ISRAEL:

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

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Note by FAO

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CHAPTER 1
Introduction to Israel and its Agricultural Sector

1.1 GEOGRAPHY AND DIVERSITY

Israel's compact borders enclose a land of considerable geographic, climatic and genetic diversity. Located at the eastern end of the Mediterranean, Israel is bounded by the Mediterranean Sea to the west, the Sinai Desert to the southwest, the mountains of Lebanon and the Golan Heights to the north, the Jordan Valley to the east and the Gulf of Aqaba at its southern tip (see maps, Section 1.5). Israel is only 470 km. long and 135 km. wide (at its widest), with about 300 km. of coastline and 27,800 sq. km. of area. The green sea pine forests surrounding Jerusalem, Israel's capital (835 meters above sea level), and the hot barren salt flats of the Dead Sea (400 meters below sea level, the lowest spot on earth) are less than an hour's drive apart. Jerusalem gets both hot desert wind storms and, less frequently, snow.

The winter rainy season lasts four months (November-March); and the rest of the year is sunny and dry. Rainfall varies considerably, from 25 mm. a year in the Southern Desert (Negev) to 720 mm. in the hills of the North. Much of the North's relatively plentiful water finds its way into Israel's sole reservoir of sweetwater, the Sea of Galilee (Lake Kinneret). Three quarters of Israel's water resources are used for agricultural irrigation.

In terms of its flora, Israel is situated at the meeting point of three great phytogeographical regions - Mediterranean, Irano-Turanian and Saharo-Arabian (with enclaves of tropical climates) and contains a diverse collection of herbaceous plants, especially annuals and geophytes, typical of all three. The country has four distinct natural geographic regions based on topography, climate, rainfall, soil, flora and fauna: (1) the coastal plain, (2) mountain regions, (3) the Negev/Arava and (4) the Jordan and Jezreel Valleys.

Coastal Plain. The coastal plain contains over half the country's population. Urbanization is increasingly affecting the coastal area. The well-traveled highway between urban centers, however, still passes some relatively unspoiled rural areas. Inland, the beautiful sandy beaches give way to flat plains of fertile farmland. This was the home of Israel's citrus industry, her first major international agricultural export. There are sheer chalk and limestone cliffs on the far North coast. Summers are hot and humid; winters are mild. Temperatures range from 9°C (average January minimum) to 29°C (average August maximum) with 500-540 mm. of rain a year.

Mountain Regions. This region mostly consists of tall rolling hills and low mountains along the country's raised central spine. The hilly regions of Jerusalem, Judea and Samaria are less populated than the plains, and are dotted with ancient terraced hillsides and old olive groves and pine forests. A few examples of the varied original of oak/pistachio forest that once covered the hill-country remain. The Northern hill-country of the Galilee and Golan are separated from the central hill country by the agriculturally-rich Jezreel Valley. In the North, steep basalt cliffs tower above the Hula Valley, while the limestone and dolomite hills of the Galilee rise 500-1200 meters above sea level. Ample rainfall and springs create year-round greenery, while the Southern hill country has many seasonal streams and a more pronounced brown dry season. Temperatures vary from about 5°C (January minimum) to 28°C (August maximum). The air is usually dry, despite annual rainfall varying from 486 mm. (Jerusalem) to 718 mm. (Safed). There is only occasional snow.

The Negev and Arava. The Negev, the arid Southern region, contains half of Israel's land, but only 7% of her population. Most live in the Northern Negev, where aggressive irrigation and reforestation, the widespread use of recycled, industrial and brackish wastewater, the development of drought and salt-tolerant crop varieties and the introduction of advanced trickle-dripagriculture techniques (an Israeli specialty) have pushed agriculture far further South than previously thought possible. Still further south lie the sandstone hills, canyons and dry riverbeds of the Negev Desert proper, followed by still drier and higher plateaus, peaks and craters (the largest of which is 35 km. long and 8 km. across). The low-lying stretch of desert between the Dead and Red Seas, part of the Great African Rift Valley, is known as the Arava. Temperatures in the Negev are extreme, ranging from 6°C (January minimum) to 33°C (August maximum) at Beer-Sheva at the Northern edge of the Negev to 9°C and 39°C (respectively) in Eilat at the far South. Rainfall varies from 204 mm. near Beer-Sheva to only 25 mm. near Eilat.

The Valleys. The highly fertile land of the Northern Jordan Valley, also part of the Great African Rift Valley, becomes increasingly arid as the Jordan River descends 700 meters, along a 300 km. course, from its source near

Mount Hermon to the Dead Sea. The river is naturally narrow and shallow. Advanced agricultural techniques and irrigation have turned the hot, sunny, arid region below the Dead Sea into an almost ideal area for producing out-of-season fruit and vegetables for export. The potash, magnesium, bromine and chlorine deposits of the Dead Sea region represent Israel's only major natural resource. The Jezreel Valley, which stretches westward from the Jordan Valley, in the well-watered North, is particularly productive and well-cultivated, often by cooperative farming communities (kibbutzim, moshavim). The Northern Jordan Valley (e.g. Tiberias on the shores of Lake Kinneret) is significantly hotter (8°C January minimum, 36°C August maximum) and drier (431 mm. annual rainfall), than the nearby hill-country (e.g. Safed).

1.2 POPULATION

Israel has a total population of about 5.5 million, 4.5 million Jews and 1 million non-Jews. Most are native born. Despite the Government's efforts to encourage a more even distribution of population, 90% of all Israelis live in cities. Most cluster around the Greater Tel-Aviv area (about 1.5 million), with other large concentrations near Jerusalem (570,000), Haifa (250,000) and Netanya, Beer-Sheva and Ashdod (100,000-150,000 each).

Education is the largest item in Israel's national budget, after defense. The result is an exceptionally highly-trained workforce. Some 130 of every 10,000 workers are scientists and engineers; and their scientific productivity gives Israel the world's highest number of scientific publications per capita. Only about 2% of Israel's student body major in agriculture, compared to 12% in the biological sciences and medicine (and 57% in the humanities and social sciences).

About half of Israel's rural population live in kibbutzim (voluntary highly-communal societies) or moshavim (private ownership mixed with cooperative purchasing, heavy equipment and marketing). Israel's 270 kibbutzim and 450 moshavim supply much of the country's farm produce.

1.3 ECONOMY

Although Israel started with a largely agricultural economy, far-sighted investments in R&D throughout the 1960's and 1970's by the Ministry of

Industry and Trade (MIT) and others promoted the rapid expansion of high-tech industries. Much of that growth was in electronics, aviation, electro-optics and computers. Israel's high-tech exports leaped from 15% of its Gross Industrial Product in 1960 to over 54% in 1989. The share of agricultural exports has correspondingly decreased. In 1992, R&D-based industries employed over 100,000 Israelis and accounted for over half of Israel's $8.8 billion annual industrial exports (excluding diamonds). In contrast, the absolute number of people involved in Israel's increasingly mechanized and intensive agriculture has actually decreased over the last three decades (see Section 1.4.1). Exports, essential to Israel's economic growth, totaled $22.8 billion in 1993. Israel's industrial exports now equals 100% of its industrial GDP. An early, heavy dependence on U.S. markets has recently shifted. Now 38% of all Israeli exports are destined for Europe, compared to 34% for North America (mostly the U.S.) and 16% to Asia. Because of Israel's geographical proximity and the lucrative off-season market, almost all (80%) of Israel's agricultural exports are sent to Western Europe.

1.4 THE AGRICULTURAL SECTOR

1.4.1 History, Size and Trends

Since the founding of the State of Israel in 1948, the amount of land under cultivation has more than doubled, to 1.1 million acres, almost half of which is irrigated. Even so, only about 17% of Israel's land is arable (compared to 32% in France). Another 40% is (often sparse or seasonal) pasturage; while permanent crops and forests account for only 5% and 6% respectively. For the first two decades, agriculture, especially citrus production (largely for export), were a major part of Israel's society and economy. Once agricultural self-sufficiency was achieved, often using advanced technology developed in Israel, and once Israel's high-tech industrial base was well-developed, the relative importance of agriculture began to decline. From 1950 to 1993, the number of Israelis living in agricultural settlements doubled, although its percentage of the total population was halved, from 12% to 6%. Agriculture's contribution to Israel's GDP dropped from 11% to 3.5% and, even more dramatically, agriculture's share of exports dropped from 60% to less than 3% over the same period. This is despite an absolute increase in agricultural exports from $20 million in 1950 to $547 million in 1993. Today, agricultural exports are increasingly high-value off-season vegetables, fruits, melons and flowers to the European market, rather than citrus. Even within citrus, the trend is to higher value exotics (pomello) and easy-peelers. Agriculture now attracts only 4% of the Israeli working force, compared to 22% in industry and 61% in commercial/private/public services; and it garners only 2% of all Israeli investments (compared to 54% in construction, transportation and communication).

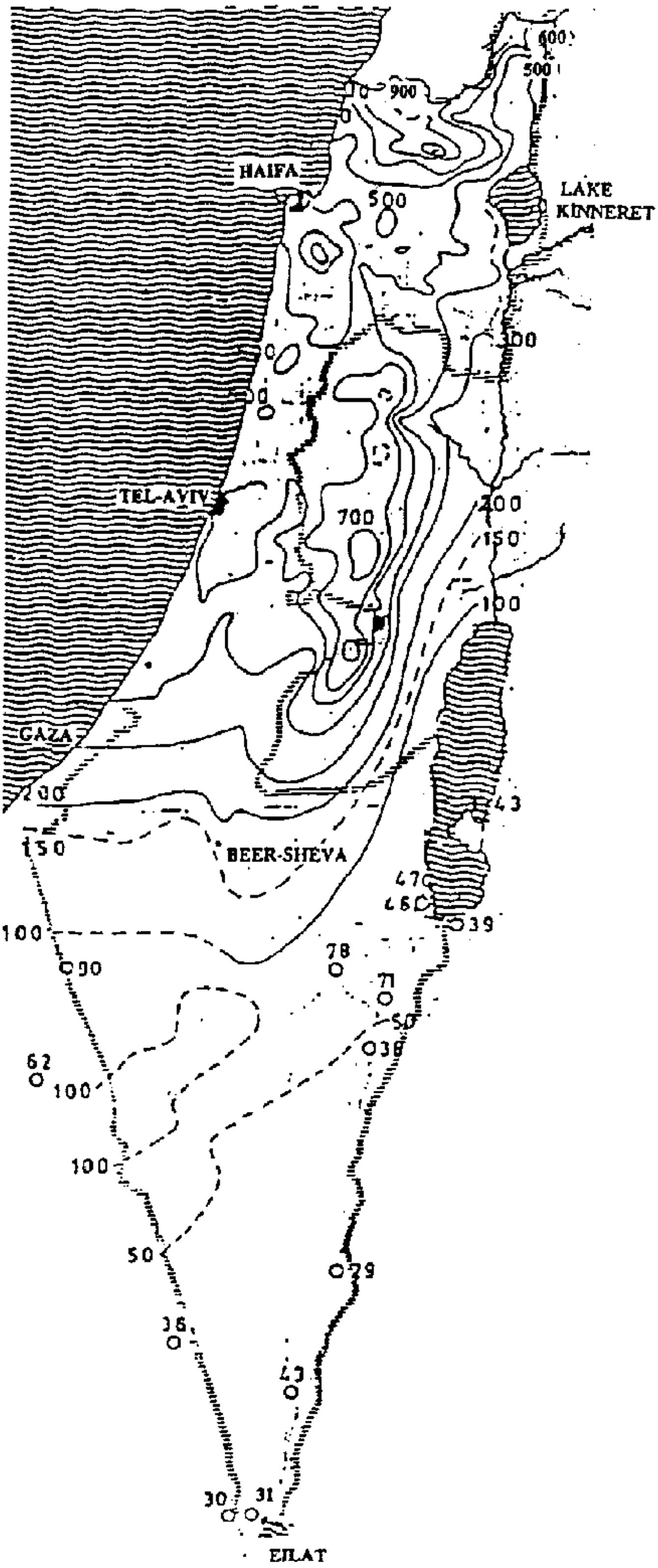
1.4.2 Nature of Sector

Three-quarters of Israel's $2 billion agricultural production is for domestic consumption. Farm production centers on highly-efficient dairy and poultry production, plus fruits and vegetables. Limited agricultural imports, mostly grains, oilseeds, meat and sugar, are more than covered by exports. Israel has captured about 40% of the European off-season fruit/vegetable/melon market and is second only to Holland in European flower sales. Israel has pioneered advanced agricultural biotechnology, trickle-drip irrigation often microprocessor-controlled), soil solarization and the sustained use of industrial wastewater for agriculture. This has created lucrative markets for Israeli agricultural equipment, technologies, expertise and management skills abroad. Like most developed countries, Israel has almost no subsistence farming, beyond a few Arab villages and Bedouin settlements, and a comparatively small rural population. Israel's well-organized 750 cooperative agricultural settlements (kibbutzim, moshavim) utilize, and often help develop, modern agricultural equipment, chemicals, plant varieties and methods. They have ready access to national and international markets. They produce most of Israel's domestic consumption, plus a series of specific, usually high-value, products for export. They typically identify and develop unique new products and niches, moving on to pioneer other new opportunities as countries with larger resources or lower labor and transportation costs (eventually) offer stiff competition. Israel has a highly-advanced agricultural research effort and a well-developed, efficient agricultural system. It is interested in regional and international cooperation; and several cooperative proposals, including several related to germplasm preservation and utlization, are now under discussion.

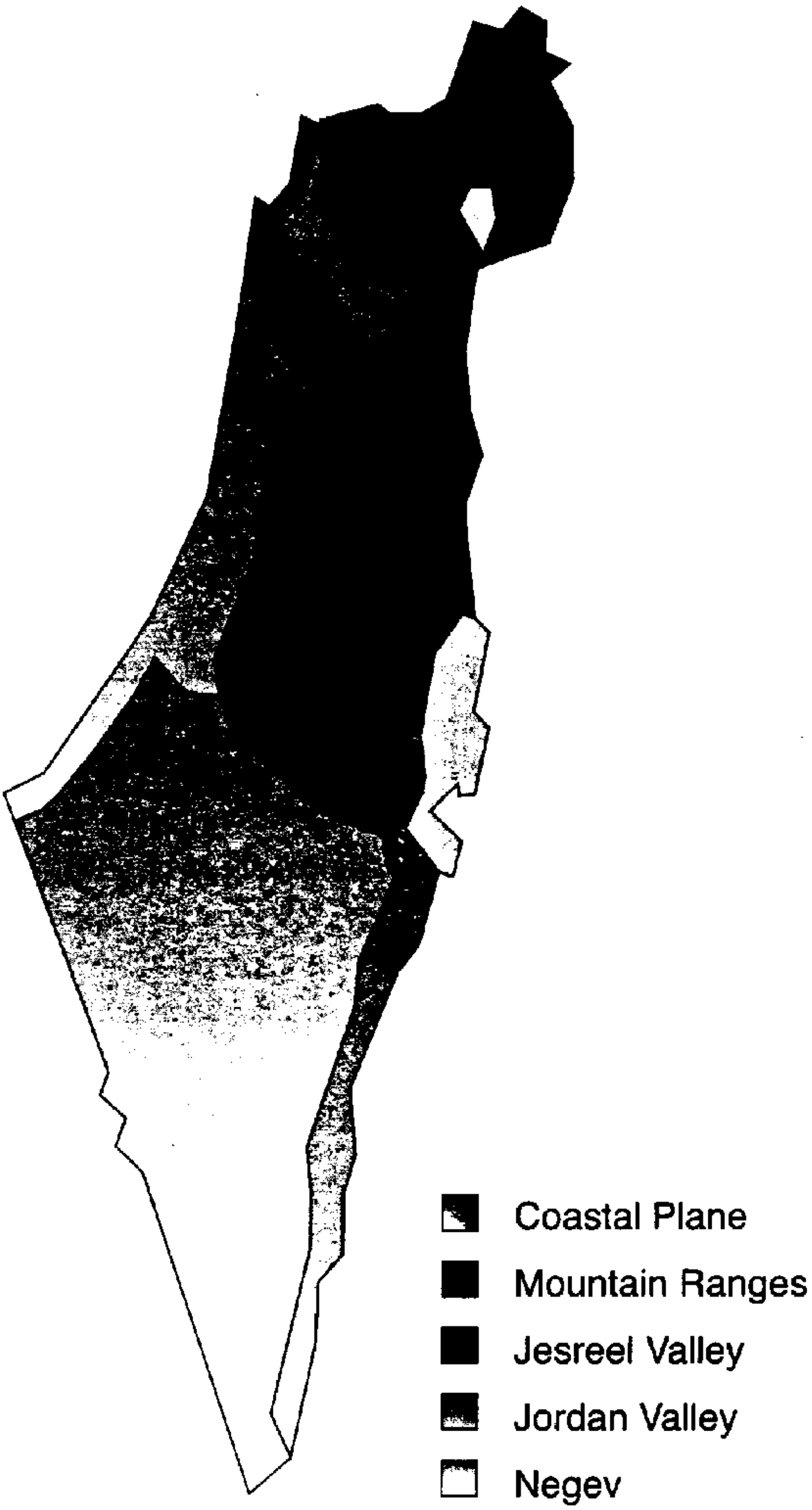
1.4.3 The Seed Industry

Special mention should be made of Israel's seed industry. Despite its small size, Israel exports $40 million of agricultural seeds a year, including a significant fraction of the world's exported hybrid tomato and onion seeds. Hazera, Israel's largest seed company, was jointly founded by the country's cooperative farms, at first to meet their own needs. Now over 80% of their vegetable seeds (including the Daniela long shelf-life tomato) are exported. Several other companies also actively produce seeds in Israel, mostly on the basis of original, in-country breeding programs. Among the leaders are: Zeraim Gadera (founded 1952), A.B. Seeds (1990) and Pioneer Vegetable Genetics, Ltd. There is considerable emphasis on R&D and breeding new varieties, often using RFLP, DNA repeats and other high-tech methods to guide and evaluate crosses. Most such research is done for the seed companies by plant scientists at Israeli universities, particularly the Hebrew University of Jerusalem Faculty of Agriculture in Rehovot (Israel's only full-Agricultural School), and the Israel Agricultural Research Organization's Volcani Center (under the Ministry of Agriculture).

1.5 MAPS



The attached maps indicate Israel's rainfall contours main geographical regions and population centers.


Coastal Plane
Mountain Ranges
Jesreel Valley
Jordan Valley
Negev

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 FOREST GENETIC RESOURCES

Israel's indigenous forests have been almost totally destroyed by centuries of continuous grazing by wandering herds and, most recently, by the search for wood for the Ottoman trans-Levant railway at the turn of the century. There were fewer than 5 million trees in the whole country in 1948. Almost 200 million trees have been planted due to an active reforestation program spearheaded by the Jewish National Fund (JNF, Keren Kayemet), founded 1901, whose activities preceded the State. Despite the success of this program in reestablishing land cover, preventing erosion, etc., the new forests, most less than 50 years old, are dominated by 1-2 foreign pine or eucalyptus species and bear little resemblance to the original, biologically-diverse forests. The few remaining indigenous forests, mostly small enclaves on hill or mountain tops, have been mostly of historical and recreational value. More recently, a new interest in native tree species has been emerging.
The natural distribution of the main forest tree species are described in many publications, two of which are mentioned below:

Zohary, M. (1962) *Plant lie of Palestine, Israel and Jordan. The Ronald Press Company, New York, NY.*

Zohary, M. (1973) *Geobotanical Foundations of the Middle East. Gustav Fischer Verlag, Stuttgart*

The native species are: *Pinus halepensis, Cupressus sempervirens, Quercus calliprinos, Quercus ithaburensis, Quercus boissieri, Arbutus andrachne, Styrax officinalis, Crataegus azarolus, Pistacia palaestina, Pistacia atlantica, Ceratonia siliqua, Cercis siliquastrum. Ziziphus spina-christi, Tamarix articulata, Phillyrea media, Rhamnus palaestina, Acer obtusifolium ssp. syriacum, Pyrus syriaca* and several *Acacia species*.
Several species occur in park like forests such as *Acacia sp. Tamarix sp. Pistacia atlantica Quercus ithaburensis, Ziziphus spinachristi* and *Ficus sycomorus*. *Populus euphratica, Platanus orientalis* and *Fraxinus syriaca* occur only along water ways.

Descriptions of the various populations and ecogeographic zones are given in the above mentioned publications. All these species are protected *in situ* in different ecogeographic zones in nature reserves spread throughout the country. There is no need for *ex situ* conservation. However in some cases there is need for an improved implementation of the *in situ* conservation.

Out of the many forest tree species only very few are under threat. *Pinus halepensis* is under threat by the pine bast scale Matsucoccus josephi Boden. et Harpas. A scale which is endemic on *Pinus brutia* growing in Turkey, Crete and Cyprus, causing no damage to this particular pine species. However, there is no knowledge as to how and when this pine bast scale has commenced feeding on *Pinus halepensis* and subsequently causing degradation of plantations in Israel.

Mendel Z. (1984). *Provenances as a factor in susceptibility of Pinus halepensis to Matsucoccus josephi. Forest Ecology and Management. 9: 259-266.*

Mendel Z., Nestel, D. and Gafny R. (1994). *Examination of the origin of the Israeli population of Matsucoccus josephi using random amplified polymorphic DNA-polymerase chain reaction method. Ann. Entomol. Soc. Am. 87: 165-169.*

Tree species which are under threat due to their very small population are: Ulmus canescens and Populus euphratica.

a. Intra-specific diversity through provenance trials and genetic marker studies was made on the following native species: *Pinus halepensis Mill.* and *Cupressus sempervirens* L.

Results were published in: Silva Genetica, 1986, 1989, 1993; Israel J. of Botany, 1982, 1986, 1992; For. Ecol. and Manage., 1989; J. of For. Pathology, 1991.

b. Studies of intraspecific diversity through provenance trials of indigenous oak species started recently by researchers of the Department of Natural Resources, section of Forestry Research, the Agricultural Research Organization (ARO), The Volcani Center, Bet Dagan.

c. There is an information system on forest genetic resources which is located within the "Seed and Nursery" unit of the Forest Department of the Jewish National Fund (Keren Kayemet).

d. Plant breeding activities of forest species used for afforestation are conducted by the Forest Department of the Keren Kayemet in close collaboration with scientists of the section of Forestry Research at the ARO the Volcani Center, Bet Dagan.

e. Intra-specific diversity through provenance trials and/or genetic markerstudies was carried out on the following species introduced in to Israel: *Pinus brutia Ten., Eucalyptus camaldulensis Dehn, Eucalyptus microtheca F. Muell.*

Results were published in: Biochemical Sys. and Ecol., 1987; Systematic Botany, 1988; Silvae Genetica, 1974, 1983.

Many other species have been introduced in to Israel. *Pinus eldarica, Pinus nigra, Pinus maritima, Pinus pinea, Cedrus atlantica, Prosopis sp. Casuarina sp.* and other *Eucalyptus* species are being examined in provenance trials.

Use of Forest Genetic Resources

a. In 1983, a program for improved production of seed of Pinus halepensis has been started. First generation seed orchards were planted from plus trees selected from natural forests and plantations of this species in Israel and Greece. Until seed collection can be carried out in these seed orchards, *Pinus halepensis* seed material is imported from Greece. This provenance is more resistant to the Israeli pine bast scale *Matsucoccus josephi*. It has also a better growth in volume and a better straightens of the bole.

b. Trees of *Pinus brutia* have been selected in the plantations planted in Israel since 1950 for the establishment of first generation seed orchards. Until these seed orchards can be used, seed of *Pinus brutia* is imported from Turkey where it is collected in selected seed orchards or selected seed stands in the forests.

c. Trees of *Eucalyptus camaldulensis Dehn.* have been selected in plantations, growing under different ecological conditions. Vegetative propagation of these plus trees was done in 1992, and a clonal plantation for vegetative propagation of selected material was established at the Volcani Center.

d. *Pinus halepensis Mill.* native to Israel differs in its genetic makeup from all the other populations of this species growing around the Mediterranean area. Therefore, the native populations of this species in Israel, and especially the population of the Mt. Carmel are of interest and must be conserved *in situ*.

2.2 WILD RELATIVES OF CROP PLANTS

This is the area in which Israel's exceptionally rich plant genetic resources and advanced scientific and biotechnological expertise meet toCreate truly unique opportunities for genetic preservation, characterization, utilization and commercialization.

Israel is in the heart of the Near-Eastern center-of-origin and/or center-of-diversity for many highly important agricultural crops, such as:

- Wheat
- Pea
- Carrot
- Alliums
- Flax
- Barley
- Lentil
- Date
- Artichoke
- Beet
- Oats
- Chick-pea
- Almond
- Safflower
- Fig

as well as grapes and olives (which may also have had a European origin). One need only walk along an Israeli roadside or empty lot in the Spring to see that wild varieties of wheat, barley and oats still abound. The scientific protection of this precious resource is a top national agricultural priority.

The importance of such genes for improving the growth, yield, nutrition and disease, pest, drought and salt tolerance of major crop varieties has long been recognized. As early as 1909, Aaron Aaronsohn of the Jewish Agricultural Experiment Station in Haifa, the discoverer of wild emmer wheat in the Galilee (1906) began collaborating with the U.S. Department of Agriculture (USDA) on a search for plants, particularly wheat varieties, worthy of introduction into the United States.

To give a recent example, Israeli researchers have found genes responsible for the high protein content of some Israeli wild wheats. Using a collection of wheat varieties differing by only a single chromosome (part-of-a-chromosome substitution lines), they were able to sexually transfer such genes toCommercial wheat varieties, in a highly specific and controlled manner.

Many of their first crosses did indeed produce high-protein grain (up to 18% above normal), but at the cost of overall yields. Unexpectedly, other strains, with real but less spectacular protein increases, were remarkably high yielding. Their genes boosted the yields of pasta wheats up to 40%; and bread wheats, up to 15%. Several newer strains have both higher protein content and overall yields. The potential impact on world wheat production has already interested several commercial companies, who are conducting field trials.

Israeli wild wheats have long been known (1970) to harbor genes conferring resistance to yellow stripe rust. These are now widely used by commercial wheat breeders. Israeli wild barleys harbor several genes conferring resistance to powdery mildew, leaf rust and several other diseases. Israeli wild oats harbor genes conferring resistance toCrown rust, and many commercial U.S. oat varieties now incorporate this gene. Israeli wild thistles were used in developing seed-propagated artichokes. Local colocynth varieties with mildew resistance have been found and tested in watermelon-breeding programs. Still, the surface has barely been scratched, and many wild varieties have not yet been critically evaluated.

Spreading urbanization, intensive farming and the almost universal use of superior commercial hybrid strains by farmers represent sources of potential genetic erosion. Development of the rural land surrounding cooperative farms has recently accelerated due to the financial crisis of the kibbutzim, the rising cost of land and the recent mass immigration from the former Soviet Union. Today 10% of Israel (excluding the Negev) is already covered by built-up areas. Given Israel's high population growth rate and other trends, one academic research project predicts that this could rise to a staggering 50% by the year 2020, making Israel one of the most densely-populated countries in the world. This makes the need for preserving Israel's wild genetic riches particularly acute.

Some Israeli populations of wild progenitors and relatives of cultivated plants now occupy fairly limited areas, but still most maintain high levels of genetic diversity. They are widely studied, monitored and increasingly used in advanced breeding programs. Israeli genetic preservation activities are also well underway in the Israel Genebank (IGB, see Section 3.2.1) and in large private, usually university, collections (see Section 3.2.2). For example, one Tel Aviv University team has collected, studied and preserved over 8000 accessions of wild barley alone. There are also national parks and nature reserves (see Section 3.1). Government policies are generally supportive, as is the highly-active Israel Society for the Protection of Nature there are even laws against picking wildflowers but, given the individualistic Israeli temperament, most protection comes from an inherent Israeli love of the land and its flora.

Given the incredible genetic diversity found in the crop plants listed above, only a small fraction of their full genetic potential has been utilized to date.

For example, the FAO and the Israel ARO have jointly developed *Allium ampeloprasum* as an ornamental. Israel is already exporting the beautiful umbels to Europe (two days after cutting negligible odor remains). Such work continues at a steady pace in Israel's universities, agricultural research institutes and seed companies, often in cooperation with scientists and agronomists from abroad (e.g. through the BARD program, see Section 1.3).

2.3 LANDRACES AND OLD CULTIVARS

Israel's commercial agricultural sector is totally Western in its reliance on recent high-performance hybrids and intensive year-round cultivation. This and spreading urbanization (habitat erosion) threaten many old landraces, some of which (particularly domesticated fruit trees such as olives and dates) date back many centuries, if not to Biblical times.

Landraces and old fruit tree cultivars still remain, however, in some small traditional Arab villages and among the Bedouin in the Northern Negev. Most Arabs in Israel have also switched to higher-yielding commercial varieties. Many field expeditions, especially in the early decades of the State, have systematically collected landrace varieties and local information. These historical collections are preserved and monitored. The Israel Genebank is now checking its collections of Bedouin wheat, small grains, chickpeas, lentils, faba beans and other legumes from the Judean Desert for continued viability (see Section 3.2.4).

Israeli agricultural scientists are well aware that old local varieties can help improve modern imported varieties, by increasing their adaptability to Israel's particular climate, soils, plant diseases and pests. A case in point is the small local Hashabi apple. Many generations of selection pressure have given it considerable resistance to Israeli soil diseases, pests, etc. This makes the Hashabi a useful rootstock for many local and imported apple varieties. Twenty years of controlled selection at ARO have created superior Hashabi's with increased vigor, yields, fruit size and quality. Similarly, a 100,000-seedling breeding program for grapes has combined local and imported genes to produce six patented new hybrids, including Odem, Nava, Elul and Kislev.

Other examples include landrace varieties of temperate fruit trees, adapted to Israel's mild winters, which can provide useful genetic input into Commercial varieties. For example, a small local plum-size apple, crossed with Golden

Delicious, yielded the popular Ana subtropical apple. The Hebroni local walnut requires only about one-third the number of vernalization hours required by standard California cultivars. Local bitter almonds, after repeated selection, are resistant to the root knot nematode, M. javanica, and have important early-bearing and fertility traits. Crosses with superior commercial cultivars yielded such new varieties as Samish and Dagan.

Under an innovative multi-landuse plan, combining genetic preservation with tourism, the ARO is establishing a Galilee Biblical Fruit Trees National Park to preserve such landrace varieties, while educating the public as to their importance (Section 3.1).

CHAPTER 3
National Conservation Activities

3.1 *IN SITU* CONSERVATION

Israel has long been aware of the need for comprehensive *in situ* conservation. The Nature Reserve Authority, established in 1964, now supervises over 100 nature reserves (an average of one per every 278 sq. km.). These occupy over 1000 sq. km., 3.5% of Israel's total area. Many plants and trees (including oaks and palms) are protected, and it is illegal to pick most wildflowers. The reserves also serve an important education function. The 20 most-developed reserves attract over 2 million visitors a year. Another popular educational facility is Neot Kedumim, a park with trees and plants from all parts of the country, which are typical of Israel's original, ancient (especially Biblical) flora. The Israel Genebank (IGB, see next section) coordinates and cosponsors, with the Israel Ministry of Science and the Arts (MOSA) and the Ministry of Agriculture (MOA), a wide variety of *in situ* conservation studies. They have pioneered the concept of dynamic gene preservation, preserving genes in wild interacting populations rather than by the static preservation of seeds. The plants continue to Crossbreed, forming new combinations, but the genes themselves are preserved, as long as the overall system stays in a roughly steady-state equilibrium. Israel's landmark studies on dynamic *in situ* conservation in wild wheat populations have drawn considerable international attention.

For example, over a decade, a multidisciplinary team of Israeli scientists, with support from the USDA and MOSA, have been studying the genetic diversity and population dynamics of wild emmer wheat on a hilly slope near Ammiad in the Eastern Galilee. Each year, samples of wheat seeds are collected every 3-4 meters along four transects. These are grown in experimental plots and tested for biochemical markers, disease resistance and other gene-related traits. Differences are carefully noted and correlated with the highly-localized soil, water, topographic and ecological conditions at each collection site. These researchers have found that, despite their limited geographical area, these populations are, genetically, highly diverse. They also found that wild wheat genes are not spread randomly across the terrain. Groups of genes exist as stable clusters or complexes associated with specific geographical features, such as north-facing slopes. Interim results were presented at an international workshop on the Dynamic *In Situ* Conservation of Wild Relatives of Major Cultivated Plants in April 1990 (abstracts published by MOSA as NCRD 2-90). They were later the subject of a special issue of the Israel Journal of Botany (Vol. 40, Nos. 5-6, 1991) devoted to the Population Dynamics of Wild Wheat in a Natural Habitat in the Eastern Galilee. These results will help guide future Israeli and international efforts at dynamic gene preservation.

The Israel Genebank (IGB) network's interests and activities include the collection and propagation of landraces of old fruit tree varieties. In cooperation with the Jewish National Fund (Keren Kayemet), ARO scientists have already selected 75 fig, 40 grape, 35 pommegranate and other local fruit varieties for preservation in a special Galilee Biblical Fruit Trees National Park (BFTNP). Filling the 8 hectare park and genetic-preserve presents special challenges since, due to vegetative propagation, most traditional local trees are infected with diseases and insect pests. Israeli scientists have grafted budwood and cuttings onto more than 15,000 rootstocks to produce over 10,000 seedlings; but they get only a 2% survival rate. Despite such difficulties, this innovative project to preserve old Israeli horticultural landraces is still a priority.

Both the Ammiad (wild tetraploid wheat) and BFTNP (fruit tree) projects, and several other *in situ* preservation efforts, are run by technical experts with a specific interest in genetic preservation, population dynamics, etc.

Recently the Israel Genebank for Agricultural Crops (see Section 3.2.1) and the Italian CNR/RAISA received approval for their joint proposal to the European Union (EU) to study the conservation of crop plant germplasm in nature reserves. This PGR project, one of three recently submitted to the EU's Peace Campus program, will also involve Egyptian and Palestinian scientists in a broad scientific dialogue. Italian facilities include a gene park of primitive traditional deciduous fruit-tree cultivars; Israeli facilities include existing stands of wild tetraploid wheat and the BFTNP. The project's data will be the basis for a subsequent workshop involving investigators throughout the Mediterranean region. Israel has also proposed an ambitious joint survey of all the plant genetic resources in the Southeast Mediterranean region (see Section 7).

3.2 *EX SITU* CONSERVATION

3.2.1 The Israel Genebank Network (IGB)

Only in the 1970's did the need for preserving genetic diversity and the problem of genetic erosion attract serious international attention. Israel was one of the first countries to respond, by forming a national committee (1973) to investigate the feasibility of establishing a national genebank and PGR network. The Israel Genebank (IGB) for Agricultural Crops was established in 1979 by Israel's National Council for Research and Development (now the Ministry for Science and the Arts, MOSA) and the Ministry of Agriculture (MOA) as a central focus for Israel's highly decentralized plant genetic resource efforts (see next section). The IGB is specifically charged with collecting, preserving and evaluating plant species indigenous to Israel.

The IGB is really more a national network than a bricks-and-mortar facility, as in some other countries. The IGB performs invaluable networking, data collection, information transfer, advisory, coordinating and curatorial functions. It is the central focus for Israel's germplasm collection, research and utilization community.

In particular, the Israel Genebank and the members of its network:

- Maintain active and passive germplasm collections,
- Maintain hebaria (voucher specimens), gene parks and genetic reserves,
- Facilitate the intra- and international exchange of plant material,
- Maintain a national database and information network,
- Promote intra- and international cooperation and coordination,
- Promote limited collection and research activities,
- Sponsor and participate in national and international workshops, conferences and training activities (see Section 5.3),
- Disseminate information on IGB-sponsored research, workshops and accessions through publications.

The IGB operates under the direction of its eight-member Scientific Executive Board, comprised of senior government, university and commercial end-user plant scientists. They are responsible to the MOSA and MOA, which provide operating funds. There are also a series of crop-specific ad hoc advisory committees that help the IGB:

- Develop priorities and policies
- Initiate national and international workshops
- Coordinate ongoing national and private programs
- Initiate and coordinate germplasm collection efforts.

The IGB Scientific Executive Board prepares a national 5-year plan which helps evaluate where Israel's genetic preservation efforts stand, where they need to go and special opportunities and problems that should be considered. They also set specific goals for more efficient IGB management and data-collection, and determine the research priorities for the IGB's limited research budget.
Nine crop-specific committees also report directly to the National Plant Genetics Board, which formulates national plant genetic policy, under the guidance of the MOA and MOSA.

These committees help link together Israeli plant scientists working on the same species. The full organization of the IGB network is delineated in Figure 1. The IGB's core budget is provided by the MOSA and MOA, and suffices to Cover central infrastructure and activities. Limited additional funds are available for PGR research.

For the IGB's first 15 years the ARO's Plant Introduction Department acted as the hub of the IGB network. This past May (1994), in accordance with the recommendation of the Scientific Executive Board's 1992-97 Five Year Plan, the IGB became an administratively and budgetarily independent facility. They are now improving genetic preservation and upgrading the IGB database. The IGB headquarters office, its base collection and its computer facilities (see next Section) are all still located on the campus of the ARO's Volcani Center in Bet Dagan.

The IGB does maintain a national base collection of indigenous varieties and landraces as a long-term national service (see next Section). It catalogs incoming accessions, facilitates exchanges and distributes material to users. In addition to its own collection, it also houses backup collections for other Israeli genetic resource centers.

The IGB base collection acquires foreign germplasm, including wild species, landraces and unimproved varieties. The IGB's small, efficient, permanent staff (a part-time Scientific Director, a full-time Seed Exchange Officer and a computer consultant) acquire 1500-2500 such accessions a year. The IGB staff also helps Israeli investigators locate and acquire local and foreign germplasm to meet specific breeding needs. Further details will be found in Section 4.1 and Tables 2,3.

The IGB's main users are university researchers and research institute scientists, who maintain their own collections, obtain their own research funds (often through contracts with seed companies) and are a major source of new Israeli commercial crop varieties. Other main users include the Israeli seed companies themselves.

Taken as a whole, the IGB system and its collections require further growth to fully meet Israel's needs. Recommendations for improvement are included in the IGB Five-Year Plan for 1992-97 (see Section 7.0).

- The IGB's main research interests include the:
- *In situ* conservation (e.g. wild tetraploid wheat)
- Field genebanks for vegetatively-propagated species (*Allium, rosaceous fruit, citrus material*)
- Phytosanitary procedures for transferring germplasm.
- Other research-related interests include the collection and propagation of wild fruit-tree clones, ornamental annuals and geophytes, molecular genetic and protein markers for genotype identification and a survey of wild medicinal and aromatic plants.

3.2.2 IGB Germplasm Collections and Facilities

The main central IGB germplasm preservation facilities are:

- The IGB Base Collection at the Volcani Center in Bet Dagan. The base collection has about 20,000 accessions. Over 1000 additional accessions are added yearly: about 75% from foreign exchanges and 25% from IGB domestic collecting expeditions and private Israeli collections and users. Most accessions are unimproved wild species and landraces. The IGB collection has its own refrigeration, equipment, laboratory, quarantine facilities and grow-out fields.
- The National Clonal Repository at the ARO/Matityahu Farm which maintains plants, trees and rootstocks in vegetative storage.
- The National Herbarium at the Givat Ram campus of the Hebrew University of Jerusalem.
- The International Genebank for Vegetatively-propagated, Short-day Allium Species at the Faculty of Agriculture of the Hebrew University of Jerusalem. This IPGRI-affiliated international collection also inclues a representative collection of wild species from Israel and neighboring countries.

In general, the IGB base and working germplasm collections are stably maintained in facilities conforming to internationally-recommended standards. The IGB's base collection is not itself disseminated; instead, a separate working collection is maintained for potential users. Seeds are routinely kept 10-20 years at -10^{o}C, with periodic checks for viability and reproduction.

Israeli material is often contributed by individual university and ARO scientists who have completed their projects. It is, thus, already collected and often characterized, evaluated and documented, before being offered for incorporation into the IGB base collection. The IGB's Science Executive Board reviews the material offered to it, from time to time, and decides what to maintain in the base collection. In terms of its own collection priorities, the IGB's Science Executive Board (and most Israeli researchers) give highest priority to indigenous wild relatives of agricultural crops. Cruciferae and Beta vulgaris collections were made recently; and an IGB-supported survey of indigenous medicinal and aromatic flora is in progress.

Special mention should be made of Israel's important collection of *Allium spp.* About 40 species of *Allium* grow wild in Israel and neighboring areas. Some are relatives of such cultivated *Alliums* as leeks, great-headed garlic and pearl onion. Some have such beautiful umbels, that they are being developed in Israel for export as flowers. Although many *Alliums* could be stored as seeds, their seeds are often hard to obtain and are highly perishable. Some taxa are completely sterile (e.g. *A. tilfoliatum var. hirsutum*) but often have a unique heterozygous genome worth preservation. This requires plant preservation of the *Allium* material in field collections. There also has been IGB-sponsored research on the cryopreservation of *Allium* (and fruit tree) vegetative material and *Allium* plant tissue culture. The International Plant Genetic Resources Institute (IPGRI) has helped Israel and Czechoslovakia, establish global field gene banks for short-day and long-day *Allium* species, respectively. The Israel IGB collection has 500 worldwide accessions of short-day, vegetatively-propagated *Allium*, which is located at the Rehovot campus of the Faculty of Agriculture of the Hebrew University of Jerusalem.

The IGB is now developing a more comprehensive and accessible national plant genetic resources database that will permit on-line access to personal computers (PC) anywhere in the country. References to the primary collector/researcher/breeder help enquirers obtain additional, more detailed information from the relevant parties. Israel has sufficient taxonomic and other expertise to generally assure the accurate description of its entries.

The IGB's national germplasm database contains information on 20,000 accessions. There are already detailed descriptions and records for wheat and *Alliums*, and the records for other species are being upgraded. The system also Contains information on the members of Israel's PGR community and their activities, accessions, expertise and interests. The new system is highly versatile and uses the internationally-accepted set of descriptor prototypes.

PGR data is widely shared. Linkages with the USDA go back to the early 1900's. Relationships with European databases are also well-established. The full set of the IGB's documentation records is not yet duplicated elsewhere, except as maintained piecemeal by the original donors, exchangers and users. To this extent, they are vulnerable. Users of IGB material usually give copies of their subsequent data to the IGB as a matter of course.

The National Herbarium, located at the Hebrew University of Jerusalem (Givat Ram Campus), dates back to the University's founding in the early 1920's, and thus predates the State of Israel itself (1948). Two-thirds of its 500,000 specimens were collected in the Mediterranean and Middle East regions. Some incorporated collections go back to the turn of the century. There is an active program of exchanges with other herbaria around the world.

The herbarium also serves as a documentation center for Middle East floras, in general. It is often the only source of information on the previous distribution of plant species that have been forced into extinction by the rapid urbanization and development of the past few decades. Its collection served as the basis for the definitive multi-volume series Flora Palestina, published by the Israel Academy of Sciences and Humanities. It also serves as a documentation center for studies undertaken on the recommendation of the IGB's Scientific Executive Committee (usually with MOSA or MOA funding). The herbarium's massive database is now being computerized, an initiative which should greatly facilitate its use.

3.2.3 Related PGR Activities and Collections

The Israeli research community is highly decentralized. Most PGR-related research is done in Israel's seven major universities, in the Agricultural Research Organization (ARO), in regional research stations and in public and private companies. These collections are housed and funded by the crop experts themselves. Those Israel PGR collections which contain over 100 accessions are listed in Table 1. Further details on these and smaller, but often quite important, collections will be found in Israel's submission to the FAO World Information System on Plant Genetic Resources. While supportive of individual freedom and initiative, this original decentralized system had several drawbacks. Researchers often did not know about or have access to the accessions and data of others. Interinstitutional barriers and geographical distances discouraged cooperation. When a researcher completed his research project, or when project goals or funds were shifted to other varieties or species, there was little incentive (or support) to maintain a collection when no one had an immediate interest. The establishment of the IGB's central facilities and PGR network in 1979 (see previous Section) helped overcome many of these difficulties.

The largest of the many major and minor private collections in the IGB network is Tel Aviv University's Institute for Cereal Crop Improvement. Their collection includes 20,000 (mostly wild) accessions of Israeli cereals and 2000 worldwide accessions. The University of Haifa's Institute of Evolution has a sizable collection of wild Israeli Hordeum (2000 accessions) and *Triticum* (1000 accessions) species.

In addition to an exceptionally large international sesame collection (3000 accessions), and sizable Lens (500), *Allium* (500) and other collections, the Hebrew University of Jerusalem Faculty of Agriculture has a 60 acre experimental station and 600 square meter phytotron for growing out, evaluating, studying and improving its preserved varieties and crosses. The Hebrew University of Jerusalem also has an Applied Genetics Experiment Farm in Talpiot, near Jerusalem.

The Ben-Gurion University of the Negev's J. Blaustein Center for Desert Research at Sde Boqer has a sizable collection of arid-land plants, which are resistant to salinity and drought, and many of which have agricultural or industrial (e.g. guayule, jojoba) potential. Israel’s location in the Mideast heartland of genetic diversity for many major agricultural crops, and her great geographical and climatic diversity (see Section 1.1), create a particularly rich ensemble of habitats and corresponding local varieties, including varieties tolerant to high salt concentrations and drought. Preventing the disappearance of such varieties, as remote or rural areas are developed, and using them to incorporate valuable new traits into Commercial varieties, are the main goals of most permanent indigenous collections.

Table 1. Israeli ex situ Collections With Over 100 Species-specific Accessions (Worldwide Unless Noted)

Israel Agricultural Research Organization/Volcani Center	
Base Collection, *Various spp.*	(20,000)
Wheat, Legumes, Cucurbits, Forage, Cotton, Other *Allium spp.*	(300)
Avocados	(200)
Mango	(100)
Grapes	(100)
Tel Aviv University/Institute for Cereal Crop Improvement	
Hordeum spontaneum	(8000) - Israel
Hordeum vulgare	(500)
Triticum dicoccoides	(4500) - Israel
Triticum aestivum	(1000)
Avena sterilis	(5000) - Israel
Avena sativa	(500)
Aegilops spp.	(2500) - Israel
University of Haifa/Institute of Evolution	
Hordeum spp.	(2000) - Israel
Triticum spp.	(1000) - Israel
Hebrew University of Jerusalem/Faculty of Agriculture	
Sesamum spp.	(3000)
Lens	**(500)**
Allium spp.	(500)
Trifolium alexandrinum	(140)
Trifolium resumpinatum	(100)
Weizmann Institute of Science	
Triticum spp.	(600) - Israel
Ben-Gurion University of the Negev	
Arid Land Species	(various)

3.2.4 Evaluation, Characterization and Regeneration

As mentioned, Israel's genetic collection and preservation system, while efficient and technically advanced, is highly decentralized. That means that individual scientists independently do most of the characterization and evaluation (and often utilization) of their own material, before distributing it to the national network. IPGRI and other recognized descriptors are commonly used. Indeed, Israeli plant scientists have made major contributions to the development of many IPGRI descriptors, especially the *Allium*, *Prunus* and *Trifolium* descriptors.

Both the holders of individual collections and the IGB base collection have grow-out facilities and can regenerate their collections as needed. The IGB Science Executive Board is currently discussing whether the current base collection regeneration program and procedures are adequate. Genetic drift also remains a serious concern, especially in collections from small populations. The issue has been well-studied only in the case of the *in situ* preservation of wild wheats (see Section 3.1), and the results of those studies have made significant contributions to the world literature on the subject. Regeneration history may be part of the new database, currently under development, but is not currently provided to users.

Regeneration was a low priority in the early years of the IGB, and there is a sizable backlog of material needing attention. Major efforts are underway to assess the viability of the base collection's landrace material. The legume species have since been reproduced; and regeneration of the cucurbits is planned later this year.

CHAPTER 4
In-Country Uses of Plant Genetic Resources

4.1 USE OF PGR COLLECTIONS

Individual scientists usually obtain their genetic material directly from colleagues, private collections and field missions, without IGB involvement. They often undertake collection and research activities with specific applications and goals in mind. They are the primary users of their own material until, and often after, they release it to the IGB. Farmers usually have access to these genetic resources through domestic seed companies (see Sections 1.2, 1.4.3).

The IGB does receive some requests for local landraces, as a source of useful genes for breeding programs and basic research. Most Israeli researchers and breeders, however, turn to the IGB staff as an experienced intermediary for locating and acquiring foreign germplasm from the worldwide PGR network. The IGB's Seed Exchange Officer processes 1000-2000 such new accessions each year, most in response to specific requests by Israeli users. Not all such material can be kept in the base collection, because the seed samples received are often too small (20-40 seeds per accession) and must be transferred directly, in their entirety, to the requester. Thus the IGB's central hub is basically a highly-active service organization, with a more passive (if no less important) curatorial role.

Much current user interest centers on cotton, cereals, sunflowers, faba bean, lentils and curcubits. A more detailed listing of varieties acquired by the IGB for Israeli users in 1992-94 is provided in Table 2. The major users of the IGB's PGR-acquisition system are ARO/Volcani plant scientists, who were responsible for 20 (65%) of the 31 official requests for germplasm received by the IGB in 1994. Other important users include individual university scientists, research institutes and seed companies.

The main supplier of foreign germplasm is the U.S. Department of Agriculture USDA), which has particularly extensive, well-organized collections. There is also Contact with most other major foreign genebanks, of which CIMMYT, CSIRO, ICRISAT and AVRDC have been particularly helpful. A notable exception is ICARDA (in Syria) which systematically excludes Israeli participation.

At present, the IGB's four main sources of new foreign accessions are:

- USDA (20 lots)
- Private Seed Companies (18 lots)
- Botanical Gardens (17 lots)
- Research Institutes/Genebanks (14 lots)

The numbers in parentheses indicate the number of distinct shipments, each containing many accessions, processed in 1994.

The number of foreign requests for Israeli germplasm and Israeli requests for foreign germplasm are approximately equal (30 and 31 requests respectively). This does not tell the whole story, however, since most foreign requests are for small specialty items (5-10 accessions) and many foreign shipments, especially from the USDA, are quite large (20-100 accessions). Most material requested by foreign users is supplied. The spectrum of foreign requesters is expanding with Israel's expanding diplomatic ties. In particular, with the fall of the Iron Curtain, Eastern Europe and Bulgaria have shown an encouraging interest in Israeli wheat varieties. The IGB publishes an annual list of its seed introductions and distributes it worldwide. This sometimes leads to foreign requests based on these new IGB accessions.

4.2 BREEDING AND BENEFITS

Improved hybrid vegetable seeds are a major Israeli export (see Section 1.4.3), and plant breeding is an important national industry. Improving local varieties, and adapting imported germplasm for local use, were the original motivations for establishing Hazera, Israel's largest seed company. Not surprisingly, then, many of Israel's current breeding goals involve introducing specific desirable traits (high yield; high protein; pest, disease, salt and drought resistance) into major international crops, or developing varieties aimed at specialty export markets (long shelf-life tomatoes and onions, off-season melons). Similarly, much of the genetic input is from specifically-targeted foreign germplasm, obtained directly or through the IGB's Seed Exchange Officer (see previous Section). In general, Israeli breeding programs tend to emphasize increasing yields, marketability, profitability, hardiness and resistance to adverse conditions, rather than widening the genetic base of crops and reducing crop vulnerability.

Table 2. Main Foreign Accessions Received by the Israel Genebank (IGB) in 1992-94, in Response to Israeli User Requests

1992	1993	1994
Allium	*Allium*	*Capsicum*
Beta vulgaris	*Cicer*	*Cicer*
Capsicum	*Cruciferae*	*Cucurbits*
Cucurbits	*Cucurbits*	*Cuphea*
Flowers, Ornamentals	*Forage crops*	*Forage Crops*
Gossypium	*Gossypium*	*Gossypium*
Helianthus	*Helianthus*	*Helianthus*
Medicinal Plants	*Melilotus*	*Hordeum*
Lens	*Triticum*	*Lycopersicum*
Lupinus	*Vicia spp*	*Medicago*
Pisum	*Zea mays*	*Medicinal Plants*
Sesamum	*Triticum*	*Vigna*
Triticum		
Vigna spp.		
Zea mays		
Total = 2532	**Total = 1737**	**Total = 1426**

Table 3. Israeli Users of IGB Foreign Germplasm Acquisitions in 1994

ARO/Volcani Center Scientists	20
Seed Companies	4
Kibbutzim (Collective Farms)	2
Universities	3
Israel Society for Coastal and Sand Vegetation	1
Biblical Reserve Park (Neot Kedumim)	1

One should emphasize the critical importance of new genetic resources, plant breeding and agricultural R&D to the success of Israel's seed and produce export industries. Israeli firms still find it difficult to Compete head-on with the largest international concerns. Instead they depend on being the first in an important niche market (e.g. long shelf-life tomatoes, machine-harvestable melons). This dynamic strategy also assures a continuing, intense national interest in exploiting new genetic resources. The benefits to the national economy, in terms of exported produce (Section 1.4.2), and hybrid seeds (Section 1.4.3) are quite direct, tangible and widely appreciated.

Although the IGB readily honors foreign requests for plant genetic material, and despite the IGB network's access to large amounts of potentially-valuable germplasm, Israel is still a net genetic importer (see Tables 2 and 3). In that sense, the indigenous plant genetic resources of the IGB network are mostly a long-term resource for future exploitation. Hopefully, the IGB's new on-line database, once completed, will make more local and international scientists and breeders aware of the IGB network's accessions and increase their usage.

CHAPTER 5
National Goals, Programs and Legislation

5.1 NATIONAL PROGRAMS

The Scientific Executive Board of the IGB recommends national policies and programs in plant genetics resources (PGR) to the Ministry of Agriculture (MOA) and the Ministry of Science and the Arts (MOSA). Conversely, MOSA and the MOA appoint the members of the Board. The main element of Israel's PGR policy is to support a decentralized network of independent investigator generated activities, rather than a large, centrally - planned national program. The IGB network joins together three various elements and provides coordination and central services (see Section 3.2.1). Funds are provided for central infrastructure and research by both the MOA, MOSA and by foreign organizations. The IGB's Scientific Executive Board represents most segments of the interested national scientific community, both government, academic and commercial. Different areas, disciplines and crops are also well represented. The post of IGB Scientific Director is long-standing and secure. The IGB's staff consists of a part-time Scientific Director, a full-time Seed Exchange Officer, and a Computer Consultant.

More prominence to PGR, genetic preservation and genetic diversity issues is provided, at the national (government) policy level by the MOSA Director-General and the MOA Chief Scientist. The former is advised on such issues by the Director of Biological and Ecological Research in the MOSA Division of Life Sciences. The Director is also a member (and Scientific Coordinator for Foreign Affairs) of the IGB Science Executive Board and Israel's representative to the IPGRI, the FAO Commission on PGR and the ECP/GR.

Recent policy decisions include decisions to emphasize:

- Indigenous food, ornamental, medicinal, aromatic and industrial plants of Mediterranean origin
- Dynamic *in situ* conservation,
- An appropriate ratio of Israeli to foreign holdings, and
- More formal guidelines on how freely to exchange genetic material.

5.2 NATIONAL LEGISLATION

Israel's quarantine laws for plant material are very strict and comply with international legislation. There are detailed lists of: forbidden materials, those requiring greenhouse quarantine, those allowed to be tested in open controlled plots, etc. Seed import licenses and phytosanitary certificates are required even for the smallest seed samples. One of the major advantages of going through the IGB's Seed Exchange Officer is her expert knowledge and experience with the system, which is overseen by the Plant Protection and Inspection Service of the Israel Ministry of Agriculture. In some cases, inclusive five-year licenses have been granted for all acquisitions of a given material from a given continent. This greatly expedites IGB seed acquisition. Special, more stringent, permits are required for plant-tissue culture material, bulbs and seedlings. This specialized service is provided by the MOA. There is negligible loss of material due to quarantine.

As might be expected of a country with a large science base, Israel fully protects Intellectual Property Rights (IPR). Variety registrations are common and breeder rights are protected. The impact on IPR is generally positive, and Israel's legal community is quite capable of providing the assistance needed by breeders. Decisions on importing PGR can be made freely by individuals and organizations, subject only to Israel's stringent quarantine laws (see previous section).

5.3 TRAINING

Israel's plant scientists, geneticists and breeders are highly trained, and advanced agricultural courses are offered at Israeli institutions of higher education. The Hebrew University of Jerusalem has a fully-developed Agricultural Faculty in Rehovot, and most other universities have related biological R&D and teaching facilities. For example, the Ben-Gurion University of the Negev's J. Blaustein Center for Desert Research at Sde Boqer (in the Negev Desert) is world famous for its arid-lands botanical and physiological research, and related training programs. The MASHAV (International Cooperation Center) in the Foreign Ministry, often in cooperation with CINADCO (Center for International Agricultural Development and Cooperation), holds a variety of courses each year, especially designed for foreign participants.

The IGB sponsors both a series of one-day workshops and seminars (yomei iyyun) and larger, often international, workshops on specific topics. Examples include a workshop on Wild Genetic Resources in Israel and their Potential for Crop Improvement (1983) and Dynamic *In Situ* Conservation of Wild Relatives of Major Cultivated Plants (1990). The proceedings and results of the larger conferences are usually published and disseminated to the wider PGR community.

Every two years Israel holds an international course on Exploration of Wild Genetic Resources: Principles of Collection and Sampling, under the general auspices of the International Plant Genetic Resources Institute (IPGRI). The course includes both classroom lectures by recognized Israeli experts and an extensive series of field trips and exercises. The course is held at the Hebrew University of Jerusalem's Faculty of Agriculture in Rehovot, and is jointly sponsored by Israel's MOSA and GIFRID, the German-Israel Fund for Research and International Development. The IGB assists this effort by providing the names and addresses of appropriate institutes abroad and, conversely, the IGB benefits from the opportunity for personal contacts the course affords. The IGB also Conducts demonstration classes for these and other trainees.

Israel is well aware of its international responsibilities, and readily sends its PGR experts abroad to provide on-site consultations, courses and assistance to other countries. It is hoped that the proposed FAO International Fund and other sources will help other countries, especially less-developed countries (LDCs) benefit from Israeli experience in this area.

CHAPTER 6
International Collaboration

The State of Israel attaches great importance to international cooperation, and is an active participant in the United Nations, and other international, scientific and technical activities. On the individual level, Israel's researchers are particularly international-minded. Israeli scientists have the world's highest percentage of papers co-authored with foreign scientists (30% in 1990, about three-times the U.S. average). A large fraction of Israel's scientists undertake their postdoctoral training abroad; and close networking with leading laboratories abroad remains a prominent feature of Israeli R&D. This is especially appropriate for a small, but highly advanced, country anxious to avoid intellectual inbreeding and to keep up with leading-edge world research.

Israel is well aware of its responsibility to share its advanced PGR facilities with others, and proactively seeks opportunities to be of assistance. Israel is prepared to provide experts to help other countries, especially less-developed countries (LDCs), identify, characterize, preserve and exploit their plant genetic resources as part of the new FAO Plan of Action (see Section 8) and other international initiatives.

6.1 UNITED NATIONS INITIATIVES

6.1.1 UNCED

Israel was a full participant at the UNCED (Rio deJaneiro, 1992) and is a signatory to Agenda 21, although this is awaiting ratification by the Knesset, Israel's Parliament. Israel continues to actively pursue the goals of Chapter 14-G (Conservation and Utilization of PGR) and Chapter 15 (Conservation of Biological Diversity) through specific programs. These include, re Chapter 14-G, the activities of the Israel Genebank (see Section 3.2) and its associated network of researchers, collectors and breeders and, re Chapter 15, Israel's Nature Reserve Authority (see Section 3.1) and Israel's pioneering decade-long research on the genetic diversity of wild wheats in the Galilee (see Section 3.1). Israel sees the Convention on Biological Diversity Forum and the FAO Commission as having distinct, but complementary, roles in strengthening international cooperation in this area.

6.1.2 FAO Global System

Israel has a long-standing policy of supporting and participating in FAO activities and is a member of the FAO Commission. Israel's representative is the Director of Biological and Ecological Research in the Ministry of Science and the Arts (see Section 5.1). Israel is a signatory to the Undertaking, and supports its purposes.

Israel would hope that, over the next decade, these and other U.N. efforts will:

- Strengthen and promote the further development of international PGR networks.
- Strengthen international and regional cooperation in plant genetic resources.
- Israel would particularly welcome increased cooperation with its neighbors and other Mediterranean countries, who share many of the same plant genetic resources, environmental conditions and problems.
- Strengthen international research on the effect of desertification and climate change on plant genetic resources and agriculture.
- Give greater emphasis to the PGR of the Fertile Crescent with food and industrial potential. Improve international techniques for preserving PGR, including reliable systems for the cryopreservation of vegetatively-reproduced material.
- Develop reliable markers for the fast screening and evaluation of PGR for desired traits, and to avoid genetic duplication (to reduce storage costs).
- Develop a reliable system for the risk-free (pest-free) exchange of genetic material.

In this latter regard, one new technique of great potential importance, especially for less-developed countries (LDCs), is *in situ* genetic preservation (see Section 3.1). For over a decade, Israel has done pioneering work in this area using wild wheat populations; but comparisons with similar studies in different species in different regions (e.g. legumes in Central America, rice in Southeast Asia) are essential for setting this new scientific approach to PGR-preservation on a firm basis. The results could be particularly important to Countries with limited budgets for the often expensive facilities required for proper ex situ preservation. Israel would strongly support the use of the proposed International Fund as a catalyst to stimulate LDC research in, and development and use of, such advanced *in situ* PGR-preservation techniques. Israel would be willing to Contribute its expertise to such a worldwide effort.

6.1.3 Other

Israel participates in the UNESCO Man and the Biosphere (MAB) Program. There have been MAB-affiliated research activities in both the Carmel and Machtesh-Ramon regions. Other MAB-sponsored projects have been proposed. Israel is a member of the Union for the Protection of New Varieties of Plants (UPOV) and supports its goals. New Israeli plant varieties are registered with the UPOV once their uniqueness has been determined.

6.2 OTHER INTERNATIONAL AND REGIONAL COLLABORATION

Israel maintains close useful ties with many members of the CGIAR (Consultative Group on International Agricultural Research) network of research centers. The IGB works particularly closely with CIMMYT (Mexico), from whom it has received many useful new wheat accessions. It also works closely with ICRISAT (India), and other CGIAR centers. Israel's relationship with these and most other CGIAR centers has been both cordial, adequate and highly useful. Israel is eager to share its world-class expertise and interest in dry areas agriculture, with the other countries of its region. Given Israel's exclusion from ICARDA (Syria), it is hoped that an alternative truly regional forum, perhaps sited in Israel, can be established to facilitate such technology transfer and cooperation. Since there is currently no. CGIAR centers or facility in Israel, and given Israel's high level of expertise, interest and genetic resources, Israel would seem an ideal location for a truly open, accessible regional center, one which could contribute most effectively to PGR, while promoting regional cooperation and peace (see, e.g. the MERGE proposal of Section 7). As clearly demonstrated by Israel's ten years of experience and successful technology transfer to other countries under the CDR Program (see Section 6.3) and thirty years of technology transfer and training for other countries under MASHAV (see Section 5.3). Israel has a great deal to offer the other countries of its region, especially in terms of applied modern biotechnology, modern PGR techniques, arid lands agriculture and dynamic *in situ* preservation.

Israel cooperates fully with the IPGRI (International Plant Genetic Resources Institute). It houses, with IPGRI assistance, the global genebank for short-day Allium species (see Section 3.2.2), and conducts a well-attended, biennial International Course on the Exploration of Wild Genetic Resources: Principles of Collection and Sampling, under IPGRI auspices. The IPGRI was also helpful in assembling the large, worldwide collection of Sesamum (3000 accessions) at the Hebrew University of Jerusalem and promoting its international use, related workshops, etc.

Israel also maintains useful cordial relations with many regional research centers. Of these, the Asian Vegetable Research and Development Center (AVRDC) and the Centro Agronomico Tropical de Investigation y Ensenzana (CATIE) have been particularly helpful; and germplasm has been exchanged on an occasional basis.

Israel is also an active member of the European Cooperative Program for the Conservation and Exchange of Crop Genetic Resources (ECP/GR), and a variety of other international and European working groups, commissions, conferences and other bodies. Israeli Genebank representatives are active participants in the ECP/GR working groups on Allium, Avena, Prunus and for The European Union (EU) has been instrumental in funding the Peace Campus and other programs that promote regional cooperation in this and other scientific areas. A proposed Israeli-Italian crop gene park initiative has already been mentioned (see Section 3.1). This joint project to preserve the genetic diversity of Mediterranean crop species and their wild relatives will also include Egyptian, Turkish, Palestinian and other regional cooperators. The project, part of the EU Peace Campus Program has already stimulated considerable regional and international interest. Recent articles on the new project have appeared in Diversity (Vol. 9, no. 4, 1994) and IPGRI's Gene Flow (1994).

Another, even more ambitious undertaking, which also grew out of Israel's participation in the EU-sponsored Peace Campus program, is a proposed Joint Regional Study of Plant Genetic Resources in the Middle East. In this epoch-making international pilot project, investigators from Israel, Jordan, Egypt, Syria and Lebanon would survey wild relatives of crop plants and local landraces throughout the Eastern Mediterranean. One result of this five year study would be the first comprehensive inventory of the plant genetic resources of this genetically-rich region. Another important element would be a model in-depth study of a single species common to all the countries of the survey; wild emmer wheat has been suggested.

Both conventional and molecular methods would be used to study the model species' genetic diversity throughout the region. Although some desirable traits, such as resistance to drought, disease, heat and salinity, may be sought and subjected to pre-breeding evaluation, the project's primary aim would be the exploration and documentation of genetic diversity per se. The study of such patterns, and their historical and ecological determinants, will also help to formulate germplasm conservation policies and strategies for the future. Such studies would have implications far beyond the region, since many important crop plants have their origin in the Middle East, the core area ages of Old World plant domestication. The proposed project will include field collection, screening, experimentation and selected pre-breeding evaluation, plus a series of regional meetings, workshops and publications. If successful, such a preliminary effort could be an important step towards greater regional scientific and PGR cooperation including, perhaps, the long-term MERGE concept, recommended by the IGB Scientific Executive Board as part of its recent Five Year Plan (see Section 7).

6.3 BINATIONAL COLLABORATION

Israel's plant science community maintains close bilateral ties with many other countries at both the personal and national level. The IGB is in contact with, and freely trades germplasm with, its counterparts around the world. The oldest and largest bilateral relationship, that between Israel and the United States, dates back to 1909, long before the establishment of the State itself in 1948 (see Section 2.2). Hundreds of joint U.S.-Israel agricultural research projects were funded in the 1950-70's under U.S. Public Law 480. The current U.S.-Israel Binational Agricultural Research and Development Fund (BARD) was established by a formal binational agreement in 1977. As indicated by an extensive series of 10-year reviews (summarized in BARD's 1992 publication Partnership for Tomorrow), the program has been highly successful with major concrete benefits accruing to both sides.

The BARD has funded about 650 joint agricultural research projects, including many in the plant sciences, from the over 2300 proposals submitted. The BARD's $8-10 million annual budget funds about 40 new joint U.S.-Israel research projects a year. Almost a quarter of all Israeli agricultural scientists have been BARD grantees at some stage in their careers.

In addition, many Israeli plant scientists conduct individual bilateral research projects on specific topics, such as recent joint projects on phytopathological cereal research, with the Technical University of Munich (Germany). There is also IGB and CGN (Netherlands) cooperation on wheat. Bilateral relations also lead to an important expanding circle of personal contacts. For example, counterparts in Europe were helpful in setting up contacts between the IGB and counterparts in Morocco.

For many years, Israel has had an active program of joint research with counterparts in less-developed countries (LDC's). Other countries, particularly the U.S. and Germany, have been helpful in facilitating the application of Israeli expertise to important development goals. The U.S. Agency for International Development, for example, sponsors both the U.S.-Israel Cooperative Development Research Program (CDR) and the Middle-East Program in Regional Cooperation (MERC). Both programs fund occasional projects which involve plant genetic resources and biological diversity. For example, Israeli CDR investigators have studied wheat (including wild wheat), drought and disease resistance with Portuguese colleagues, genetic variability in sesame with Thai colleagues and new indigenous arid-land subtropical fruit and nut crops with African colleagues. One Israel CDR investigator, working together with CIP (the CGIAR's Centro Internacional de la Papa, Lima, Peru), discovered a male-sterile line of potatoes, a major breakthrough in breeding improved hybrids of this native Andean crop.

The German-Israel Fund for Research and International Development (GIFRID) is a co-sponsor of Israel's biennial international courses on the Exploration of Wild Genetic Resources at the Hebrew University of Jerusalem (see Section 5.3), each of which typically involves 20 or so IPGRI Third World training fellows.

CHAPTER 7
National Needs and Opportunities

Israel's immediate goals for the Israel Genebank (IGB) network are summarized in the recommendations of the IGB Scientific Advisory Board in its Five Year Plan for 1992-1997. Specific goals are to:

- Review the vitality of the existing collection (already underway) and set collection and renewal priorities,
- Upgrade the IGB's database infrastructure and on-line accessibility by users (already underway),
- Increase linkages between Israeli breeders and farmers to give more attention to short and long-range national priorities,
- Promote the collection and preservation of landrace and acclimated fruit trees, Strengthen international information and research links, including increasing the relevant budgets, number of international courses in Israel, etc.
- Consider setting up a state-of-the-art Middle East Regional Genebank Endeavor (MERGE) to preserve the genetic resources of the Eastern Mediterranean and Fertile Crescent, the heartland of genetic diversity for many important crops, while promoting regional cooperation and understanding.

  The Board also Called for the administrative and budgetary independence of the IGB (granted in the reorganization of May 1994) and an increase in the IGB budget to expand activities and to upgrade existing infrastructure.

  Israel's broader PGR goals are to:

  Conserve local flora and prevent the loss of valuable genetic resources, Improve service to, and coordination between, the local scientific commercial breeder and agricultural communities.

  Contribute Israel's expertise to other countries in the region, through programs supportive of truly regional cooperation and peace.

CHAPTER 8
Proposals for a Global Plan of Action

Israel maintains its intense commitment to, and interest in, joint international efforts on such global problems as: desertification and arid lands agriculture, reduced use of pesticides through active search for, and integration of, genes for pest resistance, climate change and its impact on plant genetic resources and agriculture, new technologies for *ex situ* and *in situ* genetic conservation, improved food quality traits, such as nutritional and flavor characteristics.

At the same time, Israel would seek the maximal international support for truly regional programs to survey, preserve and exploit the extraordinary genetic resources of the Middle East for the benefit of its inhabitants and all mankind. Israel has already suggested two possible first steps in this direction, which also supports the broader goals of increased regional understanding, cooperation and peace, namely a: Joint Regional Study of Plant Genetic Resources in the Middle East (see Section 6.2) Middle East Regional Genebank Endeavor (MERGE, see Section 7).

Israel has already undertaken a joint crop plant gene park project with Italy (see Sections 3.1, 6.2), that will include cooperating scientists throughout the Mediterranean region.

We would welcome the assistance of the international community in linking our scientific and PGR communities and institutions in these and other meaningful efforts for our joint benefit.

Finally, Israel would reiterate its long-standing commitment to share its expertise and experts in plant genetic resources research, preservation and utilization with all other countries, both in its own region and throughout the world. Israel would be pleased to provide experts, set up training courses and help set up genebanks and *in situ* PGR-preservation (see Section 6.1.2) programs in all other countries, as well as sharing its own plant genetic resources, as part of the FAO Global Plan of Action. Only through such all-encompassing cooperation can we maximize the benefits of our common genetic heritage for all Mankind.

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Abbreviations

ARO	Agricultural Research Organization (under the MOA)
AVRDC	Asian Vegetable Research and Development Center
BARD	U.S.-Israel Binational Agricultural Research Development Fund
CDR	U.S.-Israel Cooperative Development Research Program
CGIAR	Consultative Group on International Agricultural Research
CIP	Centro Internacional de la Papa (Peru)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
ECP/GR	European Cooperative Program for the Conservation and Exchange of Crop Genetic Resources
EU	European Union
GIFRID	German-Israel Fund for Research and International Development
ICARDA	International Center for Agricultural Research in the Dry Areas (Syria)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
IGB	Israel Genebank
IPGRI	International Plant Genetic Resources Institute (Italy)
IPR	Intellectual Property Rights
JNF	Jewish National Fund (Keren Kayemet LeIsrael)
LDC	Less-developed Country
MASHAV	Israel Center for International Cooperation
MERC	Middle East Program in Regional Cooperation
MERGE	Middle East Regional Genebank Endeavor (proposed)
MOA	Israel Ministry of Agriculture
MOSA	Israel Ministry of Science and the Arts
NIS	New Israeli Shekels (approx. U.S. $0.33)
PGR	Plant Genetic Resources
UPOV	Union for the Protection of New Varieties of Plants
USDA	U.S. Department of Agriculture