NEW ZEALAND:

COUNTRY REPORT FOR THE COMMISSION ON PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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Chapter 1: INTRODUCTION

This is the second country report on the state of plant genetic resources in New Zealand. The report has been prepared for the Commission on Genetic Resources for Food and Agriculture, a division of the Food and Agriculture Organisation (FAO) of the United Nations.

A first New Zealand country report was prepared in 1996. The 2007 report updates the data and factual information contained in the 1996 report and follows a similar format. Some material is retained from the 1996 report where the factual or descriptive information remains unchanged since 1996. Acknowledgment is made to the authors of the original report (Warmington *et al.*, 1996) for their material included in this updated report.

Chapter 2 of the report provides an overview of the agriculture and food production landscape and changes that have occurred over the past ten years. Indigenous plant resources are discussed in Chapter 3 and the main agricultural and crop genetic resources in Chapter 4. Within these two chapters plant genetic resources are detailed as follows:

- *In situ* and *ex situ* collections including their location, funding, documentation, evaluation, characterisation, regeneration, and provision of materials to breeders and other users;

- The uses which are presently made of those plants, and important past uses in the case of indigenous plants;

- The principal threats to the conservation of plant genetic resources.

Summary information on New Zealand's important plant collections is contained in Annex 1.

Chapter 2: NEW ZEALAND AND ITS AGRICULTURAL SECTOR

2.1 Geographical and Population Outline

New Zealand is situated in the south-west Pacific Ocean. It consists of two main islands, the North Island and the South Island, along with numerous smaller islands, with a total land area of 27,050,000 hectares.

New Zealand is over 1,600 km in length, and around 450 km wide at its widest part. The terrain of New Zealand is very mountainous, and only a quarter of the land area lies below 200 metres in elevation. The North Island (11,577,700 hectares) and the South Island (15,121,500 hectares) are separated by Cook Strait, which measures 20 km wide at the narrowest point. The smaller Stewart Island (174,600 hectares) lies offshore of the southern tip of the South Island.

New Zealand is a long, narrow, mountainous country, which is surrounded by a large expanse of ocean. Most of the country experiences a moist, temperate climate. Climate is affected by:

- New Zealand's location in a latitude where westerly winds are prevalent;
- The oceanic environment, and
- The mountain ranges and the resulting orographic effects.

This can create "rain-shadows" in the leeward localities, often to the eastern side of the ranges, playing a large role in localised weather patterns. The predominantly westerly weather system is periodically interrupted with cooler, southerly weather systems and warmer, northerly weather systems.

The ranges affecting the westerly progress of the weather systems result in more marked east-west differences in weather patterns than the north-south climatic differences. Many parts of the country are exposed to extreme wind and rain events, with associated wind damage to property; cold fronts especially can lead to heavy rain resulting in flooding. The warmest temperatures in New Zealand usually, but not always, occur to the east of the main dividing ranges, where droughts can occur.

New Zealand's population is highly urbanised with 86% residing in urban areas. The North Island has the highest population with 3 in every 4 New Zealanders living in the North Island (76% of the population). The single largest urban area is Auckland with over 1 million people. The next largest is the Wellington region at 450,000 residents. Urban areas in the north of each island have experienced the most growth in recent years. Although net internal migration from the South to the North Island has occurred for most of the 20th century, in recent years more people are moving south than north[1]. New Zealand's total population at the last census (2006) was 4,027,947.

About 29 percent of New Zealand is legally protected (e.g., National Parks or reserves) in a natural or near-natural state, but there are some significant gaps in representation. Conservation of indigenous plants is discussed in greater detail in Chapter 3.

[1] Statistics New Zealand, 2002(a)

The total area of New Zealand under agricultural and horticultural use (including exotic forestry plantings) was 13.6 million hectares in 2005. Of this, 11.3 million hectares (82%) was pasture land (grassland, tussock or danthonia). The area utilised for horticultural production was 120,000 hectares, and planted production forest 1.8 million hectares. Arable and fodder crop land accounted for 350,000 hectares. The concentration of horticultural land use and exotic forestry plantings is higher in the North Island than in the South Island, due to climate, soils, and economic factors[2].

Small farms (less than 40 hectares) made up 48% of all farms in 2002, compared to 46% in 1992. The number of mid-sized farms (40 to 200 hectares) represented 30% of all farms. Farm sizes greater than 200 hectares accounted for 22% of the 70,000 total farms recorded in 2002. The small holdings or lifestyle farms increased significantly in the late 1970s and through the 1980s but numbers have stabilised in the last decade. These farms have low agriculture output and are often a secondary source of landowner income[3].

2.2 New Zealand Agriculture and Forestry

The agriculture and forestry sectors employed close to 5% of the total employee count in New Zealand as at February 2006. Employee numbers have declined steadily over the last 20 years reflecting sector wide rationalisation in a number of farming operations. Agriculture employs around 81,000 people according to the 2006 census data. The largest number of workers are in the horticulture and fruit growing sector (28,000) followed by mixed sheep and beef farming (26,500) and dairying (20,000). Around 7000 workers are employed in the forestry and logging sector[4].

Total agriculture and forestry production (including meat, dairy, wood and paper manufacturing) represented 10% of New Zealand's Gross Domestic Product (GDP) in 2003[5]. This is a 35% increase over the period 1995 to 2003. Agricultural product exports represented 56% of New Zealand total exports in the year to December 2006. Dairy and meat exports are the top two export commodities accounting for 33% of New Zealand's total exports. Forestry represented approximately 20% of total commodity exports[6].

The agricultural and horticultural industries in New Zealand are almost totally reliant on plants and animals imported from other countries. The main exception to this is the presence of native grass species in unimproved and semi-improved pastures. The timber industry still harvests native trees, notably in the west and south of the South Island, but at a much diminished rate following passage of the Forests Amendment Act, 1993 which requires indigenous forests to be logged in a sustainable manner.

2.2.1 Pastoral Farming

New Zealand lamb and mutton is produced by a relatively low cost, outdoor and grass-fed system, which gives it a comparative advantage over many of its competitors. The area of pasture land used for sheep farming (including mixed

[2] All land use figures -Statistics New Zealand, 2002(b)
[3] Statistics New Zealand, 2002(b)
[4] Statistics New Zealand, 2006 (a)
[5] Statistics New Zealand, 2003(a)
[6] Statistics New Zealand, 2006(b)

sheep/beef/cropping farms) was 7.4 million hectares in 2005. This is slightly less than the 7.7 million hectares farmed in 1995. Sheep numbers declined steadily from their highest levels of 70.2 million in 1982 to 40 million in 2002 and have stabilised at this level through to 2006[7]. Sheep and wool contributed 17% of New Zealand's total agricultural output in 2003[8]. This compares to 19% in 1995.

In 2001 New Zealand's sheep contributed 4.2% of the world's total numbers, 9% of sheepmeat production, and nearly half (49.7%) of the sheepmeat in international trade. New Zealand exported 368,000 tonnes of sheepmeat and 149,000 tonnes of wool in 2005/2006[9].

The area of pasture land used for beef farming (including mixed beef/sheep/cropping farms) was 2.6 million hectares in 2005. This compares to 1.7 million hectares in 1995. Beef cattle numbers were 4.4 million at 30 June 2006. Of the main livestock sectors, beef numbers have changed the least over the past 25 years. Beef contributed 13% of total agricultural output in 2003 and has remained at about this level since 1995. New Zealand exported 370,000 tonnes of beef and veal in 2006[9].

The area of pasture land under dairy production was 1.8 million hectares in 2002. This compares to 1.7 million hectares in 1995. During the past 25 years dairy cattle numbers have risen from 2.9 million in 1981 to 5.2 million in 2006. Dairy products as a proportion of total agricultural output increased from 25% in 1995 to 28% in 2003. Dairy products are the single largest contributor to agricultural output and are the largest export commodity group generating approximately $6.2 billion from exports in 2006[10].

New Zealand has approximately 300,000 hectares used for deer farming. This compares with 220,500 hectares farmed in 1995. Total deer numbers are estimated at 1.6 million in 2006, around half the world's farmed deer population. The deer farming industry has developed in the past 25 years, from just 109,000 deer in 1981. There are an estimated 3,800 deer farms in New Zealand. These farms range in size from smaller lifestyle properties to extensive stations. Generally deer are farmed as part of a diversified livestock portfolio with other species including sheep and cattle.

More than 90 percent of the New Zealand deer industry's products are exported. The main products are venison, velvet, hides, and leather. In 2006 deer exports were worth $316 million.

2.2.2 Horticulture/Viticulture[11]

New Zealand has approximately 120,000 hectares dedicated to the growing of fruit, vegetables, and flowers. This compares to 99,000 hectares of horticultural production land in 1995. Horticulture accounted for 18% of total agricultural output in 2003, the same as in 1995. More than 50 different types of vegetables are grown in New Zealand with a trend towards growing Asian vegetable varieties. Domestic consumption of fruit and vegetables is estimated at $2.5 billion.

[7] All stock numbers -Statistics New Zealand, 2006(c)
[8] All agricultural output numbers - Statistics New Zealand, 2003(b)
[9] Meat and Wool NZ, 2005-2006
[10] Unless otherwise stated all export figures – Statistics New Zealand, 2006(b)
[11] All horticulture statistics – HortResearch, 2006

In 2006 horticulture exports exceeded $2.3 billion with markets across 100 countries. Horticulture exports have grown steadily from 1970 (2% of agricultural exports) through to 2006 (11% of all food and fibre exports). Kiwifruit is the largest horticulture export with 30% of total horticulture export value, followed by wine (22%), apples (14%), processed/frozen vegetables (12%), and fresh vegetables (9%). Of the fresh vegetables, onions, squash, and capsicum dominate fresh vegetable exports. The key export markets are the European Union, Japan, Australia, and the USA. Globally New Zealand kiwifruit exports represent over 35% of world trade, frozen sweet corn about 10%, and apples, squash, and onions 3 - 5% each.

The area under grape production was 22,600 hectares in 2006. The total grape crush was 185,000 tonnes of grapes in 2006 up from 75,300 tonnes in 1996. The dominant varieties planted are Sauvignon Blanc (36%), Chardonnay (17%), Pinot Noir (18%) and Merlot (7%). Demand for New Zealand wine continues to be strong particularly in the premium quality wine market. Exports were $510 million in 2006, up from $60 million in 1996. The European Union, United States, and Australia are the major markets taking 83% of all exports.

2.2.3 Production Forestry

The New Zealand forest industry is almost entirely based on planted forests, which covered 1.8 million hectares or 6.6 % of New Zealand's land area in 2005. Radiata pine (*Pinus radiata*) makes up about 91% of the planted production forest resource. Other planted production forest species include Douglas fir (*Pseudotsuga* spp.) and other introduced hardwoods and softwoods. Radiata pine grows quickly under New Zealand conditions, and the average time from planting to harvest is around 28 years. Much of the planted forest area is young, with approximately 59 percent being 15 years old or younger, so timber production will increase substantially over the next ten years[12].

Forestry and forest product exports amounted to $3.2 billion in 2006. In global terms New Zealand is a relatively small player, accounting for only 1 percent of the world's total supply of wood for industrial purposes. Australia is New Zealand's largest single market, generating 28 percent of forestry export earnings, predominantly from lumber and newsprint. Of total forest exports, lumber contributes 23% by value, logs contribute 14%, wood pulp 15% percent, paper and paperboard 17%, and panel products 16%[12].

2.2.4 Seeds, Grains and other Field Crops

The agricultural land area under arable use is approximately 350,000 hectares. Production of seeds and grains contributes only 3% to the overall value of New Zealand's gross agricultural output. However, New Zealand is well suited to produce forage seeds for export. New Zealand is not self sufficient in cereal production, and currently imports about half of its grain requirements. The area planted under wheat in New Zealand is currently around 42,000 hectares, with 300,000 tonnes harvested in 2002. The area planted with barley in New Zealand is presently about 78,000 hectares, and 440,000 tonnes was harvested in 2002. Other grain crops produced in

[12] Ministry of Agriculture and Forestry, 2007 (a).

New Zealand include maize (148,000 tonnes in 2002), and oats (35,000 tonnes in 2002)[13].

2.2.5 Crown Research Institutes

New Zealand has nine Crown Research Institutes (CRIs) which were established in 1992 as Government-owned businesses with a scientific purpose. Each institute is based around a productive sector of the economy or a grouping of natural resources. The CRIs relevant to plant genetic resources and their conservation are:

- AgResearch Limited (AgResearch);
- The New Zealand Institute for Crop and Food Research Limited (Crop & Food Research);
- The Horticulture and Food Research Institute of New Zealand Limited (HortResearch);
- Manaaki Whenua - Landcare Research New Zealand Ltd (Landcare Research);
- The New Zealand Forest Research Institute Limited (Scion), and
- The National Institute of Water and Atmospheric Research (NIWA).

[13] Statistics New Zealand, 2002(b)

Chapter 3: INDIGENOUS PLANT GENETIC RESOURCES

The indigenous vegetation of New Zealand has been defined for the purposes of this report as vegetation which evolved to a large extent within this country, and hence existed here before the first human settlement.

3.1 General

New Zealand has an indigenous plant flora which contains a fairly small number of species relative to the land area by world standards, but has a high proportion of endemic species. New Zealand has 10% of the world's vascular plant species, of these 7.8% are native, 7.8% are introduced plants that have naturalised, and 84.4% are introduced plants in cultivation or gardens, but not yet naturalised. There are in New Zealand approximately 2,357 recognised indigenous species of vascular plants and an estimated 25,000 to 35,000 introduced species. Of the introduced species, around 2,400 are naturalised and the remainder are used in cultivation. There are over 5,000 species of moss, liverworts and freshwater algae. Approximately 3% of the mosses and liverworts are introduced. About 10% of New Zealand's vascular plants are known but yet to be scientifically described and in addition new species are still being discovered[14].

Present day New Zealand was originally part of the great southern land mass, Gondwana. Over geological time, this land mass broke up into a number of smaller land areas. Those with which New Zealand was most recently connected are Antarctica, South America, Australia, New Guinea, New Caledonia, Africa, and India. New Zealand thus shares, to varying extents, a common biological lineage with these land masses. New Zealand is 1600 km from Australia, the nearest significant land area. This separation has constituted a barrier to the natural movement of plant genetic resources, although many plant colonisations have been from Australia.

New Zealand was settled by Māori, the indigenous people of New Zealand, about 1000 years ago, making it the last of the major land areas in the world to be permanently settled. Prior to human settlement, most of the land area was covered in forest or scrub, with the remainder as grassland (mainly alpine) and wetlands. There were no browsing mammals prior to those introduced by humans, the only mammals being two species of insectivorous and pollinivorous bats, along with marine mammals. The medium to large herbivore niches were filled by birds, many of which were flightless, and many of those birds are now extinct or critically endangered. As a consequence of such factors, New Zealand's indigenous plants:

- Display a high degree of endemism. At least 85% of the approximately 2,300 indigenous vascular flora species are endemic. There are also considerable numbers of endemic species among the approximately 1,200 indigenous species of mosses, liverworts, and hornworts, and over 4,000 species of algae (for example, 43% of seaweed species are endemic).

- Generally do not produce large, edible fruits.

[14] Landcare Research, 2007

- Generally do not produce large, edible storage organs such as tubers (perhaps due to absence of extreme dry or cold periods which might select for such structures).

- Domestication for human use and any associated breeding has occurred over a relatively short period (compared to the thousands of years of domestication for some world crops).

Despite these constraints, Māori survived on the land and sea resources, using many species of indigenous plant prior to European settlement, and many of these uses have continued into the present. These include uses of a wide range of timber species for construction and cultural purposes such as carving, several species of fibrous plants for making mats, clothing, bags, baskets, and other woven goods, and food and medicinal use.

New Zealand's 6.4 million hectares of indigenous forest (24 percent of the total land area) is located mainly in the mountains and hill country, and on the West Coast of the South Island. The major indigenous tree species in these complex forests are beech *(Nothofagus spp.*), kauri *(Agathis* spp.), rimu *(Dacrydium cupressinum)*, taraire (*Beilschmiedia tarair)* and tawa (*Beilschmiedia tawa).* Approximately 77 percent of New Zealand's indigenous forest is in national parks and reserves, covering 18.2 percent of the total land area[15].

Indigenous plant species are valued by New Zealand society because of their uniqueness and the contribution they make to our landscapes. This value is clearly shared by many visitors, making a strong though difficult to measure contribution to the tourism sector of the economy. The contribution of the indigenous flora to tourism is likely to be their major economic benefit for the foreseeable future. The discussion here will be restricted to the species of direct use to people, in the past or at present, or which have reasonable potential for future use. Terrestrial plants and marine algae (seaweeds) are covered separately, as the approaches to management and threats for each are distinct.

3.2 Terrestrial plants

3.2.1 Conservation activities

Location, description and funding of collections

Most of New Zealand's threatened vascular plant species are small herbs, grasses, and shrubs. In total 868 taxa (species, subspecies, or other intraspecific taxa) of vascular plants are listed as threatened by the Department of Conservation. Of these, 175 taxa are considered acutely threatened (critical, endangered, or vulnerable), 108 taxa are chronically threatened (serious or gradual decline), and 585 taxa at risk (range restricted or sparse). Six taxa are considered to have become extinct since European settlement (c.1840). Approximately 85 species of mosses, hornworts, and liverworts are listed as nationally critical or endangered.[16]

[15] Ministry of Agriculture and Forestry, 2007(b)
[16] Hitchmough *et a*l, 2007

Indigenous species are mainly conserved through *in situ* conservation. Sites range from national and local government parks and reserves through to sites of remnant vegetation on private land, the latter often with no formal protection. New Zealand gives high priority to conserving all indigenous species, and particularly those under threat, as an important part of New Zealand's heritage and of world biological diversity. Some species have known economic value and the potential value of many others is being researched.

About 29% of New Zealand's land area is legally protected in its natural state, but there are some significant gaps in representation. Most protected areas are mountainous land types. Underrepresented areas such as lowland forests are a focus of the Government's objectives for increasing protected areas status of land habitats under threat.

About 77% (4.8 million hectares) of New Zealand's surviving indigenous forests are in national parks and reserves managed for ecological and recreational purposes by the Department of Conservation. A further 5% (about 230,000 hectares)[17] has been voluntarily protected or committed for protection by private owners who have offered them for sale to the Department of Conservation or have attached legal covenants to the titles. The covenants may last from 20 years to perpetuity. These voluntary protection arrangements are funded by:

- The Forest Heritage Fund, which was established by the Government in 1990;
- Ngā Whenua Rahui, which was established in 1990 for use by Māori forest landowners;
- The Queen Elizabeth II National Trust, which was established in 1977 with funding from both government and non-government sources. Landowners can enter a binding legal agreement with the Trust to protect all or part or their property. The agreement is usually in the form of a covenant which is registered on the property title. To date the Trust has secured approximately 3,000 covenants protecting approximately 100,000 hectares in perpetuity[18].

Nature conservation in the tussock lands (areas of indigenous grassland) is being achieved through negotiation with individual lessees or owners. Protection mechanisms can include covenants or transfer of land to the Department of Conservation. Areas in need of protection are being identified through surveys under the Department's Protected Natural Areas (PNA) Programme. This programme, which began in the 1980s, aims to identify and protect representative areas of high biodiversity throughout the entire country.

Living *ex situ* collections of some plant species and varieties are maintained at a variety of sites around the country. These include:

- Botanic gardens in most major cities and some other localities, notably Auckland, Christchurch, Timaru and Dunedin, and the Otari Open Air Native Plant Museum in Wellington;
- Research collections (e.g., those of Landcare Research at Lincoln and Havelock North and of the Universities);

[17] Department of Conservation, 2007
[18] QE II National Trust, 2007

- Several private arboreta (e.g., Hackfalls Arboretum near Gisborne and that of A. P. and H. Druce, near Wellington).

Significant conservation is also achieved, albeit usually un-coordinated, through use of indigenous species in private gardens and in landscaping of business premises and public areas.

The flax (*Phormium* spp.) collection held by Landcare Research is one significant *ex situ* living collection. It was developed from the Rene Orchiston base collection of 50 Māori weaving cultivars. The cultivars were collected from around the country, and are propagated vegetatively because of high genetic variation in plants grown from seed. Flaxes have strong significance to Māori. Flaxes were traditionally used for making many woven items and for medicinal and spiritual uses. The flax collection also includes plants from 80 wild sourced populations. This collection, and its associated research programme, is an example of a focus on within-species variation in native plants. Current research is on genetic diversity at species and population level. In addition, Landcare Research has several collections of plant species that are maintained for research purposes[19].

The *ex situ* storage of indigenous plant seeds is undertaken at the Margot Forde Germplasm Centre in a collaborative project between the Centre, New Zealand Plant Conservation Network, and Landcare Research.

Documentation, characterisation, regeneration, and provision
Many herbaria around the country have extensive collections and, together with Universities, have skilled staff able to identify and classify indigenous species and varieties. The New Zealand National Herbarium Network comprises 13 herbaria and includes collections held by Crown Research Institutes, Universities, Museums, and Botanic Gardens. The largest are located at Christchurch (Landcare Research), Auckland (Auckland Institute and Museum), and Wellington (Museum of New Zealand Te Papa Tongarewa).

Landcare Research is the custodian of important national plant and plant related collections. These include the New Zealand Fungal Collection, the Allan Herbarium, and the National Flax Collection. The Allan Herbarium contains species from around the world but specialises in indigenous and exotic plants of the New Zealand region and tropical South Pacific. In addition it holds specialist collections of fruit, wood, plant leaf cuticle, and liquid preserved specimens. There is some storage of seeds and other living matter (e.g., algal cultures) but conservation of living material is not the main purpose of these facilities. The Landcare Research collections are maintained through public funding.

[19] Landcare Research, 2007

3.2.2 Use, evaluation, and improvement

Traditional Use

Māori have a long history of use of indigenous plant resources as summarised in Table 1. Traditional Māori uses of native plants were varied and several are still a vibrant part of Māori cultural life, particularly weaving of harakeke flax (*Phormium tenax)* and pingao grass (*Desmoschoenus spiralis)*, and totara *(Podocarpus totara)* and other trees which are used for carving. Some native plants are still sought after today, such as young green shoots of the pikopiko fern (*Polystichum richardii*), the soft heart of the nikau palm (*Rhopalostylis sapida*) trunk, and berries from various trees. The most enduring traditional use of native plants has been in weaving and carving.

Table 1: Māori use of indigenous plants

Common name	Scientific name	Use
Harakeke (flax)	*Phormium tenax*	Fibre
Whararíki (flax)	*Phormium cookianum*	Fibre
Ti kōuka (cabbage tree)	*Cordyline* spp.	Fibre, food
Kiekie	*Freycinetia baueriana*	Fibre
Pingao	*Desmoschoenus spiralis*	Fibre
Karaka	*Corynocarpus laevigatus*	Food
Aruhe Raarahu (bracken fern)	*Pteridium esculentum*	Food
Kawakawa	*Macropiper excelsum*	Medicine
Pate (seven finger)	*Schefflera digitata*	Medicine (fungicide)

Various other species are used for food, medicinal, perfume, and cultural purposes. The latter includes use for religious, decorative, and perfumery purposes. Descriptions of many plants and their uses have been documented, for example by Cooper and Cambie, 1991, and Harris and Kapoor, 1988. Māori continued to investigate for useful properties of indigenous plants after European settlement, particularly in the case of medicinal properties (Brooker *et al*, 1992).

Contemporary Uses

Flax (*Phormium* spp.) was grown in several parts of New Zealand for commercial uses such as making woolpacks and floor coverings until the 1970s.

Under amended legislation passed by the New Zealand Government in 1993, indigenous timber can only be produced from forests which are managed in a way that maintains continuous forest cover and ecological balance. To achieve this, indigenous forestry is managed under a system of sustainable forestry plans and permits administered and overseen by the Government. Historically, over 80% of indigenous sawn timber has been kauri (*Agathis* spp.) and podocarps (principally rimu, *Dacrydium cupressinum*), the remaining 20 percent comprising hardwoods, mainly beech *(Nothofagus* spp.) and tawa (*Beilschmiedia tawa)* .

Notwithstanding the significant changes brought about in the early 1990s, sustainable management of private indigenous forests has the potential to underpin a viable long term industry. The three main species that have potential for

management are *Nothofagus* spp (beech), the podocarps (mainly *Dacrydium cupressinum*), and broadleaved hardwoods (mainly *Beilschmiedia tawa*). Beech *(Nothofagus* spp.) will remain the most important species group in terms of production, by virtue of resource availability and growth rates compared to other indigenous hardwood species[20].

A significant industry exists, based mainly on the West Coast of the South Island, harvesting sphagnum moss (*Sphagnum* spp.) for use as a potting material and in a range of sanitary pads. This latter use, along with use of the moss for bandaging wounds, was widely practised by Māori.

Ethno botanical work is focused on plants of traditional importance to Māori, such as harakeke or flax (*Phormium* spp.), pingao *(Desmoschoenus spiralis)* and kiekie (*Freycinetia bauerian*) for weaving and other handcrafts, and kouka or cabbage tree (*Cordyline australis*) for fructose and fibre production. Landcare Research is undertaking much of this work, in association with Māori.

Non-timber uses of terrestrial native trees are for forage, soil conservation, pulp, and shelter belts. Indigenous grasses are a component of many hill and high country pastures, being generally adapted to low fertility sites. Soil conservation on eroding land is often achieved by excluding livestock and allowing indigenous shrub and tree species to regenerate, sometimes assisted by plantings of indigenous species, although more often by planting of exotics such as poplars and willows.

Research is continuing into deriving useful extracts from indigenous plants. Manuka (*Leptospermum scoparium*) and kānuka (*Kunzea* spp.) have long been known to yield essential oils. Investigation of plants which could be developed as new pharmaceuticals and agrichemicals continues. Bioprospecting in its widest form has been occurring in New Zealand since the arrival of the first human settlers. Today, bioprospecting is closely linked with the growth in the biotechnology sector. As the range of biotechnology applications increases the use of this technology to unlock valuable properties of indigenous plants is likely to increase.

3.3 Marine and Freshwater Plants

3.3.1 Marine Macroalgae

New Zealand has a marine macroalgal flora of approximately 1000 species (classified within the Rhodophyta, Phaeophyta, and Chlorophyta). Table 2 lists genera/species that either are, or have been, used in New Zealand or have attracted interest because of their potential use.

The vast bulk of marine algae are conserved *in situ*, with very little material held *ex situ* (e.g., as laboratory cultures) except for the purpose of research on individual species.

New Zealand has established a network of protected marine areas. The New Zealand Government has a target of protecting 10% of New Zealand's marine environment by 2010. Protected marine areas principally include marine reserves

[20] Ministry of Agriculture and Forestry, 2002

and fisheries closures. As at June 2006 there were 28 marine reserves ranging in size from 780,000 hectares to 93 hectares. Currently, 7.61% of the territorial sea is in marine reserves[21].

Table 2: Distribution and use of marine algae with existing or identified potential economic uses

Taxon	Distribution	Uses	Threats
Pterocladia lucida, *Pterocladiella capillacea*	North Island, Northern South Island.	Source of agar; basis for New Zealand agar industry since 1941, wild harvest has been sustained for more than 40 years.	
Porphyra spp. - (Karengo)	6 spp. described in New Zealand, but likely to be 30-35 spp. World-wide genus.	Genus used wherever it occurs world-wide; very high in protein (30% dry weight) and high in vitamins and minerals. Known as nori in Japan. Highly prized by Māori and harvested throughout the country for local, non-commercial use; some commercial harvest.	Complex life history in which the conspicuous phase alternates with a microscopic phase that lives within shells and/or rock. There is the potential for local over-harvest if harvesters not aware of seasonal/yearly fluctuations in population size/ distribution.
Gracilaria chilensis	New Zealand and Chile.	Contains agar; used as fodder for paua.	Grows in harbours, estuaries, quiet coastal areas - alterations to habitat will influence local abundance (e.g., reclamation of coastal/estuarine land; building of marinas, coastal installations etc.; changes in sedimentation rates, nutrient regimes in estuarine or harbour areas).
Curdiea spp	4 species endemic to New Zealand each with restricted distributions. Genus distributed in Australasia and Antarctica.	Sources of agar with very distinct properties	Restricted distributions make these species potentially vulnerable to over-harvest unless managed with full knowledge of growth, reproduction, and recruitment rates.
Gelidium spp/*Capreolia* spp.	6 species endemic to New Zealand, some with restricted distribution. World-wide genus.	Contains agar.	Lack of knowledge about resource size and biology of species.

[21] Department of Conservation, 2006

Gigartina sensu lato	More than 15 species in New Zealand. World-wide genus.	Contain carrageenan. The carrageenan properties are unique to particular species and phases within species.	Require knowledge about biology, growth, reproduction, recruitment before wild harvest or aquaculture can be undertaken.
Durvillaea - (Rimurapa) (*D. antarctica*, *D.willana*, *D.chathamensis*, undescribed species)	New Zealand and Southern Ocean.	*D. antarctica* used for poha titi (for storage of mutton birds in fat); contains alginates; harvested in Bass Strait.	Grows only on exposed shores; must be harvested during fertile period otherwise population does not recover from harvesting; considered to provide a buffering role in protecting coastal areas from wave erosion.
Ecklonia radiata	New Zealand, Australia, South Africa, Oman.	Contains alginate; used in production of sheep/animal health products.	Important tree species in structuring sub-tidal forests therefore harvesting practices need to be careful to minimise habitat changes/impacts on other species.
Macrocystis pyrifera	California, Chile, Australia, New Zealand.	Species harvested extensively for more than 90 years from coast of California; contains alginates, also used for kelp powder/salt.	

3.3.2 Conservation activities

Location, description and funding of collections

Identification and description is mainly undertaken by the National Institute of Water and Atmospheric Research (NIWA) with major collections housed at the Museum of New Zealand Te Papa Tongarewa (Te Papa). All the macroalgae are housed in registered herbaria – e.g., Te Papa, Landcare Research, or Auckland Museum. NIWA also has a research culture collection of both macro and microalgae.

The Cawthron Institute has a culture collection solely of microalgae and undertakes work on introduced species and toxic microalgae.

Use, evaluation, and improvement

Any evaluation for potential commercial uses is likely to be done by private firms, or by research institutes within New Zealand with funds from private firms.

There are other species within New Zealand that are similar to, or related to, species used in other parts of the world but which have not yet received commercial attention here e.g., *Caulerpa* spp. (used extensively as a salad vegetable throughout Pacific and Asia); *Asparagopsis* spp. (highly prized by Hawaiian community) *Lessonia variegata* (farmed and commercially harvested from wild stocks in Chile).

3.3.3 Freshwater algae

Freshwater algal research, including identification and documentation, takes place at the Universities of Canterbury and Waikato, and at NIWA and Landcare Research. A number of species are rare or threatened. Although freshwater algae perform an essential role in freshwater systems and provide an indicator of water quality, no individual species has yet been identified as having any other specific economic value.

3.4 Threats to conservation and sustainable use of indigenous plants

New Zealand's Biodiversity Strategy 2000 lists a number of threats to the conservation of indigenous plants. Of most concern is the loss of habitat due to land use changes. Many distinctive natural habitats are underrepresented in New Zealand's formally protected network, including lowland and coastal forest remnants, dunelands, natural shrublands, wetlands, and lowland tussocklands. Many of these habitats are located on private land and vulnerable to further loss[22].

The impact of introduced plants and animals that are (or may become) pests is a significant threat. There is insufficient information to judge if the current efforts in pest and weed management will be sufficient to assure long-term protection of indigenous species and to minimise the risks of extinction of threatened species. Significant gains in the future will require a suite of new tools and technologies that can take the ability to control pests to levels well above small incremental improvements[23]. Interest in indigenous plant derived products and growth in bioprospecting may not always be compatible with their conservation. Some species are conserved on offshore islands and harvest from wild plants is only permitted on public conservation land if a permit is obtained for the Department of Conservation. The issues of ownership and management of indigenous plants and consequent rights to use them are the subject of a current claim before the Waitangi Tribunal (see section 5.2).

New Zealand's indigenous grasses are not systematically conserved at present, although they are valuable for forage and soil conservation on less fertile sites. Native timber species are difficult to domesticate and hard to store as seed, so *in situ* populations need to be maintained. Few of New Zealand's threatened native plant species are woody plants with timber potential. Nevertheless, within species variation of some woody species might be at risk despite there being considerable numbers of the species as a whole.

3.5 Threats to conservation of marine macro-algae

Many marine species and habitats remain undescribed and information on the distribution or lifecycle of many species remains sparse. Threats from direct human actions such as development in the coastal zone, pollution, and potentially from over-harvesting for some species is not well understood. The discharge of ballast water in New Zealand coastal waters may have in the past caused the introduction

[22] Department of Conservation, 2000
[23] Green & Clarkson, 2005

of pests into the marine ecosystem. New Zealand now has strict regulations in place requiring the exchange of ballast water to occur outside of New Zealand territorial waters. These measures should help prevent future introductions of pest marine organisms.

Chapter 4: EXOTIC PLANTS

4.1 Introduction

Exotic plants are the foundation of most of New Zealand's land based economy. New Zealand relies on fewer than 50 species of animals and plants for its primary production. The most recent survey of exotic species collections was undertaken for the Ministry of Agriculture and Forestry (MAF) by Brockerhoff *et al.* in 2004. This survey included all exotic species (including animals) and did not specifically distinguish collections on the basis of their contribution to food and agriculture security. However, as over 90% of the collections surveyed consisted of plants, the results provide a good overview of the status of exotic plant collections in New Zealand. In summary the survey found:

- There are an estimated 3,000-4,000 substantial collections of exotic species;
- Almost 90% of the collections contained over 100 different types of organisms, and 44% have over 1000 types of organisms in their collections;
- Three quarters operate on private funding. Only a very small proportion are directly funded by Government;
- Two thirds of the collections have computerised catalogues;
- In general, the size of collections is increasing only slowly with a key problem being the acquisition of new material;
- Many species are duplicated within New Zealand, but linkages are poor or sporadic.

The following sections outline the status of exotic plant genetic material specifically for food and agriculture, including forestry.

4.2 Pastoral plants for forage and soil conservation

This section covers grasses, herbs, shrubs and forage crops grown to provide animal feed and/or to stabilise soil, including turf grasses.

4.2.1 Conservation activities

Location, description and funding of collections

Due to the importance of pastoral agriculture to the New Zealand economy, forage plants are New Zealand's single most important plant genetic resource in economic terms, and are likely to remain so for the foreseeable future. New Zealand also grows considerable quantities of pasture and lawn herbage seeds mainly for export.

New Zealand's most important *ex situ* pastoral plant genetic resource collections are:

- Margot Forde Germplasm Collection, at AgResearch Palmerston North, established in the 1930s which holds over 85,000 accessions of species including ryegrasses (*Lolium* spp.), fescues (*Festuca* spp.), cocksfoot (*Dactylis* spp.), bromes (*Bromus* spp.), white clover (*Trifolium repens*), red clover (*Trifolium pratense*), lucerne (*Medicago sativa*), *Lotus* spp. legumes, soil conservation plants, and other grassland plants.

- HortResearch national collection of poplar and willow species held at various locations throughout New Zealand.

Specific details of pastoral genetic resources are set out in Table 1 of Annex 1. The Margot Forde Collection is maintained by AgResearch. The collection is housed at the Margot Forde Germplasm Centre and is considered to be the national gene bank of a wide variety of forage and grassland plants. The collection forms the basis for grassland breeding and research in New Zealand. It is maintained under conditions that maximise the life of material in the collection.

The Margot Forde collection is important internationally and the Centre undertakes an active exchange programme. The Centre became the Australasian genebank in 1994 and funding was provided by the Australian Rural Industry Research Corporation to establish the Australian component of the collection. Funding for the Centre is through the Government's contestable funding process and at the current time is considered to be stable. The Government, however, is currently reviewing the long term funding for nationally important collections.

Another significant source of pastoral (and horticultural) genetic resources is maintained and developed through New Zealand's commercial plant and seed development industry. While conservation is not the primary driver, significant commercial collections are maintained on an ongoing basis. New Zealand has around 80 companies which not only breed seed, but also research, produce, process, and market the nation's grain and seed outputs. This involves both importing and exporting. Some companies produce seed under contract. Others sell seed or licenses for advanced pastoral seed technologies including forages, animal-friendly fungal endophytes and pasture legumes.

New Zealand's large areas of permanent pasture effectively provide *in situ* conservation of locally adapted genotypes, from which collections are sometimes made.

Documentation, characterisation, regeneration and provision

The Margot Forde Centre database is computerised and access can be obtained via the internet. Regeneration is systematic but limited to 200 entries per year. The collection is significantly larger than can be maintained by present regeneration practices, which are constrained by resources. Some erosion of accessions due to decline in seed viability seems inevitable.

4.2.2 Use, evaluation, and improvement

Access to material at the Margot Forde Centre is possible if quantity permits, except for breeding lines and new selections. Regulatory restrictions on the ability to regenerate and commercially develop species held in the Centre have been relaxed in recent times. This has resulted in improved access to the collections for commercial development and improvement.

International collaboration is generally very good, with free flow of accessions between New Zealand and overseas gene banks.

4.2.3 Threats to conservation and sustainable use of forage and soil conservation plants

Regeneration practices at the Centre have not been sufficient in the past to sufficiently maintain all seed accessions. Increased regulatory flexibility to allow for wider use of some species held at the Centre should enhance conservation activities. Nevertheless, the collection will still need rationalisation to ensure the most important lines are maintained in a viable state.

Access to new genetic material from outside New Zealand can be restricted by biosecurity regulations. The regulations require quarantine requirements (e.g., inspection, testing and/or treatment) to be followed before new material can be imported and used in New Zealand. The objective is to ensure that risks from new plants and any associated pests and diseases are adequately managed. However, the regulatory requirements can be costly and in some cases quarantine facilities are not available in New Zealand to facilitate the release of new material. These regulatory issues can act as a barrier to accessing new plant genetic material.

4.3 Field crop and vegetable crop plants

This section covers cereals, root crops, and other vegetables.

4.3.1 Conservation activities

Location, description, and funding of collections

New Zealand's most import *ex situ* crop collections are:

- The Crop Germplasm Resources Unit housed at Crop & Food Research, which has collections of wheat, barley, oats, maize, peas, onions, potato, and sweet potato (kumara), and other vegetables, along with other minor crops such as essential oilseeds.
- HortResearch, which conserves and researches hops.

Specific details of field and vegetable crop genetic resources are set out in Tables 2 and 3 of Annex 1. The Crop Germplasm Resources Unit is housed at Lincoln, with some species in long-term storage at controlled temperature and humidity and others at ambient temperature and humidity. There is no dedicated public funding of this collection, however the Ministry of Research, Science and Technology and the Foundation for Research, Science and Technology have been considering funding structures. The Crop Germplasm Resources Unit is currently funded through internal investment via a discretionary public capability fund. Ongoing funding needs to be continually justified (internally and externally). Thus, the funding is at risk if priorities change, or the fund itself changes. With declining public funding, overall custodial management of the collections is managed within the relevant individual crop improvement projects. Some custodial support is also provided by the commercial group within the crop improvement team.

The HortResearch hops collection is housed at the Nelson Research Centre, Riwaka. Hops grown in New Zealand are free of the pests and diseases found in the main hop growing regions of the world. The threat of pest introduction in hops is the main concern faced. The collection is government funded.

Tobacco growing in New Zealand has effectively ceased. The current germplasm is now out of date, and would not be considered of great value to the international tobacco growing community. However, the New Zealand collection does have uniqueness in terms of disease resistance and, as such, parts of the collection should be maintained.

Documentation, characterisation, regeneration, and provision

Documentation relating to the Crop & Food Research collection varies. The wheat, barley, oat, and potato collections are fully computerised and described. Most other collections have some systematic description and evaluation data. Regeneration is systematic for all crops. Some material is publicly available (wheat, barley, oats, peas, and potatoes). The remaining collections are only available to research organisations on request. The level of exchange varies depending on the crop. Active exchange occurs for wheat, barley, oats, peas, onions, sweet potato, and asparagus.

The HortResearch collection of hops is presently maintained and documented and the tobacco collection is computerised. Documentation on hops is not available outside HortResearch. The hops collection has significant value with the triploid and tetraploid types being unique.

4.3.2 Use, evaluation, and improvement

Crop & Food Research has active commercial and/or research breeding programmes for wheat, oats, triticale, potatoes, process peas, and sweet potatoes. Additionally Crop & Food has active germplasm development (research) programmes with barley and onions. Arabidopsis (particularly *A. thalian)* is an important model organism for research in plant systematics. From time to time, the other crops listed in Appendix 1 (Tables 1 and 2 (maize, asparagus)) are used for research purposes other than germplasm development.

The hops collection is primarily a working collection for the breeding programme and is also used as a database for industry. Improvement of the hops collection will focus on disease resistant germplasm and maintaining a modern collection that can be used for new breeding targets such as health-related compounds, different hop chemistry components, as well as diseases and pest resistance.

4.3.3 Threats to conservation and sustainable use of field crop and vegetable plants

Ongoing funding of collections remains an important factor in conserving genetic resources of field crops. At present, conservation security can only be provided where the crop genetic resources are associated with active research programmes. The current funding regime provides only limited security for the maintenance and development of collections solely for conservation purposes. As a result it is likely that many potentially valuable genes in old landraces will not be conserved because breeders and researchers are not using them at present.

Private breeding firms have their own working collections, for which conservation is not a significant objective. Discontinued breeding lines are rarely maintained, and therefore usually lost. Plant breeding firms generally do not make extensive direct use of the national cereals collection.

4.4 Horticulture

This section covers fruit and nut crops.

4.4.1 Conservation Activities

Location, description, and funding of collections

The most significant collections of horticulture plants are:

- HortResearch which holds collections of berryfruit, citrus, pipfruit (apples and pears), summerfruit (apricots, cherries, nectarines, peaches, and plums), kiwifruit, grapes, and some sub-tropical fruits.

Specific details of horticulture genetic resources are set out in Table 4 of Annex 1. The collections are maintained on various HortResearch research orchards with the more valuable genotypes held at several sites. Many of the accessions are taken directly

from the wild and are held as starting material for breeding and improvement programmes. In addition, reference collections of many fruit plant cultivars are held. The collections are funded by government and industry for both breeding and conservation purposes.

Much of the berryfruit (*Ribes*, *Rubus*, and *Vaccinium*) collection is unique and irreplaceable. The collection includes the raw germplasm for selecting for low chill blackcurrants and spineless black raspberries with high anthocyanin content.

The National Citrus Germplasm Collection is based at HortResearch, Kerikeri, and contains genetic resources specifically suited to New Zealand conditions. A limited amount of propagating material is available for breeding.

The kiwifruit (*Actinidia*) collection is the best outside of China and is particularly comprehensive in terms of species with the greatest commercial potential.

The apple (*Malus*) germplasm collection is significant in international terms. The apple collection is not only essential for on-going research but can also be considered as a part of New Zealand's heritage because so many cultivars were brought here by the first European settlers. Also these original cultivars have been bred in New Zealand and have now been distributed worldwide.

The collection of Asian peaches and nectarines is unique outside of Asia. The apricot collection is rich in genetically diverse material with cultivars from California, Canada, France, Greece, Italy, North Africa, Romania, and Russia.

Collections of nut crops are held primarily by private individuals. Their conservation is therefore not underwritten by any public agency at present, and relies on the commitment of those individuals involved.

Over the last decade there has been a growth in collections of heritage crops, especially vegetable crops and fruit trees. The basis for many of these collections has been the enthusiasm of individuals who have built up garden collections on their own properties. In some cases loose associations or societies have been formed e.g., Koanga Trust and Southern Seed Exchange which have formal membership. These groups have a network of growers who agree to perpetuate particular crops. A few networks maintain a germplasm bank but it is uncertain how viable many of the accessions are likely to be[24].

Documentation, characterisation, regeneration, and provision

Computerisation and documentation of the HortResearch collections is ongoing. Most fruit crops are held as long-lived perennial plants which take a long time to establish and are expensive to maintain in terms of labour and land costs. Collections are nevertheless continuously maintained and renewed.

Collections of heritage crops are usually well catalogued albeit in simple computer spreadsheet format. Propagation is achieved either centrally or by dedicated individual growers, or a combination of these[24].

[24] Brockerhoff et al.,2004

4.4.2 Use, evaluation, and improvement

The primary use of the fruit genetic collections is for the development of new fruit cultivars, but some collections are also used extensively for more basic studies. Collections are readily available except for protected cultivars and proprietary breeding lines. There are links with similar collections overseas and limited exchange of genetic material. Overseas scientists come to New Zealand to make use of the collections.

4.4.3 Threats to conservation and sustainable use of horticultural plants

Proper documentation and authentication of collections is very time consuming and hence expensive. This is probably the aspect that is currently most limited by resources. Access to adequate resources is an ongoing issue for groups conserving heritage crop material. These groups are run on low budgets, voluntary time, and are kept going by dedication and enthusiasm. Loss of expertise and resources can impact significantly on the ongoing viability of these collections.

Access to new genetic material can be hindered by regulations governing importation of plants and the availability of quarantine facilities. Often the cost and complexity of the import approvals system and lack of high security quarantine facilities that may be required to import some new species, act as deterrents for individuals wishing to obtain new plant material.

4.5 Trees

This section covers trees grown for timber, crops, shelter, amenity, and soil conservation.

4.5.1 Conservation activities

Location, description, and funding of collections

Conservation of plantation forest resources is almost entirely achieved through *in situ* commercial plantations and isolated sites previously maintained by the now privatised State Forestry Corporation. *Pinus radiata* is by far the most important species at present, with Douglas fir (*Pseudotsuga* spp.) also important.

Specific details of forest genetic resources are set out in Table 5 of Annex 1. Scion holds a number of living collections plus some seed and tissue-culture stocks in modern facilities. Stocks of special purpose timber species and various minor species are also held, for market niches and as a contingency measure should biological problems (e.g., disease) impact on resources of *Pinus radiata.* Funding for research on and breeding of a small number special-purpose species is provided by government with contributions from industry parties. Such funding generally does not address genetic conservation.

HortResearch holds collections of trees for soil conservation, shelter, and timber (poplars and willows) at Aokautere near Palmerston North and at Clyde in Otago. These are maintained as living collections (annually coppiced stoolbeds[25]). Since 2003 there has been no central government funding to maintain the HortResearch

[25] Beds for production of rootstocks

collections or breeding programme, so there is some risk to the long term security of the gene pool collection at Aokautere.

HortResearch also holds some collections of deciduous hardwoods (such as oaks), but the bulk of these genetic resources rest in botanical gardens (mostly managed by local government), and private properties.

Nut crop trees are discussed under the section on horticultural plants. As noted in that section, conservation is solely by private individuals.

A number of arboreta have been established by individuals concerned for the conservation of tree collections. Some of these collections hold species of significance to food and agriculture security. Eastwoodhill, located near Gisborne, is perhaps the best example and is New Zealand's most diverse arboretum. Eastwoodhill covers 135 hectares and contains over 4,000 species of trees, shrubs, and climbers and is the largest collection of Northern hemisphere trees in NZ. Arboreta are under a wide variety of ownership regimes. Many are in private hands, and while some collections provide for public access, most do not. Some larger arboreta operate as trusts with the collection maintained under covenant.

Documentation, characterisation, regeneration, and provision
The national rootstocks collection at Aokautere and Clyde is fully computerised. Computerisation of other collections is incomplete. The more valuable or rare varieties of poplar and willow are vegetatively propagated. Most species are wind pollinated so ensuring pure seed supply is a continuing problem. Clonal material is available under a non-propagation or trial site agreement. A royalty or cost for released cultivars and unimproved selections applies.

There has been limited updating of plantation forest resources, except where intensive breeding is occurring. Regeneration is variable and mainly associated with specific breeding programmes rather than for purely conservation purposes. Of these, preferred populations of *Pseudotsuga menziesii* are being regenerated on a larger scale.

4.5.2 Use, evaluation, and improvement

The HortResearch collections are primarily used for breeding and selection of improved clones for soil conservation, windbreaks, agroforestry, and bioenergy. Selection activities are focused on pest and disease resistance, vigour, form, and wood quality. Little international exchange occurs although some New Zealand bred willow cuttings were provided to Chile in 2004.

The plantation forestry resources are primarily used as selections for intensive breeding programmes.

4.5.3 Threats to conservation and sustainable use of trees

Loss of material tends to be compounded by a number of factors including fluctuations in funding, changes of ownership and management of forests, and the business cycle in an industry that follows a regular harvesting cycle.

The key factor influencing conservation of plantation forest resources is the ownership structure of the forestry industry. The national forest resource is privately

owned and therefore the management of genetic resources is driven by commercial needs. These seldom recognise the value of conservation in its own right.

Funding of collections is also a limiting factor as government contributions have become conditional on co-funding by industry.

These factors are likely to lead to a loss of genetic diversity for *Pinus radiata*. They also impact strongly on the conservation and management of various species that are now termed 'contingency' species. These are species that command no immediate commercial interest while *P. radiata* can be grown satisfactorily, but are potentially important substitutes for *P. radiata* in the event of it being affected by a biotic crisis. While there is minor effort on hybridisation of such species with *P. radiata*, they are not being actively researched, or conserved, for the 'contingency', and they are subject to continuing losses of genetic material.

Various biosecurity (plant quarantine) restrictions (e.g., relating to pine pitch canker), while they are necessary can act as a barrier to importing genetic resources of exotic species.

Chapter 5: NATIONAL GOALS, POLICIES, AND PROGRAMMES

5.1 National Programmes and Policies

The framework for New Zealand's national programmes and policies in this area is the Biodiversity Strategy which was launched in 2000. The purpose of the Strategy is to establish a strategic framework for action, and to conserve and sustainably use and manage New Zealand's biodiversity. The primary focus is on New Zealand's indigenous biodiversity. However, because of the value and economic importance of much of New Zealand's introduced biodiversity, the conservation of the genetic resources of certain introduced species is also addressed.

One of the themes of the Strategy is the use of genetic resources. Some of the goals relating to the conservation of plant genetic resources are to:

- Develop a collaborative strategy to manage New Zealand's genetic resources (from both introduced and indigenous species), focusing on:
    - effective cooperation between Government, industry, research institutions, and managers of collections of genetic resources;
    - clearly assigning responsibilities for maintaining New Zealand's genetic resources; and
    - managing information about collections of genetic resources.
- Identify significant areas of risk in the management of the genetic resources of New Zealand's introduced species, including information gaps, and recommend how these risks can be effectively managed.
- Identify significant areas of risk in managing genetic resources of New Zealand's indigenous species that are threatened or in decline (with reference to threatened species recovery programmes), and recommend how these risks can be reduced, for example through germplasm banks.
- Support the *in situ* conservation of threatened introduced species by returning them, where possible and environmentally desirable, to their place of origin.
- Maintain small populations of threatened introduced species in facilities or clearly defined areas where their presence will not pose a threat to indigenous species, where reintroduction to their country of origin is not feasible or is undesirable because of the risk of introducing pests or diseases.

A 2005 review[26] of the first five years of the Strategy identified the priorities in the plant genetic resources area as:

- Development of a collaborative strategy to manage New Zealand's genetic resources (both indigenous and introduced); and
- Identifying significant areas of risk relating to their management.

5.1.1 Legislation and programmes to conserve natural resources

There are a number of laws and policies that aim to conserve indigenous vegetation which are listed below.

[26] Green & Clarkson, 2005

The Conservation Act 1987, which established the Department of Conservation, the New Zealand Conservation Authority and Boards, and the New Zealand and Regional Fish and Game Councils, aims to promote the conservation of natural and historic resources. It defines conservation as the preservation and protection of natural and historic resources (which include plants and animals of all kinds as well as fungi, algae and bacteria) for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations.

The National Parks Act 1980 affords New Zealand's national parks special protection and provides for the continuance of existing national parks, the creation of new parks, and the management of all national parks. The Act requires a balance to be struck between preservation and public access. Specially protected areas can be established that allow partial or complete exclusion of the public from sensitive areas.

The Reserves Act 1977 provides for covenants to protect private land, wildlife, freshwater and marine life with natural, scientific, scenic, or historic values, but depends upon the willingness of the landowner to have the land protected.

The Wildlife Act 1953 provides for wildlife sanctuaries, wildlife management reserves, and wildlife refuges to be set up by Order in Council to protect wildlife and their habitat.

The Native Plants Protection Act 1934 provides that it is an offence to remove protected native plants from any place.

The Resource Management Act 1991 which sets out the environmental management responsibilities of local authorities, aims to promote the sustainable management of natural and physical resources (which includes all forms of plants and animals). Matters of national importance to be provided for in regional and district plans and policies include the protection of areas of significant indigenous vegetation, significant habitats of indigenous fauna, and wetlands. Resource management authorities are also required, among other things, to have particular regard to intrinsic values of ecosystems, any finite characteristics of natural and physical resources, and the protection of trout and salmon habitat.

Rules in regional policy statements and district plans have the status of law, as do Heritage Protection Orders and Water Conservation Orders issued under the Resource Management Act. A range of funding mechanisms also exist to purchase land for conservation purposes or to pay landowners for reserving land through legally binding protection covenants.

The Environment Act 1986, which reformed the Commission for the Environment and established the Ministry for the Environment, aims to ensure that, in the management of natural and physical resources (which are defined to include, among other things, all forms of flora and fauna), full and balanced account is taken of, among other things, their sustainability, the intrinsic values of ecosystems (which are defined as systems of interacting organisms within their natural environment), and the needs of future generations. The Act also established the Parliamentary Commissioner for the

Environment, who makes investigations, reports to Parliament, and advises public authorities on the allocation, use and preservation of natural and physical resources.

The 1993 amendment to the **Forests Act 1949** requires that the milling of indigenous timber from most privately owned indigenous forests in New Zealand be subject to a sustainable forest management regime that maintains the forest's ability to provide products and amenities in perpetuity while also retaining its natural values.

The Fisheries Act 1996 aims to sustainably utilise fisheries resources while maintaining associated or dependent species, aquatic ecosystems and their genetic diversity. It replaced the much amended Fisheries Act 1983.

The Biosecurity Act 1993 provides for the exclusion, eradication and effective management of pests and unwanted organisms. This includes quarantine matters, and aims to ensure that incoming goods, vessels and passengers do not carry significant risk of introducing a new disease or pest.

The Hazardous Substances and New Organisms Act 1996, set up a new agency, the Environmental Risk Management Authority (ERMA), to assess hazardous substances and new organisms, including genetically modified organisms, for any adverse effects on the environment or human health and safety, before they are manufactured, developed, imported or released into the New Zealand environment, and to establish safeguards for their use.

Beside these major laws, a range of more specific laws operate to promote conservation at the national and local levels. They include the Marine Reserves Act 1971, the Wild Animal Control Act 1977, the Queen Elizabeth the Second National Trust Act 1977, the Marine Mammal Protection Act 1978, the Trade in Endangered Species Act 1989, and the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992.

5.2 Other relevant legislation

The **Treaty of Waitangi Act 1975** provides for claims from any Māori to be heard by the Waitangi Tribunal on acts or omissions of the Crown since 1840 which are claimed to be contrary to the principles of the Treaty of Waitangi. Following a public inquiry, the Tribunal produces a report in which it makes findings and recommendations on the claims. The findings and recommendations are not binding on Government; however the report informs any settlement negotiations between the Crown and Māori.

A current claim (Wai 262 – also known as the flora and fauna claim) before the Tribunal concerns rights in respect of Mātauranga Māori (Māori knowledge) and indigenous flora and fauna. The claimants assert that they should have control and decision making rights over the use of indigenous plants and their genetic material, considered to be tāonga (Māori treasures) protected under Article 2 of the Treaty of Waitangi, as well as control over Mātauranga Māori that relates to indigenous flora and fauna. The claimants seek the restoration of their relationship to indigenous flora and fauna and the corresponding rights. Customary rights and Treaty rights (namely tino rangatiratanga and kaitiakitanga) are at the heart of these assertions. Similar matters have been raised by indigenous peoples the world over, and form part of discussions in several international fora such as discussions on the implementation of Article 8(j) of the Convention on Biological Diversity.

Hearings of the Wai 262 claim concluded in June 2007. The Tribunal will release its report in due course. The New Zealand government recognises that for Māori the exercise of tino rangatiratanga and kaitiakitanga over New Zealand's indigenous plants is an important issue. This issue is being considered by the government in the context of its obligations under the Treaty of Waitangi and New Zealand's international obligations.

The Crown Research Institutes Act 1992 set up the Crown Research Institutes.

The Research, Science and Technology Act 1990 set up the Foundation for Research, Science, and Technology which administers the Public Good Science Fund.

The Commodity Levies Act 1990 enables industry organisations representing a group of producers to impose a compulsory levy on a commodity by means of an Order in Council. The funds collected through levies can be used for research including for the purpose of importing and developing new plant genetic resources.

Intellectual Property Rights Legislation

There are two elements of New Zealand's intellectual property rights system which are relevant to plant genetic resources. These are plant variety rights (PVR) under the Plant Variety Rights Act 1987, and patents under the Patents Act 1953. Patents can protect new products or processes derived from genetic research on plants through the grant of a proprietary right that lasts for a period of 20 years. PVR can provide proprietary protection for new varieties of plants. Plant variety protection lasts for up to 20 years in the case of non-woody plants, or 23 years in the case of woody plants. PVRs are particularly important in plant genetic research because:

- They provide incentives to breeders and, therefore, encourage investments and effort into plant breeding in New Zealand; and
- They allow New Zealand access to overseas-bred varieties which would not be released here by their breeders without PVR protection.

The grant of plant variety rights provides plant breeders with the exclusive right to sell seed or reproductive material of their new varieties. As the rights conferred by the Act are relatively limited, a revision of the legislation was commenced in 2002. The proposed amendments seek to increase the protection afforded to plant breeders and thereby encourage investment in new plant varieties. The review also recommends amendments to technical terms used in the legislation.

Chapter 6: INTERNATIONAL CO-OPERATION

New Zealand generally experiences good international co-operation in plant genetic resources matters. There is mainly free flow of materials between overseas genebanks and New Zealand. Co-operation with Australia in temperate forage plants is particularly close. Expeditions to collect wild or cultivated material from overseas countries are occasionally undertaken and in recent times are normally associated with active research programmes with dedicated funding for this purpose. Strict import regulations have significantly restricted new plant imports and the lack of suitable quarantine facilities has impacted on some new variety and cultivar imports for certain species requiring high-security quarantine. When expeditions are undertaken they are done so with the full knowledge and cooperation of the host country.

New Zealand has not ratified the International Treaty on Plant Genetic Resources for Food and Agriculture, and generally relies on private agreements between plant breeders in dealing cooperatively with other countries.

Plant genetic resources specialists in this country note that New Zealand benefits greatly through its membership of the Consultative Group on International Agriculture Research (CGIAR) network, and consider it to be an important body with valuable resources.

New Zealand is a member of the FAO Commission on Genetic Resources for Food and Agriculture.

6.1 Trade, Commercial and other International Agreements

New Zealand's intellectual property rights system is consistent with the Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS) entered into under the World Trade Organisation. The *sui generis* system for protection of plant varieties (required under Article 27(3)(b) of TRIPS) is provided for in the Plant Variety Rights Act, 1987.

New Zealand is a member of the International Union for the Protection of New Varieties of Plants (UPOV), and is currently a party to the 1978 Revision of the UPOV Convention. New Zealand's system of PVRs is being amended to adopt some aspects of the UPOV 1991 Convention but New Zealand has not yet ratified UPOV 1991.

The New Zealand Government is currently investigating policy options for domestic access and benefit-sharing (bioprospecting), particularly through the development of a domestic bioprospecting framework. Access and benefit sharing are focuses of the Convention on Biological Diversity - parties have agreed to develop an international regime on access to biological material, and sharing benefits in return for allowing access. The outcome of discussions in this forum will be of interest to New Zealand.

Chapter 7: NATIONAL NEEDS AND PRIORITIES

7.1 Issues

In 2000 New Zealand adopted a national biodiversity strategy and action plan in accordance with Article 6(a) of the Convention on Biological Diversity. The Strategy identified a number of key issues relating to the conservation of genetic resources. These issues remain current as confirmed by the Brockerhoff *etal.* 2004 study of plant collections and from discussions held with New Zealand's plant breeders. The following are the key issues facing New Zealand's genetic resource collections.

7.1.1 Erosion of Genetic Diversity

New Zealand's primary production economy depends on introduced species. Meeting the changing market demand for agriculture based products requires a genetically diverse resource base, so loss of genetic diversity of New Zealand's economically important species could have significant economic effects.

Secure maintenance of the genetic resources of diverse species and varieties, either in living populations or in collections, can be costly. Funding for the maintenance of collections for conservation purposes is limited. The contribution of public funds to maintaining these collections is under review by the New Zealand government. Lack of resources means that not all the genetic material in national genebanks is maintained. In some cases it is not known how much material held in genebanks is still viable.

Current market mechanisms and intellectual property regimes, including the patent system, provide protection for some genetic resources (particularly new varieties), but do not encourage the conservation and storage of existing species or the comprehensive protection of genetic diversity. Protection of genetic diversity therefore will require ongoing collaboration between the public and private sectors.

7.1.2 Maintaining access to genetic resources

Almost all of New Zealand's land based production comes from fewer than 50 animal and plant species. The small number of species, and the low genetic variability within some of these species contribute to high agricultural productivity but makes land-based production more vulnerable to biological failures caused, for example, by pests and disease or climate change. Maintenance and expansion of this genetic base is therefore heavily dependent on resources held in other countries.

Such access may not always be available due to other countries' policies or laws, and requires negotiation of reciprocal access arrangements. Access to such stocks can be achieved partly through the Consultative Group on International Agricultural Research system.

7.1.3 Commercial use and bioprospecting of indigenous genetic resources

Using the genetic resources of indigenous species for commercial benefit raises ecological, commercial, cultural, and ethical considerations. The key issue is how benefits from their use are shared.

New Zealand is currently working through processes of ensuring fair and equitable access to indigenous genetic resources taking into account the interests and rights of Māori as Treaty partners.

Government facilitated discussion on the development of a framework for bioprospecting will include consideration of access to and commercial use of indigenous genetic resources in line with Article 15 of the Convention on Biological Diversity (Access to Genetic Resources), with an intention of providing certainty for New Zealand and overseas companies and research institutions.

7.1.4 Balancing the risks and benefits of import regulations and access to new genetic material

New Zealand has strict regulatory and quarantine requirements covering the importation of new genetic material. The two primary laws are the Biosecurity Act, 1993, and the Hazardous Substances and New Organisms Act, 1996. The objective of this regime is to protect New Zealand's environment, human health, and economy from introduced pests and diseases. The costs of complying with the import requirements and lack of high-security quarantine facilities can act as a barrier to accessing new genetic material.

The Government has recognised these tensions and is working through solutions with the plant import industry. New Zealand recognises the importance of maintaining access to important plant genetic resources for both conservation and economic purposes. Emphasis will likely be placed on fine tuning the regulatory regime for plant imports. The objective is to ensure regulations are not acting as a deterrent to access while at the same time ensuring new material is safe and free of pests and diseases.

7.2 Priorities

An independent review after the first 5 years of implementing the Biodiversity Strategy examined the progress that has been made across all the Strategy themes as well as the achievements of the programmes that received government funding. The review, undertaken by Green and Clarkson (2005), identified the following priorities for managing New Zealand's plant genetic resources.

7.2.1 Conserving Genetic Resources

The review identified that policy leadership was required in the form of an evaluation of the need for a collaborative strategy to manage New Zealand's genetic resources (both indigenous and introduced). The evaluation would need to identify significant areas of risk in the management of these resources, and options for managing these risks. A more coherent response to the management of New Zealand's many collections of genetic resources, given the difference in private and Crown interests, is the single most important priority.

A related priority is the completion of an integrated policy and legislative framework for managing bioprospecting in New Zealand. This has been delayed by complex issues surrounding unresolved Treaty of Waitangi claims.

7.2.2 Māori interests

Māori have particular concerns about New Zealand's genetic diversity, including possible implications from an eventual bioprospecting policy, intellectual property rights, the protection of collections, and the retention of matauranga Māori (traditional knowledge). Concerns of Māori are articulated and clarified within the Waitangi Tribunal process, including Wai 262, the claim regarding indigenous flora and fauna. Progress in Treaty of Waitangi areas is most likely to determine how rapidly Māori interests in their use of genetic resources are able to be addressed in these aspects of the Strategy.

Annex 1

Summary of the status of plant genetic resources in New Zealand

Table 1: Genetic Resources of Pasture and Soil Conservation Plants

	Forage and turf grasses, forage legumes & other grassland plants	**Poplars and Willows**	**Soil conservation shrubs and herbs**
Living Collections	Extensive areas of permanent pasture	HortResearch, Palmerston North (Aokautere); Clyde; Eastwoodhill Arboretum, Ngatapa, Gisborne; Hackfalls Arboretum, Tiniroto; Cousins pty, Colyton, Palmerston North; McKellar pty, Hunterville.	Some scattered in past soil conservation species trial sites
Seed Storage	Controlled long-term storage at 0^0C and 25% Relative Humidity (RH), Ag Research Grasslands Division, Palmerston North	N/A	AgResearch Grasslands, Palmerston North, at 0^0C and 25% RH, and Alexandra at room temperature
Regeneration	Systematic but limited by resources to 200 entries per year	Vegetative propagation of 'valuable' or rare phenotypes	Selective; isolation provided as far as physically possible
Representation	Ryegrasses (*Lolium* spp) 24,000 Fescues (*Festuca* spp) 9,200 Cocksfoot (*Dactylis* spp) 2,000 Bromes (*Bromus* spp) 1,400 Other grasses 8,600 White clover (*Trifolium repens*) 22,000 Red clover (*Trifolium pratense*) 3,700 Lucerne (*Medicago sativa*) 2,100 *Lotus* spp 3,400 Other legumes 9,600 Other grassland 1,200 Plants (includes soil conservation plants)	National Collection: bi-annually-coppiced stoolbeds at Aokautere Poplar: 178 clones of 9 species and 4 hybrids. Willow: 207 clones of 40 species and 14 hybrids. Over 500 additional poplar and willow clones (principally hybrids) held in arboreta and trials.	80-100 miscellaneous herbaceous and shrubby species

	Forage and turf grasses, forage legumes & other grassland plants	Poplars and Willows	Soil conservation shrubs and herbs
Value and uniqueness	Significant as a world collection, although relatively little unique except breeding lines & NZ collections	Significant for NZ, Australia, Argentina, Chile and South Africa. NZ-bred hybrids of use to temperate zones of China.	Local importance; not unique
Use	Primarily a working collection, conservation secondary to breeding objectives but significant	Primarily for breeding and selection of improved clones for soil conservation, windbreaks, agroforestry and bioenergy. Selection focused on disease, possum resistance, vigour, form and wood quality.	Primarily for selection
Documentation	Computerised and available on Internet; no systematic descriptors	Currently computerised for national stoolbed collection at Aokautere and Clyde. Other sites mentioned above are computerised but incompletely.	Accession lists circulated; no systematic descriptors; computerised
Availability to other users	Available if quantity permits, except for breeding lines and new selections. Distribution within New Zealand is frequently restricted by tough biosecurity regulations.	Clonal material available from Hort Research under non-propagation or trial site agreement. Royalty payment for released cultivars, unimproved selections and older hybrids at cost.	Available
Location of chief world genetic resources	Europe, North and South America	Northern hemisphere (20-70N), particularly China, Himalayas and USA/Canada	Europe, USA and Australia
Adequacy of conservation in NZ	Facilities excellent; documentation needs to be increased; more NZ collections sought; more overseas collections desirable	Gene pool collections now being documented, but pure species poorly represented for most willows. Narrow poplar representation.	Better physical isolation needed during regeneration. Given increasing emphasis on sustainable land management, collection may not be adequate.
Funding source & security	NZ government through contestable funding pool. Stable. The government is currently reviewing security of funding for nationally important collections.	Since 2003 there has been no central government funding to maintain the collection or the breeding programme and consequently there is no long term security for the significant gene pool collection at Aokautere.	NZ government through contestable funding pool. Stable. The government is currently reviewing security of funding for nationally important collections.
Active exchange	Yes	Acquisitions of *S. lasiandra* willow and *P. trichocarpa* poplar seed from California and Oregon were made in 2001and	Yes

	Forage and turf grasses, forage legumes & other grassland plants	Poplars and Willows	Soil conservation shrubs and herbs
		2002. Some NZ bred willow cuttings were despatched to Chile in 2004.	

Source: AgResearch; HortResearch.

Table 2: Genetic Resources of Field Crops

	Wheat	Barley	Maize	Tobacco	Hops	Oats
Seed Storage	Long-term storage at 0 °C and 35% RH (Crop & Food Research, Lincoln)	Long-term storage at 0 °C and 35% RH (Crop & Food Research, Lincoln)	Long-term storage at 0 °C and 35% RH (Crop & Food Research, Lincoln)	10 °C sealed containers (HortResearch Riwaka)	N.A. (vegetatively propagated)	Long-term storage at 0° C and 35% RH (Crop & Food Research, Lincoln)
Regeneration	Systematic	Systematic	Systematic	Collection grown in rotation to produce new selfed seed every 10 years	Living collections maintained at Riwaka Research Centre (HortResearch)	Systematic
Representation	2,500 wild accessions, breeding lines and cultivars	1,500 cultivars and breeding lines, mainly of overseas origin	200 in-breds and breeding lines, mostly of NZ origin	100 overseas cultivars and breeding lines, the latter mostly of N.Z. origin.	60 overseas cultivars and 350 breeding lines of N.Z. origin	400 wild accession, breeding lines and cultivars
Value and uniqueness	Important for local use; perhaps 75% unique (old land-races lost overseas).	Small international value; approx. 20% unique	Local value only	Local *Verticillium* wilt-resistant/ black root rot resistant cultivars and breeding lines are unique	Significant value, triploid types unique, resistant to black root rot. Tetraploid breeding material unique.	Local value; some old N.Z cultivars and breeding lines may be unique.
Use	Conservation and working collection	Working collection	Working collection	Tobacco industry now defunct	Primarily a working collection for breeding programme. Also used as a database for industry.	Working collection
Documentation	Full computer documentation of passport, characterisation and some evaluation characteristics.	Full computer documentation of passport, characterisation and some evaluation characteristics.	Some evaluation characteristics	Computerised	As a working database, confined to HortResearch	Full computer documentation of passport, characterisation and some evaluation characteristics.
Availability to other users	Publicly available	Publicly available	Upon request from research organisations	Freely available overseas and to NZ universities and CRIs	Some used commercially in New Zealand	Publicly available

	Wheat	Barley	Maize	Tobacco	Hops	Oats
Location of chief world genetic resources	Centre of origin: Middle and Near East. Major gene banks Europe, USA., Mexico (CIMMYT) and Australia.	Centre of origin: Asia Minor, Afghanistan and Ethiopia. Major gene banks Europe, USA & St Petersburg.	Major gene banks Europe, Mexico (CIMMYT), and USA.	Japan, U.S.A. Zimbabwe	U.S.A. (several), Slovenia, Germany, China, Czech Republic UK, Japan	Centre of origin: Mediterranean, Asia, N.E. Africa. Major gene banks Europe and USA.
Adequacy of conservation in NZ	Adequate	Adequate	No	Adequate. Very little use. Most valuable material is the unique disease resistance populations, which are regenerated.	No new germplasm introduced since early 1990s. (Due to quarantine situation). Now barely adequate.	Adequate
Funding source & security	At risk internal investment	At risk internal investment	At risk internal investment	Government stable	Government stable	At risk internal investment
Active exchange	Yes	Yes	No	No	No/ very limited to public world collections only	Yes

Source: HortResearch (Hops), Crop & Food Research (others)

Table 2: Genetic Resources of Field Crops (continued)

	Peas	Arabidopsis	Amaranth	Azuki Beans	Forage brassicas
Seed Storage	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)
Regeneration	Systematic	Systematic	Systematic	Systematic	Systematic
Representation	275 breeding lines and cultivars	40 research accessions	16 breeding lines	28 breeding lines and cultivars	28 cultivars
Value and uniqueness	Local value only	Local value only	Local value only	Local value only	Local value only
Use	Working collection	Working collection	Working collection	Working collection	Working collection
Documentation	Some systematic description and evaluation data	Some systematic description	None	None	Some systematic description and evaluation data
Availability to other users	Publicly available	Upon request from research organisations	Upon request from research organisations	Upon request from research organisations	Upon request from research organisations
Location of chief world genetic resources	Europe, USA and India	Europe, USA	Asia, USA, South America	USA and South America	Europe and USA
Adequacy of conservation in NZ	Adequate	No	No	No	Yes
Funding source & security	At risk internal investment	At risk internal investment	At risk internal investment	At risk internal investment	At risk internal investment
Active exchange	Yes	No	No	No	No

Source: Crop & Food Research

Table 3: Genetic Resources of Vegetable Crops

	Potatoes	Onions	Sweet Potato	Asparagus
Living Collections	Field and tissue culture (Crop & Food Research, Lincoln)		Field and tissue culture (Crop & Food Research, Lincoln)	Field and tissue culture (Crop & Food Research, Lincoln)
Seed Storage	N/A	Long-term storage at 0° C and 35% RH (Crop & Food Research Lincoln)	N/A	N/A
Regeneration	Systematic	Systematic	Systematic	Systematic
Representation	400 wild accessions breeding lines and cultivars	100 breeding lines, inbreds and cultivars	8 lines representing total existing representation of Māori varieties (pre-European), plus other breeding lines and cultivars	174 wild species and accessions, breeding lines and inbreds
Value and uniqueness	Mainly local value; 10% unique	Local value only	Pre-European collection unique, remainder local value	Local value only
Use	Working collection	Working collection	Conservation and working collection	Working collection
Documentation	Full computer documentation of passport, characterisation and some evaluation characteristics	Some systematic description and evaluation data	Some systematic description and evaluation data	Some systematic description and evaluation data
Availability to other users	Publicly available	Publicly available	Restricted. Available upon request to some research groups.	Upon request from research organisations
Location of chief world genetic resources	Peru (CIP), Europe, and USA	Europe, USA and Asia	Japan, China, Peru (CIP) and USA	Europe, Asia, and USA
Adequacy of conservation in NZ	Adequate	Adequate	Adequate	Adequate
Funding source& security	At risk internal investment	At risk internal investment	At risk internal investment	At risk internal investment
Active exchange	No	Yes	Yes	Yes

Source: Crop & Food Research

Table 4: Genetic Resources of Fruit and Nut Species

	Apples, Asian pears and European pears	Stone fruit (apricots, cherries, nectarines, peaches, plums)	Kiwifruit
Living Collections	Havelock North Research Centre, (HortResearch) for apples and Riwaka centre for pears	Havelock North Research Centre (HortResearch) for peaches, nectarines and plums and Clyde Research Station for apricots and cherries	Te Puke Research Centre, Nelson Research Centre, Kerikeri Research Orchard, (HortResearch)
Regeneration	Ongoing	Ongoing	Ongoing
Representation	850 accessions of apple including wild species, old cultivars, many thousands of genotypes in breeding populations. 120 accessions of pear including European and Asian pears	450 accessions wild species, cultivars, sports. 10,000 breeding progeny.	300 accessions, often with many genotypes per accessions. Nearly 1000 genotypes selected for long-term retention. Wild species, cultivars, sports, also breeding populations.
Value and uniqueness	Apples are one of the best collections in the world. Asian pears are one of the best collections outside of Asia.	Rare old New Zealand selections and Japanese peaches	The most comprehensive collection in the world outside China, particularly in wild germplasm of commercialised species. Much of the collection is irreplaceable.
Use	Breeding, conservation, experimental studies	Breeding, conservation	Conservation, breeding, experimental studies
Documentation	Computerisation ongoing	Computerisation ongoing	Computerisation ongoing
Availability to other users	Readily available except for protected cultivars and proprietary breeding lines	Mostly available except for protected cultivars and proprietary breeding lines	Available except for protected cultivars but much material imported with restrictions
Location of chief world genetic resources	USA, U.K. France, Japan, Italy, Germany	USA, China, Europe, Commonwealth of Independent States, Rumania, Iran, Canada	China, Japan, Europe, USA,
Adequacy of conservation in NZ	Adequate, although replication on more sites needed to spread risk. Also, more effort required on characterisation.	Adequate	Adequate but some replication required. More effort required on characterisation.
Funding source & security	Government/industry	Government/industry	Public – FRST. Stable at present.
Active exchange		Limited	Limited international exchanges

Source: HortResearch

Table 4: Genetic Resources of Fruit and Nut Species (continued)

	Grapes	Berryfruit	Sub-tropicals	Temperate nut trees
Living Collections	Te Kauwhata, Blands, Blenheim, Rakaia, Lawn Road, Lincoln etc.	Nelson Research Centre, (HortResearch)	Various orchards, (HortResearch)	Private Individuals and botanical gardens
Representation	650 accessions of cultivars, clones, rootstocks, selections all imported from overseas institutes	Rubus: 600 accessions wild species, cultivars, Ribes approx. 100 accessions Vaccinium spp.	Mainly overseas cultivars or wild genotypes: Citrus 160 accessions, *Feijoa* 170, avocado 65, pepinos 80, olive 24, persimmons 40	40 N.Z. & overseas collections and cultivars include 40 pecan, 14 almond, 30 hazel, 30 chestnut, 50 walnut, 20 *Geruina avellana*, 40 macadania named varieties and local improved selections
Value and uniqueness	Replaceable only at great cost and with considerable difficulty. Very little unique. Virus status often uncertain.	The Rubus collection is particularly valuable with half being irreplaceable	Mostly of local significance only; little unique (except for pepino which are largely irreplaceable)	Locally selected seedlings have been commended
Use	Conservation, experimental studies, source of budwood	Breeding	Mainly conservation	Working and resource collections
Documentation	Database held by NZ Winegrowers and various educational institutes	Variable	Variable	None
Availability to other users	Generally available	Rubus available except for protected cultivars,	Mostly available	Insufficient material as yet
Location of chief world genetic resources	France, Germany, California, Australia	USA	Various	France, U.S.A., Romania, Turkey
Adequacy of conservation in NZ	Not adequate, no permanent funding, collection at risk	Not adequate. Conservation depends on breeding programmes. Strawberry collection no longer maintained due to lack of funding.	Most collections are being lost, suffering deterioration or definitely at risk because very little funded research on most of these crops and therefore declining expertise and interest	Not adequate - conservation usually depending on private individuals with limited resources
Funding source & security	NZ Winegrowers Inc (industry body)	All collections funded as part of breeding programmes	Very little; At risk.	Usually privately funded, botanic gardens publicly funded
Active exchange	Yes, but infrequently, cooperating with overseas institutes on research projects	Infrequent	Infrequent	No

Source: HortResearch; New Zealand Wine Growers (Grapes)

Table 5: Genetic Resources of Forest Trees

	Pinus radiata	***Pseudotsuga menziesii***	***Pinus muricata***
Living Collections	Extensive; country-wide; systematic collections and local plantations scattered	Scattered; systematic collections and local plantations	Systematic collections and local plantations
	Some attrition across all species due to felling and mortality through disease and tree competition		
Seed Storage	Both New Zealand and overseas; wild collections and breeding material (Scion (Forest Research Institute), Rotorua)		
Regeneration	Apart from limited exploitation for intensive breeding programme, gene resource collections are not being regenerated, despite proposals	Preferred populations being regenerated on large scale as open-pollinated seed collections, alongside fairly intensive breeding programme	Two of the three preferred populations have being regenerated as plantations by open-pollinated seed collection. The third such population is not yet due for regeneration. Material of remaining populations largely lost.
Representation	Good representation of secondary gene-resources (land-race) stock was secured in mid-1980s with approximately 1000 open-pollinated plus-tree families, but this material faces prospect of major narrowing of genetic base.	Provenance material not of high interest heading for extirpation	Southern provenances have essentially disappeared
Value and uniqueness	Highly significant, little unique owing to cooperative germplasm sharing	Significant; broad geographic representation , in-depth over part of range	Very significant; none unique but may be most substantial collection outside natural stands
Use	Limited exploitation of gene-resource plantings to provide selections for intensive breeding programme	Exploitation of provenance-trial plantings and large, post-1970 seed importations for intensive breeding. The latter element is being regenerated for continuing availability of good (if not actually elite) seed sources.	Completely on hold beyond perpetuating by seed collection
Documentation	Limited updating, except where intensive breeding is being practised.		
Availability to other users	Freely available except for highly select breeding; sometimes subject to temporary constraints on seed collection or production		
Location of chief world genetic resources	California and Mexican Islands (natural stands); NZ & Australia, Chile	U.S. & Canada (natural stands); Europe and NZ	California (natural stands); Australia & NZ
Adequacy of conservation in NZ	Good at present; logistics of long-term conservation of living genetic resource material may be a problem in future.	Generally adequate. Good scheme initiated in USA but future access problematic.	No urgent problems seen
Funding source & security	Government and industry. Funding security has been an issue, with wide fluctuations in support for work on species other than *P. radiata* and *Pseudotsuga menziesii*. Such funding has tended to be short-term. Intentions are being stated to make funding longer-term.		

	Pinus radiata	***Pseudotsuga menziesii***	***Pinus muricata***
Active exchange	Historically, there has been much collaboration between New Zealand and Australian agencies, in collecting and donating genetic material of ***Pinus radiata***, and free supply of native germplasm from Australia. More recently, there has been some exchange of select ***P. radiata*** material involving Chile. However, such exchanges are now becoming much reduced by combinations of biosecurity restrictions and commercial pressures.		

Source: Forest Research Institute (Scion)

Table 5: Genetic Resources of Forest Trees (continued)

	Eucalyptus spp.	Cypress macrocarpa; Cypress lusitanica	Other exotic species	Native timber species
Living Collections	Various sites; systematic collections and local plantations	Substantial	Various, being extended	Native forests *in situ* (potential as plantations limited)
Seed storage	Very limited current use for preserving genetic collections, although technically not difficult for almost all exotic conifers. A major technical hurdle with various native species, not that there is any current pressing need.			
Regeneration	Some regeneration for essentially amenity planting for many species. 2 species subject to modest breeding programmes, 2 others to limited breeding efforts. Material slowly disappearing. Small-scale regeneration of eucalypts tends to be dysgenic, through inbreeding and loss of genetic diversity.	Active breeding programmes in two species, and some material recently imported, but systematic collections of other gene-resource material have been subject to attrition	Collections of material, already often representing very limited population bases, have generally not been getting regenerated, while suffering continuing attrition	For the most part, young stands sufficient to assure future of species, without much short-term recruitment, provided such stands are protected, which seems to be pretty well assured in most cases
Representation	Provenance representation effectively being eroded in species of major past interest	Losses limited	Losses of material have occurred	No concern over population losses in significant timber species.
Value and uniqueness	Not unique; but significant for some species	Some unique	Little if any unique, but some collections very important	Unique
Use	Continued exploitation of preferred provenance material of two currently preferred species	Exploitation for intensive genetic improvement mainly involving land-race selections. Pilot-scale hybridisation studies proceeding, involving a number of species.	Very limited, except producing and researching hybrids between *P. radiata* and other species, main progress being made in hybrids with *P. attenuata*	Native species. These species are now subject to research on plantations, with significant reference to Māori. With 2 species significant living provenance collections serving research purposes.
Documentation	Limited updating, except where intensive breeding is being practiced			
Location of chief world genetic resources	Australia (natural	California and Mexico	Various; conifers	New Zealand

	Eucalyptus spp.	**Cypress macrocarpa; Cypress lusitanica**	**Other exotic species**	**Native timber species**
	stands) New Zealand for some species		chiefly U.S., Mexico & Central America	
Adequacy of conservation in NZ	Progress satisfactory	Generally adequate, but more *Clusitanica* desirable	Patchy; genetic base often narrow and sometimes suspect. Pressures now exist for liquidation.	Scattered relict stands may be efficient for gene conservation but we lack genealogical knowledge
Funding source & security	Government and industry			
Active exchange	Minimal			

Source: Forest Research Institute (Scion)

Table 6: Indigenous Plants (other than forest trees)

	Indigenous vascular plants
Living Collections	Extensive *in situ* conservation, 29% of land area under legal protection. • 77% (4.8 million hectares) of indigenous forest are in national parks & reserves. • 2% (130,000 hectares) private land protected. • 7% of territorial sea area in marine reserve. 28 marine reserves. A small number of significant *ex situ* collections include: • The flax (*Phormium* spp.) collection held by Landcare, based on 50 Māori weaving cultivars; • Auckland Botanic gardens; • Taupo Native Plants Nursery. The nursery has been in existence for over 40 years now. It was part of the Department of Conservation, which was then required to grow and supply native plants for the restoration of scenic reserves, forest and national parks. Today the Nursery produces over 1.7 million plants despatching them to destinations New Zealand wide. The Taupo Native Plant Nursery team comprises 40 full-time staff and up to 25 casual staff.
Seed storage	Very little; more research needed; some forest species may be intractable. Some maintained by Margot Forde Germplasm Centre (See Table 1).
Representation	10% of world vascular plant species. Mountainous land types well represented. Lowland and coastal forest, dunelands, wetlands and lowland tussocklands are all under-represented in protected area network.
Value and uniqueness	Mostly unique; 85% of 2,300 indigenous vascular plants are endemic, and 43% of marine algae.
Use	*Ex situ* collections used for research, breeding and conservation. Increase in bioprospecting activity related to growth in biotechnology sector.
Documentation	Most *ex situ* collections well documented and computerised. Significant literature on *in situ* indigenous plants.
Availability to other users	Varies
Location of chief world genetic resources	New Zealand
Adequacy of conservation in NZ	Not adequate for a number of species, although few of these have known economic uses at present. 868 taxa listed as threatened, 175 taxa acutely threatened, 108 chronically threatened, 585 at risk, 6 taxa extinct (since 1840), 85 species of mosses, hornwarts & liverworts endangered.

Source: Department of Conservation; Landcare Research.

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Abbreviations

CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CRI	Crown Research Institutes
DOC	Department of Conservation
ERMA	Environmental Risk Management Authority
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FRST	Foundation for Research, Science & Technology
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
HSNO	Hazardous Substance and New Organisms
ICPPGR	International Conference and Programme on Plant Genetic Resources
MAF	Ministry of Agriculture and Forestry
MoRST	Ministry of Research, Science & Technology
NIWA	National Institute of Water and Atmospheric Research Ltd

Māori words

Aotearoa	New Zealand
iwi	tribe/race of people/nation
tangata whenua	local person
taonga	treasures, other properties
te tino rangatiratanga	to possess and control what is yours
mauri	physical life force
matauranga māori	traditional knowledge

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