addition to an analysis of the experience gained with existing EC programmes for the promotion of research. Consequently, funds were made available by the European Parliament from 1992 already. The Council Regulation (EC) No. 1467/94 on the conservation, characterization, collection and utilization of genetic resources in agriculture took into account the initiatives. This Regulation promotes the more effective organization and coordination of the measures to conserve and use the genetic resources in the EU. For details about the Action Programme under Regulation No. 1467/94 see Chapter 6.2.2.

6.2.2 European Programmes and Measures

Under the Action Programme of EC Regulation No. 1467/94 the EC Commission promotes, on a priority basis, activities to reduce genetic erosion and improve the conservation and use of agricultural and forest genetic resources. The programme explicitly excludes research measures. It was drawn up for a period of 5 years and funded with 20 million ECU.

The Flora-Fauna-Habitat Directive (FFH Directive No. 92/43/EEC on the protection of natural habitats and wild fauna and flora) commits the EU member states to incorporate habitats of certain importance into an EC-wide network of protected areas (NATURA 2000). The necessary amendments to the Federal Nature Conservation Act to implement the FFH Directive are in preparation. Protected areas are being selected by the member states to set up the EC-wide biotope network system NATURA 2000.

The European Cooperative Programme on the Conservation and Exchange of Plant Genetic Resources of Crop Plants (ECP/GR) was launched by German participation. Both German states have taken part since 1983 in the ECP/GR. Germany's present contribution amounts to US $ 30,000. German institutions have taken over the responsibility for a number of networks (see Annex 2, Table 18) for single crops and are taking part in the establishment of the following ECP/GR databases:

- The European Barley Database (EBDB) has been in operation since 1983. In 1987 already, it had over 60,000 data. In cooperation with the Ethiopian and Russian genebanks first steps were taken to set up an International Barley Database. On the basis of the available data duplicate searches were carried out and a core collection for barley developed (see also Chap. 6.1.2).

- The European Beta Database was established in 1987 on the basis of German-Netherlands preparatory work, extended in the course of time beyond Europe's frontiers and developed to become the International Data Bank on Beta (IDBB, FAL Braunschweig) with meanwhile over 200,000 data from 25 collections (see also Chap. 6.1.2).

The European Data Bank on Brassica (BrasEDB) was established through the German-Dutch Cooperation. It has at the moment data on 11,958 samples of 15 countries and is located at the Center for Genetic Resources of the Netherlands (CGN).

The *in vitro* collection of European potato varieties was also established within the framework of the German-Dutch Cooperation.

The European Forest Genetic Resources Programme (EUFORGEN) was set up at the suggestion of the Ministerial Conference on the Conservation of Forests in Europe in Helsinki in 1993 (see Chap. 6.2.1). The core tasks of EUFORGEN are to coordinate and promote the *in situ* and ex situ conservation of the forest genetic resources in Europe, to exchange reproductive material and information as well as to monitor progress. IPGRI has taken over coordination. Activities concentrate on spruce (*Picea abies*), oak (*Quercus suber*), black poplar (*Populus nigra*) and valuable hardwoods (*Rosaceae* etc.). Germany takes part in the programme by making technical contributions. It has not yet signed the Letter of Agreement.

6.2.3 European Cooperation in Research

The European System of Cooperative Research Networks in Agriculture (ESCORENA) was established in 1994 with the support of FAO. In a time of fast technological and scientific developments when not all institutions and countries are able to cover all research and development areas, ESCORENA should facilitate better coordination. 10 crop-specific networks were established dealing to a varying degree with the problems of genetic resources.

The Research Framework Programme of the European Union (4th Framework Programme 1995-1998) is playing an increasingly important role for projects in the field of genetic resources, primarily through the Programme on "Agriculture and Fisheries", "Biotechnology", Environment and Climate", "Cooperation with Third Countries and International Organizations" (STD Follow-up Programme) and "Training and Mobility of Scientists". Under this programme bilateral or multilateral research programmes are promoted carrying out, for example, studies concerning "Novel and optimized raw

materials and high-quality food commodities" (FAIR), "sustainable management of renewable natural resources" (STD follow-up) or "impact of climate change on natural resources" (environment and climate).

Under the Programme "Biotechnology" research projects are being promoted to develop cellular and molecular methods for a fast and effective identification of genetic diversity and to ascertain the variation of specific properties of economic value as well as to develop different techniques to improve the *ex situ* and *in situ* conservation under the aspects of population genetics, evaluation, phylogenetics and environment.

Since 1984, German and Dutch research institutions and scientists have been working on Beta beet, potatoes, forage grasses and brassica within the framework of German-Dutch cooperation. In this connection, collecting missions were carried out, the material was propagated and tested and initiatives launched to develop international conservation and documentation activities.

The European Association for Research on Plant Breeding (EUCARPIA) has drawn attention as early as in 1962 to the threat to the genetic diversity of the wild relatives of our crop plants. In 1968, a genebank committee was set up. On its recommendations subregional genebanks should be set up in Europe. The genebank at the Institute of Agronomy of the FAL, like other genebanks, goes back to that initiative.

Germany takes an active part in the European Forest Institute (EFI) established in 1993. It is an independent European non-governmental research association with headquarters in Finland. EFI is dealing, inter alia, with questions of sustainable management and biodiversity of European forests.

The European Tropical Forest Research Network (ETFRN) was established in 1991 by the EU Commission in order to promote the cooperation between research institutions, governments and industry regarding the tropical forest and to support the exchange of information and cooperation between institutions. ATSAF is the coordinator of ETFRN (see Chap. 6.1.2).

6.3 INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS

German development cooperation is ensured to a significant extent by non-governmental organizations. One of the focal points of work is to promote projects to improve agriculture and rural development to combat the hunger in the world.

The work of the NGOs is financed from own funds, donations, church taxes and public grants. Church NGOs are, for example, aid organizations belonging to the Working Group of the Church Development Service, Misereor, Adveniat, Children's Emergency Aid and Protestant Missions. Important non-church organizations are, for example, German Agro Action (Deutsche Welthungerhilfe), Terre des Hommes, Eirene and ASW/WFD. Various NGOs like Overseas Services (DÜ) and the Working Group on Development Aid (AGEH) procure European and overseas personnel for programme participation. In addition, practical development cooperation takes place by a great number of small initiatives and action groups. It is chiefly thematically and regionally limited, such as the German-Nepal Aid Agency (DNH) and the Association to Promote Agriculture and Environment (VFLU). In addition, private foundations promote cooperations with institutions in developing countries, such as the Eiselen Foundation in West Africa, which promote the use of biotechnology methods in breeding research.

The projects support very heterogenous local initiatives and are not centrally recorded. Partners are farmers' associations, cooperatives and local non-governmental technical and welfare organizations. A characteristic feature of development cooperation at the NGO level is the clear orientation towards poverty and the restriction of cooperation to small and subsistence farmers, tenant farmers and farm workers.

The success of modernizing agriculture with the aid of modern inputs and methods which had priority importance in former times is meanwhile seen with scepticism in the light of poverty alleviation. Therefore, the priority has shifted to projects of site-adequate sustainable agriculture with increasing attention to seed issues. Purely seed-oriented projects that promote traditional rather than modern seed are gaining momentum.

German NGOs engaged in development cooperation also promote international seed action networks, e.g. Genetic Resources Action International (GRAIN), Rural Advanced Foundation (RAFI) and Seed Action Network (SAN) as well as regional or national networks in developing countries, e.g. Latin American Center for Economic and Social Documentation (CLADES),

Advice and Service for Alternative Agricultural Projects (ASPTA, Brazil), Center for Education and Technology (CET, Chile), Center for Research and Education for the Development (CICD, Peru), Main Agricultural Center (IMC, Columbia), PGRC/E (Ethiopia), Community Technology Development Association (CTDA, Zimbabwe), South East Asian Regional Institute for Community Education (SEARICE, Philippines) and Partners for Community Organizations of Sabah (Malaysia). These organizations are in contact with local initiatives and organizations. The networks chiefly serve to promote the exchange of information and seed. Local seed projects are also directly supported by NGO.

In 1993, the international and 15 regional and/or national seed networks of the Third World formed the Community Biodiversity Development and Conservation Programme (CBDC). The four-year programme and a coordinating office of the CBDC are co-financed by some German NGO. CBDC endeavours to improve conservation and utilization measures at village level through socalled Community Based Seed Management. This approach primarily pursues *in situ*/ON FARM strategies.

The informal sector in developing countries is of greater importance for plant breeding, seed supply and conservation than the formal sector. This applies in particular to small-scale and subsistence agriculture as well as above all to crops which are important for nutrition but have no market importance. In addition to the evaluation of farm owned seed and its improvement through simple breeding methods the reproduction, distribution and conservation of seed takes place mostly on the basis of traditional village community relations.

Another aspect of the approach is building awareness about all aspects regarding the conservation and use of seed as well as the education and training of farmers in the seed sector. This strengthens the self-reliance of local communities also regarding the importance of indigenous knowledge.

The International Federation of Organic Agriculture Movements (IFOAM) is an international federation of associations and initiatives to promote organic farming and advocates as sustainable a use as possible of plant genetic resources in the production process.

In the forestry development cooperation of German NGOs projects are carried out on a priority basis regarding sustainable forest management at local level, the use of local knowledge and traditional methods, the integration of silviculture and agriculture through agroforestry and silvipastoral types of use, the diversification of forest use as well as afforestation projects for the

protection of water, soil and timber supply and for the stabilization of landscape areas.

The Association of Ecologically Minded Foresters in Europe (PRO SILVA, founded in 1989) is a federation of national or regional associations in 18 European states. PRO SILVA promotes the European cooperation between foresters, forest owners and forest friends to ensure and conserve forest ecoystems regarding efficiency, sustainable use and diversity, the exchange of experience of ecologically managing enterprises also on the basis of pilot enterprises as well as forest ecosystem related research and teaching. The Working Group on Natural Silviculture (see Chap. 5.4) is the German group of PRO SILVA.

The Environment and Development Forum is a union of German NGOs engaged in the political sector (see Chap. 5.4).

The International Union for the Conservation of Nature (IUCN) submitted a global programme on the conservation of biodiversity in 1992 to allow the sustainable use of genetic resources as well. The Federal Government (responsible Ministry: BMU), government agencies as well as a great number of German nature conservation associations and individual persons are represented in the IUCN.

German botanic gardens are also represented in the Botanic Gardens Conservation International (BGCI). The BGCI has set up a database on all species and provenances represented in the affiliated botanic gardens with the aim of promoting especially the exchange of plants between the gardens.

6.4 INTERNATIONAL TRADE AND COMMERCIAL ARRANGEMENTS

The influence on and importance of international trade flows for the genetic resources in agriculture and forestry has in its complexity not yet been analysed in greater detail (see also Chap. 7.1.2). The recognition that international trade agreements and international trade flows are important for the environment led in Rio in 1992 to the inclusion of the request for mutual support of trade and environmental policies into Agenda 21.

Article 15 of the Convention on Biological Diversity states that the authority to determine access to genetic resources rests with the national governments, while access in conformity with the objectives of the Convention should be

facilitated by other contracting parties. In accordance with Article 16 of the Convention Germany provides access to other contracting parties, especially developing countries, to technologies for the environmentally sound use of genetic resources. National and international regulations are, however, still, necessary regarding the access to plant genetic resources and to relevant technologies.

Even before UNCED 1992, the Organization for Economic Cooperation and Development (OECD) and the General Agreement on Tariffs and Trade (GATT) startd to analyze the topic "environment and international trade". Within the framework of OECD economic incentives to improve the preservation of biological diversity are being discussed.

A working party of the World Trade Organization (WTO) as the successor to GATT is designed to clarify whether and/or what changes in the multilateral trade system are necessary to meet the requests of UNCED under trade and environmental policy aspects. The preamble to WTO explicitly states the aim of protecting and conserving the environment. The Committee on Trade and Environment is designed to coordinate the policy of WTO in the fields of trade and environment. Within the framework of these developments the requirements of conserving and using plant genetic resources in a sustainable way could also play an increasingly important role, as they provide a vital basis of life at present and in the future.

The International Convention on the Protection of New Varieties of Plants was revised again in 1991 (UPOV '91). On the basis of UPOV '91 the EC issued Regulation (EC) No. 2100/94 on Community varieties protection (see Chap. 5.3.3) which entered into operation on 27 April 1995. Under UPOV '91 further actions, going beyond trade, are covered by the right to ban of the varieties protection owner, contracting states, however, have the possibility to grant the right of farmers to re-use farm-saved seeds for part of crops taking the legitimate interests of breeders into account. The right to ban of the varieties protection owner was extended to the effect that a right to ban is granted to the original breeder chiefly for derived varieties. UPOV '91 has not been ratified in Germany yet.

The TRIPS Agreement (Agreement on trade-related aspects of intellectual property rights) as part of the agreement on the establishment of the World Trade Organization, is based on the principle that patents in all fields of technique must be obtainable. Under Article 27.3 of the TRIPS Agreement states are allowed to exempt from patenting animals and plants, if an effective sui-generis protection system for plant varieties also exists.

The SPS Agreement on health and plant protection measures as part of the world trade system allows member states to take measures against the introduction of diseases and pests to protect mankind, animals and plants.

In Germany, the EC Directives 66/404 EEC and 75/445/EEC apply to trade in forest reproductive material. In addition, Germany joined the OECD Scheme on International Trade in Forest Reproductive Material.

From the very beginning Germany strongly committed itself for the CITES Convention (Washington Species Protection Convention). In the Federal Republic the CITES Convention came into force in 1976. The EC implemented the Convention in all EC Member States with Regulations (EEC) No. 3626/82 and 3418/83. Complementary regulations are contained in the Federal Nature Conservation Act and the Federal Species Protection Ordinance (see Chap. 5.3.1). Recently, Germany has made special endeavours to protect endangered valuable tropical broadleaved trees.

CHAPTER 7
National Problems and Possible Solutions

7.1 ANALYSIS OF THE PRESENT SITUATION

7.1.1 General Situation

1) The fundamental causes for a reduction of genetic diversity in Germany are to be found in a change from an agricultural to an industrial society and an intensification of farming. Germany is a highly developed industrialized country. Its agricultural and forestry primary production, at 3.6% of the labour force and 1% of the gross value added, still play a minor role only. It produces per unit area substantially more foodstuffs than in former times. This was achieved primarily through biological-technological progress, above all through improved seed and a high input, for example, of energy, machinery, fertilizers and plant protection products which are purchased as intermediate inputs by the upstream stages of the sectors of the economy. The degree of self-sufficiency in foodstuffs is high.

2) Industrialization, with its increasing division of labour and rationalization, forced agricultural holdings increasingly into the role of producers of high-quality, as uniform as possible raw materials for supraregional markets. These chiefly provide the basis for the production of food and feedingstuff industry. The diversity of cultivation at the farm level was increasingly replaced by the diversity of processed products. Labour division is also playing an important role in the upstream sectors. Thus plant breeding has developed into a specialized sector of the economy. Due to breeders' efforts of many years today's crop varieties possess a great number of direct or indirect yield- and quality-relevant genes and properties under the prevailing cultivation and environmental conditions. Simultaneously, undesired properties were eliminated from the breeding material to a large extent. Resistance breeding performed for many years has partly allowed to substantially reduce the use of agrochemicals in the case of many crops.

3) Specialization and rationalization have also led to a restriction of the crops under cultivation. In addition, landraces, which had adapted to certain sites and microclimates, were lost to a large extent in cultivation. In contrast, the

number of varieties within the main crop species has been increasing slightly for about 25 years, while only few varieties take over large market shares in practical cultivation. However, the varieties having great importance for the market are subject to an increasingly fast change in varieties. In view of the surplus production of agricultural products new crops are tested for their worthiness of cultivation and are being promoted.

4) The environmental problems resulting from an intensification of agriculture and the changes in the economic overall conditions require an adjustment of agricultural production and lead to additional breeding objectives for crops. In this respect, breeding research and plant breeding depend on the availability of genetic resources.

5) Developments of basic research provide new opportunities especially in the field of molecular genetics for work on genetic resources. Thus, molecular genetic techniques for ascertaining genetic distances serve to establish core collections. In addition, molecular marker techniques can support the comprehensive identification and taxonomic classification of samples and thus a more precise analysis of relationship and duplicate identification. These methods are applied to a small extent only. Molecular genetics and breeding feel increasingly in a position to ascertain the precise function of genes in the metabolism of plants, store defined DNA fragments in DNA banks and create new genotypes systemically.

6) Globally, increasing urbanization and division of labour necessitate, inter alia, regional specialization and concentration of agricultural production due to different natural, socio-economic and environmental production conditions and thus a reduction of the diversity of agricultural ecosystems and the cultivated crops at a regional level.

7) So far, it has been difficult to assess the type and extent of stresses resulting from the expected climate change and the ozone hole on the genetic resources. Increasing world trade and tourism involve the danger of an uncontrolled introduction of foreign plants and the spread of new diseases and pests.

8) The public is not yet adequately aware of the importance of the genetic diversity of crops as a basis of future food security. Moreover, the use of genetic resources, like other natural resources such as land, water and air, as public goods is subject to a limited economic assessment only, while neglecting external costs. Specific certification and markets for products, which serve to conserve genetic resources through appropriate use, are not yet widely spread.

9) Germany maintains, by international comparison, one of the biggest collections of genetic resources of agricultural crops which are preserved

under *ex situ* conditions and are available for the different uses and world-wide exchange. These collections need substantial funds of the Federal Government and the Laender for their maintenance.

10) The contexts mentioned provide the framework for all objectives and activities pursued in Germany to improve the conservation of the scientific work on, and the sustainable use of plant genetic resources. Efforts are made to achieve a more efficient organization of the facilities involved, including the establishment of a coordination and information system on plant genetic resources, and to create the appropriate political, legal and economic overall conditions. Other priority areas are the strengthening and integration of *in situ* conservation into the existing measures of conservation and use as well as the improvement of the efficiency and quality of *ex situ* conservation. The effectiveness of national measures depends on increasing international division of labour and is strengthened by development cooperation in the field of plant genetic resources.

7.1.2 Special Causes of Genetic Erosion

a) Agriculture and horticulture

11) The number of crops cultivated in agriculture and horticulture has diminished over the last 150 years. Some crops and their products were replaced by artificially produced substitutes (dye plants, medicinal plants) or by imports from areas having more favourable production conditions (e.g. some fruit and vegetables species, fibre plants, grain legumes). Increasing specialization of farms and intensification of farming also played a role in this respect. This development interacts with global division of labour in agricultural production, the processing of agricultural and forestry products as well as a concentration of marketing.

12) The reduction of genetic diversity of agricultural crops mainly occurred as a result of the development of systematic breeding as well as administrative measures and requirements. The great spread of leading high-yielding varieties reflects this development. The narrowing of the genetic basis of single species which contrasts with a broadening in the case of other crops through crossing with wild and breeding material from abroad.

b) Forestry

13) Forest clearance on arable land in earlier centuries has led to the loss of important parts of habitats for many tree species typical of these sites. In

addition, overexploitation of existing broad-leaved stands and a preference of afforestation for fast-growing pure spruce and pine stands has caused a further reduction of natural diversity. Efforts to extend the range of species and forms partly resulted in the cultivation of non-adapted tree species and provenances. Excess game populations are a danger to natural regeneration in certain regions. The cultivation over decades of exotic provenances of tree and shrub species in landscape management must be seen critically.

14) The immission of pollutants and nutrients from industry, traffic and agriculture affect, in addition to climate changes and the ozone hole, the forest ecosystems on a large scale. They lead, like in most industrialized countries, to forest damage. They exert a special selection pressure on the forest ecosystems. The impact on some sites particularly exposed to pollution in the low mountain ranges has even led to forest decline. The result of pollution is a reduction of genetic diversity, especially in highly affected areas.

c) Environmental protection and Nature conservation

15) The main causes of genetic erosion are changes in the man-made landscape. Substantial interferences with agricultural and forest ecosystems continue to occur in favour of settlement and traffic areas. This goes hand in hand with an increasing fragmentation of the landscape. The biological diversity of agricultural ecosystems has, in addition, been reduced by immissions of pollutants and nutrients, land consolidation, irrigation and drainage, the use of plant protection products and a high input of fertilizers. Decline in species, reduction of genetic diversity and suppression of the exchange of genes of isolated populations are essential characteristics of gene erosion of wild species as well.

7.1.3 Problems in Connection with Conservation

a) *ex situ* conservation

16) Storage capacities in Braunschweig and Gatersleben are exhausted. The long-term storage capacity with modern equipment is inadequate at Gatersleben in particular. There is a distinct overlapping of tasks among the individual conservation facilities. Low-cost techniques for long-term storage for mainly vegetatively conserved species and various forest tree species do not exist yet.

17) We have no complete overview yet regarding the extent and importance of further *ex situ* collections of permanent and special crops as well as special and working collections and collections of crop plants in botanical gardens and arboreta. They are still inadequately integrated into the concept for conservation and use, and funding is not always ensured.

18) As regards the collection and inclusion of new samples a consistent strategy is lacking partly. Individual crops are inadequately represented in the collections (e.g. berry fruit, permanent and special crops, shrubs). A definition of (international) core-collections so far exists for barley only. Genebanks have not sufficiently been examined for duplicates. A systematic safety storage only exists in individual cases.

19) So far, it has not been possible to adequately assess the dangers of loss of rare genes during regeneration through genetic drift and selective influence. Partly, too small populations are regenerated. The intervals of regeneration are very short for institutions having inadequate long-term storage capacities. Problems arise in connection with the isolation of cross-fertile species and a lack of secure bases for decision-making on handling identified duplicates.

b) *in situ* conservation

20) Measures for the *in situ* conservation ON-FARM are carried out in individual cases only and require support through a consistent concept. Inadequate use is still made of the possibilities of promotion within the framework of Regulation (EEC) No. 2078/92 for ON-FARM conservation measures, because a systematic inventory of old varieties and landraces is still lacking to a large extent. Too little is known yet about the requirements for effective ON-FARM conservation, their genetic bases and their importance for economic and other uses.

21) The bases for effective and secure *in situ* conservation of genetic resources within ecosystems and natural habitats are largely unknown, especially against the background of fast and far-reaching environmental changes. A mapping of grassland, forest and wild plants is not available for all relevant species and areas. Valuable preparatory work exists for the new Laender. The concept, available for the forest sector, for the integration of *in situ* conservation into forest exploitation has so far been implemented only in part.

22) Methods concerning the characterization and evaluation of *in situ* resources have not yet been elaborated adequately. Relevant descriptor lists as well as methods for genetic monitoring are not available for most plant groups.

The knowledge about genetic variation and the risk at population level is only inadequate.

23) At present, there is no satisfactory opportunity for farmers to use set-aside areas within the framework of the agricultural reform of the EC for the cultivation of neglected crop species (with the exception of some raw material plants) or old varieties and thus to help conserve these crops ON-FARM.

c) Organization of conservation

24) It becomes increasingly obvious that a clear strategy is needed concerning the political and financial support of a coordinated national programme for the conservation and use of plant genetic resources for the Federal Republic of Germany within the framework of international cooperation. The concept of organization presented in 1990, its additions and the recommendations based on an organization analysis carried out in 1994 provide the necessary framework for such a national programme. So far, it has been implemented in part only.

25) Only a central documentation, information and coordination agency can ensure an effective coordination of the activities of the various conservation institutions. In particular, the improvement of the exchange of information and cooperation between the public and private sectors in the field of conservation and use of plant genetic resources is a priority work area.

7.1.4 Problems in Connection with Use

26) The promotion of intra-specific genetic diversity, that means the highest possible genetic distance between the cultivation-relevant varieties, is in principle possible. But it is impeded by still inadequate, crop-specific methods and the economic conditions prevailing for breeders. When applying the legal regulations concerning the granting of variety protection and the registration of varieties (inter alia, novelty criterion, value for cultivation and use), the genetic distance between varieties as a criterion for increasing genetic diversity has not been taken into adequate consideration yet.

27) The access to plant genetic resources, which are conserved, in public collections in Germany, is free of charge and possible for any user and interested person. Thus, the use of collections is promoted and administrative expenditure avoided. In future, it will be necessary to harmonize the conditions for providing plant genetic resources with the

international regulations in force. In this respect, the free access to material and current information for non-commercial conservation work as well as research and development should be ensured as far as possible.

28) There are problems in connection with the characterization and evaluation of samples in genebanks. As primary evaluation mostly takes place parallel to the regeneration of samples, the data have to be interpreted only in close connection with the environmental conditions like weather in a certain year. Inparticular, studies of genotype-environment interactions are lacking.

29) The use of plant genetic resources in research and breeding is partly even impeded and limited because of deficits in evaluation, structuring and documentation of collections, working and specific collections and the *in situ* conserved resources.

30) In the case of some crop species, little is known about the taxonomic classification and crossability of wild plants and crops for breeding. Considerable obstacles still result from problems in connection with breeding technology for the integration of properties from material which is hardly or not domesticated at all.

31) The introduction and development of new crops requires an integrative strategy involving breeding, cultivation technique, processing and marketing in order to ensure sustainable success and economic efficiency. Existing approaches need to be reviewed and complemented.

32) There are approaches to economically sound concepts for the reintegration of old crops and varieties in production and marketing. Such approaches are, however, limited, as long as old cultivars are not authorized for trade according to the Seed Trade Act on account of minor market importance, and land races additionally on account of a lack of homogeneity. In the case of varieties of crops, which are subject to the Seed Trade Act, it is necessary to review the registration requirements.

33) The documentation of and information on all collections and conservation activities in Germany is inadequate to date. Passport, characterization and evaluation data are available, differing in quality and accessibility. A comprehensive central documentation at the IGR to which users have online access to the documentation in genebanks is being established.

34) In forestry and landscaping the use of suitable indigenous provenances of tree and shrub species is gaining momentum. The increasing demand for these provenances of tree species which are not subject to the certification requirements of the Forest Seed Act as well as shrub species in forestry and landscaping contrasts with low supplies of provenance-identified seed and planting stock. In addition, the high costs of seed harvest in Germany also lead to a far-reaching use of unknown or foreign provenances.

35) Ecological silvicultural systems are increasingly used in forestry; their impact is, however, only successively felt due to the long-term transformation of forest ecoystems. The Federal/Laender Working Party on the "Conservation of Forest Genetic Resources" established the bases for a greater consideration of genetic resources which have, however, not yet been implemented sufficiently in forest planning and management.

7.1.5 Problems in Connection with Development Cooperation

36) In the developing countries in particular the overexploitation of ecosystems and the extension of agricultural production on marginal sites and slopes as well as the fast replacement of local landraces by new varieties are contributing to the risk to and loss of the partly still rich potential of genetic resources. Development projects serving the sustainable use of natural resources take aspects of *in situ* and on-farm conservation of plant genetic resources into account still too rarely.

37) Up to now, German development cooperation has primarily provided technical aid and partly not given sufficient attention to the socio-economic conditions and the target groups. In addition, the activities have concentrated on the collection of genetic material and on the technical equipment of genebanks and have been tied too much to administrative institutions. There are deficits in the further development of conservation strategies which seek to ensure a preservation on a durable basis and provide for an adequate legal framework. The reasons for it are the inadequate promotion in terms of staff and funds within the framework of development cooperation and the low importance attached by policy makers in the partner countries to the conservation of genetic resources. Budgetary bottlenecks in the conservation and research institutions have also contributed in the developing countries to the inadequate development and use of conservation, evaluation and utilization methods.

38) Aspects relating to the valorization of genetic resources through characterization, evaluation and breeding as well as the improvement of storage, regeneration and documentation have pretty much been ignored up to now. Likewise concepts for the integration of *ex situ* conservation and promotion of *in situ* conservation and the incorporation of requirements, techniques and knowledge of farmers and local user groups are largely lacking.

39) The German Non-Governmental Organizations involved in development cooperation have not yet fully exhausted their possibilities for the improved

conservation and sustainable use of plant genetic resources, especially at a local level.

7.2 NEED FOR ACTION

40) Greater international cooperation is indispensable for the conservation of the globally threatened plant genetic resources for agriculture and forestry. It must be based on coordinated national strategies and on multilateral agreements on the transfer of financial resources, information and technology. National action is highly incentivised by international commitments. On the other hand, national approaches have an important incentive function for other states. The industrialized countries have to fulfill an important modelling function.

41) In order to counteract the known causes for the threat to and loss of plant genetic resources, immediately realizable, technical-organizational measures are suggested. In addition, there is need for action for research into cause-effect interrelations and for improving existing techniques for the conservation, description and use of plant genetic resources.

7.2.1 Measures

42) There is a pressing need for the implementation of the national programme. Political and financial commitment for a future-oriented strategy as well as the full participation and support of international cooperation must be ensured in addition to the further development and establishment of appropriate organizational structures.

43) The relevant legal provisions in force have to be reviewed as regards their effects on plant genetic resources. It would be of benefit if plant genetic resources were taken into greater consideration in seed and environmental law (e.g. EIA) and in an amendment to the Federal Nature Protection Act. (e.g. arrangements for interferences and designation of protected areas).

44) The collections of international importance established at public institutions should be incorporated into the global *ex situ* network under the auspices of FAO in order to maintain in that framework a largely free access to and exchange of plant genetic resources for the mutual benefit of all participants. However, the conditions must be specified before.

45) There is a pressing need to establish and extend the decentralized documentation system with central information at the IGR by successively incorporating all *ex situ* collections and *in situ* resources. Activities of private initiatives and private plant breeders should also be included, if possible and appropriate. Documentation should include passport, management, characterization and evaluation data taking into account data on taxonomic-nomenclatural references, geobotany/geography, risk, use, literature as well as traditional knowledge. Possibilities for using geographic information systems have to be examined for the documentation of *in situ* conservation measures.

46) A consistent collecting strategy should be drawn up to complement existing collections. Decisive for it are criteria like the closing of gaps in the spectrum of species and in the diversity of individual species, degree of threat to species and forms, orientation on use of collections important for Germany and assuming international obligations. Closely related to it is the removal of undesired duplicates from the collections.

47) The *in situ* conservation within natural habitats should take place by means of a representative protection of autochthonous grassland associations as well as forest genetic resources of all main and secondary tree species, rare tree species and shrub species in forest ecological regions. The resources should be managed in such a way that genetically diverse populations regenerate under the impact of natural and anthropogenous selection.

48) Further agricultural policy measures should help continue the extensification and diversification of agriculture taking the requirements of plant genetic resources into account.

49) Incentives complying with market requirements and the imposition of charges should promote products and procedures which sustain resources to an increased extent by using environment-economic measures. The application of the polluter pays principle to an increased extent can help internalize external costs and benefits which arise from a threat to and/or conservation of genetic resources.

50) Improved scientific qualification possibilities should be provided regarding the conservation and sustainable use of plant genetic resources, and the necessary infrastructural conditions should be worked out and made available. Findings from scientific and practical work on genetic resources should be made known by means of regular symposia and publications and thus stir up the public and scientific interest.

51) The traditional responsiblities of botanical gardens (basic research, training and public relations work) should be intensified, if possible, in the field of genetic resources, and better use should be made of experience existing for

many years. It should be examined how existing comprehensive special collections, being important for the conservation of plant genetic resources, in botanical gardens, arboreta and outdoor museums of agricultural history can be incorporated, in organizational terms, into the national conservation system.

52) Importance, risk, conservation possibilities and uses of genetic resources must increasingly be selected as central themes in education and public relations work as well as in school, professional and academic education. In this respect, continuous exchanges of information and cooperation between public institutions and in associations, citizen's initiatives and other Non-Governmental Organizations are of great importance.

a) Agriculture and horticulture

53) In order to maintain the high effectiveness of the German crop plant collections (genebanks), it is necessary to implement the recommendations of the organization study of 1994 and ensure that the tasks are met on a broad scale.

54) Important collections for which other institutions are responsible should closely cooperate with the central genebank at Gatersleben, while maintaining their organizational autonomy and, if appropriate, be integrated into the central conservation system.

55) The capacities for long-term storage and regeneration must be extended at the central genebank. For regeneration, the risk of genetic shifts in the material should be reduced by extending the regeneration intervals following the extension of long-term storage, using sufficiently great samples and isolating cross-fertile species. The systematic establishment of safety storage should be effected, if possible, by means of international division of labour.

56) In addition to the *ex situ* conservation biosphere reserves and museums of agricultural history should be used to a greater extent for the ON-FARM conservation of agricultural crops and for safety conservation, especially of fruit, permanent and special crops.

57) The characterization and evaluation of *ex situ* collections and *in situ* resources must be intensified parallel to the improvement of documentation by using new state-of-the-art methods. Use should be made in this connection of Regulation (EEC) No. 1467/94. Secondary evaluation, especially of the core-collections to be established, should be speeded up at public and private institutions in close cooperation with genebanks, research and breeding at the national and international levels.

Use should also be made of research programmes of the EC (biotechnology and FAIR programmes).

58) In order to promote a broad genetic basis in the variety material the aspect of genetic diversity for variety registration should be taken into consideration in the legislation concerning the seed trade law and its implementation. As a precondition for effective *in situ* conservation ON-FARM legal regulations and possibilities of promotion should be established for the cultivation of such varieties.

59) Brands and marketing channels for products produced with special regard for plant genetic resources should be developed and protected. Existing legal provisions like grades, phytosanitary standards, product standards and bans on cultivation (e.g. hemp and poppy) must be reconsidered in this connection.

60) The various programmes of promotion of the EC, Federal and Laender Governments must be reviewed concerning their impact on the conservation and use of plant genetic resources. Promotion should not only be restricted to agronomical measures, but should above all consider the development of market potentials for certain crop species and varieties worthy of conservation as well as the production methods designed to maintain their diversity. Existing possibilities for implementing such programmes for the conservation of plant genetic resources, for example provided by Regulation (EEC) No. 2078/92, should be used to an increased extent.

61) Promotion should be given to approaches for the conservation and advancement of a varied agriculture which have already been developed and are being implemented by individual farms, agricultural and landscape management associations. In this respect, further positive effects (water conservation, recreational value of a varied landscape, biotope networking etc.) have to be taken into consideration.

b) Forestry

62) Ecological silviculture, the restructuring of forests into varied, stable, natural forests, while increasing the share of tree species of the natural forest ecosystem and indigenous provenances as well as afforestation, especially in forest-poor agricultural landscapes and industrial regions should be given further promotion.

63) Greater consideration should be given to forest genetic resources and the provenances of tree and shrub species in the inventory and planning sections of forest management plans as well as in public tenders for

landscape management measures. For this purpose, propagation capacities should be extended for indigenous seed and planting stock of rare species and provenances in cooperation with forestry testing stations and nurseries.

64) The forest genebanks should continue to maintain their organizational autonomy within the framework of the Federal/Laender Working Party on the "Conservation of Forest Genetic Resources" as part of the national programme on plant genetic resources. They should strengthen their cooperation, complete the collections of tree and shrub species and ensure the genetic diversity, especially of endangered forest tree populations.

65) In order to give users of tree and shrub species, which are not subject to the Forest Seed Act, the opportunity of acquiring site-adequate or indigenous reproductive material in conformity with their conditions, voluntary certification should take place according to provenances.

66) It should be examined how far a certification of timber and timber products can help preserve genetic resources in forest ecosystems.

c) Environmental protection and nature conservation

67) In order to improve the *in situ* conservation of plant genetic resources, greater attention should be given to plant genetic resources in the case of interferences with nature and landscape, environmental impact studies, within the framework of biotope networking, tending and development measures as well as visitor's access to highly frequented recreation areas. In order to protect ecosystems by reducing inputs of pollutants, especially nitrogen into the forest, from traffic, industry and agriculture, further decisions need to be taken at political level.

7.2.2 Need for Research

There is need for research in the following areas:

68) Ascertainment and assessment of the extent of genetic erosion as well as of its medium- and long-term effects on man and ecology, especially through interdisciplinary research projects and model approaches.

69) Development of concepts for effective *in situ* conservation , especially within the framework of ecosystem research, its integration into existing *ex situ* conservation measures and for solving conflicts between conservation and use.

70) Technical and organizational approaches in connection with the incorporation of comprehensive data of different categories (meta data, data on taxonomic and geographical references, risk, use, literature and traditional knowledge) into the documentation system at the IGR as well as use of a geographic information system (GIS) for incorporation into *in situ* conservation measures.

71) Strengthening of taxonomic basic knowledge by means of molecular genetic methods, clarification of relationship, and relations within gene pools of crop plants. Further development of methods to examine the genetic stability of samples for the regeneration in the *ex situ* conservation and for the purpose of comparison and assessment of different regeneration procedures.

72) Development of other use potentials of plants, especially with regard to the development of environmentally sound technologies, enlarging the cropping range of crops as suppliers of renewable resources and improved use of natural energies for food and raw material production.

73) Economic assessment of the genetic resources to improve their conservation and sustainable use. Development of suitable economic incentives to promote the consideration of plant genetic resources requirements in planning and for appropriate measures.

a) Agriculture and horticulture

74) Further development of methods to establish core-collections in international cooperation as well as techniques for long-term storage (cryoconservation, ultradrying, *in vitro* conservation, species-specific storage techniques) to improve the *ex situ* conservation in genebanks. Further development of molecular-biological and biochemical methods for identifying duplicates to improve the utilizability and rationalization of collections.

75) Improving the utilizability of the characterization and evaluation data collected during regeneration. Increased implementation of studies of genotype-environment-interaction and of biometrical analysis of evaluation data.

76) Development of basic populations for breeding purposes through selection from natural accessions and their genetic characterization and evaluation.

77) Developing of and working on new crops taking into account the whole chain of production from breeding through worthiness of cultivation to commercial use and product placement.

b) Forestry

78) Exploring the genetic structures of populations of forest genetic resources as well as new methods of provenance description as a basis for taking an inventory of forest genetic resources. Reviewing the representation of protected resources and existing collections.

79) Improving the integration of conservation and use of forest genetic resources through a scientifically sound further development of sustainable management practices in the forest.

80) Exploring the key factors of adaptation potentials (e.g. to climate changes) which are of special importance for the forest sector due to the long generation time in order to take these characteristics into account in future evaluations.

81) Clarifying the extent and effect of hybridization of forest species with cultivars and foreign provenances.

82) Further development of techniques for secure long-term storage of seed in the case of problematic tree species.

c) Environment and nature protection

83) Developing generally acceptable concepts for the *in situ* conservation of plant genetic resources through better coordination with and integration into activities for the conservation of biodiversity as a whole and with *ex situ* measures. Developing methods for delimiting and describing populations as well as for identifying representative *in situ* conservation areas. Developing effective and labour extensive monitoring procedures and specific *in situ* descriptor lists to investigate the dynamics of *in situ* conserved populations and to assess *in situ* conservation measures.

7.2.3 Need for Action in Development Cooperation

84) There is an urgent need for giving advice and support to developing countries in drawing up national strategies and action plans for the conservation and sustainable use of their own genetic resources as well as for their incorporation into a regional and international framework. In this respect, it is necessary to include, in addition, ecological and socio-cultural objectives as well as advice on legal and biosafety aspects apart from technical and economic considerations.

85) An important precondition for conserving genetic resources is a coordinated division of labour at the national, regional and global levels. Greater importance must be attached to supporting the establishment of a legally binding framework of law for the conservation of genetic resources. The development of national funding strategies must be promoted to a greater extent in order to ensure the cost of maintenance in the long run and the establishment of suitable local and national structures and capacities which guarantee the implementation of action plans and measures.

86) In addition to technical aspects, training and advanced training measures must also take into account the relevant policy areas, organizational development and the formulation of the legal framework. That requires an approach which beyond technical aspects considers the ecological, socio-economic, political and legal overall conditions (integrated system approach and action, interdisciplinary and inter-institutional team work, etc.)

87) Continued support must be given to maintaining the operativenness and promoting the further development of national and regional genebanks and living collections, for example, by providing experts being entrusted with special tasks. The conservation is, however, not an end in itself, but must be rendered transparent for policy decision-makers as far as its ecological and economic importance is concerned. Development cooperation must promote to a greater extent the use of genetic resources in breeding at the local and international levels and ensure the access of the countries to technological procedures.

88) A focal point in German development cooperation should be the integration of *in situ* and on farm conservation of plant genetic resources into the sustainable management of natural resources. By involving suitable institutions, local user groups, forest users and farmers their requirements, techniques and knowledge should be taken into consideration to an increased extent. Other projects of development cooperation (e.g. energy supply, water engineering and road construction) must be examined more than so far with regard to their effects on the conservation and use of plant genetic resources. This includes environmental impact studies and assessment of technology impact.

89) The Non-Governmental Organizations involved in development cooperation should extend their approaches for the conservation and sustainable use of plant genetic resources in developing countries.

CHAPTER 8
Proposals for a Global Plan of Action

1) The basis of the Global Plan of Action are effective national programmes, including all relevant policy areas which are well coordinated at a national level and implemented in close regional cooperation. The programmes should comprise measures to improve the legal and economic overall conditions which encourage the conservation of diversity. *in situ* and *ex situ* conservation, evaluation, documentation, research and effective use as well as training should be promoted in a sustainable way. Any country should be involved financially and institutionally according to its abilities in implementing the Global Plan of Action. If establishing institutions to be entrusted with long-term responsibilities, the long-term fund requirement has to be taken into consideration.

8.1 REGIONAL (EUROPEAN) LEVEL

8.1.1 Measures

2) The ecological and cultural diversity of European countries, their role in developing modern agricultural and forest sciences and their extensive research capacities assign them an important role and responsibility in the field of plant genetic resources for food, agriculture and forestry. This role results from the fact that leading collections of plant genetic resources are to be found in Europe, and agriculture in some regions of Europe continues to be based on a relatively great diversity of crops and variety material. The European countries should develop strategies for intergovernmental cooperation within the European Union as well as between the Union and the Eastern European countries, including labour division, and should incorporate their activities at a supra-regional level.

3) After recording and analyzing the collections existing in European countries, to be started within the framework of Regulation (EC) 1467/94, regional crop specific networks should be established on the basis of the ECP/GR work. These collections should be coordinated systematically and

complemented according to the needs of partners. The present promotion of such activities within the framework of the EC Regulation should be extended on the basis of the experience gathered. The regional division of labour should be improved by eliminating undesired duplicates, identifying and securing valuable unica and establishing safety storages where they do not exist. The aim is to develop regional competences of genebanks. An example for it is the Nordic genebank for the Scandinavian region.

4) The work performed so far by the ECP/GR should be evaluated by an external expert before extending it further. EUFORGEN should also be reviewed. As a result, in particular a more efficient coordination of bilateral and regional activities in Europe and in the EU should be possible (e.g. Regulation [EEC] No. 1467/94). Special consideration should be given to collections in Eastern Europe.

5) Important collections of all European countries should be incorporated into the global *ex situ* network (multilateral system) of FAO. The conditions should be fixed before in international negotiations.

6) Coordinated concepts for the *in situ* and ON FARM conservation of crop plants should be developed at a European level. An important prerequisite is to complete the inventory of still existing regionally typical species and varieties of crop plants in the European region.

7) The decentralized documentation of European conservation and utilization activities should be established and extended further as part of the Global Information System of FAO to allow a comprehensive exchange of information within the framework of an information network. Existing *in situ* resources of wild relatives of crop plants should be recorded and incorporated into the documentation system.

8) With regard to the central importance of the economic and legal overall conditions for the conservation of varied cultivated landscapes and the promotion of environmentally sound agriculture the action programme concerning agriculture and environment should be extended by the EC agricultural policy and gradually be incorporated into the basic principles of the common agricultural policy. Existing EC regulations should be examined with regard to their impact on the conservation and use of plant genetic resources and measures be coordinated more effectively.

9) Instruments of the common agricultural policy existing at a European level should be used in order to make the diversity in agriculture a sustainable element for the development of agriculture and the rural areas, inter alia, through the specific promotion of the cultivation of neglected crops and varieties. In this respect, appropriate measures are set-aside and the linkage of compensatory payments to genetic conservation and diversity criteria

instead, as it has been the case so far, to the cultivation of certain cash crops. In addition, the possibilities to promote national activities concerning agricultural production methods compatible with the requirements of the protection of the environment and the preservation of the countryside according to Regulation (EEC) No. 2078/92 have to be reviewed with regard to a comprehensive extension in terms of content and funds. The possibilities for the on farm conservation of plant genetic resources existing in that framework should be implemented to an increased extent at a national level.

10) The EC seed trade law should be extended by regulations concerning the conservation of genetic resources. The procedure concerning the assessment of the efficiency and qualification of old varieties, landraces and population varieties should be designed accordingly as a prerequisite for authorization. Activities concerning the assessment of the efficiency and qualification of these varieties should continue to receive promotion with regard to the agricultural policy objectives of the EC, for example through Regulation (EC) No. 1467/94.

11) The European countries should develop common standards for programmes for the conservation of forest genetic resources. Priority should be given to the *in situ* conservation, the establishment of reproductive populations for rare tree species as well as the exchange of material of populations from transboundary growth regions. In the case of the tree and shrub species which are not subject to the EC legislation the countries should examine possibilities of certifying reproduction material by provenances.

12) The dialogue between scientists, plant breeders, practical farmers, consumers and industry about the requirements of research in the field of conservation and sustainable use of plant genetic resources should be intensified considerably within the framework of local, national as well as European administrative structures.

13) Research on the conservation, assessment and sustainable use of plant genetic resources for food, agriculture and forestry should be promoted to an increased extent with the participation of third countries and be considered in relevant EC research programmes. The establishment of a common research structure in Europe is of priority importance.

8.1.2 Need for Research

There is need for research in the following areas:

14) Extension of current knowledge of the effects of legal, economic and agricultural policy overall conditions of the EC on the diversity of plant genetic resources in Europe.

15) Exploration of economic assessment systems for genetic resources and for the ecosystems in which they are embedded as well as of instruments of market economy to promote their conservation. Exploration and development of suitable overall conditions for economically sustainable agriculture compatible with the requirements of environmental protection and for the maintenance of a varied cultivated landscape. These overall conditions have to take the medium-term and long-term social interests of the European countries into account.

16) Further development of the research promotion programmes of the EC concerning the requirements of plant genetic resources and increased promotion of European cooperation and division of labour in research. Priority investigation of the taxonomic and genetic bases as well as the relations within the European gene pools of crop plants.

17) Drawing up methods to identify representative areas for the *in situ* conservation in order to make measures efficient and to maximize the resultant genetic diversity, spatial distribution of *in situ* conservation activities according to regional diversity priorities. Drawing up appropriate methods for the on farm conservation of crop plants. Development and use of suitable monitoring methods for controlling the efficiency of *in situ* and ON FARM conservation against the background of the expected environmental changes.

18) Study of the plant genetic resources for the development of economically sustainable crop plants with regard to their worthiness of cultivation, usability and competitiveness of products within the framework of European community projects.

8.2 GLOBAL LEVEL

8.2.1 Measures

19) Measures at the global level must meet the objectives formulated in Chapter 14 G of Agenda 21 at the 1992 United Nations Conference on Environment and Development in Rio and comply with the provisions of the Convention on Biological Diversity. In general, in view of the growing world population, the integration of conservation objectives (nature conservation, species protection, resources protection) and development objectives in as environmentally compatible and sustainable a use as possible of the natural resources should be pursued, among which the genetic resources have a high priority. The speedy adjustment of the International Undertaking on Plant Genetic Resources of FAO as a Protocol to the Convention on Biological Diversity is endorsed as well as the establishment of global mechanisms as a compensation for Farmers' Rights.

20) The existing manifold global initiatives and activities concerning the conservation and use of plant genetic resources (e.g. taken by FAO, CGIAR, UNEP, UNDP, UNCESCO, etc.) should be coordinated on a medium-term objective-oriented basis and implemented through close cooperation.

21) In the field of conservation and sustainable use of plant genetic resources the global coordination of the relevant policy areas should be improved, the binding nature of international agreements be increased and the efficiency of global instruments be strengthened. This especially applies in the broadest sense to agricultural, environmental, development, trade and economic policies. A central area is the growing world trade. The approach developed in conjunction with the establishment of the new World Trade Organization (WTO), that means that environmental requirements should increasingly be taken into account in world trade as well, should be developed further in a politically consistent way and with regard to plant genetic resources.

22) With regard to a better conservation and broader use of plant genetic resources, suitable economic incentives have to be developed at the global level and, by means of international cooperation, measures be promoted for neglected, regionally important crops. In this respect, it is important to create suitable economic, legal and agricultural policy overall conditions and to preserve and improve locally adapted farming systems.

23) Great importance has to be attached to the designation of protected areas and to the initiation of protective measures for natural populations of wild relatives and for the cultivation of local crops (on farm) in Centers of high genetic diversity. These protected areas should be linked in the medium-term to a global network of *in situ* protected areas. The countries concerned should receive technical, political and financial support in this respect.

24) On the basis of the *ex situ* network of FAO a multilateral system should be established including CG collections with sufficient safety storage and with the freest possible exchanges of material and information. The development of internationally coordinated *ex situ* core collections helps to implement and rationalize this system. Global activities for the conservation and sustainable use of plant genetic resources for food and agriculture should be promoted by international funding.

25) Within the framework of the Global System of FAO the establishment of the "World Information and Early Warning System on Plant Genetic Resources" should be speeded up and the efficiency be improved by creating suitable network structures and intervention mechanisms.

26) At national level legal, economic, social, agricultural policy and other administrative overall conditions have to support the conservation and sustainable use of plant genetic resources. If necessary, principles and measures have to be agreed upon in this respect at the international level.

27) Breeding activities of national research institutions, private breeders and farmers should be supported and promoted in all countries by suitable national overall conditions. At the global level, national legislation should provide adequate protection to breeders for their bred varieties. In order to establish a balance between the protection interests of breeders and those of farmers in the developing countries, efforts have to be strengthened at the international level in order to achieve the practical implementation of the concept of farmers's rights adopted by FAO with an adequate financing and compensation mechanism.

28) Regulations on seed trade should be examined with regard to their impact on the conservation of plant genetic resources. Methods for the assessment of performance and suitability as a reqirement for the registration of old varieties and heterogenous material like landraces and population varieties for trade should be designed according to these aspects.

29) It should be examined to what extent, in the field of patent and variety protection, further reaching measures are useful or desirable, to achieve the objectives of the Convention on Biological Diversity and of the International Undertaking on Plant Genetic Resources.

30) Sustainable management methods should be introduced to an increased extent in the various forest and agricultural ecosystems to complement *in situ* conservation. It should be examined at the international level to what extent the certification of timber, timber products and other forest products can help preserve genetic resources in the forest ecosystems.

31) The exchange of information and transfer of technology should be ensured through intensified cooperation between the international agricultural research institutions of the CG, bilateral development cooperation, private agencies and national agricultural research systems (NARS).

32) In order to strengthen the role of developing countries as equal partners in international cooperation, national agricultural research has to be expanded and promoted.

33) The establishment of training capacities and the organization of training courses in all aspects which are of importance for the conservation and sustainable use of genetic resources should be strengthened by international cooperation. In this respect, the provision of local training possibilities has priority.

8.2.2 Need for Research

Research is required in the following areas:

34) Extending the knowledge of the impact of legal, economic and agricultural policy overall conditions on biodiversity and genetic resources at the global level. Development of principles for the creation of suitable overall conditions against the background of differing and individual interests and objectives of different countries and social groups.

35) Analysis and documentation of the effects of international regulations and agreements (e.g. TRIPS, UPOV etc.) on the conservation and sustainable use of plant genetic resources in industrialized and developing countries. Identification of priority action areas.

36) Study of the impact of patent and variety protection systems on the conservation of biodiversity of crops and genetic resources.

37) Study of the effects of different agricultural and forestry use systems on the diversity of agricultural and forest ecosystems with regard to a globally necessary protection of natural resources. Developing sustainable management systems taking into account medium-term and long-term social interests in order to ensure the conservation and sustainable use of the resources of such ecosystems. The conservation of a great diversity of

indigenous species within the framework of management is of special importance in the forestry sector.

38) Development of methods for the economic, sociological and ecological assessment of genetic resources and ecosystems in which they occur.

39) Exploring and documenting the globally still available traditional knowledge of the possible use of plants and parts of plants, while promoting simultaneously the conveying of this knowledge by preserving traditions. Safeguarding the rights of the indigenous populations according to the national and international commitments, inter alia, by developing models enabling them to benefit from the results of research on the basis of this knowledge.

40) Study of the practices of mixed crop cultivation of small-scale systems taking into consideration the relevant traditional knowledge and the farmers' ideas about objectives and uses with regard to an improved assessment and exploitation of development potentials.

41) Identification of neglected crops, especially those of potential importance and long-term economic efficiency and their increased development up to worthiness of cultivation and marketability.

42) Interdisciplinary development of early warning methods for especially endangered species as well as for intra-specific genetic erosion taking into consideration traditional knowledge with the aim of reducing reaction times for necessary measures and adjustments.

43) Development of methods for impact assessment if new technologies (e.g. genetic engineering) are introduced for the conservation of plant genetic resources. Deriving parameters for decision-making and recommendations for action.

44) Development of methods for the identification of originally indigenous or ecologically adapted genetic resources for the reclamation and usability of the globally vast degraded areas (e.g. semi-arid areas, tropical forest belts, mountain areas, mining regions).

45) Further development of methods for the determination of core collections of important crops within the framework of international cooperation as well as of evaluation systems with the aid of molecular-biological and genetic analyses.

46) Development of integrated information systems as well as of species-specific descriptor lists for the uniform characterization and evaluation of *in situ*/ON FARM conserved plant genetic resources through international cooperation.

47) Review of the global network of biosphere reserves of UNESCO with regard to possible contributions to conserving plant genetic resources (*in situ*, ON FARM).

48) Analysis of the role and of the realistic potentials of national genebanks with regard to strengthening national agricultural and forestry research and plant breeding.

49) Further development of technologies for the conservation of plant genetic resources adapted to the specific conditions and crops of the countries like:

- possibilities and risks of living collections under controllable conditions which can be financed as an alternative to *in situ* conservation;
- slow-growth properties for *in vitro* techniques for storing plant genetic resources;
- methods of cryoconservation of vegetatively reproduced crop plants;
- crop-specific regeneration cycles during *ex situ* conservation and
- optimum capacities for expensive long-term storage under limited possibilities of many countries.

50) Improvement of the exchange of information on current and planned research projects and use of integrated, intersectoral research programmes in order to improve the efficiency and optimum use of existing institutional, personnel and financial possibilities in all areas relevant to plant genetic resources.

ANNEX 1
Definitions of the Term "Plant Genetic Resources"

1. Definition in the First Draft of the Revised International Undertaking of FAO (CPGR/94/WG9/3, para 21(a); February 1994)

"plant genetic resources" means the reproductive or vegetative propagating material of the following categories of plants:

a) cultivated varieties (cultivars) in current use and newly developed varieties;

b) obsolete cultivars;

c) primitive cultivars (land races);

d) wild and weed species, near relatives of cultivated species;

e) special genetic stock (including elite and current breeders' lines and mutants).

This Undertaking relates to the plant genetic resources described in para 21(a), of all species of economic and/or social interest, particulary for agriculture at present or in the future, and has particular reference to food crops.

2. Definition within the framework of the Convention on Biological Diversity (Federal Law Gazette II, p. 1741, of 05 June 1992)

a) biological resources include: genetic resources, organisms or parts thereof, populations or any other biotic component of ecosystems with actual or potential use or value for humanity.

b) genetic resources means: all genetic material of actual or potential value.

3. Definition in the Regulation (EC) on the Conservation, Characterization, Collection and Utilization of Genetic Resources in Agriculture (Reg. [EC] 1467/94 of 20 June 1994)

Plant genetic resources in agriculture are particulary genetic resources of

a) agricultural plants, including vine and fodder crops,

b) horticultural plants, including vegetables, ornamentals, medicinal and aromatic plants,

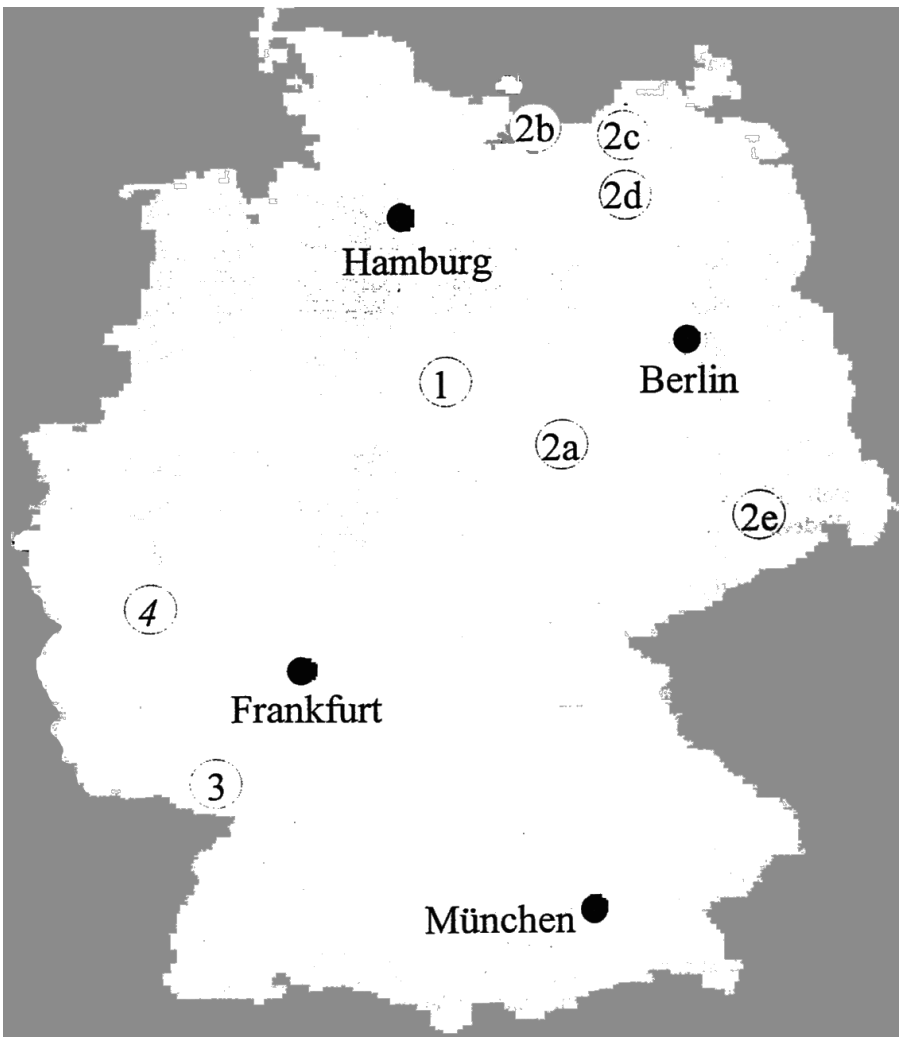
c) fruit culture,

d) silviculture,

e) fungi as well as of microorganisms, if they are of actual or potential use for agriculture.

ANNEX 2
Tables and Figures

FIG. 1: MAP: INSTITUTIONS CONSERVING PGR IN THE FEDERAL REPUBLIC OF GERMANY



1 FAL Braunschweig. Institut für Pflanzenbau
2a IKP Gatersleben. Genbank
2b IPK Außenstelle Nord. (Öl- und Futterpflanzen Malchow/Poel)
2c IPK Außenstelle Nord. (Kartoffeln,Gr.Lüsewitz)
2d IPK Außenstelle Nord. (Roggen und Triticale, Gülzow)
2e IPK Außenstelle Süd. (Obst, Dresden-Pillnitz)
3 BAZ Quedlinburg. Institut für Rebenzüchtung Geilweilerhof, Siebeldingen
4 ZADI Bonn. Informationszentrum für Genetische Ressourcen

Table 1 Categories of Land Use in Germany (1993) from: Statistische Jahrbuch über Ernährung, Landwirtschaft und Forsten 1994, Nationaler Waldbericht (1994)

Type of Use		Area	
		Mio. ha	%
Agriculture		17,2	48
	Arable land	11,7	32
	Grassland	5,3	15
	Permanent Crops	0,2	1
Forest		10,7	30
Others[1]		7,9	22
Specie		**35,7**	**100**

[1]**Buildings, open areas, traffic areas, lakes, rivers, waste land, etc.**

Table 2 Cultivation and Production of Diverse Groups of Crop Plants (1992) from: Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten 1993; Agrarbericht 1993; Bundeswaldinventur (1987/90); Datenspeicher Waldfonds

Crop Groups	Cult. Area		Production (Mio. t)	Self-Sufficiency %	Value of Production (Mrd. DM)
	1.000 ha	%			
Arable Land					**>12,2**
Cereals	6246	17,5	34,8	127	7,2
Corn (grain/CCM)	296	0,8	2,1	99	0,4
Oil plants[1]	1000	2,8	2,6	45	0,7
Sugar beet	534	1,5	27,2	129	2,7
Potatoes	361	1,0	10,9	90	1,1
Arable fodder crops[2]	1804	5,0	53,8	-	-
Grain legumes[3]	57	0,2	0,6	28	0,06
Fallow	1003	2,8	-	-	-
Grassland					**-**
Meadows	2632	7,4	-	-	-
Pasture/mowing pasture	2611	7,3	-	-	-
Vegetable culture					**1,9**
Field cropping	76	0,2	2,0	37	1,9
Glasshouse	1,4	0,0	0,1	-	
Fruit culture					**4,0**
Fruit trees	59	0,2	1,3	12	4,0
Other fruit plants	15	0,0	-	-	
Other permanent crop, special crops					**>2,2**
Hop	23	0,1	0,03	300	0,2
Vine (prod.:mill.hl)	100	0,3	13,4	58	2,0
Trade crops	140	0,4	-	-	-
Ornamentals					**4,3**
Field cropping (FC)	10	0,0	-	-[5]	FC+GH:
Glasshouse (GH)	3	0,0	-	-[5]	2,7
Tree nurseries	34	0,1	-	-	1,6
Forest (Production: mill. m³ under bark)					**2,3**
Oak	928	2,6	1,0	68[6]	2,3
Beech	1508	4,2	4,4		
Other broadleaved trees	1209	3,4	0,9		
Spruce	3493	9,8	15,4		
Fir, Douglas fir	312	0,9	1,5		
Pine, larch	3290	9,2	4,8		

1 Rape, bird rape, sunflower, mustard, linseed, gold of pleasure
2 Maize, fodder grasses, trefoil, alfalfa, fodder beet, oil radish, california bluebell
3 Field bean, pea, vetch, lupin
4 Tobacco, medicinal plants and spices, poppy, flax
5 Cut flowers: approx. 20%, potted, bed and balcony plants: approx. 60%
6 including recycling of waste paper

Table 3 Structure of Agricultural Holdings (1993) from: Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten 1994

Farm size ha	Number of farms 1.000	Agricultural area (AA) 1.000	Share of total AA %	Average AA per farm ha
<1	32	16	0,1	0,5
1-10	270	1,137	6,7	4,2
10-50	256	6,170	36,2	24,1
50-100	49	3,278	19,2	66,9
>100	16	6,461	37,9	395,8
Total	**625**	**17,062**	**100**	**28**

Table 4 Structure of Forest Enterprises (1993). from: Forst, Holz 1994 (AID)

Size of enterprise (ha)	Number (1000)	Forest area (1000 ha)	Share of total forest area (%)
<1	96	40	<1
1-50	339	1.770	19
50-200	7	640	7
200-1000	3	1.320	14
>1000	1	5.660	60
Total	**447**	**9.430**	**100**
of these:			
• agricultural holdings with forest	314	1.520	16
• forest enterprises	133	7.910	84

Table 5 Forest Area According to Ownership Type from: Bundeswaldinventur (1987/90); Datenspeicher Waldfonds (1990)

Ownership	Forest area (1000)	Share of total forest area (1000 ha)
State-owned forest	3.639	34
Corporate forest	2.123	20
Privately-owned forest	4.299	40
Trust-owned forest	679	1.320
Total	**10.740**	**100**

Table 6 Protected Forest Areas in Germany (1993) Size and Percentage of Forest Area from: Nationaler Waldbericht, 1994

Table 6.1 Protected Areas under Nature Conservation Law (excl. nature parks)

Protected area category	National parks	Nature conservation areas	Biosphere reserves	Other categories of protection of the *Laender*	Landscape conservation areas
Area (ha)	62.869	271.703	194.817	58.012	3.590.730
%	0,6	2,5	1,8	0,5	33,1

Table 6.2 Protected Areas under Forest Law

Protected area category	Natural forest reserves	Protection forest	Recreation forest	Other forest
Area (ha)	44.696	497.220	53.614	215.213
%	0,4	4,6	0,5	2,0

Table 6.3 Protected Areas under other Public Law

Protected area category	Game reserve	Water conservation area	Road protection forest
Area (ha)	20.496	1.371.089	41.282
%	0,2	12,6	0,4

Table 7 Protected Areas in Germany: from: Daten zur Umwelt 1992/93

Table 7.1 Large-scale Protected Areas (excl. tidal marsh land and water areas of the North and Baltic Seas)

Protected area category	National parks	Biosphere reserves	Wetlands (Ramsar)	Nature parks
Number	8	9	29	≈ 67
Area (ha)	180.302	628.690	≈ 134.240	5.569.477
%	0,5	1,8	0,4	15,6

Table 7.2 Nature and Landscape Conservation Areas

Protected area category	Nature conservation areas	Landscape conservation areas
Number	≈ 4.480	≈ 6.206
Area (ha)	≈ 617.000	≈ 9.039.871
%	1,7	25.3

Table 8 In situ Conservation Measures of the "Federal/Laender Working Group on the Conservation of Forest Genetic Resources" and of the Federal and Laender Governments (until 1993) from: Tätigkeitsbericht der Bund-Länder-Arbeitsgruppe 1992-1993

Conservation measure	Number	*Species*	Area (ha)
Stands	744	37	2.142
Single trees	9.535	>40	-

Survey 1: Special Collections and Working Collections

A) Working collections at other institutes of the BAZ

History BAZ founded in 1991 as merger of various institutes of the German Democratic Republic and the Federal Republic of Germany on recommendation of Scientific Council (headquarters: former Institute for Breeding Research of the GDR)

Organization working collections at 5 of 13 Institutes of the BAZ: Institute for Resistance Genetics (Institut für Resistenzgenetik), Grünbach,
Institute for Epidemiology and Resistance (Institut für Epidemiologie und Resistenz), Aschersleben,
Institute for Breeding Methodology (Institut für Züchtungsmethodik), Groß Lüsewitz,
Institute for Breeding of Vegetables, Medicinal Plants and Spices
(Institut für Gemüse-, Heil- und Gewürzpflanzenzüchtung), Quedlinburg,
Institute for Breeding of Ornamental Plants (Institut für Zierpflanzen züchtung), Ahrensburg

Agency responsible and financing Federal Government

Aims and approach resistance research, development of new breeding methods, evaluation of genetic resources, collection of base material

Samples received according to crop groups wheat (Grünbach) barley and wheat (Aschersleben) potatoes, rye (Groß Lüsewitz) vegetable plants (Quedlinburg) ornamentals (Ahrensburg)

B) Federal Office of Varieties in Hannover with Experimental Stations

History since 1953 acting as independent Superior Federal Authority in Germany; 1990 integration of Central Agency for Varieties of the GDR

Organization headquarters in Hannover, 17 experimental stations throughout Germany

Agency responsible and financing Federal Government

Aims and approach implementation of the Seed Trade and Cultivar Protection Acts; preparation of the descriptory list of cultivars (material of and relevant

information on any variety, whose cultivar protection or authorization expire is trans-ferred to FAL genebank)

Samples received according to stage of cultivation annual species: seed samples of current varieties as comparative assortments; perennial species: current varieties and old cultivars of 56 species

C) Max-Planck-Institute for Breeding Research (Max-Planck Institut für Züchtungsforschung), Köln

History collection founded in 1927 as Kaiser-Wilhelm-Institut für Züchtungs-forschung, since 1945 in Köln-Vogelsang

Agency responsible and financing Federal and Laender Governments

Aims and approach basic research and breeding research on crops; development of bioengineering and genetic engineering methods

Samples received according to crop groups *Arabidopsis*, wheat (*Triticum*), barley (*Hordeum, mutants*)

Samples received according to stage of cultivation wild relatives and primitive forms (and a few varieties) from different genebanks world-wide

D) University of Hohenheim, Land Seed Breeding Station (Landessaatzuchtanstalt), Stuttgart

Agency responsible and financing University, Land of Baden-Württemberg

Aims and approach applied breeding research: evaluation of genetic resources, development of breeding methods and base material for practical breeding

Samples received according to crop groups maize, broad beans, wheat, rye, triticale, sunflower, lupin, forage grasses

E) Hessian Teaching and Research Station for Grassland Farming and Forage Cultivation (Hessische Lehr- und Forschungsanstalt für Grünlandwirtschaft und Futterbau), Bad Hersfeld

Agency responsible and financing Land of Hesse

Aims and approach Samples received according to crop groups teaching and research for practice perennial forage grasses

F) Hans-Pfülf-Institute for Research on Hops (Institut für Hopfenforschung) in Hüll/Bavaria

Agency responsible and financing Land of Bavaria

Organization field office of the Bavarian Institute for Soil Cultivation and Crop Husbandry

Aims and approach research on hops (environmentally compatible cultural methods, marketing, breeding) and hop extension

Samples received according to crop groups hop (*Humulus lupulus*): 120 varieties, 200 wild hops

G) Land Institute for Crop Husbandry (Baden-Württembergische Landesanstalt für Pflanzenbau), Forchheim

History collection established in 1927 at the Tobacco Research Institute

Agency responsible and financing Land of Baden-Württemberg

Aims and approach research on tobacco growing and breeding

Samples received according to crop groups 700 samples of tobacco (*Nicotiana spp.*)

Samples received according to stage of cultivation cultivars 79%, landraces 14%, wild relatives 7%

H) Fruit Growing Department of the Teaching and Experimental Station for Integrated Crop Husbandry Güterfelde e.V. (Abteilung Obstbau der Lehr- und Versuchsanstalt für Integrierten Pflanzenbau), Müncheberg

History collection established in 1930 at the Kaiser-Wilhelm-Institut für Züchtungsforschung, since the early 70s field branch and phyto-safety site of fruit research in Dresden-Pillnetz, since 1993 department of Teaching and Experimental Station

Agency responsible and financing association of sponsors

Aims and approach compilation of inventories and evaluation of old fruit cultivars in Brandenburg, conservation in the field and in field collections, recommendation for multivalent use (orchards, landscaping)

Samples received according to crop groups primarily apple (*Malus*); approx. 500 old and new varieties, stock is increasing continuously

I) Institute for Agricultural Research and Investigation (Institut für Landwirtschaftliche Forschung und Untersuchung e.V.), Halle/Saale

Organization registered association

Agency responsible and financing self-financing, membership fees, donations

Aims and approach collection, propagation and development of wild plants for recultivation measures and erosion protection in agriculture

Samples received according to stage of cultivation only wild plants

J) University-Comprehensive University of Kassel at Witzenhausen

Organization university institute

Agency responsible and financing Federal Government and Land of Hesse

Aims and approach conservation of crops from tropical regions for research and teaching; international exchange of seed

Samples received according to stage of cultivation tropical crops

Survey 2: Forest Ex Situ Stands of Federal/Laender Working Group on the "Conservation of Forest Genetic Resources" (until 1993)

History establishment partly before, mostly only after foundation of Joint Working Group on the Conservaton of Forest Genetic Resources in 1985

Organization coordination by Joint Working Group, decentral stands serviced by forest experimental stations of the Laender

Agency responsible and financing Laender, Federal Government

Aims and approach measures supplementing *in situ* measures (Chap. 3.1.1) and forest genebanks (Chap. 3.2.1), especially for gene resources from forest damage areas

Number of samples 1,575 *ex situ* stands on 1,259 ha., 45 tree and shrub species

Samples received according to crop groups 100% wild tree species (among which 5% wild fruit)

Samples received according to stage of cultivation almost entirely pure wild relatives

Survey 3: Botanic Gardens and Arboreta

The **Botanical Garden and Rhododendron Park in Bremen** possesses 10,200 samples with the focus on rhododrendron, azalea and evergreen shrubs.

The **Botanical Garden of the University of Frankfurt/Main** has maintained a seed bank for about 25 years. Some 5,000 plant species in a total of about 10,000 accessions are stored, around half of these under deep-freezing conditions. The species in question are mostly wild plants of indigenous and central European origin. Many species are endangered.

In the school garden for medicinal plants and spices of the **Botanical Garden at Groß-Pösna near Leipzig** (established in 1936) about 440 species from 54 plant families are conserved, mainly indigenous provenances of wild relatives of former and present importance as medicinal plants and spices.

The **Botanical Garden of the University of Jena** has started to establish a seed bank for diversity of vascular plants of Thuringia (approx. 1,700 species).

Table 9 Parameters of Seed Storage

Containers	glass containers with Silica gel (Gatersleben system), tinplate containers (Braunschweig system) welded plastic film
Moisture content of seed	5 to 7% (Gatersleben) 4 to 6% (Braunschweig)
Storage temperature	0 to -3°C (3/4 of samples at Gatersleben) 10°C (Braunschweig) 15°C (1/4 of samples at Gatersleben) 20°C (wild vine) 5 to -30°C (forest plants) +3 to +5°C (working collections)

Table 10 Number of Varieties in yhe European Community Variety Catalogues from: Bundessortenamt 1994

Year	1972/75	1979	1984	1988	1992
Agricultural crops	1,512	2,701	3,293	5,203	10,856
Vegetables	2,980	5,090	5,678	8,165	9,123

Table 11 Seed Propagation Area and Degree of Self-Sufficiency for Arable Crops 1993. from: Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten 1994; Bundesverband der Pflanzenzüchter

Crops	Seed propagation area (1000 ha)	*Re-use of farm-saved seeds (%)*	Degree of self-sufficiency (%)
Cereals (excl. maize)	172.535	50	98
Maize	2.261	insignificant	15
Potatoes	20.732	40	90
Beets	197	0	<5
Grasses	34.891	0	60-90
Fine grain legumes	2.510	insignificant	60-90
Coarse grain legumes	15.455	30-50	80-90
Spring rape	600	insignificant	80-90
Winter rape	4.042	insignificant	100-120
Linseed	2.381	insignificant	100
Sunflower	-	insignificant	10-20

Table 12/a Propagation of Seed and Planting Stock in Selected Crops in Germany from: Blatt für sortenwesen 1980, 1990, 1994

Species	1980 old Laender		
		Propagation area	
	N°var	ha	5 leading var. (%)
Winter wheat	43	36,905	62
Spring wheat	19	4,919	69
Winter barley (four-rowed)	31	14,818	69
Spring barley (two-rowed)	32	15,781	76
Winter rye	8	14,156	99
Triticale	-	-	-
Oats	25	16,251	69
Maize	19	1,435	84
Field bean	8	691	92
Winter rape (oil)	7	1,095	99
Potatoes	124	15,905	34
Italian ryegrass	21	1,869	62

Table 12/b

Species	1990 old Laender		
		Propagation area	
	N°var	ha	5 leading var. (%)
Winter wheat	54	37,700	40
Spring wheat	16	1,648	82
Winter barley (four-rowed)	35	14,871	59
Spring barley (two-rowed)	43	15,798	69
Winter rye	13	11,921	85
Triticale	5	4,136	100
Oats	21	8,191	81
Maize	17	1,408	71
Field bean	17	1,288	81
Winter rape (oil)	13	2,420	80
Potatoes	119	9,591	30
Italian ryegrass	21	3,118	69

Table 12/c

Species	1994 Germany as a whole		
		Propagation area	
	N°var	ha	5 leading var. (%)
Winter wheat	64	52,335	43
Spring wheat	18	3,091	70
Winter barley (four-rowed)	39	19,980	64
Spring barley (two-rowed)	27	18,168	76
Winter rye	20	13,173	65
Triticale	9	9,768	93
Oats	22	12,045	69
Maize	23	1,575	68
Field bean	19	2,720	74
Winter rape (oil)	17	1,981	78
Potatoes	151	16,279	24
Italian ryegrass	25	5,548	48

Table 13 Propagation of Planting Stock in Vine in Germany 1990 from: Blatt für Sortenwesen 1990

Categories	Mother plant stands		Vine nurseries	
	Propagation area (ha)	Leading variety (%)	Number of plants propagated	Leading variety (%)
Stock-vine	47	26.9	94,000	40.3
Grafted vine	490	23.5	21 mill.	26.6

Table 14 Forest Stands and Seed Orchards from: Zusammenstellung über zugelassenes Ausgangsmaterial (1993),Angabender DKV(1994)

Categories		*Species*	Number	Area (ha)
Stock-vine	approved under Forest Seed Act	19	38,706	202,548
	Privately controlled provenances (DKV)	21	91	329
Seed Orchards	approved under Forest Seed Act	14	143	442
	Privately controlled provenances (DKV)	2	5	11

Table 15 Use of Genebanks

	IPK		FAL	
Samples provided per year	12,000		10,000	
of these: domestic/foreign (%)	65/35		56/44	
IPK: **type of use** (%) FAL: **user groups** (%)	screening other evaluation breeding research others	25 40 18 9 8	research institutions breeders private GFP	62 16 16 6
Crop groups (%)				
Arable plant species	53		86	
Grassland species	4		9	
Vegetables	27		4	
Fruit species	3		-	
Permanent and special crops	10		1	
Ornamentals	1		-	
Forest species	-		-	
Wild plants	2		-	

Table 16 ***Examples for the Transfer of Properties from PGR with the Aim to Improve the Varieties of Arable Plants, Grassland Species and Vegetables by Breeding***

Crop	Properties	Source of properties
Wheat	resistance to powdery mildew	*Triticum dicoccoides*, diverse *species* of *Aegilops*
Wheat	resistances to *septoria* and *fusarum*	South America and East Asian land races
Wheat	resistance to steam break	*Aegilops ventricosa*
Wheat	resistance to yellow rust	*Triticum dicoccoides*
Wheat	resistance to brown rust	*Triticum spp.*, Secale cereale
Barley	resistance to powdery mildew and dwarf leaf rust	*Hordeum spontaneum,* barley from Eastern Africa and Western Asia
Barley	resistance to yellow mosaic virus	East Asian land races
Barley	resistance to *Rhynchosporium* and *Helminthosporium teres*	genebank material
Beta-Beets	resistance to *Heterodera schachtii (nematodes)*	*species* of the Section *Procumbentes*
Beta-Beets	resistance to *rizomania* virus	*Beta vulgaris spp.*
Beta-Beets	CMS (Cytoplasmatic male sterility)	*Beta vulgaris spp.*
Potatoes	resistance to *Globodera rostochoiensis* and *G. pallida*	*Solanum vernei*
Rape	freedom from glucosinolate	Polish spring rape variety
Rape	resistance to finger-and-toe-disease	Wild relatives and lines of wild cabbage and bird rape
Rape	Polina CMS	Asian or Eastern European provenances of *Brassica*
Sunflower	resistance to *phomopsis*	Wild *Heliantus-species* from Eastern Europe and/or America
Sunflower	resistance to *Plasmopara heli.* (downey mildew)	
Grassland *Species*	improvement of rapid growth, widening of phenological range, winter hardiness, stress tolerance	autochtonous material from regions with corresponding selection pressure
Vegetables	CMS in cabbage, carrot, leek, etc.	non-crossable wild *species*

Table 17 ***Examples for the Transfer of Properties from PGR with the Aim to Improve the Varieties of Fruit Crops, Permanent and Special Crops by Breeding***

Crop	Property	Source of properties
Apple	resistance to apple scab	*Malus floribunda, Malus micromalus, Malus atrosanguinea, Malus pumilia*
Apple	resistance to apple mildew	*Malus zumi calocarpa, Malus robusta persicifolia*
Sweet cherry	rootstock with good properties	Caucasian and indigenous wild cherry and Mahaleb cherry forms
Vine	resistance to diverse fungi, bacteria, nema-todes, viruses, drought, winter frost, chlorosis	American and Asian wild wine
Vine	quality (aroma, sugar contents) and low input properties	*Vitis vinifera*
Grafted vine	resistance to *oidium* and *plasmopara*	American wild vine like *Vitis riparia, V. rupestris, V. aestivalis, V. labrusca*
Stock vine	• tolerance towards vine louse • improved tolerance towards calcium and drought	American wild vine like *Vitis berlandeieri, V. riparia, V. cinerea*
Hop	• tolerance towards *verticillium*-wilt • higher number of flowers per plant	German wild hops (*Humulus lupulus*)

FIG. 2: ORGANIZATION SCHEME (GERMAN CONCEPT ON PLANT GENETIC RESOURCES) FROM: BOMMER&BEESE 1990

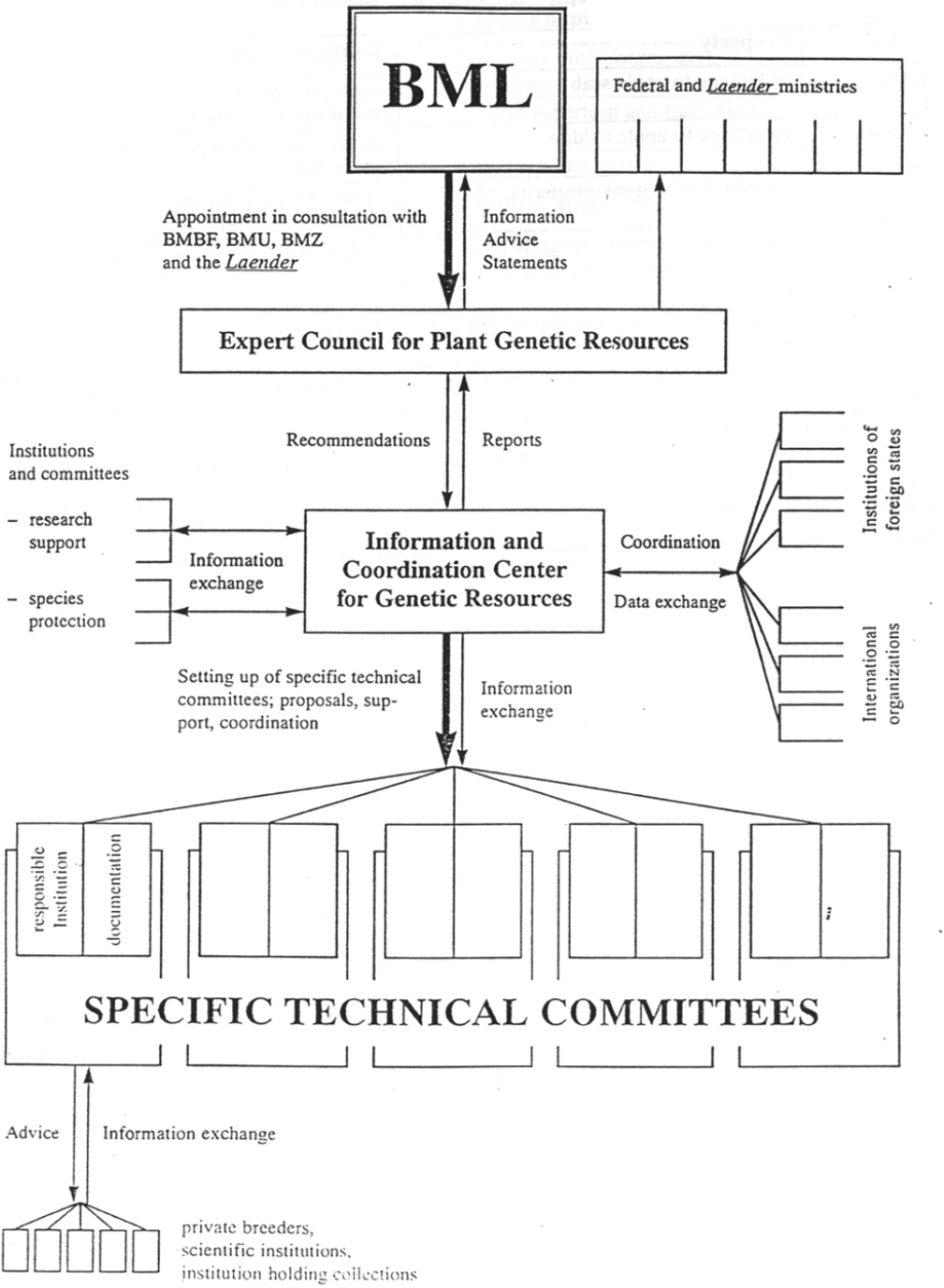


FIG. 3: TASKS OF GENEBANKS. FROM: OGANIZATION ANALYSIS; BMBF (1994)

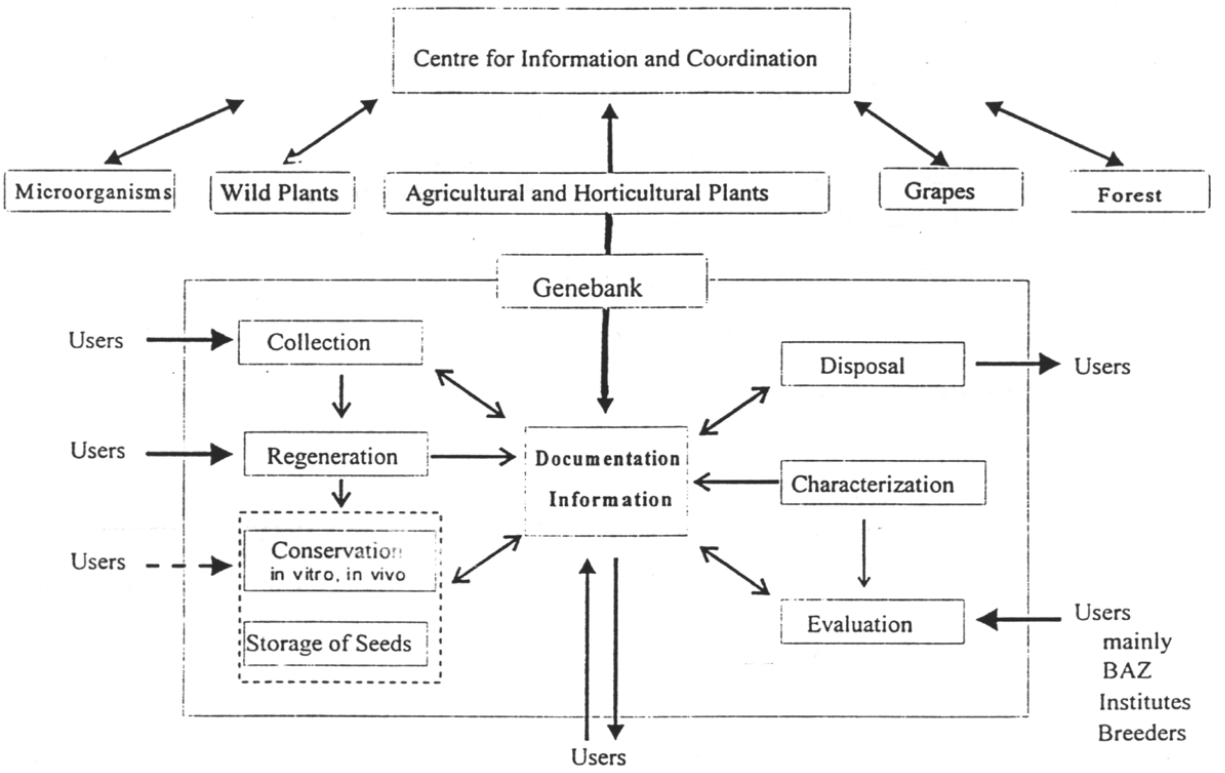


Table 18 Special Projects in Cooperation with IPGRI (1993) from: Jahresbericht 1993 der GTZ

Name of Project	Subjects, Objectives	Time
Refinement of cryoconservation techniques for potatoes	Development of a secure possibility of long-term-storage of genetic material of potatoes with constant quality	1991-1994
Effective methods of directed pollination during the regeneration of genetic material	Optimized utilization of pollinating insects to improve seed formation in cross-pollinating plants	1992-1994
Distribution of genetic diversity in wild fodder plant species in time and space under stress conditions in the Sahelian-Sudan-region	study of the conditions for effective *In Situ* conservation of fodder plants	1993-1997
Genetic resources of neglected crops with good potential of development: their conservation, utilization and breeding status	collection and processing of information on neglected species, development of suitable selection criteria	1993-1996

Table 19 German Contribution to ECP/GR-Programme

Crop	Institution	Information about the Data Base
Barley (*Hordeum spp.*)	IPK Gatersleben	1990: Data on more than 55.000 samples of 34 collections from 26 countries
Oats (*Avena spp.*)	Fal Braunschweig	Data on more than 17.000 samples from 21 collections
Meadow grass (*Poa spp.*)	Fal Braunschweig	Data on more than 1.000 samples from 9 collections

Some 450 seed samples of wild provenances have already been stored (at -18•C).

The **Europe Rosarium of Sangerhausen** has a rose collection (established in 1903) of 450 wild species as well as 6,500 old and new varieties. The Rosarium is sponsored by the town of Sangerhausen.

The **Forest Botanical Gardens at Tharandt** (established 1811) with over 2,000 woody plant species and varieties as well as many forest soil plants on 18 ha and at **Eberswalde** (established 1830) with over 1,100 woody plant taxa on 30 ha are among the oldest botanical gardens in Germany.

The **Botanical Garden of the University of Würzburg** maintains collections of different crops from temperate as well as subtropical and tropical climates in glasshouses and outdoors (garden with agricultural crops and vegetable plants, medicinal plants and spices as well as a cottage garden with crops and ornamentals side by side).

ANNEX 3
List of Wild Plants with Actual or Potential Value for Food, Agriculture and Forestry

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Abies alba	*L *FO AG p	3	3
Acer campestre	*L FO n p	*	**
Acer monspessulanum	*L n p	*	-
Acer opalus	*L n p	4	-
Acer platanoides	*L FO *n p	*	**
Acer pseudoplatanus	*L *FO *n p	*	**
Acer tataricum	*L n p		
Achillea collina	*AG	*	**
Achillea millefolium	*AG *Z FU	*	**
Achillea nobilis	*AG	*	**N
Achillea pannonica	*AG	4	*s
Achillea ptarmica	*Z AG	*	3
Achnatherum calamagrostis	*Z	4	-
Aconitum napellus	*AG *Z n p	*-4	4
Acorus calamus	*AG Z	*	**
Actaea spicata	*Z AG	*	**
Adonis aestivalis	*Z AG p	3	2
Adonis vernalis	*AG *Z *p	2	*s
Aegopodium podagraria	*GE AG	*	**
Agrimonia eupatoria	*AG *p	*	**
Agrimonia procera	*AG *p	*	*s
Agropyron caninum	*FU		
Agropyron intermedium	*FU ST R		
Agropyron junceum	*R ST		
Agropyron repens	*AG ST R FU		
Agrostemma githago	Z	1	1
Agrostis canina	*Z	*	**
Agrostis capillaris	*Z FU	*	**
Agrostis castellana	*Z	*u	*sN
Agrostis gigantea	*FU R	*	**
Agrostis stolonifera	*Z R	*	**
Ajuga reptans	*Z AG n p	*	**
Alchemilla vulgaris	*AG		
Alisma plantago- aquatica	R Z	*	**
Alliaria petiolata	*ÖF GE AG	*	**
Allium carinatum	*Z *n p		
Allium schoenoprasum	*GE AG n p	*	*s
Allium scorodoprasum	GE AG n p	*	**
Allium ursinum	*AG GE *n p	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Allium victorialis	GE *n p	*	-
Alnus glutinosa	*R *L *FO AG *p	*	**
Alnus incana	*R *L FO *p	*	**
Alnus viridis	*R L *p	*	*sN
Alopecurus arundinaceus	*FU	-	1
Alopecurus pratensis	*FU Z	*	**
Althaea officinalis	*AG *n p	2	3
Alyssum argenteum	*Z *n p		
Alyssum montanum	*Z n p	*-2	**
Amaranthus lividus	*GE		
Amelanchier ovalis	*OU L n p	*	**
Ammophila arenaria	*R	*	**
Anchusa azurea	*Z AG *n p		
Anchusa officinalis	*AG *n p	*	**
Andromeda polifolia	*L	3	3
Anemone sylvestris	*Z p	3	3
Angelica archangelica	*AG GE *n p	*	**
Antennaria dioica	*AG *Z	3	3
Anthemis tinctoria	*Z AG TK	*	**
Anthericum liliago	*Z n p	*	*s
Anthericum ramosum	*Z AG n p	*	*s
Anthoxanthum odoratum	FU Z	*	**
Anthyllis vulneraria	*R AG FU n p	*	**
Apium graveolens	*GE *AG	2	3
Aquilegia vulgaris	*Z AG *n p		
Arabis alpina	*Z *n p	*	1
Arabis glabra	AG *n p	*	*s
Arctium lappa	*AG *GE n p	*	**
Arctostaphylos uva- ursi	*AG OU L	2	2
Armeria arenaria	*Z n p	0	.
Armeria maritima	*Z n p		
Armoracia rusticana	*AG n p	*	**N
Arnica montana	*AG n p	3	2
Arrhenatherum elatius	*FU Z	*	**
Artemisia absinthium	*AG Z	*	**
Artemisia pontica	*AG	*N	3
Artemisia vulgaris	*AG GE R	*	*
Aruncus dioicus	*Z *p	*	**
Asarum europaeum	*AG Z	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Asparagus officinalis	*GE AG *n *p	*	**
Asperula tinctoria	TK	3	*s
Aster alpinus	*Z *n *p	*	4
Aster amellus	*Z *n *p	*	*s
Astragalus arenarius	FU n	*N	3
Astragalus cicer	*FU R n	3	**
Astragalus glycyphyllos	*FU AG	*	**
Astrantia major	*Z	*	**
Athyrium filix- femina	*Z	*	**
Atriplex nitens	*GE FU		
Atriplex rosea	FU	*u	3
Atropa bella-donna	*AG	*	**
Aurinia saxatilis	*Z n p	4	4
Avena barbata	ST	*u	*u
Avena fatua	ST	*	**
Avena sterilis	ST		
Avenella flexuosa	*Z		
Barbarea vulgaris	*ÖF GE AG FU Z	*	**
Beckmannia eruciformis	*FU		
Bellis perennis	*AG *Z p	*	**
Berberis vulgaris	*L OU AG TK n p	*	**
Berteroa incana	*ÖF	*	**
Beta vulgaris	*ST *GE *FU AG		
Betonica officinalis	*AG n p	*	3
Betula humilis	L p	3	2
Betula nana	*L p	2	1
Betula pendula	*AG *R *L *FO TK	*	**
Betula pubescens	*AG *R *L *FO TK	*	*-s
Blechnum spicant	*Z	*	*s
Brachypodium pinnatum	*R Z	*	**
Brachypodium sylvaticum	Z	*	**
Brassica elongata	*ÖF *n *p	*u	*sN
Brassica nigra	*ÖF *AG *FU GE	*	**N
Brassica oleracea	*ÖF *GE *FU Z *n	*/u	*u
Brassica rapa	*ÖF *GE *FU *n *p	*/u	*u
Briza maxima	*Z		
Briza media	*Z FU	*	**
Bromus arvensis	*FU	3	*s
Bromus erectus	*FU	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Bromus hordeaceus	*FU	*	*
Bromus inermis	*FU R Z	*	**
Bromus secalinus	*FU	3	2
Bromus tectorum	R	*	**
Bryonia dioica	*AG Z n p	*	**
Buglossoides purpurocaerulea	*Z n		
Bunium bulbocastanum	*GE AG FU	*	*s
Bupleurum rotundifolium	AG	2	2
Butomus umbellatus	*Z ST	*	**
Buxus sempervirens	*L AG n p	*	-
Calamagrostis epigejos	R Z	*	**
Calamagrostis varia	*Z	*	**
Calamagrostis villosa	R	*	**
Calla palustris	*Z	3	*s
Calluna vulgaris	*AG *L R Z *n *p	*	**
Caltha palustris	*Z GE AG n p	*	3
Camelina alyssum	*ÖF n p	0	0
Camelina microcarpa	ÖF n p	*	3
Camelina sativa	*ÖF n p	*	*-s
Campanula cochleariifolia	*Z n p	*	-
Campanula glomerata	Z n p	*	3
Campanula latifolia	*Z n p	*	**
Campanula persicifolia	*Z n p	*	**
Campanula rapunculus	GE n p	*	*s
Capsella bursa- pastoris	*GE *AG p	*	**
Cardamine amara	*GE AG *n p	*	**
Cardamine pratensis	GE AG *n p	*	*
Cardamine trifolia	*Z *n p	*	-
Cardaria draba	*GE n p	*	**
Carex arenaria	*R AG	*	**
Carex baldensis	Z	4	-
Carex elata	Z	*	**
Carex firma	*Z	*	-
Carex humilis	Z	*	**
Carex lasiocarpa	Z	3	3
Carex montana	Z	*	*s
Carex ornithopoda	*Z	*	**
Carex pendula	*Z	*	**
Carex pseudocyperus	Z	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Carex sylvatica	Z	*	**
Carex umbrosa	*Z	*	*s
Carlina acaulis	*Z AG n p	*-3	*s
Carpinus betulus	*L *FO p	*	**
Carum carvi	*AG n p	*	3
Castanea sativa	*OU *L *FO ÖF ST	*	*u
Celtis australis	*L *FO		
Centaurea cyanus	*Ag *Z *n *p	3	3
Centaurea jacea	*Z *n p	*	**
Centaurea montana	*Z *n p	*	*s
Centaurium erythraea	*AG	*	*s
Centranthus ruber	*Z GE n p		
Cerasus avium	*OU L FO *n *p		
Cerasus fruticosa	*OU L *n *p		
Cerasus mahaleb	*OU *L AG TK *n		
Chaerophyllum bulbosum	*GE	*	**
Chamaecytisus ratisbonensis	*L n p	*	-
Chamaecytisus supinus	*L n p	*	**N
Chelidonium majus	*AG p	*	**
Chenopodium album	*GE ST FU	*	**
Chenopodium bonus-henricus	*GE AG	3	**
Chenopodium foliosum	*GE	*u	*u
Chenopodium vulvaria	AG	2	3
Chrysanthemum segetum	*Z	*	3
Cichorium intybus	*GE AG TK *n *p	*	**
Cirsium oleraceum	*GE *n *p	*	**
Clematis alpina	*L p	*	-
Clematis recta	Z	*	3
Clematis vitalba	*L R n p	*	**
Clematis viticella	*L		
Cochlearia officinalis	ÖF GE AG Z *n p	3	4
Colchicum autumnale	*AG *Z *TK n p	*	3
Colutea arborescens	*R *L AG TK *n p	4	*sN
Conium maculatum	*AG	*	**
Conringia orientalis	*ÖF GE n p	2	3
Consolida ajacis	*Z	*u	*u
Consolida regalis	*Z AG	*	3
Convallaria majalis	*AG *Z	*	**
Convolvulus arvensis	*AG n p	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Cornus mas	*OU *L AG R TK *n	*	* *
Cornus sanguinea	*R *L ÖF TK n p	*	* *
Coronilla varia	*R *FU AG Z		
Coronopus squamatus	GE AG	3	*s
Corydalis cava	*Z AG n p	*	* *
Corydalis lutea	Z n p		
Corylus avellana	*ÖF *OU *L TK p	*	* *
Corylus colurna	*L OU TK p		
Corylus maxima	*ÖF *OU *L TK p		
Corynephorus canescens	*R	*	* *
Cotinus coggygria	*L TK n p	.	*s
Cotoneaster integerrimus	R L *n *p	*	* *
Cotoneaster tomentosus	R L *n *p		
Crambe maritima	*GE FU n p	4	4
Crataegus curvisepala	*OU *AG *L TK n p		
Crataegus laevigata	*OU *AG *L TK n p	*	* *
Crataegus monogyna	*OU *AG *L TK n p	*	* *
Crocus albiflorus	*Z n p		
Crocus tommasinianus	*Z n p		
Cyclamen purpurascens	*Z	4	-
Cymbalaria muralis	*Z n	*	* *
Cynodon dactylon	*FU AG R Z	*	* *
Cynosurus cristatus	*Z R FU	*	*s
Cypripedium calceolus	*Z	2	*s
Cytisus sessilifolius	L p		

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Dactylis glomerata	*FU Z		
Dactylis polygama	*FU		
Daphne cneorum	L	2	-
Daphne laureola	L	4	-
Daphne mezereum	*L AG n p	*	**
Daphne striata	L n p	*	-
Datura stramonium	*AG	*	**
Daucus carota	*GE *AG *FU n p	*	**
Delphinium elatum	*Z AG n p		
Deschampsia cespitosa	*R *Z	*	**
Descurainia sophia	AG n p	*	**
Dianthus arenarius	Z	-	3
Dianthus carthusianorum	*Z	*	**
Dianthus deltoides	*Z	*	*s
Dianthus gratianopolitanus	*Z	3	*s
Dianthus plumarius	*Z	*	*u
Dianthus superbus	*Z	3	2
Dianthus sylvestris	*Z	*	-
Dictamnus albus	*Z AG n p	3	*s
Digitalis grandiflora	AG Z n p	*	*s
Digitalis lanata	*AG n p		
Digitalis purpurea	*AG *Z n p	*	**
Digitaria sanguinalis	ST FU	*	**
Diplotaxis tenuifolia	*GE AG	*	**
Dipsacus fullonum	TK *n p	*	**
Doronicum columnae	*Z	4	*u
Doronicum orientale	*Z		
Draba aizoides	*Z	*	-
Dryas octopetala	*Z	*	-
Dryopteris affinis	*Z	*	4
Dryopteris filix-mas	*Z AG TK	*	**
Echinochloa crus- galli	*ST *FU	*	**
Echinops ritro	*Z *n p		
Echinops sphaerocephalus	*Z AG *n p	*	**
Empetrum nigrum	*L	3	*s
Epilobium angustifolium	*AG GE FU TK *n p	*	**
Epimedium alpinum	*Z	*	*u
Equisetum arvense	*AG TK	*	**
Eragrostis pilosa	*ST	*	*s

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Eranthis hyemalis	*Z n *p	*	**
Erica cinerea	*L Z n p	1	-
Erica herbacea	*L *Z *n *p		
Erica tetralix	*L Z *n p	*	3
Erinus alpinus	*Z n p		
Eriophorum latifolium	*Z	3	2
Eriophorum vaginatum	*Z	*	*s
Eryngium campestre	GE AG n p	*	**
Eryngium maritimum	*Z GE AG n p	2	2
Eryngium planum	*Z AG n p	.	1
Erysimum cheiranthoides	ÖF	*	**
Erysimum hieraciifolium	ÖF		
Euonymus europaeus	*R *L TK n p	*	**
Euonymus latifolius	*R *L n p	*	-
Eupatorium cannabinum	*AG n p	*	**
Euphorbia esula	ÖF AG	*	**
Euphorbia lathyris	*ÖF AG Z	*u	*s
Euphorbia polychroma	*Z ÖF		
Euphrasia rostkoviana	*AG		
Fagus sylvatica	*AG *L *FO ÖF KE	*	**
Festuca amethystina	*Z	*	-
Festuca arundinacea	*FU *Z R	*	**
Festuca cinerea	*Z		
Festuca filiformis	*Z	*	*s
Festuca gigantea	FU Z	*	**
Festuca heterophylla	*Z	*	**
Festuca nigrescens	*Z FU	*	**
Festuca ovina	*R *FU *Z	*	**
Festuca pratensis	*FU Z	*	**
Festuca psammophila	FU	0	*s
Festuca pseudovina	R FU Z	*N	**
Festuca rubra	*FU *Z R	*	**
Festuca rupicola	Z	*	**
Festuca valesiaca	*Z	2	**
Filipendula vulgaris	*AG ST FU Z p	*	**
Fragaria moschata	*OU n p	*	**
Fragaria vesca	*OU *AG n p	*	**
Fragaria viridis	*OU n p	*	*s
Frangula alnus	*AG *L TK n p	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Fraxinus angustifolia	*L FO p		
Fraxinus excelsior	*R *L *FO AG p	*	**
Fraxinus ornus	*AG *L p	*	*u
Fritillaria meleagris	*Z n p	2	1
Fumaria officinalis	*AG n p	*	**
Galanthus nivalis	*Z n p	3	*sN
Galega officinalis	AG FU Z n p	*	*s
Galeopsis segetum	*AG n p	*	3
Galium odoratum	AG n	*	**
Galium verum	*AG TK	*	*
Genista anglica	*L p	*	2
Genista germanica	*L p	*	3
Genista pilosa	*L p	*	*s
Genista tinctoria	*L AG TK p	*	**
Genistella sagittalis	*L R p		
Gentiana acaulis	Z p	3	-
Gentiana asclepiadea	*AG Z n p	3	*sN
Gentiana clusii	*Z n p	3	-
Gentiana cruciata	*Z n p	2	3
Gentiana lutea	*AG n p	3	*sN
Geranium macrorrhizum	AG Z n p	*	*s
Geranium robertianum	*AG n p	*	*
Geranium sanguineum	*Z AG TK n p	*	*s
Geum montanum	Z n p	*	*sN
Geum urbanum	*AG GE TK n p	*	**
Gladiolus imbricatus	*Z	-	1
Gladiolus palustris	*Z	2	0
Glaucium flavum	*AG p	*u	**
Glechoma hederacea	*AG R Z *n p	*	**
Glyceria fluitans	ST FU	*	**
Glyceria maxima	*FU Z TK	*	**
Gratiola officinalis	*AG	2	3
Gypsophila paniculata	*Z *TK n p	.	*sN
Gypsophila repens	*Z n p	*	-
Hedera helix	*AG *L *Z n *p	*	**
Helianthemum apenninum	*Z p	3	4
Helianthemum nummularium	*Z p	*	**
Helichrysum arenarium	*AG	2	*s
Helleborus niger	*Z AG n *p	3	*u

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Helleborus viridis	AG *n *p	*	4
Hepatica nobilis	AG *Z n p	*	**
Heracleum sphondylium	GE AG FU *n p	*-4	*
Herniaria glabra	*AG	*	**
Hieracium aurantiacum	*Z n p	*	**
Hippophae rhamnoides	*OU *R *L AG n p	*	**
Hippuris vulgaris	*Z	*	2
Holcus lanatus	FU	*	**
Hordeum marinum	ST	*	*u
Hordeum murinum	ST		
Hordeum secalinum	ST	3	3
Hottonia palustris	*Z	3	3
Humulus lupulus	*AG GE Z	*	**
Hyoscyamus niger	*AG	3	3
Hypericum perforatum	*AG p	*	**
Hyssopus officinalis	*AG *Z *n p	*	*s
Iberis amara	*Z	1	*sN
Iberis sempervirens	*Z		
Ilex aquifolium	*L AG n p	*	*s
Inula ensifolia	*Z n *p		
Inula hirta	*Z n *p	3	**
Iris aphylla	*Z n p	-	2
Iris graminea	*Z n p	*	-
Iris pallida	*Z AG n p		
Iris pseudacorus	*Z AG n p	*	**
Iris pumila	*Z n p	.	**
Iris sibirica	*Z n p	2	2
Iris spuria	*Z n p	1	-
Isatis tinctoria	*TK ÖF FU n p	*	*sN
Juglans regia	*ÖF *OU AG TK	*	*u
Juncus effusus	*TK R Z	*	**
Juncus gerardi	FU	*	**
Juncus inflexus	Z	*	**
Juncus maritimus	*TK	*	**
Juniperus communis	*AG *L TK p		
Juniperus sabina	*L AG R p	4	-
Koeleria glauca	R Z	2	**
Koeleria macrantha	*Z FU		
Laburnum alpinum	*R *L n p		

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Laburnum anagyroides	*R *L n p	*	*s
Lactuca perennis	*GE	*	**
Lactuca quercina	AG	2	*s
Lactuca saligna	GE	2	0
Lactuca serriola	*GE	*	**
Lactuca virosa	*AG	*	*s
Lamiastrum galeobdolon	*Z n p		
Lamium album	*AG GE Z n p	*	**
Lamium maculatum	Z n p	*	**
Larix decidua	*L *FO AG	*	**N
Laser trilobum	AG	4	-
Lathyrus hirsutus	*FU R n p	2	*sN
Lathyrus latifolius	*Z FU n p	*u	**
Lathyrus pratensis	*FU *n p	*	**
Lathyrus sylvestris	*R *FUZ n p	*	**
Lathyrus tuberosus	ST FU n p	*	3
Lathyrus vernus	*Z AG FU n p	*	**
Laurus nobilis	*AG *L Z		
Lavandula angustifolia	*AG *Z TK n p		
Ledum palustre	AG Z TK n p	2	3
Leersia oryzoides	ST	3	3
Lembotropis nigricans	*L p	*	*s
Lens nigricans	KE		
Leontopodium alpinum	*Z	2	-
Leonurus cardiaca	*AG TK *n p	3	*sN
Lepidium latifolium	*GE *AG n p	*	**
Leucanthemum vulgare	*Z GE AG		
Leucojum aestivum	*Z n p	*	*s
Leucojum vernum	*Z AG n p	3	3
Leymus arenarius	*R ST Z	*	**
Ligustrum vulgare	*R *L TK n p	*	**
Lilium bulbiferum	*Z n p	3	2
Lilium martagon	*Z n p	*	*s
Linaria vulgaris	*AG	*	**
Linum austriacum	*Z n p	*	**
Linum catharticum	AG n p	*	**
Linum flavum	*Z n p	1	-
Linum perenne	*Z n p	1	*sN
Lobularia maritima	*Z AG n p	*u	*u

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Lolium multiflorum	*FU	*	**
Lolium perenne	*FU *Z	*	**
Lolium remotum	FU	0	1
Lolium rigidum	*FU		
Lolium temulentum	FU	0	1
Lonicera alpigena	*L n p	*	-
Lonicera caerulea	*L OU n p	*	-
Lonicera caprifolium	*L Z	*N	**
Lonicera nigra	L n p	*	*s
Lonicera periclymenum	*L Z n p	*	**
Lonicera xylosteum	*L n p	*	**
Loranthus europaeus	TK	-	1
Lotus corniculatus	*FU *n p	*	*
Lotus tenuis	*FU n p		
Lotus uliginosus	*FU *n p	*	**
Lunaria annua	*Z	*u	*u
Lunaria rediviva	*Z	*	**
Lupinus angustifolius	*KE *FU p	*u	*u
Luzula nivea	*Z	*	-
Luzula pilosa	*Z AG	*	**
Luzula sylvatica	*Z	*	**
Lychnis alpina	*Z		
Lychnis coronaria	*Z	*u	*u
Lychnis viscaria	*Z	*	3
Lysimachia nummularia	*AG *Z	*	**
Lysimachia punctata	*Z	*	*s
Lythrum salicaria	*Z GE AG *n p	*	**
Malus sylvestris	*OU L *n *p	*	*s
Malva alcea	*Z n p	*	*s
Malva moschata	*Z AG n p	*	*s
Malva neglecta	*AG n p	*	**
Malva sylvestris	*AG n p	*	**
Marrubium vulgare	*AG *n p	1	2
Matricaria chamomilla	*AG		
Matteuccia struthiopteris	*Z	3	*sN
Medicago falcata	*R *FU *n p	*	**
Medicago glomerata	FU *n p		
Medicago lupulina	*FU R *n p	*	**
Medicago minima	FU n p	*	*s

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Medicago prostrata	FU n p		
Medicago sativa	*R *FU *n p	*u	**
Melica ciliata	*Z	*	*s
Melica nutans	*Z	*	**
Melilotus albus	*R FU *n *p	*	**
Melilotus altissimus	AG FU *n *p	*	3
Melilotus dentatus	*FU n p	1	**
Melilotus officinalis	*AG *FU TK *n *p	*	**
Mentha aquatica	*AG n p	*	**
Mentha arvensis	*AG n p	*	**
Mentha longifolia	*AG n p	*	**
Mentha piperita agg.	*AG n p		
Mentha pulegium	*AG TK n p	3	3
Mentha spicata	*AG n p	*	*s
Mentha suaveolens	*AG n p	*	*s
Mentha verticillata agg.	*AG n p		
Mentha x dalmatica	*AG n p	*	*
Mentha x dumetorum	*AG n p	*	*
Mentha x gentilis	*AG n p	*	*
Mentha x maximilianea	*AG n p	*	.
Mentha x muellerana	*AG n p		
Mentha x piperita	*AG n p	*	**
Mentha x verticillata	*AG n p	*	**
Menyanthes trifoliata	*AG	3	3
Mercurialis annua	GE AG	*	**N
Mercurialis perennis	AG	*	**
Mespilus germanica	*OU *L n p	*	*sN
Meum athamanticum	*AG GE Z	3	3
Molinia caerulea	*Z	*	**
Muscari botryoides	*Z n p	3	4
Muscari comosum	*Z n p	2	2
Muscari racemosum	*Z n p		
Myosotis palustris	*Z n p		
Myosotis sylvatica	*Z n p	*	**
Myrica gale	*L AG	3	3
Myrrhis odorata	*AG	*	*sN
Narcissus poeticus	*Z	*	*u
Narcissus pseudonarcissus	*Z	3	*
Nasturtium officinale	*GE *AG n p	*	3

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Nerium oleander	*Z n p		
Nigella damascena	*Z AG *n p	.	*u
Nuphar lutea	*Z ST AG	*	**
Nuphar pumila	Z	1	1
Nymphaea alba	*Z TK	*	**
Nymphaea candida	*Z	2	3
Nymphoides peltata	*Z GE	3	2

TAXA	Utilization index	Endangering	
		old Laender	new Laender
Veronica austriaca	*Z n p	2	*s
Veronica fruticans	*Z n p	*	-
Veronica longifolia	*Z n p	3	3
Veronica officinalis	*AG n p	*	**
Veronica prostrata	*Z n p	3	*s
Veronica spicata	*Z *n p	3	3
Veronica teucrium	*Z n p	*	*s
Viburnum lantana	*L R n p	*	**
Viburnum opulus	*L R n p	*	**
Vicia angustifolia	*FU R n p	*	**
Vicia cassubica	FU n p	3	**
Vicia cordata	FU n p		
Vicia cracca	*FU *n p	*	**
Vicia dumetorum	*FU n p	*	*s
Vicia hirsuta	*FU n p	*	**
Vicia lutea	FU n p	*	*s
Vicia narbonensis	*KE FU n p	*	*s?
Vicia pannonica	*FU n p	*	*s
Vicia sativa	*FU KE n p	*u	**
Vicia sepium	FU n p	*	**
Vicia serratifolia	KE FU n p		
Vicia tenuifolia	FU n p	*	**
Vicia tetrasperma	FU n p	*	**
Vicia villosa	*FU *n p	*	*N
Vinca major	*Z AG	*	.
Vinca minor	*AG *Z	*	**
Viola arvensis	*AG n	*	**
Viola odorata	*AG *Z n	*	**N
Viola tricolor	*AG *Z n	*	**
Viscum album	*AG n p	*	*-s
Vitis vinifera	*OU L n p	1/u	*N
Xanthium albinum	*ÖF TK n p		
Xanthium strumarium	*ÖF TK n p	*	*s
Zostera marina	ST R FU TK	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Oenanthe aquatica	*AG	*	**
Omphalodes verna	*Z	*	*s
Onobrychis viciifolia	*FU *n *p	*	*s
Ononis campestris	*AG n p	*	**
Onopordum acanthium	*AG Z*n p	3	**
Orchis mascula	AG	3	3
Origanum vulgare	*AG *Z *n p	*	**
Ornithogalum umbellatum	*Z n p	*	**N
Ornithopus perpusillus	FU n p	*	**
Osmunda regalis	*Z	2	3
Oxalis acetosella	GE AG TK	*	**
Oxycoccus microcarpus	*OU AG		
Oxycoccus palustris	*OU		
Padus avium	*OU *L AG TK n p		
Paeonia officinalis	*AG Z n *p	*	*u
Papaver alpinum agg.	*Z p		
Papaver rhoeas	*Z AG p	*	**
Paronychia kapela	*Z AG		
Pastinaca sativa	*GE AG FU n p	*	**
Periploca graeca	*L		
Petasites hybridus	*AG *n *p	*	**
Petrorhagia saxifraga	*Z	*	*sN
Peucedanum ostruthium	*AG	*	*s
Phalaris arundinacea	*FU R Z	*	**
Philadelphus coronarius	*L R	*u	*u
Phillyrea latifolia	*Z L		
Phleum alpinum	*FU		
Phleum bertolonii	*Z	*	**
Phleum phleoides	FU Z	*	*s
Phleum pratense	*FU *Z	*	**
Phleum pratense			
Phragmites australis	*TK ST GE R	*	**
Phyllitis scolopendrium	*Z GE AG		
Physalis alkekengi	*AG *Z OU	*	*s

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Picea abies	*AG *L *FO TK p	*	**
Pimpinella major	*AG	*	*s
Pimpinella saxifraga	*AG	*	**
Pinus cembra	*L *FO AG TK p	*	-
Pinus mugo	*AG *R *L p	*	*?
Pinus nigra	*AG *R *L *FO TK	*	*
Pinus picea			
Pinus rotundata	*AG*R *L p	*	*s
Pinus sylvestris	*AG *R *L *FO *TK	*	**
Pinus uncinata	*AG *R *L *FO p		
Plantago lanceolata	*AG FU p	*	**
Plantago major	*AG p	*-2	*
Poa alpina	*FU	*	-
Poa angustifolia	*Z R FU	*	**
Poa annua	Z	*	**
Poa bulbosa	*FU	*	*s
Poa chaixii	Z	*	**
Poa compressa	*R *FU	*	**
Poa nemoralis	*Z FU	*	**
Poa palustris	*FU	*	3
Poa pratensis	*FU *Z R	*	**
Poa supina	*Z	*	**
Poa trivialis	*Z FU	*	**
Polemonium caeruleum	*Z AG *n p	3	4
Polygala amara	*AG		
Polygonatum multiflorum	AG Z	*	**
Polygonum aviculare	*AG GE n p	*	*
Polygonum hydropiper	*AG n p	*	**
Polypodium vulgare	*AG Z	*	**
Polystichum aculeatum	*Z	*	*s
Populus alba	*R *L FO p	*	*s
Populus nigra	*AG *R *L *FO TK	3	*s
Populus tremula	*R *FO L p	*	**
Populus x canescens	*R *L *FO p	*	*u
Portulaca oleracea	*GE AG	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Potentilla anserina	*AG GE n p	*	**
Potentilla argentea	*Z n p	*	**
Potentilla aurea	*Z n p	*	-
Potentilla erecta	*AG n p	*	**
Potentilla neumanniana	*Z n p	*	**
Potentilla recta	*Z n p	*	*s
Primula auricula	*Z n p	3	-
Primula elatior	*Z AG n p	*	**
Primula farinosa	AG Z n p	3	1
Primula hirsuta	*Z n p	4	-
Primula veris	*AG *Z n p	*	3
Primula vulgaris	*Z GE n p		
Prunella grandiflora	*Z n p	*	*s
Prunella vulgaris	*Ag n p	*	**
Prunus spinosa	*OU *R *L AG n *p		
Prunus x fruticans	*OU n p	*	**
Pulmonaria angustifolia	*Z n p		
Pulmonaria officinalis	*AG GE n p		
Pulsatilla pratensis	AG Z n *p	1	2
Pulsatilla vulgaris	*A *Z n *p	3-2	3
Pyrola rotundifolia	*AG	*	*s
Pyrus nivalis	*OU *n *p		
Pyrus pyraster	*OU L FO *n *p	*	*s
Quercus cerris	*L *FO TK p		
Quercus petraea	*AG *R *L *FO TK	*	**
Quercus pubescens	*L *FO p		
Quercus robur	*AG *R *L *FO TK	*	**
Ranunculus acris	AG Z n p	*	**
Ranunculus ficaria	GE Z n p	*	**
Ranunculus lingua	*Z n p	3	3
Raphanus raphanistrum	ÖF GE FU *n p	*	**
Reseda lutea	*AG n p	*	**
Reseda luteola	*TK ÖF n p	*	**
Rhamnus alpina	*L n p		
Rhamnus cathartica	*AG *R *L TK n p	*	**

TAXA	Utilization index	Endangering	
		old Laender	new Laender
Rosa subcollina	*OU *AG *L p	*	**
Rosa tomentosa	*OU *AG *L p	*	**
Rosa villosa	*OU *AG *L p	4	**
Rosa vosagiaca	*OU *AG *L p	*	**
Rubia tinctorum	*TK AG		
Rubus caesius	*AG OU *n p	*	**
Rubus chamaemorus	*OU n p	2	0
Rubus fruticosus	*AG *OU Z *n *p		
Rubus idaeus	*AG *OU *n *p	*	**
Rubus saxatilis	*OU *n p	*	**
Rumex acetosa	*GE p	*	**
Rumex alpinus	GE AG FU p		
Rumex crispus	AG GE p	*	**
Rumex hydrolapathum	GE AG p	*	**
Rumex patientia	*GE AG p	*	*s
Rumex scutatus	*GE AG p	*	*sN
Rumex thyrsiflorus	FU p	*	**
Ruta graveolens	*AG Z n	*	*s
Sagina subulata	*Z	2	0
Sagittaria sagittifolia	ST FU Z	*	3
Salicornia stricta	*R *GE		
Salix alba	*AG *R *L *FO *TK	*	**
Salix alpina	*L n p	4	-
Salix aurita	*AG *R L n p	*	**
Salix bicolor	L n p		
Salix caesia	*L R n p		
Salix caprea	*AG *R *L *n *p	*	**
Salix cinerea	*AG *R L *n *p		
Salix daphnoides	*AG *R *L *n *p	2	4
Salix eleagnos	*R *L n p	*	*sN
Salix fragilis	*AG *R *L *TK FO	*	**
Salix myrsinifolia	*AG *R *n *p	*	4
Salix pentandra	*AG *L TK n p	*	**
Salix phylicifolia	L n p	0	1
Salix purpurea	*AG *R *L *TK *n	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Salix repens	*R *L n p		
Salix triandra	*AG *TK L *n *p	*	**
Salix viminalis	*AG *R *L *TK n *p	*	**
Salvia nemorosa	*Z *n p	*N	*s
Salvia officinalis	*AG *n p	*	*sN
Salvia pratensis	AG Z *n p	*	**
Sambucus ebulus	AG R TK	*	*s
Sambucus nigra	*OU *AG L	*	**
Sambucus racemosa	OU AG Z	*	**
Sanguisorba minor	*GE AG R FU		
Sanguisorba officinalis	*AG	*	**
Sanicula europaea	*AG Z	*	**
Saponaria ocymoides	*Z	4	*sN
Saponaria officinalis	*AG Z TK	*	**
Sarothamnus scoparius	*AG *R *L p		
Satureja montana	*AG Z n		
Saxifraga burseriana	*Z	4	-
Saxifraga cotyledon	*Z		
Saxifraga decipiens	*Z		
Saxifraga oppositifolia	*Z	*-0	-
Saxifraga paniculata	*Z	*	-
Schoenoplectus lacustris	*R ST FU TK Z	*	**
Scilla bifolia	*Z n *p	*	3
Scorzonera hispanica	*GE AG TK n p	2	**
Scrophularia nodosa	AG *n	*	**
Scutellaria alpina	*Z n		
Sedum acre	AG Z n p	*	**
Sedum album	*Z GE AG n p	*	**
Sedum maximum	*Z GE AG *n p	*	**
Sedum reflexum	*Z GE AG *n p		
Sedum rosea	*AG *Z *n p		
Sedum sexangulare	*Z n p	*	**
Sedum telephium	GE AG Z *n p	*	**
Selaginella helvetica	*Z	*	*s?
Sempervivum arachnoideum	*Z n p	4	-

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Sempervivum tectorum	*Z n p	*	*sN
Senecio abrotanifolius	Z n p	*	-
Serratula tinctoria	TK n p		
Sesleria varia	*Z	*	**
Setaria pumila	*Z ST FU	*	**
Setaria verticillata	ST	*	**
Setaria viridis	*ST FU	*	**
Silaum silaus	AG	*	3
Silene acaulis	Z		
Silene alpestris	*Z		
Silene armeria	*Z	*	0
Sinapis alba	*AG *FU ÖF GE R	*u	*u
Sinapis arvensis	ÖF AG *n p	*	**
Solanum alatum	AG		
Solanum dulcamara	*AG Z	*	**
Solanum luteum	AG		
Solanum nigrum	*GE AG	*	**
Soldanella montana	*Z	*	-
Solidago virgaurea	*AG n p	*	**
Sonchus oleraceus	GE AG FU n p	*	**
Sorbus aria	*L OU AG n p		
Sorbus aucuparia	*OU*R *AG *L FO	*	**
Sorbus austriaca	*OU *L n p		
Sorbus chamaemespilus	*L OU n p	*	-
Sorbus danubialis	*L OU n p	*	-
Sorbus domestica	*OU *L AG n p	*	4
Sorbus graeca	*L OU n p	*	*
Sorbus intermedia	*L OU n p	*	4
Sorbus mougeotii	*L OU n p	4	-
Sorbus sudetica	*L OU n p		
Sorbus torminalis	*L OU FO TK n p	*	**
Spergula arvensis	*FU n p	*	**
Spiraea cana	*L n p		
Spiraea chamaedryfolia	*L n p		
Spiraea media	*L n p		

TAXA	Utilization index	Enda
		old
		Laender
Trifolium medium	*FU n p	*
Trifolium montanum	AG FU *n p	*
Trifolium pannonicum	FU *n p	
Trifolium pratense	*FU AG *n *p	*
Trifolium repens	*FU AG R *n *p	*
Trifolium subterraneum	*FU R n p	
Trigonella caerulea	AG *n p	
Trisetum flavescens	*FU	*
Trollius europaeus	*Z n *p	3
Tussilago farfara	AG n p	*
Typha angustifolia	*Z	*
Typha latifolia	GE Z TK	*
Typha minima	*Z	1
Ulex europaeus	*L R FU p	*
Ulex minor	L p	
Ulmus glabra	*L *FO *p	*
Ulmus laevis	*L FO *p	*
Ulmus minor	*L *FO R *p	2
Ulmus procera	*L *FO *p	
Urtica dioica	*AG *TK GE FU	*
Urtica kioviensis	FU	2
Urtica urens	*AG TK	*
Vaccinium gaultherioides	OU n p	
Vaccinium myrtillus	*OU *AG *n p	*
Vaccinium uliginosum	*AG OU n p	*
Vaccinium vitis- idaea	*AG *OU n p	*
Valeriana officinalis	*AG n p	
Valerianella locusta	*GE	*
Veratrum album	*Z	*
Verbascum densiflorum	*AG *Z p	*
Verbascum phlomoides	*AG *Z p	*
Verbascum phoeniceum	*Z p	1
Verbascum thapsus	*AG Z TK p	*
Verbena officinalis	*AG GE n	*
Veronica anagallis- aquatica	*GE AG n p	*

TAXA	Utilization index	Endangering	
		old Laender	new Laender
Trifolium medium	*FU n p	*	**
Trifolium montanum	AG FU *n p	*	3
Trifolium pannonicum	FU *n p		
Trifolium pratense	*FU AG *n *p	*	**
Trifolium repens	*FU AG R *n *p	*	**
Trifolium subterraneum	*FU R n p		
Trigonella caerulea	AG *n p		
Trisetum flavescens	*FU	*	**
Trollius europaeus	*Z n *p	3	2
Tussilago farfara	AG n p	*	**
Typha angustifolia	*Z	*	**
Typha latifolia	GE Z TK	*	**
Typha minima	*Z	1	-
Ulex europaeus	*L R FU p	*	*s
Ulex minor	L p		
Ulmus glabra	*L *FO *p	*	**
Ulmus laevis	*L FO *p	*	*s
Ulmus minor	*L *FO R *p	2	**
Ulmus procera	*L *FO *p		
Urtica dioica	*AG *TK GE FU	*	**
Urtica kioviensis	FU	2	4
Urtica urens	*AG TK	*	**
Vaccinium gaultherioides	OU n p		
Vaccinium myrtillus	*OU *AG *n p	*	**
Vaccinium uliginosum	*AG OU n p	*	**
Vaccinium vitis- idaea	*AG *OU n p	*	**
Valeriana officinalis	*AG n p		
Valerianella locusta	*GE	*	**
Veratrum album	*Z	*	-
Verbascum densiflorum	*AG *Z p	*	**
Verbascum phlomoides	*AG *Z p	*	*s
Verbascum phoeniceum	*Z p	1	3
Verbascum thapsus	*AG Z TK p	*	**
Verbena officinalis	*AG GE n	*	3
Veronica anagallis- aquatica	*GE AG n p	*	**

TAXA	Utilization index	Endangering	
		old	new
		Laender	Laender
Veronica austriaca	*Z n p	2	*s
Veronica fruticans	*Z n p	*	-
Veronica longifolia	*Z n p	3	3
Veronica officinalis	*AG n p	*	**
Veronica prostrata	*Z n p	3	*s
Veronica spicata	*Z *n p	3	3
Veronica teucrium	*Z n p	*	*s
Viburnum lantana	*L R n p	*	**
Viburnum opulus	*L R n p	*	**
Vicia angustifolia	*FU R n p	*	**
Vicia cassubica	FU n p	3	**
Vicia cordata	FU n p		
Vicia cracca	*FU *n p	*	**
Vicia dumetorum	*FU n p	*	*s
Vicia hirsuta	*FU n p	*	**
Vicia lutea	FU n p	*	*s
Vicia narbonensis	*KE FU n p	*	*s?
Vicia pannonica	*FU n p	*	*s
Vicia sativa	*FU KE n p	*u	**
Vicia sepium	FU n p	*	**
Vicia serratifolia	KE FU n p		
Vicia tenuifolia	FU n p	*	**
Vicia tetrasperma	FU n p	*	**
Vicia villosa	*FU *n p	*	*N
Vinca major	*Z AG	*	.
Vinca minor	*AG *Z	*	**
Viola arvensis	*AG n	*	**
Viola odorata	*AG *Z n	*	**N
Viola tricolor	*AG *Z n	*	**
Viscum album	*AG n p	*	*-s
Vitis vinifera	*OU L n p	1/u	*N
Xanthium albinum	*OF TK n p		
Xanthium strumarium	*OF TK n p	*	*s
Zostera marina	ST R FU TK	*	**

LEGEND:

Groups of Utilization (Abbreviations):

ÖF Plants with high oil or fat content

ST Plants with high starch or sugar content

KE Plants with high protein content

GE Vegetables, wild vegetables

OU Fruits, wild fruits incl. nuts, rootstocks for fruit trees

AG Medicinal plants or spices, plants with basic substances for cosmetic use

R Plants for land reclamation, protection against soil erosion or soil improvement

L Woody plants for garden or landscape planning, for protection against wind and for ornamental purposes

FO Woody plants of the forest

FU Fodder plants

Z Ornamental plants and lawn grasses

TK Technical crops (*species* with high colour or fibre content or usable for wickerwork). Special utilizations (e.g. production of haploids through the Colchicin of the Colchicum *species*)

Abbreviations with asterisk (*), e.g. *Z, indicate the actual or main utilization of the plant.

Utilization groups without asterisk are mentioned as possible utilization of the wild plant with little actual significance.

Donor plants of nectar or pollen with high value ("nectar value" 3 and 4) are indicated with *n or *p, those with low value ("Nectar value" 1 und 2) are indicated with n or p .

Endangering indices:

0 extinct or missing

1 threatened by extinction

2 highly endangered

3 endangered

4 potentially endangered

* Species with known occurence but unknown degree of endangering

** Occurence not endangered

. Unknown occurence

\- Species mentioned neither in "red data list", nor in the *species* lists. Occurence in respective regions is unlikely

N neophyte

r decrease of occurence

s rare

u erratic

0/u, 1/u, 1/N

These signs indicate extinct *species* or highly endangered *species* that, in some cases, occur occasionally by (0/u), erratically by (1/u) or as neophytes (1/N).

? Uncertainty of data (e.g. *? for uncertain occurence)

Regarding higher-level accessions (aggregates, *species*), summarized data of the low-level accessions (e.g. sub-*species*) are linked with an hyphen (-)

Source: •Schlosser, S.; Reichhoff, L. und Hanelt, P. (Eds): Wildpflanzen Mitteleuropas. Nutzung und Schutz. Deutscher Landwirtschaftsverlag, Berlin 1991. •Datenbank der deutschen Flora. Bundesamt für Naturschutz (BfN), Stand 1990

ANNEX 4
List of Ornamental Plants

Indigenous Plant Genera to which species belong which are used as Ornamentals

(Note: It is possible that for some genera only foreign species are relevant as ornamentals)

Legend:

w wild species

z bred species

zs bred species with variety protection

Abies	*w*
Abutilon	*z*
Acer	*zs*
Achillea	*zs*
Achnatherum	*w*
Acinos	*w*
Aconitum	*zs*
Acorus	*zs*
Actaea	*z*
Adenophora	*w*
Adenostyles	*w*
Adiantum	*w*
Adonis	*w*
Adoxa	*w*
Aegilops	*w*
Aegopodium	*w*
Aesculus	*zs*
Aethionema	*w*
Aethusa	*w*
Agrimonia	*w*

Agropyron	*w*
Agrostemma	*w*
Agrostis	*zs*
Ailanthus	*w*
Aira	*z*
Ajuga	*w*
Alcea	*z*
Alchemilla	*zs*
Aldrovanda	*w*
Alisma	*z*
Alliaria	*z*
Allium	*zs*
Alnus	*z*
Alopecurus	
Althaea	*w*
Alyssoides	*w*
Alyssum	*zs*
Amaranthus	*zs*
Ammophila	*w*
Amorpha w	
Anacampseros	*w*
Anacamptis	*w*
Anacyclus	*zs*
Anagallis	*w*
Anaphalis	*zs*
Anarrhinum	*w*
Anchusa	*zs*
Andromeda	*w*
Androsace	*z*
Anemone	*zs*
Anethum	*zs*
Angelica	*z*
Antennaria	*zs*
Anthemis	*w*
Anthericum	*z*
Anthoxanthum	*w*
Anthriscus	*zs*
Anthyllis	*w*
Antirrhinum	*zs*
Apera	*w*
Aphanes	*w*
Apios	*w*
Apium	*zs*

Aposeris	*w*
Aquilegia	*zs*
Arabidopsis	*z*
Arabis	*zs*
Arbutus	*w*
Archangelica	*w*
Arctium	*w*
Arctostaphylos	*z*
Arenaria	*w*
Aristolochia	*w*
Armeria	*zs*
Armoracia	*z*
Arnica	*w*
Arrhenatherum	*w*
Artemisia	*w*
Arum	*z*
Aruncus	*w*
Arundo	*w*
Asarina	*w*
Asarum	*w*
Asparagus	*zs*
Asperula	*w*
Asphodelus	*w*
Asplenium	*w*
Aster	*zs*
Asteriscus	*w*
Astilbe	*zs*
Astragalus	*w*
Astrantia	*zs*
Athamanta	*w*
Athyrium	*z*
Atriplex	*z*
Atropa	*w*
Aubrietia	*zs*
Avena	*zs*
Avenella	*w*
Avenula	*w*
Azalea	*zs*
Azolla	*w*
Baldellia	*w*
Ballota	*w*
Barbarea	*z*
Bassia	*w*

Bellis	*zs*
Berberis	*z*
Bergenia	*zs*
Berteroa	*w*
Beta	*zs*
Betula	
Bidens	*w*
Biscutella	*w*
Blechnum	*z*
Blitum	*z*
Borago	*w*
Bothriochloa	*w*
Botrychium	*w*
Brachypodium	*w*
Brassica	*zs*
Briza	*w*
Bromus	*w*
Broussonetia	*w*
Brunnera	*w*
Bryonia	*w*
Buddleja	*z*
Buglossoides	*w*
Bulbocodium	*w*
Bunium	*w*
Buphthalmum	*w*
Bupleurum	*w*
Butomus	*w*
Buxus	*w*
Calamagrostis	*z*
Calamintha	*w*
Calceolaria	*zs*
Caldesia	*w*
Calla	*w*
Callistephus	*zs*
Callitriche	*w*
Calluna	*zs*
Caltha	*zs*
Calystegia	*z*
Camelina	*zs*
Campanula	*zs*
Cannabis	*z*
Capsella	*w*
Capsicum	*zs*

Cardamine	*z*
Carduus	*w*
Carex	*z*
Carlina	*z*
Carpinus	*w*
Carthamus	*w*
Carum	*w*
Castanea	*w*
Catabrosa	*w*
Celosia	*zs*
Celtis	*w*
Centaurea	*zs*
Centaurium	*w*
Centranthus	*z*
Cephalanthera	*w*
Cephalaria	*w*
Cerastium	*z*
Ceratophyllum	*w*
Cerinthe	*w*
Ceterach	*w*
Chaenarrhinum	*w*
Chaerophyllum	*w*
Chamaedaphne	*w*
Chamomilla	*w*
Cheiranthus	*z*
Chelidonium	*w*
Chenopodium	*w*
Chimaphila	*w*
Chorispora	*w*
Chrysanthemum	*zs*
Chrysosplenium	*w*
Cicerbita	*w*
Cichorium	*zs*
Cicuta	*w*
Cineraria	*zs*
Circaea	*z*
Cirsium	*w*
Cistus	*w*
Citrullus	*zs*
Cladium	*w*
Clematis	*zs*
Cleome	*z*
Cnicus	*w*

Cochlearia	z
Colchicum	zs
Conium	w
Conringia	w
Consolida	zs
Convallaria	zs
Convolvulus	z
Coreopsis	zs
Coriandrum	zs
Cornus	w
Coronilla	w
Cortusa	w
Corydalis	z
Corylus	w
Corynephorus	w
Cosmos	zs
Cotinus	w
Cotoneaster	zs
Crambe	w
Crassula	z
Crataegus	z
Crepis	w
Crocus	zs
Cryptogramma	w
Cucumis	zs
Cucurbita	z
Cuscuta	w
Cyclamen	zs
Cydonia	w
Cymbalaria	w
Cynara	z
Cynoglossum	w
Cynosurus	w
Cyperus	w
Cypripedium	w
Cystopteris	w
Cytisus	z
Dactylis	zs
Dactylorhiza	w
Daphne	z
Datura	z
Daucus	zs
Delphimium	zs

Dentaria	*w*
Deschampsia	*z*
Desmazeria	*w*
Dianthus	*zs*
Dictamnus	*w*
Digitalis	*z*
Digitaria	*z*
Dipsacus	*w*
Doronicum	*zs*
Draba	*z*
Dracocephalum	*w*
Drosera	*z*
Dryas	*z*
Dryopteris	*z*
Ecballium	*w*
Echinops	*z*
Echium	*w*
Elatine	*w*
Eleocharis	*w*
Elymus	*w*
Empetrum	*w*
Epilobium	*w*
Epimedium	*zs*
Epipactis	*w*
Equisetum	*w*
Eranthis	*z*
Erica	*zs*
Erigeron	*zs*
Erinus	*z*
Eriophorum	*w*
Eriophyllum	*zs*
Eritrichium	*w*
Erodium	*z*
Eruca	*w*
Erucastrum	*w*
Eryngium	*zs*
Erysimum	*z*
Eschscholzia	*z*
Euonymus	*zs*
Eupatorium	*z*
Euphorbia	*zs*
Euphrasia	*w*
Fagopyrum	*zs*

Fagus	*zs*
Fallopia	*w*
Ferula	*w*
Festuca	*zs*
Ficus	*zs*
Filipendula	*zs*
Foeniculum	*zs*
Fragaria	*zs*
Fraxinus	*zs*
Fritillaria	*zs*
Fumana	*w*
Fumaria	*w*
Gagea	*w*
Gaillardia	*zs*
Galanthus	*zs*
Galega	*z*
Galeopsis	*w*
Galinsoga	*w*
Galium	*w*
Gaudinia	*z*
Gaultheria	*z*
Genista	*z*
Gentiana	*zs*
Geranium	*zs*
Geum	*zs*
Gladiolus	*zs*
Glaucium	*w*
Glechoma	*z*
Globularia	*z*
Glyceria	*w*
Glycine	*zs*
Glycyrrhiza	*w*
Gnaphalium	*w*
Goodyera	*z*
Gratiola	*w*
Gymnadenia	*w*
Gypsophila	*zs*
Habenaria	*w*
Hacquetia	*w*
Hedera	*zs*
Hedysarum	*w*
Helianthemum	*zs*
Helianthus	*zs*

Helichrysum	*zs*
Helictotrichon	*z*
Heliopsis	*z*
Heliotropium	*z*
Helleborus	*z*
Hemerocallis	*zs*
Hepatica	*z*
Heracleum	*w*
Hernaria	*w*
Hibiscus	*zs*
Hieracium	*z*
Hierochloe	*w*
Hippocrepis	*w*
Hippophae	*zs*
Hippuris	*w*
Holcus	*w*
Homogyne	*w*
Hordeum	*zs*
Horminum	*w*
Hottonia	*w*
Humulus	*zs*
Hutchinsia	*w*
Hyacinthoides	*zs*
Hyacinthus	*zs*
Hydrilla	*w*
Hydrocharis	*w*
Hydrocotyle	*w*
Hymenophyllum	*w*
Hyoscyamus	*w*
Hypecoum	*w*
Hypericum	*zs*
Hypochoeris	*w*
Hyssopus	*w*
Iberis	*zs*
Ilex	*zs*
Impatiens	*zs*
Imperata	*w*
Imperatoria	*w*
Inula	*zs*
Ipomoea	*z*
Iris	*zs*
Isatis	*w*
Isoetes	*w*

Jasione	*zs*
Jovibarba	*zs*
Juncus	*z*
Juniperus	*zs*
Jurinea	*w*
Kalmia	*w*
Kernera	*w*
Knautia	*w*
Kochia	*w*
Koeleria	*w*
Laburnum	*zs*
Lactuca	*zs*
Lagarosiphon	*w*
Lagurus	*w*
Lamiastrum	*zs*
Lamium	*zs*
Lappula	*w*
Lapsana	*w*
Larix	*zs*
Laserpitium	*w*
Lathraea	*w*
Lathyrus	*z*
Laurus	*w*
Lavandula	*z*
Lavatera	*w*
Ledum	*w*
Leersia	*w*
Legousia	*w*
Lemna	*w*
Lens	*z*
Leontopodium	*z*
Leonurus	*w*
Lepidium	*w*
Leucanthemella	*w*
Leucanthemopsis	*w*
Leucanthemum	*zs*
Leucojum	*zs*
Levisticum	*w*
Leymus	*w*
Ligusticum	*w*
Ligustrum	*zs*
Lilium	*zs*
Limodorum	*w*

Limonium	*zs*
Linaria	*zs*
Linnaea	*w*
Linum	*zs*
Liparis	*w*
Listera	*w*
Lithospermum	*w*
Littorella	*w*
Lobelia	*zs*
Lobularia	*z*
Loiseleurla	*w*
Lolium	*zs*
Lonicera	*z*
Loranthus	*w*
Lotus	*zs*
Ludwigia	*w*
Lunaria	*z*
Lupinus	*zs*
Luronium	*w*
Luzula	*zs*
Lychnis	*z*
Lycopersicon	*zs*
Lycopodium	*w*
Lycopus	*w*
Lysimachia	*z*
Lythrum	*zs*
Maianthemum	*w*
Majorana	*w*
Malus	*zs*
Malva	*zs*
Marrubium	*z*
Marsilea	*w*
Matricaria	*w*
Matteuccia	*w*
Matthiola	*zs*
Meconopsis	*zs*
Medicago	*zs*
Melampyrum	*w*
Melica	*w*
Melilotus	*w*
Melissa	*Z*
Melittis	*w*
Mentha	*Z*

Menyanthes	*w*
Mercurialis	*w*
Mesembryanthemum	*Z*
Mespilus	*w*
Meum	*w*
Micromeria	*w*
Milium	*zs*
Mimulus	*Z*
Minuartia	*w*
Mirabilis	*Z*
Miscanthus	*zs*
Moehringia	*w*
Molinia	*zs*
Molospermum	*w*
Monarda	*zs*
Moneses	*w*
Montia	*w*
Muscari	*zs*
Myosotis	*zs*
Myosoton	*w*
Myrica	*w*
Myricaria	*w*
Myriophyllum	*w*
Myrrhis	*w*
Najas	*Z*
Narcissus	*zs*
Nardus	*w*
Narthecium	*w*
Nasturtium	*w*
Neottia	*w*
Nepeta	*Z*
Nerium	*zs*
Nicotiana	*zs*
Nigella	*Z*
Nigritella	*w*
Nuphar	*w*
Nymphaea	*zs*
Nymphoides	*w*
Ocium	*w*
Oenanthe	*w*
Oenothera	*z*
Omphalodes	*w*
Onagra	*z*

Onobrychls	*w*
Ononig	*w*
Onopordum	*w*
Onosma	*w*
Ophioglossum	*w*
Ophrys	*w*
Orchis	*w*
Origanum	*zs*
Ornithogalum	*w*
Ornithopus	*zs*
Orobanche	*w*
Orthilia	*w*
Oryza	*zs*
Oryzopsis	*w*
Osmunda	*zs*
Oxalis	*zs*
Oxyria	*w*
Oxytropis	*w*
Paeonia	*zs*
Papaver	*zs*
Parietaria	*w*
Paris	*w*
Parnassia	*w*
Paronychia	*w*
Parthenocissus	*zs*
Pastinaca	*w*
Pentaglottis	*w*
Petasites	*zs*
Petrocallis	*w*
Petroselinum	*zs*
Petunia	*zs*
Peucedanum	*w*
Phacelia	*zs*
Phalaris	*zs*
Pharbitis	*zs*
Philadelphus	*zs*
Phillyrea	*w*
Phleum	*zs*
Phlomis	*w*
Phlox	*zs*
Phragmites	*Z*
Phyllitis	*zs*
Physalis	*Z*

Phyteuma	*w*
Picea	*zs*
Pcris	*w*
Pilularia	*w*
Pimpinella	*w*
Pinellia	*w*
Pinguicula	*w*
Pinus	*zs*
Pistacia	*z*
Pistia	*w*
Piaum	*zs*
Plantago	*z*
Platanthera	*w*
Platanus	*z*
Poa	*zs*
Polemonium	*zs*
Polygala	*z*
Polygonatum	*w*
Polygonum	*zs*
Polypodium	*zs*
Polypogon	*w*
Polystichum	*zs*
Populus	*zs*
Portulaca	*z*
Potamogeton	*w*
Potentilla	*zs*
Prenanthes	*w*
Primula	*zs*
Prunella	*zs*
Prunus	*zs*
Pteridium	*z*
Pteris	*w*
Pulmonaria	*zs*
Pulsatilla	*zs*
Puschkinia	*w*
Pyracantha	*zs*
Pyrola	*w*
Pyrus	*zs*
Quercus	*w*
Ranunculus	*z*
Raphanus	*zs*
Reseda	*z*
Reynoutria	*w*

Rhamnus	*w*
Rheum	*w*
Rhinanthus	*w*
Rhodiola	*w*
Rhododendron	*zs*
Rhodothamnus	*w*
Rhus	*z*
Ribes	*zs*
Ricinus	*zs*
Robinia	*zs*
Rosa	*zs*
Rubia	*w*
Rubus	*zs*
Rudbeckia	*zs*
Ruaex	*z*
Ruta	*w*
Sagina	*z*
Sagittaria	*zs*
Salicornia	*w*
Salix	*zs*
Salvia	*zs*
Sambucus	*w*
Sanguisorba	*z*
Sanicula	*w*
Santolina	*z*
Saponaria	*z*
Satureja	*w*
Saussurea	*w*
Saxifraga	*zs*
Scabiosa	*zs*
Scilla	*zs*
Scirpus	*z*
Scleranthus	*w*
Scolymus	*w*
Scopolia	*w*
Scorzonera	*zs*
Scrophularia	*w*
Scutellaria	*w*
Secale	*zs*
Sedum	*zs*
Selaginella	*w*
Sempervivum	*zs*
Senecio	*zs*

Serratula	*w*
Seseli	*w*
Sesleria	*w*
Setaria	*w*
Sherardia	*w*
Sibbaldia	*w*
Sideritis	*w*
Silene	*zs*
Silybum	*w*
Sinapis	*z*
Sisymbrium	*w*
Sium	*w*
Smyrnium	*w*
Soja	*zs*
Solanum	*zs*
Soldanella	*w*
Solidago	*zs*
Sonchus	*w*
Sorbaria	*z*
Sorbus	*z*
Sorghum	*w*
Sparganium	*w*
Spartium	*w*
Spergula	*w*
Spinacia	*zs*
Spiraea	*z*
Spiranthes	*w*
Spirodela	*w*
Stachys	*zs*
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Statice	*z*
Stellaria	*w*
Stipa	*w*
Stratiotes	*w*
Streptopus	*w*
Suaeda	*w*
Succisa	*w*
Swertia	*w*
Symphoricarpos	*zs*
Symphytum	*zs*
Syringa	*zs*
Tagetes	*zs*
Tamarix	*z*

Tamus	*w*
Tanacetum	*zs*
Taraxacum	*w*
Taxus	*zs*
Telekia	*w*
Tetragolonobus	*w*
Teucrium	*z*
Thalictrum	*zs*
Thelypteris	*w*
Thlaspi	*w*
Thymus	*zs*
Tilia	*zs*
Tofieldia	*w*
Tolpis	*w*
Torilis	*w*
Tragopogon	*w*
Trapa	*w*
Trichomanes	*w*
Trientalis	*w*
Trifolium	*zs*
Trisetum	*zs*
Triticum	*zs*
Trollius	*z*
Tropaeolum	*z*
Tulipa	*zs*
Tussaligo	*w*
Typha	*w*
Ulex	*w*
Ulmus	*zs*
Urospermum	*w*
Urtica	*w*
Urticularia	*w*
Vaccaria	*z*
Vaccinium	*zs*
Valeriana	*zs*
Valerianella	*zs*
Vallisneria	*w*
Veratrum	*w*
Verbascum	*zs*
Verbena	*zs*
Veronica	*zs*
Viburnum	*zs*
Vicia	*zs*

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Abbreviations

AA	Agricultural Area
AGEH	Arbeitsgemeinschaft für Entwicklungshilfe (Working Group on Development Aid)
AGÖL	Arbeitsgemeinschaft Ökologischer Landbau (Working Group on Ecological Farming)
ANW	Arbeitsgemeinschaft Naturnahe Waldwirtschaft (Working Group on Natural Silviculture)
APIC	Association for Potato Intergenebank Collaboration
ASPTA	Assesoria e Servicos a Projetos em Agricultura Altonativa (Advice and Service for Alternative Agricultural Projects)
ASW/WFD	Aktionsgemeinschaft Solidarische Welt/Weltfriedensdienst (Action Group United World/Word Peace Service)
ATSAF	Arbeitsgemeinschaft Tropische und Subtropische Agrarforschung e.V. (Council for Tropical and Subtropical Agricultural Research)
AVRDC	Asian Vegetable Research and Development Centre
BAZ	Bundesanstalt für Züchtungsforschung an Kulturpflanzen (Federal Centre for Breeding Research on Cultivated Plants)
BfN	Bundesamt für Naturschutz (Federal Agency for Nature Conservation)
BGCI	Botanic Gardens Conservation International
BMBF	Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (Federal Ministry of Education, Science, Research and Technology)

BML	Bundesministerium für Ernährung, Landwirtschaft und Forsten (Federal Ministry of Food, Agriculture and Forestry)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry of the Environment, Nature Conservation and Nuclear Safety)
BMZ	Bundeministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry of Economic Cooperation and Development)
BrasEDB	European Data Bank on Brassica
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Training Centre)
CBDC	Community Biodiversity Development and Conservation Programme
CDG	Carl - Duisberg - Gesellschaft (Carl - Duisberg - Association)
CET	Centro de Educación y Tecnologia (Centre for Education and Technology)
CGN	Centre for Genetic Resources of the Netherlands
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Centre)
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CGIAR	Consultative Group on International Agricultural Research
CICD	Centro de Investigación y Capacitación para el Desarollo (Centre for Research and Education for the Development)
CIFOR	Centre for International Forestry Research
CIP	Centro Internacional de la Papa (International Potato Centre)

CLADES	Centro Latinoamericano de Documentación Económica y Social (Latin American Centre for Economic and Social Documentation)
CMO	Common Market Organization
CPGR	Commission on Plant Genetic Resources of the FAO
CSD	Commission on Sustainable Development
CTDA	Community Technology Development Association
DAAD	Deutscher Akademischer Austauschdienst (German Academic Exchange Service)
DED	Deutscher Entwicklungsdienst (German Volunteer Service)
DKV	Deutsche Kontrollvereinigung für forstliches Saat- und Pflanzgut e.V. (German Association for the Control of Forest Seed and Planting Stock)
DNA	Deoxyribonucleic-acid
DNH	Deutsch-Nepalesiche Hilfsgemeinschaft (German-Nepal Aid Agency)
DSE	Deutsche Stiftung für Internationale Entwicklung (German Foundation for International Development)
DSM	Deutsche Sammlung von Mikroorganismen (German Collection of Microorganisms)
DÜ	Dienste in Übersee (Volunteer Services Overseas)
EBDB	European Barley Database
EC	European Community
ECP/GR	European Cooperative Programme on Genetic Resources
EEC	European Economic Community

EFI	European Forest Institute
ESCORENA	European System of Cooperative Research Networks in Agriculture
ETFRN	European Tropical Forest Research Network
EU	Europäische Union (European Union)
EUCARPIA	European Association for Research on Plant Breeding
EUFORGEN	European Forest Genetic Resources Programme
FAL	Bundesforschungsanstalt für Landwirtschaft (Federal Research Centre of Agriculture)
FAO	Food and Agriculture Organization of the United Nations
FAST	Forecasting and Assessment of Science and Technology
FFH	Flora-Fauna-Habitat (Directive No. 92/43/EEC)
FWZ	Forschungszentrum Waldökosysteme (Centre for Forest Ecosystem Research)
GATT	General Agreement on Tariffs and Trade
GDPC	German-Dutch Potato Collection
GDR	German Democratic Republic
GEF	Global Environmental Facility
GFP	Gemeinschaft zur Förderung der privaten deutschen Pflanzenzüchtung e.V. (Association for the Promotion of German Private Plant Breeding)
GIARA	German-Israeli Research Cooperation in Agriculture
GIS	Geographisches Informations-System (Geographical Information System)
GRAIN	Genetic Resources Action International

GTZ	Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
ICRAF	International Council for Research in Agroforestry
IDBB	International Data Bank on Beta
IFOAM	International Federation of Organic Agriculture Movements
IGBP	International Geosphere-Biosphere Programme
IGR	Informationszentrum für Genetische Ressourcen (Centre for Information on Genetic Resources (at ZADI))
ILCA	International Livestock Centre for Africa
IMC	Instituto Mayor Campesino (Main Agricultural Institute)
IPGRI	International Plant Genetic Resources Institute
IPK	Institute for Plant Genetics and Crop Research
IRRI	International Rice Research Institute
IRZ	Institut für Rebenzüchtung der BAZ (Institute for Breeding of Grapes (of BAZ))
ITCPGR	International Technical Conference on Plant Genetic Resources
IUCN	International Union for the Conservation of Nature
IUFRO	International Union of Forestry Research Organizations
KARI	Kenyan Agricultural Research Institute
KWI	Kaiser-Wilhelm-Institut (Kaiser-Wilhelm-Institute)
MAB	UNESCO-Programme "Man and Biosphere"
MPI	Max-Planck-Institut (Max-Planck-Institute)
NGO	Non-Governmental Organization

OECD	Organization for Economic Cooperation and Development
OIV	International Wine Office
PGR	Plant Genetic Resources
PGRC/E	Plant Genetic Resources Centre
PRO SILVA	Association of Ecologically Minded Foresters in Europe
RAFI	Rural Advancement Fund International
SADC	Southern African Development Community
SAN	Seed Action Network
SDW	Schutzgemeinschaft Deutscher Wald (Association for the Protection of German Forests)
SEARICE	South East Asian Regional Institute for Community Education
SPDC	Special Programme for Developing Countries
TERN	Terrestrial Ecosystem Research Network
TÖB	Tropenökologisches Begleitprogramm (Accompanying Ecological Programme for the Tropics)
TRIPs	Trade Related Aspects of Intellectual Property Rights
UN	United Nations
UNCED	United Nations Conference on Environment and Development (Rio Conference)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNZA	University of Zambia

UPOV	Union pour la Protection des Obtentions VÈgÈtales (International Union for the Protection of New Varieties of Plants)
VCU	Value for Cultivation and Use
VEN	Verein zur Erhaltung der Nutzpflanzenvielfalt (Association for the Conservation of Crop Diversity)
VFLU	Verein zur Förderung von Landwirtschaft und Umwelt (Association for the Promotion of Agriculture and Environment)
WBN	Welt-Beta-Netzwerk (World Beta Network)
WTO	Word Trade Organisation
WWF	World-Wide Fund for Nature
ZADI	Zentralstelle für Agrardokumentation und -information (Centre for Agricultural Documentation and Information)