COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

JAPAN

Second Report of the State of the World's Plant Genetic Resources for Food and Agriculture

Country Report
Japan

Note by FAO

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PART I

OUTLINE

OUTLINE

1. PGRFA and Japan's local characteristics

Many Plant Genetic Resources for Food and Agriculture (PGRFA), which have traditionally been used in Japan, initially came from the Eurasian Continent. Indigenous PGRFA in Japan are said to be few but Japan has some such as wasabi (Japanese horseradish) and other spices and herbs used in traditional Japanese dishes. Due to the ecological and climatic diversity of Japan that stretches from the subtropical to sub artic zones a wide variety of crops are grown in Japan. However, in order to meet consumer and retailer needs and improve production efficiency there is a loss of diversity within crops.

The overall diversity of PGRFA is therefore declining. On the other hand, consumers are interested in growing various crop types, including functional and high-quality crops and local strains related to traditional Japanese cuisine. Some farmers find it profitable to grow landraces; municipalities protect these landraces as local specialties. Some municipalities strive to raise public awareness of the importance of preserving PGRFA through education and cultural activities.

2. Gene bank

Japan established a gene bank at the National Institute of Agrobiological Sciences in 1985. It was built and is operated under a system in which PGRFA are collected, characterized, evaluated, preserved, and distributed in a centralized manner. The gene bank has bases or sub banks at various research institutes of the Ministry of Agriculture, Forestry and Fisheries across Japan. By growing crops most suited to different regions in those regions Japan is able to maintain one of the world's largest germplasm collections in terms of varieties and quality.

The gene bank currently holds about 250,000 PGRFA accessions; there are large collections of wheat, rice, and soybeans. Future challenges include the enhanced preservation of vegetatively propagated crops and the development of simple low-temperature preservation technology.

Various factors support the enhanced conservation of vegetatively propagated crops in farmers' fields. Demand is expected to rise for genetic resources to improve existing local strains, the use of which is increasing in some localities. Some PGRFA, which have been preserved on-farm are in danger of becoming extinct in some areas due to increasing crop uniformity and declining and aging farm population. It is necessary to improve the efficiency of cryo-preservation technology in terms of the use of space required and time to cryo-preserve materials as the number of accessions stored this way is expected to increase. This is particularly relevant to the preservation of vegetatively propagated crops.

3. International activities

International activities of Japan in relation to PGRFA include agreements that have been concluded while support is being provided to developing nations to enhance their capacity to conserve PGRFA.

An example of Japan's support for the effective use of PGRFA, is that Japan has provided support for the improvement of information infrastructures in Asian developing nations in cooperation with the Food and Agriculture Organization of the United Nations (FAO). In addition, Japan is providing support to PGRFA researchers from different countries and helping to build a network of these researchers in cooperation with the Japan International Cooperation Agency (JICA).

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR) will be implemented while necessary adjustments have been made to domestic laws.

PART II

STATE OF AGRICULTURE

STATE OF AGRICULTURE

The Japanese archipelago, situated in the northwest Pacific and east of the Eurasian Continent, comprises four main islands (Honshu, Hokkaido, Kyushu and Shikoku, in order of size) and many other smaller islands. The Sea of Japan lies between the Eurasian Continent and Japan. The warm Kuroshio Current flows from southwest to northeast on the Pacific side of the country, while the colder Oyashio Current flows in the opposite direction, with these currents meeting near the country.

Much of Japan falls into the temperate zone with four distinct seasons, but Hokkaido and the highlands are cold, while the southern-most areas are tropical. Seasonal winds blow from the southeast in summer and from the northwest in winter, with relatively high precipitation in summer on the Pacific side and on the Sea of Japan side in winter. There are many volcanoes in Japan because the country is located in the Pacific Rim volcanic zone. About three-fourths of Japan's land area is forest covered mountain, and many rivers are narrow and fast flowing.

Japan is about 380,000 square kilometers in extent with a population of 127.64 million (in 2005).

There is little arable land because much of the country is covered with steep mountains. In 2005, arable land totaled 4,690,000 ha, 12.5% of the national land area, and this has been reduced by about 1,300,000 ha in the past half-century primarily due to urban expansion.

Agriculture activity in Japan is declining with less arable land being cultivated, reduced number and aging of farmers (Table 2-1-1).

Arable land per Japanese commercial farm household rose to 1.8 ha in 2006, an increase from 1.1 ha in 1965, but this figure is still one ninth of the EU and 1/99th of the U.S.

Total value of agricultural production in Japan was 8,290.0 billion yen in 2006. By product type, the most value of this was for livestock (28%), followed by vegetables (25%), and rice (22%). It has continued to decline significantly, especially for rice with declining demand, after peaking at 11,717.1 billion yen in 1984. This was 8,290.0 billion yen in 2006. Reduced output of agricultural products since 1985, and decline in prices since 1990, has contributed to the decline in total agricultural production.

TABLE 2-1-1

Transition of total cultivated land area, farm households and agricultural workforce in Japan 1965-2005 (Unit: Thousands)

	1965	1975	1985	1995	2005
Total cultivated land area (ha)	6,000	5,570	5,380	5,040	4,690
Total farm households	5,660	4,950	4,230	3,440	2,850
Agricultural workforce	11,510	7,910	5,430	4,140	3,350

Source: Annual Report on Food, Agriculture and Rural Areas in Japan FY2007
(http://www.maff.go.jp/e/annual_report/2007/index.html)

PART III

REPORT

CHAPTER 1

BIODIVERSITY

1.1 Diversity of agricultural products

The first wave of introduced PGRFA came with migrants from continental Asia, crops arrived later from various regions of the world. PGRFA that arrived in Japan were modified by farmers into a wide variety of types that is particularly noticeable with some crops such as citrus.

During agricultural modernization diversity of PGRFA has declined. The decline in germplasm diversity undermines the ability of plant breeders to develop new strains. Among efforts used to cope with this situation was the establishment of the NIAS Gene Bank Project by the Ministry of Agriculture, Forestry and Fisheries and actions of local municipalities (Table 3-1-2).

On the other hand, consumer demand persists for diverse strains, including specialized, high-quality crops and landraces that are important in Japanese cuisine.

In response to such demands, various types of plants are being grown in Japan. Some wild plants are included in traditional food (Table 3-1-1), but there are only about a dozen that are frequently used.

1.2 Genetic erosion

No comprehensive national studies have been performed on genetic erosion of PGRFA in Japan, but some research institutes are conducting studies.

In a survey conducted at 66 locations in Japan from 1984 to 2000 to determine what landraces were cultivated, it was learned that many strains were no longer cultivated. In particular, cultivation ceased in these locations for such miscellaneous grains as foxtail millet, broomcorn millet, sesame and sorghum, while 29 landraces of these crops were grown in the 1980s. Factors behind this genetic erosion include the decline in the number of people engaged in farming, in addition to the low market value of these crops. To cope with genetic erosion, it is necessary to enhance measures to conserve crops *in situ*/on-farm. As for the 29 landraces for which cultivation ceased, these are conserved in the genebank system.

1.3 Understanding PGRFA diversity

The understanding of the general public is essential for the sustainable conservation and use of PGRFA. To promote such understanding, it is necessary to know the current state of PGRFA diversity based on scientific information and explain to the public the rationale for conservation of PGRFA. Japan has formulated a number of PGRFA-related projects, including the National Biodiversity Strategy of Japan and the Biodiversity Strategy of MAFF (both are detailed in Chapter 5). All of these are explained to the public during the early stages of discussion. These procedures as well as the project details are published on the Web pages of relevant government offices.

TABLE 3-1-1

Lists of wild plants for food ("Plant Genetic Resource Corpus," Vol. 1; editorial supervisor: Matsuo 1989)

- *Seri (Oenanthe javanica)*
- *Fuki (Petasites japonicus)*
- *Yomogi (Artemisia princes)*
- *Sugina (Equisetum arvense)*
- *Warabi (Pteridium aquilinum)*
- *Suiba (Rumex acetosa)*
- *Itadori (Fallopia japonica)*
- *Zenmai (Osmunda japonica)*
- *Taranome (Aralia elata)*
- *Ashitaba (Angelica keiskei)*

TABLE 3-1-2

Examples of Conservation Project in Prefectural and Municipal Governments (Questionnaire Results by Gene Bank; 2001)

Name of the storage facility	Crop species	Number of accessions
Hokkaido Prefectural Plant Genetic Resource Center	Rice, etc.	31,892
Fujisaka Branch, Aomori Prefectural Agricultural Experiment Station	Rice	1,000
Akita Prefectural Biological Resource Comprehensive Development Application Center	Soybean, etc.	900
Iwate Prefectural Agricultural Experiment Station	Rice, etc.	1,058
Bioengineering Laboratory, Ibaraki Agricultural Institute	Rice	962
Breeding Department, Tochigi Prefectural Agricultural Experiment Station	Rice	500
Gunma Prefectural Agricultural Experiment Station	Rice, etc.	288
Saitama Prefectural Experiment Station for Tea	Tea, etc.	237
Chiba Prefectural Agricultural Experiment Station	Soybean	60
Chiba Prefectural Agricultural Experiment Station	Peanut etc.	1,430
Subtropical Agricultural Center, Ogasawara Branch, Tokyo Metropolitan Government Bureau of General Affairs	Pumpkin, etc.	2
Genetic Resource Section, Bioengineering Department, Yamanashi Agricultural Experiment Station	Orchid, etc.	180
Yamanashi Fruit Tree Experiment Station	Grape	416
Yamanashi Prefectural Daily Experiment Station	Perennial ryegrass, etc.	182
Shizuoka Prefectural Agricultural Experiment Station, Shizuoka Prefectural Experiment Station of Tea, Shizuoka Prefectural Fruit Tree Experiment Station, Shizuoka Prefectural Livestock Experiment Station	Rice, etc.	1,008
Wasabi Branch, Shizuoka Prefectural Agricultural Experiment Station	Japanese horseradish	12
Shizuoka Prefectural Fruit Tree Experiment Station	Citrus, etc.	89
Niigata Agricultural Research Center	Rice, etc.	1,085
Crop Department, Toyama Prefectural Agricultural, Forestry & Fisheries Research Center	Rice	1,911
Breeding Research Team, Wet-rice cultivation Department, Fukui Prefectural Agricultural Experiment Station	Rice	181
Ishikawa Agricultural Research Center	Rice	400
Nagano Agricultural Experiment Station	Rice, etc.	4,185
Breeding Department, Nagano Agricultural Experiment Station	Wheat, etc.	5,216
Nagano Chushin Agricultural Experiment Station	Corn, etc.	5,026
Nagano Fruit Tree Experiment Station	Apple, etc.	322
Designated Test Area for Sorgum, Nagano Livestock Experiment Station	Sorghum, etc.	3,500

Name of the storage facility	Crop species	Number of accessions
Gifu Prefectural Agricultural Technology Institute	Prairie gentian, etc.	338
Breeding Laboratory, Crop Institute, Aichi Agricultural Research Center	Rice	2,308
Forage breeding Laboratory, Aichi Agricultural Research Center	Alfalfa, etc.	270
Intermountain Agricultural Institute, Aichi Agricultural Research Center	Rice plant	1,900
Biological Resource Laboratory, Cultivation Department, Osaka Prefectural Agricultural Technology Center	Japanese butterbur, etc.	536
Kyoto Prefectural Institute of Tea	Tea	290
Nara Prefectural Agricultural Experiment Station	Rice, etc.	460
Warm Region Gardening Center, Wakayama Research Center of Agriculture, Forestry and Fishery	Pea, etc.	349
Fruit Tree Experiment Station, Wakayama Research Center of Agriculture, Forestry and Fishery	Sweet orange, etc.	122
Brewer's Rice Test Area, Hyogo Prefectural Agricultural Technology Center	Rice	256
Tottori Prefectural Agricultural Experiment Station	Rice, etc.	660
Hiroshima Prefectural Agricultural Gene Bank	Rice, etc.	17,818
Kagawa Prefectural Agricultural Experiment Station	Rice, etc.	212
Azuki Branch, Kagawa Prefectural Agricultural Experiment Station	Olive	40
Tokushima Prefectural Agricultural Experiment Station	Indigo, etc.	745
Cultivation Laboratory, Crop Laboratory, Ehime Prefectural Agricultural Experiment Station	Rice, etc.	545
Ehime Prefectural Fruit Tree Experiment Station	Citrus	67
Kochi Agricultural Research Center	Rice, etc.	1,776
Horticultural Institute, Fukuoka Agricultural Research Center	Grape	476
Tea Industry Branch, Miyazaki Agricultural Research Institute	Tea	220
Saga Prefectural Agricultural Experiment Center	Rice, etc.	520
Nagasaki Agriculture and Forestry Experiment Station	Barley	1
Aino Bareisho Branch, Nagasaki Agriculture and Forestry Experiment Station	Potato	216
Breeding Section, Nagasaki Fruit Tree Experiment Station	Japanese medlar, etc.	140
Agriculture and Horticulture Institute, Kumamoto Prefectural Agricultural Research Center	Rice, etc.	1,190
Breeding Department, Rush Grass Industry Laboratory, Kumamoto Prefectural Agricultural Research Center	Rush	450
Crop Department, Kagoshima Prefectural Agricultural Experiment Station	Rice	200
Department of Sugarcane and Ordinary Crops, Okinawa Prefectural Agricultural Experiment Station	Sugarcane	255
Nago Branch, Okinawa Prefectural Agricultural Experiment Station	Pineapple	100
Miyako Branch, Okinawa Prefectural Agricultural Experiment Station	Sugarcane	58

CHAPTER 2

IN SITU CONSERVATION

In situ conservation of PGRFA can be done in two ways—conservation of wild relatives of crops in their original habitats and conservation by cultivation on-farms.

The former refers to conservation of the environment where wild species grow. It is therefore necessary to implement measures to protect against natural disasters as well as enforcing regulations against human destruction, such as land development.

There are very few attempts to conserve genetic resources for wild relatives of crops in their natural environment. However, some wild crop relatives can be found in national parks that have in effect led to the conservation of these wild species where they naturally grow. In addition, there have been efforts to protect some important species as natural treasures.

On the other hand, conservation by cultivation on-farms can be effective if there is a continuous demand for landraces. Farmers have preserved many indigenous landraces and these have been collected for the gene bank. Farmers' efforts to cultivate and thus conserve native crops on-farm by cultivation do not receive support from public institutions.

The cultivation of some of these crops takes time and some exemplary farmers on their own initiative, regardless of market principles, are conserving them. Recently, efforts have been made to revitalize regional areas through the enhanced use of locally distinct crops as local specialties. In particular, consumer interest is growing in indigenous vegetables, with their market value rising accordingly. In some recent cases, municipalities and the exemplary farmers who have conserved native species have cooperated to continuously preserve native crops and develop local specialties. In areas where regional conservation efforts are occurring, the importance of PGRFA conservation is being publicized through education and cultural activities.

Conservation by cultivation on-farms is incorporated in the process of production, meaning that many varieties are not conserved in one place. This method is susceptible to social and economic changes, so it is often difficult to maintain continuity and uniformity. Even so, because activities of this kind take place in many areas, this helps retain crop diversity in Japan.

TABLE 3-2-1

Edible plants that are found or originated in Japan (Saburo Kumazawa, 1953)

- *Allium ledebourianum* (asatsuki)
- *Aralia cordata* (udo)
- *Brasenia schreberi* (junsai)
- *Cryptotaenia japonica* (mitsuba)
- *Equisetum arvense* (sugina/tsukushi)
- *Lilium auratum* (yama-yuri)
- *Lilium lancifolium* (oni-yuri)
- *Lilium maximowiczii* (ko-oni-yuri)
- *Oenanthe stolonifera* (seri)
- *Petasites japonicus* (fuki)
- *Phellopterus littoralis* (hama-bohu)
- *Polygonum hydropiperi* (tade)
- *Pteridium quilinum* (warabi - bracken)
- *Salsola komarovi* (oka-hijiki)
- *Suaeda glauca* (matsuna)
- *Tetragonia expansa* (tsuruna)
- *Wasabi japonica* (wasabi)
- *Zanthoxylum piperitum* (sansho)
- *Zingiber mioga* (myoga)

CHAPTER 3

EX SITU CONSERVATION

3.1 NIAS gene bank for biological resources in agriculture

3.1.1 Outline

To streamline the collection, storing, and evaluation of PGRFA, which was previously performed by several research institutes of the Ministry of Agriculture, Forestry and Fisheries (MAFF), the gene bank system* was established in 1985. This MAFF project for plants, microorganisms and animals was coordinated by the National Institute of Agrobiological Sciences (NIAS) that acted as a the Center Bank. Other research institutes in the ministry provided support to the Center Bank.

In 1986, officers in charge of genetic resource project management, and two genetic resource sections were set up at NIAS where the Center Bank was located, in a move to enhance the national gene bank system of plants, microorganisms, animals in the areas of food and agriculture.

In 2001, NIAS became an independent corporation after absorbing other agricultural research institutes, and the name of the project was changed to the "agrobiological gene bank project". In 2006, this independent corporation, NIAS, carried out a major reorganization of its system, creating units responsible for plants, microorganisms, animals and DNA in this project. Currently, 28 staff work in gene bank related areas at NIAS.

At NIAS, PGRFA preservation facilities include a cold storage room for long-term seed storage (temp. -10°C, relative humidity 30%, storage capacity 200,000 seeds), cold seed storage room for germplasm for distribution (temp. -1°C, relative humidity 30, storage capacity 400,000 seeds), an ultra-low-temperature (liquid nitrogen) storage chambers, and a database system for genetic resource management.

The plant section of the agrobiological gene bank project functions with NIAS as its central bank and the following facilities are sub-banks: the National Agriculture Research Center, the National Institute of Crop Science, the National Institute of Fruit Tree Science, the National Institute of Floricultural Science, the National Institute of Vegetable and Tea Science, the National Institute of Livestock and Grassland Science, the National Agricultural Research Center for Hokkaido Region, the National Agricultural Research Center for Tohoku Region, the National Agricultural Research Center for Western Region, the National Agricultural Research Center for Kyushu Okinawa Region, the Japan International Research Center for Agricultural Sciences, the National Center for Seeds and Seedlings, and the National Livestock Breeding Center.

The gene bank project promotes activities in the following five areas:

1. Exploration, collection and introduction of genetic resources;
2. Classification, characterization, evaluation of genetic resources;
3. Maintenance and distribution of genetic resources, and supply of relevant information;
4. Development and distribution of DNA materials and supply of relevant information;
5. Collaborative study of biogenetic resources with other countries.

A total of 243,463 PGRFAs were stored in the gene bank system as of March 31, 2008.

* NIAS Genebank http://www.gene.affrc.go.jp/about_en.php

3.2 Monitoring and collection activities

In the gene bank project, priority is placed on PGRFA, due to genetic erosion and environmental degradation. PGRFA are sources of genes to cope with future problems such as global warming. Efforts to search for, collect and analyze PGRFA are taking place in Japan and abroad. Between 1999 and 2007, 40 collecting mission were conducted in 24 countries and regions based on research cooperation agreements, and on 64 occasions in 36 prefectures of Japan. Various types of PGRFA were collected as a result (Tables 3-3-1, 3-3-2). These collected PGRFA were then stored in the PGRFA gene bank after multiplication and characterization; they can be distributed worldwide upon request for use as research materials.

TABLE 3-3-1

Overseas collaborative studies and analyses since 1999

Year	Country/region	Target crop
1999	Greece Thailand Myanmar Spain Myanmar	Vegetables Sugarcane Rice group Citrus Preliminary survey: miscellaneous grains, crops for special use
2000	Myanmar Vietnam Myanmar Italy, France, Spain Bhutan	Rice group Legumes Miscellaneous grains, konjak Family of feed crops Preliminary survey: for all crops
2001	Australia Myanmar Myanmar Taiwan	Preliminary survey: wild rice Legumes Family of feed crops Preliminary survey: tropical vegetables, fruit trees
2002	Australia Myanmar Turkey Vietnam	Wild rice plant Legumes Preliminary survey: fruit trees Tea
2003	Russia, Azarbaijan Turkey South Korea Vietnam Pakistan Russia China	Sugar beet Fruit trees (stone fleshy fruits) Fruit trees (Japanese persimmon) Tea Mulberry Preliminary survey: for all crops Preliminary survey: for all crops
2004	Myanmar	Wild rice
2005	Papua New Guinea Myanmar Vietnam Russia China Myanmar	Rice group, legumes Rice group Glutinous yam Tartary buckwheat Fruit trees Vegetables
2006	Senegal, Guinea Bulgaria Papua New Guinea China Myanmar	African rice plant Feed crops Rice group, legumes Fruit trees Preliminary survey: for all crops
2007	South Korea (Cheju) Laos India Bhutan	Fruit trees (citrus) Vegetables (gourd family, *Solanaceae*) Legumes, miscellaneous grains Legumes, miscellaneous grains

TABLE 3-3-2

Domestic collection and analyses for Japan's gene bank since 1999

Year	Prefectures	Target crop
1999	Tochigi, Shizuoka, Aichi Niigata, Toyama, Fukui, Ishikawa Kagoshima Nagano, Kyoto Okinawa Oita, Kumamoto, Miyazaki	Crops for special use (buckwheat) Miscellaneous grains, etc. Crops for special use (sugarcane) Fruit trees (nankin cherry) Legumes (azuki bean) Crops in general
2000	Fukushima Tottori, Okayama, Ibaraki, Tochigi Kochi Kagoshima, Okinawa Mie, Hokkaido Nagasaki	All types of crops Legumes (azuki bean) Fruit trees (pear) Fruit trees (orange) Flower (superb pink) Tea
2001	Niigata Niigata, Yamagata Nagano Nagano, Aichi Miyazaki, Kagoshima, Nagasaki Tokyo (Bonin Island) Nagasaki	All types of crops All types of crops Legumes Crops for special use (sesame, beefsteak plant) Forage crops, etc. (oat) Fruit trees (orange) Tea
2002	Aichi (north) Chiba (Boso peninsula) Kagoshima (Amami-oshima island) Kagoshima Okinawa Okinawa	All types of crops Legumes (wild soybean) Potato (sweet potato) Crops for special use (Swiss chard) Fruit trees (fig) Tea
2003	Ishikawa, Toyama Aichi, Gifu Iwate Aomori, Okinawa Hokkaido	Crops in general Crops for special use (sesame seed, beefsteak plant) Legumes (wild soybean) Fruit trees (peach) Mulberry
2004	Kagoshima, Miyazaki Nagano Yamanashi, Nagano Tokushima, Kochi Tokushima, Kochi Hokkaido	Crops for special use (sugarcane) Fruit trees (sweet chestnut) Fruit trees (related species) Legumes (wild soybean) Crops for special use (beefsteak plant) Mulberry
2005	Aomori, Akita, Iwate Yamagata Hokkaido, Kagoshima (Yakushima) Kagoshima, Miyazaki Akita, Tochigi, Ibaraki, Kochi, Saga Akita, Yamagata, Iwate, Aomori Hokkaido	Fruit trees (pear) Fruit trees (plum, pear) Fruit trees (blueberry relatives) Vegetables (*Brassicaceae*) Legumes (wild soybean, wild azuki bean) Legumes (soybean) Flowers (azalea)
2006	Kochi Aichi, Mie Kagoshima, Chiba, Shizuoka, Miyazaki, Nagasaki Kumamoto, Kagoshima, Ibaraki Ishikawa, Toyama Shimane Nagano, Yamanashi Aichi, Hiroshima Fukushima, Ibaraki Yamagata	Legumes (wild soybean) Crops for special use (sugarcane) Forage crops (giant reed) Feed crops (Italian ryegrass) Vegetables (cruciferous vegetables) Tea Fruit trees (apple relatives, pear relatives) Fruit trees (blueberry relatives) Legumes (wild soybean) Fruit trees (plum)
2007	Kochi, Ehime Shiga Tottori, Hyogo, Kyoto, Saga, Fukuoka, Oita Shizuoka, Akita, Nagano, Fukushima, Tochigi, Chiba, Ibaraki Toyama, Ishikawa Nagasaki (Tsushima-shi, Nagasaki-shi) Toyama Nagano Yamagata Ibaraki Shizuoka, Tochigi Wakayama, Shimane, Ehime, Ibaraki Hokkaido	Crops for special use (sugarcane) Coarse cereals (Italian millet, Japanese millet, sorghum) Legumes (soybean, wild soybean, azuki bean, cowpea) Legumes (wild soybean) Fruit trees (Toringo crabapple, Japanese pear) Fruit trees (citrus) Fruit trees (blueberry relatives) Legumes (wild soybean, wild azuki) Legumes (wild soybean, wild azuki) Legumes (wild azuki) Legumes (wild azuki) Forage crops (giant reed) Fruit trees (blueberry relatives)

3.2.1 Preservation

At the gene bank, seeds with reduced water content reduced to 5-7% are preserved by, in principle, by the following two methods to reduce risks:

1. For long term storage germplasm is stored in vacuum-sealed in a brass can and then stored in a 140 m^3 of storage room at a temperature of -10°C and relative humidity 30%.
2. Germplasm for distribution is stored in a plastic container and then placed in a 1000 m^3 of storage room (medium term seed storage) at a temperature -1°C and relative humidity 30%.

Vegetatively propagated crops are, in principle, conserved in field genebanks. However, winter buds of mulberry are collected in January and February and cryo-preserved in liquid nitrogen.

Not all strains of the vegetatively propagated crops have back up double preservation so ways to address this are being sought. Due to the land, labor and other costs associated with conservation of vegetative materials ways to cryo-preserve this material is being investigated. The regeneration of preserved PGRFA is being carried out under appropriate cultivation conditions experienced researchers. All efforts are being made to reduce the chances of genetic changes during regeneration.

3.2.2 Collection

Table 3-3-3 shows the collection of plants kept at the gene bank. There are three types of collections at the gene bank: (a) A working collection managed by researchers that evaluate plants' properties in detail, (b) A base collection managed by the gene bank after the completion of basic characterization and evaluation, and (c) An active collection comprising plants and strains of the base collection that are ready for distribution. In 2007, a total of 243,463 accessions were stored in the gene bank, consisting of 29,874 accessions in the working collection, 213,589 in the base collection, and 136,182 in the active collection.

By plant type, there were 44,224 accessions of rice, 62,333 accessions of the wheat group, 18,956 accessions of the bean group, 8,889 accessions of the potato group, 19,058 accessions of miscellaneous grains and crops for special use, 33,099 accessions of forages and pasture grass, 10,300 fruit trees accessions, 27,224 accessions of vegetables, 5,873 accessions of flowers and other ornamental plants, 7,547 tea accessions, 2,178 mulberry accessions, 418 tropical/sub-tropical plant accessions, and 3,364 accession in other crops groups.

The number of PGRFA managed at the gene bank has increased by 63,847 in the base collection and 50,035 in the active collection over the past ten years (1997 to 2007). The size of the active collection will continue to be increased, so that all the preserved PGRFA are, in principle, kept in the active collection.

In addition to these three collections, gene bank scientists are developing core collections. Based on genetic diversity analysis of a large collection of a crop group a small set of accessions that represents most of the genetic diversity in the entire set is selected. The core collections produced by gene bank scientists include rice, azuki bean, mungbean, corn, and *Amaranthus*. Core collections are being developed for sorghum and citrus, but the preserved PGRFA is currently inadequate in quantity. To develop a viable core collection, it is necessary to cooperate with overseas research institutes and expand the coverage of genetic resources for each crop group.

All the information on the conserved PGRFA is maintained in databases linked to the web. The history, properties, storage conditions and other relevant information have been stored in a database system with search functions. All the information, which used to be stored in books and cards, has been electronically processed and is now stored in databases that can be accessed at the NIAS gene bank website.

Methods to analyze and evaluate genetic properties of PGRFA have diversified as a result of advances in molecular techniques. The gene bank has prepared manuals on the evaluation of PGRFA, specifically primary characteristics (morphology), secondary characteristics (disease resistance and stress tolerance), and tertiary characteristics (crop yield and quality). The information is publicly available. Further, genetic marker information for rice, adzuki and black gram is available. The gene bank has developed an illustrated genetic resources database and also a plant collection location search system to make the gene bank databases more user friendly.

TABLE 3-3-3

Major plants preserved at the gene bank and number of accessions (2007)

Category	Total Working collection + Base collection	Preservation classification			
		Working collection	Base collection	Active collection	Vegetative
Rice group	44,224	823	43,401	33,432	9
Wheat group	62,333	1,455	60,878	38,309	73
Bean group	18,956	1,002	17,954	13,246	1
Potato group	8,889	666	8,223	4,280	8,464
Miscellaneous grains, crops for special use	19,058	1,665	17,393	11,144	4,065
Feeds and pasture grass	33,099	6,285	26,814	16,140	4,891
Fruit trees	10,300	3,025	7,275	4,817	10,213
Vegetables	27,224	7,795	19,429	11,215	1,509
Flowers, afforestation plants	5,873	3,341	2,532	494	5,772
Tea	7,547	1,460	6,087	1,352	7,546
Mulberry	2,178	495	1,683	1,386	1,423
Tropical/subtropical plants	418	67	351	18	380
Other plants	3,364	1,795	1,569	349	1,469
Total	**243,463**	**29,874**	**213,589**	**136,182**	**45,815**

Reference: Major plant groups preserved at the gene bank and number of accessions (1994, from Japan Country Report, First issue)

Category	Total Working collection + Base collection	Preservation classification			
		Working collection	Base collection	Active collection	Vegetative
Rice group	28,450	4,623	23,827	17,395	257
Wheat group	56,968	3,582	53,386	24,140	417
Bean group	15,126	2,439	12,687	8,824	0
Potato group	5,762	900	4,862	3,866	5,120
Miscellaneous grains, crops for special use	10,186	1,663	8,523	6,414	2,649
Feeds and pasture grass	42,330	25,678	16,652	11,020	8,545
Fruit trees	8,082	2,416	5,666	3,941	8,081
Vegetables	22,545	10,014	12,531	5,844	1,419
Flowers, afforestation plants	4,448	2,755	1,693	288	4,395
Tea	5,712	929	4,783	851	5,712
Mulberry	2,084	491	1,593	213	2,084
Tropical/ subtropical plants	888	726	162	161	218
Total	**202,581**	**56,216**	**146,365**	**82,957**	**38,897**

* There was no "Other plants" category in the 1994 report.

3.3 *Ex situ* conservation other than in the gene bank

3.3.1 Prefectural institutions

Prefectures and other local municipalities have agriculture-related research institutions, where efforts are centered on research into cultivation methods suited to local environments. These institutes test new breeding lines developed by government agencies, conduct research on local specialties and other studies to address local needs. Some research themes were pursued jointly with government agencies and businesses. Conservation of genetic resources by these prefectural research institutions (see Table 3-1-2) is basically carried out with local crops as the main objective.

3.3.2 National Bio Research Project (NBRP)

The National Bio Research Project (NBRP) was developed to collect, preserve, and supply bio-resources (animals, plants) - animals and plants used in experiments by university researchers, ES cells and other stem cells, and genetic materials of various creatures—that are the basis of life science. The project aims to improve the quality of these bio-resources, develop preservation techniques, and analyze genomes, develop value added resources in a way that meets current needs. The functions of the NBRP information center on bio-resources will be strengthened.

3.3.3 Future goals and challenges

In the future two important activities for *ex situ* management of PGRFA in Japan are to further collect PGRFA and to accelerate double-preservation of all germplasm to ensure their long-term safety. These challenges have both domestic and international dimensions.

In Japan the *ex situ* conservation of plants, other than rice, wheat and other grains and vegetables that have already been collected, are expected to become increasingly important. Varietal diversity of many crops is in decline due to the greater efficiency of commercial agriculture. This makes it increasingly urgent to collect these varieties. At the same time, greater attention is being paid to indigenous crops, for which demand is likely to grow in the future.

International challenges include the expansion of PGRFA's *ex situ* conservation and enhanced global information on conserved PGRFA. In particular, regions that are developing rapidly, particularly in Asia, invaluable PGRFA are at risk. There is therefore an urgent need to obtain basic information on the location of PGRFA and to speed up the collection of PGRFA.

In Japan it is necessary to develop low-cost preservation techniques. Regarding vegetatively propagated plants, cryo-preservation using liquid nitrogen is being introduced to supplement field gene bank operations. Cryo-preservation, however, still has some problems such as complicated and time consuming pre-freezing procedures and the low regeneration rate of some preserved species. Costs must also be reduced and procedures simplified for the practical application of this technique.

An international dimension to duplicate-preservation of Japanese germplasm includes regeneration in suitable areas. Even if the seeds are preserved at low temperature or by cryo-preservation, their germination rate and other qualities are bound to decline as time passes. This makes it necessary to regenerate the preserved seeds and this can lead to genetic changes. Since many plants conserved in Japan are not adapted to the climate of Japan it is necessary to seek partners in other countries to assist with regeneration.

Among crops conserved *ex situ* rice, wheat and other major crops are collected from many parts of the world. For some other crops, varieties are lacking due to collection in only part of the distribution range and inadequate quantity of seeds conserved of accessions. In some crops, resistance to local diseases and harmful insects is lacking and crops with characteristics necessary for future crop improvement are not available. To cope with these problems, it is necessary to enrich the germplasm collection. Efforts are being made to expand *ex situ* collections by conducting further joint research within the framework of memoranda of understanding (MOU) with genetic resource institutions in Asia and other regions. Other challenges include the regeneration of out-crossing plants, regeneration under enhanced protection from epidemics and inclement weather, introduction of genetic resources from other nations, and reaching agreement on profit sharing.

CHAPTER 4

USE OF PLANT GENETIC RESOURCES

4.1 Distribution of plant genetic resources

For distribution of PGRFA, those who want germplasm submit a request for germplasm to the gene bank. The PGRFA is then provided to the applicant after certain procedures, including the signing of a material transfer contract. (Table 3-4-1 Distribution points by crop at the gene bank, and Table 3-4-2 Distribution points by recipient at the gene bank)

In the domestic seed growing business, mainly the central government and prefectural institutions produce seeds of rice, wheat, soybeans, and potatoes for farmers. The gene bank cooperates with these institutions to preserve and use these germplasm of these crops; genetic resources kept at the gene bank are being used for improvement of these crops. Mainly private seed firms and individuals, however, grow flowers and vegetables for seed. Their link with the gene bank is less strong.

TABLE 3-4-1

Number of accessions distributed by crop from the gene bank

Category	2003	2004	2005	2006	2007
Rice group	1,472	1,452	951	1,782	1,591
Wheat group	898	103	2,462	2,613	2,611
Bean group	8,218	2,000	780	998	1,256
Potato group	23	9	44	54	55
Miscellaneous grains, crops for special use	223	348	662	2,511	284
Feeds and pasture grass	881	38	118	462	114
Fruit trees	20	11	0	30	21
Vegetables	537	476	784	205	133
Flowers, ornamental plants	8	1	77	28	33
Tea	0	0	0	0	0
Mulberry	1	5	13	10	15
Tropical/subtropical plants	1	0	0	1	1
Core collections	-	-	-	7	36
Total	**12,292**	**4,443**	**5,891**	**8,701**	**6,150**

TABLE 3-4-2

Number of accessions distributed from the gene bank by recipient

Year	Independent corporation, Public research institute	University	Private sector, etc.	Foreign countries	Total
2003	4,468	7,424	160	240	12,292
2004	3,418	621	238	166	4,443
2005	4,652	350	171	718	5,891
2006	6,736	1,732	175	58	8,701
2007	4,977	805	251	117	6,150

Reference: Number of accessions distributed from the genebank by recipient (1994 Japan Country Report 1st issue)

Year	Independent corporation, Public research institute	University	Private sector, etc.	Foreign countries	Total
1990	5,651	896	482	373	7,402
1991	5,394	850	380	691	7,315
1992	7,235	505	172	452	8,374
1993	3,997	444	283	1,034	5,758
1994	5,459	372	206	692	6,729

4.2 Use of plant genetic resources in breeding

In Japan, PGRFA are a basic component of plant breeding. To develop low-amylose wheat the gene bank was searched for low-amylose wheat accessions. As a result Chikugoizumi, Ayahikari and other low-amylose wheat strains were bred. These varieties enable noodles with improved viscosity to be made and they are used as a material for udon noodles. Soybeans lacking lipoxygenase were found in a mutant soybean line and this has led to the new varieties Elster and Suzusayaka for processed foods. A tropical indigenous strain of sesame has been found that contains a large amount of lignan. These cases illustrate the use of gene bank PGRFA.

An example of major effort to improve disease resistance in Japan's major rice variety Koshihikari was the development of the breeding line Koshihikari BL with several rice blast resistant genes. For further advances are needed in the following areas:

1. Development of human resources for crop evaluation and screening.
2. Training of research aides.
3. Development of screening technique for traits that are difficult to breed breeding for.
4. Enrichment of the core collections.

As a way of addressing (1) and (2) above, technical training programs have been initiated for research aides, resulting in improved germplasm management and the ability to evaluate accessions. These improvements are expected to accelerate the accumulation of quality information on plant germplasm. As for (3), it has been difficult to study quantitative traits, however, molecular assisted selection is now becoming routine in plant breeding of some crops such as rice, wheat, and soybeans.

4.3 Supply of seeds

Seeds used in plant breeding are produced, distributed and sold by groups that have concluded a consent agreement with the breeders. Rice, wheat, and soybeans seeds are often produced and distributed by public institutions and cooperatives, but some new seeds and seeds for special purposes are sometimes produced and sold by private seed and seedling companies. These private seed and seedling companies mostly supply vegetables and flower seeds.

Seeds of some crops that are being promoted as local specialties are sometimes produced and distributed by prefectural organizations. Some minor crops such as sesame and beefsteak plant sesame seeds are extremely difficult to obtain; only a few seedling companies sell them.

The gene bank does not distribute seeds directly to farmers; the gene banks main purpose is to assist scientists, particularly plant breeders.

4.4 Use of indigenous crops and market expansion

Indigenous crops are receiving increased attention from the public and they are being cultivated as local specialties. To expand the market for these plants and other crops there are challenges related to how to secure a stable supply of these crops and develop a market niche for them. Regarding supply stability, it is necessary to have producers who understand how to grow the crops so that they can provide a stable supply for consumers; regarding market niche development, the

challenge is how to secure sufficient demand. If indigenous crops are to be used as local specialties, it is commercially important to maintain the quality of seeds and seedlings and restrict their distribution.

Some institutions provide support for the establishment of local varieties of indigenous crops and assist in their market expansion. An example is the Meister system for local specialties. This system is designed to recognize and register people with years of experience and outstanding technical capabilities in the cultivation and processing of area-specific crops and those who can be leaders in crop cultivation. Such people can help in production and development of local specialties by promoting the development of techniques, mutual exchange, education and organizational ability. A total of 133 people were certified throughout the country under the system in 2007.

4.5 Breeding trends

Mainly national and public agricultural research institutions carry out breeding of major crops such as rice, wheat, soybeans, while private seed companies generally handle flowering plants and vegetables. Breeding lines generated by national and public agricultural research institutes undergo evaluation at prefectural agricultural research centers.

In Japan the number of bred and registered strains of rice rose to 572 as of April 2008. The cultivation of Koshihikari, one of the major rice varieties, occupied the largest rice area in fiscal 2006 (37%). As for other crops, Hokushin wheat occupied 49% of the total cultivated wheat area in 2006 and Fukuyutaka soybean accounted for 23% of the soybean area in 2005. These varieties have good taste, are easily processed, and high yielding. However, they are susceptibility to some harmful insects, humidity, pre-harvest sprouting and other problems that pose a challenge to plant breeders.

It requires 5-10 years to attain breeding targets, and breeding objectives are based on this time period. The direction of plant breeding over the next ten years will include marker-assisted selection using genome information for various environment stress tolerance factors including disease and pest tolerance, high temperature/excess water tolerance, and pre-harvest sprouting tolerance. Some research focuses on high yields to improve the productivity of forages and biomass.

4.6 Future technology trends in plant genetic resources

Currently, crossbreeding and mutation breeding are predominantly used, but marker-assisted selection of quantitative traits in some crops such as rice and soybean is becoming routine. In the future, marker-assisted selection and transgenic technologies will likely play an increasingly important role in plant breeding. As demand is expected to increase for useful traits from genetic resources wild plants closely related to crops that grow in diverse environments are likely to be intensively evaluated.

CHAPTER 5

STATE PLANS AND LAWS

In Japan, the Seeds and Seedlings Act is the most important law regarding PGRFA. The first agricultural seeds and seedlings law was enacted in 1947. This law was revised in 1978 when a crop registration system was introduced. A further revision to the law was made 1998 so it would be compatible with the UPOV Agreement (revised in 1991) as part of the drive to establish intellectual property rights. The law was then revised several times and the current law dates to 2007. Under the law, systems for crop registration for the protection of new strains and for labeling of designated seeds and seedlings are stipulated to promote cultivation and adjust the distribution of seeds and seedlings, ultimately contributing to the progress of agriculture and forestry in Japan.

Japan has the following State plans in relation to PGRFA: the National Biodiversity Strategy of Japan and the Biotechnology Strategy Guidelines, both created by the government, the Biodiversity Strategy of MAFF created by the Ministry of Agriculture, Forestry and Fisheries, and the Intellectual Foundation Improvement Project by the Ministry of Education, Culture, Sports, Science and Technology.

The Third National Biodiversity Strategy of Japan, which was created in November 2007, comprises two parts—Part 1 "Strategies" and Part 2 "Action Plans."

Part 1 "Strategies" explains in easy-to-understand language the importance of biodiversity, while making reference to the growing effects of global warming. It also introduces the 100-Year-Plan for restoration of the nation's ecosystem to its initial state, a desirable situation from the viewpoint of biodiversity, which has been damaged over the past 100 years. With emphasis on the need for participation by local and private sectors, Part 1 summarizes basic strategies in the following four areas that should be dealt with over the next five years: (1) Dissemination of biodiversity in society, (2) Reconstruction of the people-nature balance in local areas, (3) Enhancement of ties linking forests, villages, rivers, and oceans, and (4) Actions with a global perspective.

In Part 2 "Action Plans," concrete measures are described systematically and in an all-inclusive manner. Numerical targets are set, such as raising the rate of biodiversity recognition from 30% to more than 50%. The responsible government offices are also clearly identified.

The Ministry of Agriculture, Forestry and Fisheries created the Biodiversity Strategy of MAFF in July 2007, ahead of the National Biodiversity Strategy of Japan to gain a better understanding of biodiversity and genetic resources in agriculture, forestry and fisheries.

Its basic policies are as follows:

- The promotion of strategies for agriculture, forestry and fisheries with greater emphasis on the conservation of biodiversity;
- The promotion of public understanding of agriculture, forestry and fisheries and biodiversity; measures that utilize various local ideas;
- Contribution to protection of the global environment through agriculture, forestry and fisheries.

As for PGRFA, efforts are being made to preserve genetic resources useful to agriculture, forestry and fisheries, promote their sustainable use and examine the possible effects on biodiversity from genetically-recombined agricultural products. With these efforts, the country's biodiversity is secured.

In March 2001, the Cabinet decided the Basic Policy for Science and Technology in Japan, in which intellectual resources infrastructure including biological resources is stressed. This is based on the concept that to promote advanced, original and basic R&D requires the systematic development of intellectual resources infrastructure such as research materials and measurement standards to support stable and effective R&D activities. Subsequently in 2005 and 2006 changes were made to emphasise the quality of intellectual resources infrastructure to respond to scientific demand. To promote this policy and achieve global leadership in various fields, relevant governmental agencies and other institutions cooperate. Among them, the NIAS that coordinates a gene bank for PGRFA is one of the key research institutes for implementation of the basic policy and also contribution to the global efforts to conserve PGRFA.

The Biotechnology Strategy Guidelines, drafted in December 2002, sets out the Government of Japan's policy on biotechnology, that includes three strategic areas; accelerated R&D, enhanced industrialization, and informed public

acceptance. These strategies will provide benefits for society by promoting health, food security and food safety, improved food functions for sustainable development of industry and society. In this context, it is essential to conserve and conduct research on biological resources including PGRFA based on international cooperation.

CHAPTER 6

COOPERATION AT LOCAL AND INTERNATIONAL LEVELS

Many regions that are rich in PGRFA, both cultivated germplasm and wild germplasm the technology to conserve these genetic resources is poorly developed. Against this backdrop, the following activities have been carried out in cooperation with the Japan International Cooperation Agency (JICA) and other Japanese overseas support organizations, governmental agencies and also with international institutions such as Bioversity International.

1. Using Japanese oversea development assistance funds gene banks were set up using ODA in Sri Lanka, Chile, Pakistan and Myanmar for the conservation of genetic resources. Furthermore, JICA and the National Institute of Agrobiological Sciences cooperate to conduct various projects, including a group training course on the sustainable use of plant genetic resources, with the aim of human resources capacity building for those who handle genetic resources in developing nations.
2. To enhance the *ex situ* preservation of PGRFA, efforts are being made to build up cooperative ties with South Korea, China, and Mongolia in cooperation with Bioversity International Regional Office for Asia, the Pacific and Oceania and share information on genetic resources and activities to conserve these. Joint research projects have been conducted in Vietnam, Central Asia, and South Korea.
3. Japan is supporting FAO's activities to develop a PGRFA information network. Financial aid was given for a three-year project (2003-2006) to FAO to assist seven Asian nations (India, the Philippines, Bangladesh, Malaysia, Thailand, Vietnam and Sri Lanka) develop comprehensive PGRFA information system. Japan will continue cooperation with FAO will continue in developing the information sharing network on genetic resources in Asia and support will be given for efforts to collect and manage such information.

Based on mutual understanding on PGRFA between Japan and other countries, MOU have been developed with various research institutes (Table 3-6-1). Based on MOU local genetic diversity are analyzed, in addition to conducting on-site surveys to gather information, which is essential for securing the local conservation of genetic resources. These collaborative activities have been conducted with: Chile (tomatoes, 1996-1998), Indonesia (sweet potatoes, 2001-2003), South Korea (sesame, beefsteak plant, 2002-2004), Sri Lanka (wild rice, legumes, 2000-2002), Vietnam (indigenous rice, 1999-2001), Papua New Guinea (wild rice, legumes, 2004-2006), Laos (vegetables, 2007-), and Tamil Nadu province of India (miscellaneous grains, legumes, 2007-). The research results are open to the public on the Annual Report on Exploration and Introduction of Plant Genetic Resources, a report published by the gene bank.

TABLE 3-6-1

Examples of the Memorandum of Understanding (MOU)

Country, region	Intended crop	Other Cooperation	Period
Chile	Tomato	INIA	1996-1998
Vietnam	Rice plants	DSTPQ, MARD	1999-2001
Sri Lanka	Wild rice plants & *Vigna*	DA, MOA	2000-2002
Indonesia	Sweet potato	IAARD	2001-2003
Thailand	Sugarcane, etc.	DA, MOA	2001-2005
Vietnam	Crops in general	DSTPQ, MARD	2002-2006
South Korea	Beefsteak plant	NCES/NIAS, RDA	2002-2004
Russia	General	Vavilov Research Institute of Plant Industry	2003-2008
Papua New Guinea	Wild rice, legumes, etc.	NARI	2004-2006
The Uighur [Uyghur] Autonomous Region (of China)	Fruit trees	ICGR, XAAS	2004-2007

Country, region	Intended crop	Other Cooperation	Period
Laos	Cereal, legumes, etc.	NARI	2007-2010
Tamil Nadu province of India	Crops in general	TNAU	2007-2010

CHAPTER 7

RESPONSE TO INTERNATIONAL MOVES ON PLANT GENETIC RESOURCES

Since joining the Convention on Biological Diversity (CBD) in 1993, Japan has actively participated in and contributed to various working-level meetings on access to genetic resources, benefit sharing, protected areas and other topics. Japan is also the largest financial contributor (22% of the total) for the implementation of the convention. The 10th Conference of the Parties (COP) will be held in Nagoya City, Aichi Prefecture, in 2010.

For the national implementation of the Convention, the National Biodiversity Strategy of Japan was formulated at a Cabinet ministers' meeting on the protection of the global environment held in October 1995, based on Article 6 provisions. In November 2007, the Third National Biodiversity Strategy of Japan was formulated at a Cabinet ministers' meeting.

Regarding the Cartagena Protocol on Biosafety at the convention, it is designed to give adequate protection to the safe transportation and handling of living modified organisms (LMO) that may negatively affect the biodiversity and its sustainable use, especially when these are moved across national borders. Japan ratified the protocol in November 2003 after modifying its national collateral law. The Protocol came into effect the following year, February 2004, and the national collateral law was promulgated in the same month.

In 1991, Japan also became a signatory to the International Union for the Protection of New Varieties of Plants (UPOV), which is designed to protect the rights of growers of new plant varieties, based on unified international standards. Based on UPOV, Japan strives to improve the seeds/seedlings law, and protect and promote the growers' rights in Japan and overseas.

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR) plays an important role in conserving PGRFA and promoting their sustainable use. However, details have yet to be set for the operating rules, and the relationship with the protection of intellectual rights is not yet clear. These and other problems will be dealt with while adjustments are made by to national laws and by determining the international strategy regarding this Treaty.