LEARNING ABOUT 2.5.1 5.2 INDICATORS

SDG Indicators 2.5.1 and 2.5.2 – Plant and animal genetic resources

Lesson 2: Plant genetic diversity for food and agriculture

Text-only version

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Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

working for Zero Hunger

In this lesson

This lesson introduces the concept of plant genetic resources for food and agriculture.

It describes how these resources are under threat due to socio-economic pressures and a changing environment, explains why it is important to conserve them and illustrates the main methods of conservation. It is the first of three lessons that focus on plant genetic resources for food and agriculture (PGRFA).

Learning objectives

At the end of this lesson, you will be able to:

- define the different types of plant genetic resources for food and agriculture (PGRFA);
- describe the main threats to plant genetic resources;
- explain why it is important to conserve plant genetic resources;
- illustrate the main ways to conserve plant genetic resources.

Plant genetic resources for food and agriculture: definition

Asha: *"Plant genetic resources for food and agriculture include any genetic material of plant origin of actual or potential value for food and agriculture. They fall into three categories:*

1. ***Domesticated plant species (Crops)***
2. ***Wild food plants***
3. ***Crop wild relatives"***

Example

Asha works for the Ministry of Agriculture. She is Head of the Unit responsible for plant genetic resources. Her government has appointed her as National Focal Point for Plant Genetic Resources. This means that she is responsible for reporting to FAO on the status of conservation and use of plant genetic resources for food and agriculture in her country.

Plant genetic resources for food and agriculture: Domesticated plants species (crops)

We use hundreds of species of **domesticated plant species (crops) for food, fibre**, or **as animal feed**. They include major staples like rice, wheat and potatoes, fruits and vegetables, oilseeds, fibre crops such as cotton, forage grasses and legumes.

Domesticated plants species (crops)

Farmers' varieties/landraces	Modern/improved varieties
Farmers' varieties/landraces have been **continuously selected** since the beginning of agriculture **to improve yields and quality**. Farmers save part of their harvest and use it for planting the following season. Over time, **this has led to** distinct **varieties** that are **well adapted to local conditions**: for example, soils, climates, diseases, as well as agronomical practices.	Since the late 19th century, scientists and commercial breeders have bred crops for specific characteristics, such as high yield, tolerances to environmental stresses, and resistance to pests and diseases. **Plant breeding consists of crossing one variety with another and testing the progeny to see if it performs well**. Progeny are selected and either directly released or further crossed to enhance and stabilize improvements.

The domesticated plants species (crops) include **farmers' varieties/landraces**, as well as **modern/improved varieties.** Many countries have programmes to preserve these resources, and make them accessible for research, improvement and direct use. This is to ensure their continued availability and contribution to a sustainable agriculture.

Plant genetic resources for food and agriculture: Crop wild relatives

All our crops were originally wild plants that humans have selected and bred so that they produce desirable traits such as bigger seeds, juicier flesh or better taste. **Crop wild relatives** thrive and continuously **evolve** in their natural habitats **without human intervention**. They are found on the edges of fields, on uncultivated land, in protected areas, etc.

Many crop wild relatives **have valuable genes** that we might need one day **to improve domesticated crops** - for example to provide resistance to a disease or greater tolerance to drought, flooding, acidic or saline soils. A number of valuable traits have already been identified and used for some crops from their wild relatives.

Teosintes

Native to southern Mexico, maize (corn) has been cultivated for thousands of years. The wild relatives of maize are known collectively as **teosintes**. Farmers in Mexico and Central America regard teosintes as weeds.

In 1977, Mexican biologist, Rafael Guzman, discovered a teosinte species, ***Zea diploperennis***, in a valley in south-central Mexico. This species **carries genes for resistance to seven viral diseases that affect maize**.

Genes from *Z. diploperennis* have been used to breed new maize varieties with resistance to maize chlorotic dwarf virus (MCDV).

Zea diploperennis has a restricted geographical range of just a few square kilometres, and is threatened.

Wild potato

In 1834, **Charles Darwin** observed **wild potatoes** in the southern Chilean archipelago of Los Chonos.

More than 130 years later, the Peruvian plant explorer Carlos Ochoa found, on the same island, wild potatoes that matched Darwin's description. This species was named ***Solanum ochoanum*** in his honour.

The species is tolerant to saline soils, and its genes could be used to introduce salinity tolerance into cultivated potato varieties.

The International Potato Center genebank holds more than 150 wild potato species.

Wild rice

Genes from *Oryza longistaminata*, a perennial grass native to Africa, have been **transferred to cultivated rice (*Oryza sativa*) to confer resistance to blight disease**.

Some populations have also shown tolerance to drought stress and could be used to improve the adaptation of rice varieties to areas with lower rainfall and without irrigation.

In many cases these crop wild relatives are threatened with extinction due to drivers such as habitat loss and climate change. As a result, conservation of these resources is urgent.

Plant genetic resources for food and agriculture: Wild food plants

Wild food plants are plants that people do not cultivate, but collect from the wild to eat. There are a surprising number of them. For example, many of the **leafy vegetables** eaten in Africa come from forests, highlands and roadsides. Wild **fruits and berries** are other examples.

It is important to conserve wild food plants because they are an **important source of nutrients**, especially **in emergencies** such as drought.

Wild vegetables in Kenya

Farmers in rural western Kenya **bridge the growing seasons by collecting various types of wild leafy plants** (Sesamum calycinum, Corchorus tricolaris, Amaranthus graecizans) along roadsides and field boundaries. They consume these as vegetables at home or sell them at the local market.

<u>**Drinn in the Sahara**</u>

Drinn (*Aristida pungens*) is a perennial grass **native to the northern Sahara**. It grows in tufts up to 1.5 m tall. Its black grains **used to be** the **most important source of wild cereals** in this region.

It is highly drought resistant and is found growing even on sand dunes.

<u>**Borgou in Mali**</u>

Bourgou (*Echinochloa stagnina*) is an aquatic grass **native to the Inner Niger Delta of Mali**. It used to cover one quarter of a million hectares of land, but now much has been replaced by rice. This land is flooded every year; the bourgou stems grow up to 3 metres tall to keep their flowers and seedheads above the water surface.

Local Fulani herders harvest **the seed** for use **as food and to make beverages**.

When the water recedes, animals can graze on the vegetation: it **feeds** an estimated **5 million cattle, sheep and goats for six months of the year**.

They might someday be cultivated, so we need to conserve the genetic material and prevent future loss.

A vast diversity of genetic resources needs to be preserved

Asha: *"There are roughly 390 000 plant species in all. Approximately 6 000 of these are used by man as agricultural and horticultural crops (excluding forestry and ornamentals). They represent a vast diversity of genetic resources that are important to conserve for the future."*

Kiran: *"These resources are a global good. All countries in the world depend on plants that originated elsewhere. So all countries have to play a role in their conservation.*

No country is self-sufficient; collaboration with other countries and international institutes is necessary."

Meet Kiran

Kiran is a researcher. He works for the National Plant Genebank of his country.

Threats to plant diversity

Kiran: *"Unfortunately, many crop varieties and even species, are at risk of being lost. Farmers' varieties/landraces are being replaced by new crops or modern/ improved varieties that deliver higher yields or have qualities that the market demands. There are many reasons for this: the supply of seed and other planting materials, economic pressures, changes in the environment, and government policies."*

PLANTING MATERIALS	• **Industrial agriculture** Large-scale farming systems tend to favour monoculture and fewer varieties of each crop. This often leads to a narrowing of the crop diversity in use. • **Commercial seed supply systems** Farmers traditionally keep and replant their own seed. However, they are increasingly using commercial seed suppliers who tend to sell only the top performing modern varieties, leading to a decline in the overall on-farm diversity. • **Supply of local varieties** The supply for seeds of farmers' varieties is often poorly organized. There are few commercial providers and few seed producers who conserve or market local farmers' varieties/landraces.
ECONOMIC PRESSURES	• **Low productivity** Even though they have desirable traits, farmers' varieties/landraces often produce lower yields than those of modern/improved ones. Farmers may regard modern/improved varieties as more prestigious and economically profitable than their traditional varieties/landraces, even though the modern/improved varieties may need greater inputs and investment. • **Market demands** Supermarkets and processing plants have stringent requirements for uniformity, appearance and quality, often met by modern/improved varieties. They may even specify which of these varieties the farmers should grow. • **Consumer demand** Globally, consumers' tastes are shifting towards more processed foods and away from traditional food types. The demand for traditional crops or varieties is declining. • **Changes in production systems** Traditional production systems, which tend to be more diverse, are being replaced by more input-intensive practices that rely on monoculture,

	mechanization and agrochemicals. These modern practices are designed to produce higher yields and greater uniformity.
ENVIRONMENTAL CHANGES	• **Climate change** Many plants are not equipped to cope with extreme and abrupt environmental variations. Such environmental changes will often lead to decreased survival. • **Loss of habitat** Land clearing, environmental degradation, overgrazing and human population pressure are reducing the habitat of wild food plants and crop wild relatives. • **Overharvesting** Many wild food plants are being overharvested, failing to allow for natural regeneration.
POLICY	➢ **Government policy** Governments encourage farmers to cultivate certain crops and high-yielding modern/improved varieties. Extension services promote these crops and varieties, neglecting others. Farmers may only qualify for loans and other types of support if they grow certain crops or varieties.

Why it is essential to conserve plant genetic resources

Kiran: *"In general, we need to **conserve diversity** among and within **species**, so that it can be made available and utilized.*
The main advantages of conserving diversity are to:"

➢ PROVIDE FOOD AND INCOME

Farmers need to be able to grow enough food for themselves and, ideally, a surplus to sell.

➢ DIVERSITY INCOMES

Relying too much on a single crop or variety is risky, since markets can change.

➢ DIVERSIFY NUTRITIONAL INTAKE

Typically, a single species, does not provide all the nutrients necessary for health and survival.
A rich and diverse diet is key to improving food security and nutrition.

➢ COPE WITH DIFFICULT CONDITIONS

Crop species and their wild relatives are adapted to a wide range of agro-ecological conditions. Some species, and varieties within them, are particularly tolerant to drought, flooding, frost or saline soils. It is important that farmers can choose the crops and varieties that are best adapted to their conditions.

- WITHSTAND PESTS AND DISEASES

  The lower the diversity of crops and varieties on-farm, the higher the risk that just one pest or disease could damage the entire harvest. By planting several species or varieties, farmers can minimize their risk if there is a pest or disease outbreak.
- IMPROVE YIELDS AND QUALITY

  The diversity within a crop species and/or its wild relatives is the basis of plant breeding. By selecting and crossing different varieties, it is possible to improve a crop's yields and characteristics (for example, its disease resistance, taste or shelf life).
- ADAPT TO CHANGING CONDITIONS

  The environment is constantly changing: pests and diseases are quick to adapt to these changes, and climate change is making farming even less predictable. Plant breeders and farmers will need all available diversity of crops and varieties to cope with these shifts.
- MEET CONSUMER DEMANDS

  Consumer tastes are also shifting. To meet the changes, farmers need to be able to choose from a wide diversity of plant varieties that meet these demands.
- MAINTAIN SOIL FERTILITY

  Monocultures can impoverish the soil, and often require farmers to apply fertilizers and pesticides that damage the environment. Mixed cropping, using diverse crops and varieties, can help to prevent such problems, as can rotating crops with different species (such as cereal-legume systems).

Conservation approaches for plant genetic resources

Kiran: *"There are two approaches to conserving plant genetic resources."*

In situ	***Ex situ***
Conserving plants where they grow naturally or are cultivated	Conserving genetic resources away from their natural habitat or agricultural landscape, such as in specially designed facilities

***In situ* conservation** of crop wild relatives and wild food plants **On-farm management** of farmers' varieties/landraces	**As: seeds, plants, plants tissues, pollen, DNA**

Conserving in situ

***In situ* conservation** of crop wild relatives and wild food plants.

For crop wild relatives and wild food plants, it is important to **protect them in their natural habitats**. For example, a country might set aside protected areas or nature reserves - as is done for nature conservation in general.

On-farm management of farmers' varieties/landraces

Farmers may **cultivate farmers' varieties/landraces** to eat, or to satisfy of cultural preferences. Policies that assist farmers to continue growing, reproducing, improving, storing and replanting the seed of their traditional crops and varieties support crop diversity and conservation.

***In-situ* conservation has advantages and disadvantages:**

Advantages	Disadvantages
✓ The plants, generation after generation, continue to interact with and adapt to the environment and its biotic and abiotic stresses ✓ Traditional knowledge and cultures for conserving and using these resources are maintained	× There is a risk of the plant populations or habitats being decreased or eliminated, for example due to a drought, natural disaster or changing land use × Farmers' varieties/landraces may be lost as farmers’ interests change

Conserving *ex situ*

Ex situ conservation is generally conducted in facilities called genebanks. The **main purposes of a genebank** are to:

- Conserve genetic materials over time
- Collect and document information about the germplasm
- Make the germplasm easily available
- Ensure the long-term availability of crop germplasm
- Sustain agricultural production and ensure food security

Germplasm

The genetic material that forms the physical basis of heredity and that is transmitted from one generation to the next by germ cells.

Genebanks usually divide their collections into two types:

1. ACTIVE COLLECTION

Aimed at making the material available to users through medium-term storage.

Material held in active collections is immediately available for multiplication and distribution for research, breeding, characterization, evaluation and utilization.

Below are characteristics and purposes of an active collection in seed genebanks:

- **medium-term** storage;
- temperature of **4°C**;
- relative humidity of **15 ± 3 percent**;
- accessions **immediately available** for multiplication and distribution for research, breeding, characterization, evaluation and utilization.

When an active collection runs out of seed of a particular accession, it **can be replenished by multiplying the seed from the base collection**. The best practice is to multiply an accession when the seed supply gets low, or when viability declines below a threshold, before it reaches a critical level

2. BASE COLLECTION

Aimed at storing genetic material, mainly for conservation and over the long term. Germplasm held in a base collection is not distributed directly to users.

Below are characteristics and purposes of a base collection in seed genebanks:

- **long-term** storage;
- temperature of **-18°C** or cooler;
- used to conserve **original samples** of the seed (where possible) in order to preserve its **genetic integrity**;
- purely for **conservation purposes**: seeds are not distributed directly to users.

The main activities of a genebank are:

- **Distribution**

Distributing clean, disease free seeds (or other planting material) to users.

- **Documentation/inventory**

Maintaining and making available detailed records on each accession, including its passport data (taxonomy, origin, etc.), characterization and evaluation data (morpho-agronomic description), as well as management data (site of storage, viability status, etc.). This makes it possible to properly manage the accession under storage and identify which accessions might be used for a particular purpose.

- **Characterization and Evaluation**

Measuring and documenting the traits of each accession according to standard descriptors. Characterization refers to traits that are expressed no matter where the characterization takes place (environmentally independent traits). Evaluation refers to traits whose expression is the results of the interaction between the genotype and the environment.

- **Acquisition**

Obtaining germplasm by collecting in the field, from plant breeders or from other institutes.

- **Processing**

Assessing the quantity, quality, including viability and health, of the samples, and preparing them for storage.

- **Storage**

Storing or otherwise maintaining the sample, as one **accession**[1] of the *ex situ* collection, in a cold store, laboratory, greenhouse or in the field.

- **Regeneration/multiplication**

Periodically rejuvenating and increasing the material e.g. by growing it out in the field and harvesting fresh seed to return to the cold store.

SEED GENEBANKS

Storing seeds is usually **the easiest and most convenient way to conserve** many plant genetic materials. It is also the most-used method: some **60 percent of the accessions** conserved are stored **in seed genebanks.**

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[1] An accession is a sample of seeds, planting materials or plants, representing a wild population, a farmer's variety or landrace, a breeding line or an improved cultivar, which is conserved in a genebank.
Each accession should be distinct and, in terms of genetic integrity, it should be as close as possible to the sample originally provided.

Base collections:

Below are characteristics and purpose of a base collection in seed genebanks**:**

- **long-term storage;**
- temperature of **-18°C** or cooler;
- used to conserve **original samples** of the seed (where possible) in order to preserve its genetic integrity;
- purely for **conservation purposes:** seeds are not distributed directly to users.

Active collections

Below are the characteristics and purposes of an active collection in seed genebanks:

- **medium-term** storage;
- temperature of **4°C**;
- relative humidity of **15 ± 3 percent**;
- accessions **immediately available** for multiplication and distribution for research, breeding, characterization, evaluation and utilization;
- when an active collection runs out of seed of a particular accession, it **can be replenished by multiplying the seed from the base collection**. The best practice is to multiply an accession when the seed supply gets low, or when viability decreases below a threshold, before it reaches a critical level.

Seed genebanks' advantages and disadvantages

Here are some advantages and disadvantages of seed genebanks:

Advantages	Disadvantages
✓ Seeds of many species are easy to collect and maintain in a viable state for a long time.	× Seeds must be multiplied or grown out before they can be evaluated or used in research.
✓ Seeds are easy to distribute and control for diseases.	× Seeds may lose their ability to germinate after a period of time. Their viability must be checked from time to time, and if necessary, the accession must be regenerated.
✓ Seedbanks are suited for seeds that retain their viability if they are dried and refrigerated. Such seeds are known as orthodox seeds.	× Seed genebanks are only suitable for the conservation of orthodox seeds

Ethiopian Biodiversity Institute

The genebank at the Ethiopian Biodiversity Institute, holds Africa's biggest collection of sorghum, the fourth largest in the world. It contains more than **9 000 accessions of sorghum**.

International Rice Genebank

Maintained by the International Rice Research Institute in the Philippines, the International Rice Genebank holds nearly **130 000 accessions of rice** and more than **6 000 accessions of rice wild relatives**.

FIELD GENEBANKS

A **field genebank** is a collection of **plants grown in the field (or in pots** in a greenhouse or screenhouse). Field genebanks are the most common means of conserving diversity in the case of **crops that cannot be conserved as seeds**. This includes species:

- with **recalcitrant seeds**[2];
- that are not normally propagated by seeds, such as roots and tubers and other vegetatively propagated crops;
- that have a long lifecycle – i.e. taking a time to mature, flower and produce seeds (for example, tree species).

Examples of crops suited to field collections are banana, coffee, coconuts, cacao, cassava, apple, pear and grape.

Field genebanks: base and active collections

Collections held in field genebanks can serve as both base and active collections:

- field collections are maintained as living plants, and may serve as base collections;
- since field collections are easily accessible, they may also serve as active collections, and therefore also used for characterization, evaluation, and distribution.

Field genebanks' advantages and disadvantages

Here are some advantages and disadvantages of field genebanks:

[2] Recalcitrant seeds are seeds that die if they are dried or cooled (e.g. Cacao, Rubber, Mango, Coconuts, Other large-seeded tropical species).

Advantages	Disadvantages
✓ They do not require costly equipment or sophisticated technology. ✓ They allow the plants to be readily characterized, evaluated, used and studied.	× They are expensive to maintain in terms of labour, management and other resources. × They are vulnerable to pests and diseases and to adverse weather. × They take up a large amount of land. This limits the number of accessions and the range of genetic resources that can be maintained. × Genetic erosion in some species or genetic groups may occur due to their poor adaptation to the local environment.

The Fruit Tree Research Centre of Rome

The Fruit Tree Research Centre of Rome (CRA-FRU) was established in 1927 and includes a total area of approximately 66 hectares. The mission of the Fruit Tree Research Centre is to **develop genetic studies, breeding methodologies, and varietal selection** using conventional and innovative approaches **for different species of fruit** (excluding citrus). The Centre maintains kiwi, apricot, cherry, peach, plum, apple, pear, almond, hazelnut, walnut, pecan, pistachio, blueberry, sea buckthorn, raspberry, fejioia and grape. The **pear collection** includes almost **900 accessions**, 42% of which are farmers' varieties/landraces from Italy.

The Centre for Pacific Crops and Trees

The Centre for Pacific Crops and Trees (CePaCT) is the genebank for the Pacific region. Located some 10 km outside Suva, Fiji, it is the first modern genebank built to international standards in the Pacific Islands region.

The centre houses more than **2 000 accessions**. The taro collection is unique, being **the largest collection of taro diversity globally** with more than 1 000 accessions, conserving diversity for present and future generations. Efforts are currently focused on building up regional collections of banana, breadfruit and yam in recognition of the diversity that exists for these crops in the Pacific.

IN VITRO CULTURE

In *vitro* collections are often complementary to field genebanks.

In vitro culture is used for species that are propagated vegetatively (for example, from cuttings, roots or tubers) or that produce recalcitrant seed.

In vitro culture maintains **pathogen-free explants** (plant tissues)

in a sterile environment, with a synthetic nutrient medium.

The two main *in vitro* techniques are:

- **slow-growth conservation** by subjecting plantlets to growth limiting factors such as adjusting the temperature, amount of light, or the growth medium;
- **maintenance** of plantlets **under normal growth** (SCC) media.

***In vitro* base and active collections**

Collections held in in vitro serve as base or active collections depending on conservation protocol:

- plantlets maintained under slow-growth conditions constitute the base collection. The base collection can also be stored using cryopreservation;
- plantlets maintained in normal growth media are used for distribution, and are thus considered an active collection.

***In vitro* culture advantages and disadvantages**

Here are some advantages and disadvantages of *in vitro* collections:

Advantages	Disadvantages
✓ It is possible to propagate and disseminate material rapidly.	× Ex situ conservation via in vitro culture requires specific protocols for each species.
✓ With the right precautions to prevent virus contamination, it is possible to move germplasm safely.	× Tissue culture can result in somaclonal variation (genetic changes), which requires regular monitoring.

The International Musa Germplasm Transit Center

The International Musa Germplasm Transit Center hosted at the Katholieke Universiteit Leuven in Belgium is home to **the world's largest *in vitro* collection of banana germplasm**.

The collection contains more than **1500 accessions** of edible and wild banana maintained via *in vitro* culture under slow-growth conditions.

CRYOPRESERVATION AND STORAGE OF POLLEN AND DNA

- **Cryopreservation**

Cryopreservation is the **storage of living tissues at extremely low temperatures** (usually at -196°C) in liquid nitrogen.

These conditions guarantee long-term preservation of germplasm in a genetically unaltered state.

The samples are dehydrated rapidly and treated with cryoprotectants to prevent the formation of ice and damage to the tissue.

- **Pollen storage**

Pollen is **often stored for use in breeding**, for example to bridge the gap between male and female flowering times.

Pollen has a relatively short viability. Many species produce little pollen. Pollen represents the male flower: a female flower is still required for successful breeding.

- **DNA storage**

Advances in molecular biology mean that DNA conservation is becoming more important.

DNA cannot be used to reproduce an accession. **DNA storage is used to complement other conservation techniques** and to screen and compare accessions.

Cryopreservation advantages and disadvantages

Here are some advantages and disadvantages of cryopreservation:

Advantages

- ✓ Storing plant materials in liquid nitrogen tanks takes up very little space per sample.
- ✓ To maintain the samples, the liquid nitrogen must be topped up periodically. There is no need to re-culture the plants.
- ✓ The exchange of germplasm in the form of plantlets is easy.

Disadvantages

- × The initial cost of setting up a cryopreservation unit is high. Appropriate equipment and skilled personnel are required.
- × Cryopreservation protocols are needed for each species (though suitable protocols are now available for many species).

Choosing the ex situ conservation approach

Kiran: *"Are you wondering what **determines the ex situ conservation approach used**?*

*The two most important factors are **how the species is reproduced**, and **the purpose of conservation**. Then, of course, there are considerations such as the cost, facilities and human resources available."*

Below are some examples of storage methods:

MEANS OF REPRODUCTION	Characteristics	Conservation approach
VIA INTERMEDIATE SEEDS	Seeds that can be dried but not cooled (e.g. citrus, coffee)	field genebank, *in vitro* culture, cryopreservation
VIA ORTHODOX SEEDS	Seeds that are tolerant to drying and that can be stored at low temperatures (e.g. most cereal and legume crops and other small-seeded species)	seed genebank
PROPAGATED VEGETATIVELY	Plants normally propagated as clones or cuttings (e.g., cassava, potato)	field genebank, *in vitro* culture, cryopreservation
VIA RECALCITRANT SEEDS	Seeds that lose viability if they are dried or cooled (e.g. cacao, rubber, mango, coconuts, other large-seeded tropical species)	field genebank, *in vitro* culture, cryopreservation

Conservation status of plant genetic resources for food and agriculture

Asha: *"Let's look at the current status of plant genetic resources."*

Germplasm of crops and crop wild relatives is conserved in more than **570 genebanks worldwide**. About **5 million accessions** are maintained under medium-and long-term conditions globally. This total includes around **6 900 genera** and more than **50 000 species**.

However, the vast majority of the samples stored worldwide belong to around 100 plant species - a small fraction of the approximately 6 000 species of agricultural and horticultural crops (excluding forestry and ornamentals) that are used by humans.

The status of plants conserved *in situ* is more difficult to ascertain as surveys on-farm and in the wild, including protected areas, are not widely carried out.

FAO hosts and manages a large database, known as the **World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture**, or **WIEWS**. This contains information on around 6 900 genera and 50 800 species conserved in more than 570 genebanks in 90 countries and 16 international and regional research centres.

See Lesson 3 and 4 for more on WIEWS.

The **International Treaty on Plant Genetic Resources for Food and Agriculture** facilitates access to seeds and other genetic material stored in genebanks. It covers the vast majority of the agricultural crops that contribute to global food security. The Treaty functions through a **Multilateral System of Access and Benefit-sharing**. Bilateral agreements can be used to source germplasm of those crops **not covered** by the Treaty.

Mini-lesson – Treaty on Plant Genetic Resources for Food and Agriculture

The **International Treaty on Plant Genetic Resources for Food and Agriculture** was adopted in 2001 and came into force in 2004. Currently, 143 countries plus the European Union have ratified the Treaty; another 7 countries have signed it as a preliminary step to ratification.

The Treaty's objectives are:

- The conservation and sustainable use of all plant genetic resources for food and agriculture.
- The fair and equitable sharing of the benefits arising out of their use

… in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. The Treaty governs access and benefit-sharing through its **Multilateral System**. This puts 64 of the world's most important crops (encompassing 48 genera) - crops that together account for 80 percent of the food we derive from plants - into an easily accessible global pool. Users in nations that have ratified the Treaty can freely access this pool for some uses.

The crops in the Multilateral System are listed in Annex 1 of the Treaty and include **48 genera of food crops**, along with species from **29 genera of forage crops**.

Food crops

Annex 1 of the Treaty covers **48 genera of food crops:**

Crop types	Genus	Crop (English)	Notes
Brassica family 13 genera	*Brassica, Armoracia, Barbarea, Camelina, Crambe, Diplotaxis, Eruca, Isatis, Lepidium, Raphanobrassica, Raphanus, Rorippa, Sinapis*	Cabbage family: Rapeseed, Mustard, Cress, Rocket, Radish, Turnip, etc.	Not *Lepidium meyenii* (maca)
Cereals 10 genera	*Avena, Eleusine, Hordeum, Oryza, Pennisetum, Secale, Sorghum, Triticosecale, Triticum et al., Zea*	Oats, Millet, Barley, Rice, Rye, Sorghum, Triticale, Wheat, Maize	Not *Zea perennis, Z. diploperennis, Z. luxurians*
Fruit 5 genera	*Artocarpus, Citrus, Fragaria, Malus, Musa*	Breadfruit, Citrus, Strawberry, Apple, Banana/ Plantain	Includes genera *Poncirus* and *Fortunella* as root stock Not *Musa textilis*
Legumes 8 genera	*Cajanus, Cicer, Lathyrus, Lens, Phaseolus, Pisum, Vicia, Vigna*	Pigeonpea, Chickpea, Grass Pea, Lentil, Beans, Pea, Faba bean / Vetch, Cowpea etc.	Not *Phaseolus polyanthus*
Roots and tubers 8 genera	*Beta, Colocasia, Xanthosoma, Daucus, Dioscorea, Ipomoea, Manihot, Solanum tuberosum*	Beet, Taro, Cocoyam, Dasheen, Tannia, Carrot, Yams, Sweet Potato, Cassava, Potato	Includes *Manihot esculenta* only Not *Solanum phureja*
Other food crops 4 genera	*Asparagus, Cocos, Helianthus, Solanum melongena*	Asparagus, Coconut, Sunflower, Eggplant	

Legume forage crops

Annex 1 of the Treaty covers **52 species from 15 genera of legume forages:**

Genus	Species	English
Astragalus	*chinensis, cicer, arenarius*	Milkvetch
Canavalia	*ensiformis*	Jack-bean
Coronilla	*varia*	Crown vetch
Hedysarum	*coronarium*	French honeysuckle
Lathyrus	*cicera, ciliolatus, hirsutus, ochrus, odoratus, sativus*	Peavines
Lespedeza	*cuneata, striata, stipulacea*	Bush clovers, Japanese clover
Lotus	*corniculatus, subbiflorus, uliginosus*	Bird's-foot trefoil
Lupinus	*albus, angustifolius, luteus*	Lupin
Medicago	*arborea, falcata, sativa, scutellata, rigidula, truncatula*	Medick, Burclover, Alfalfa, Lucerne
Melilotus	*albus, officinalis*	Sweet clover
Onobrychis	*viciifolia*	Sainfoin
Ornithopus	*sativus*	Bird's-foot
Prosopis	*affinis, alba, chilensis, nigra, pallida*	Algarrobillo, Algarrobo, American carob
Pueraria	*phaseoloides*	Tropical kudzu
Trifolium	*alexandrinum, alpestre, ambiguum, angustifolium, arvense, agrocicerum, hybridum, incarnatum, pratense, repens, resupinatum, rueppellianum, semipilosum, subterraneum, vesiculosum*	Clover, Trefoil

rass forage crops

Annex 1 of the Treaty covers **26 species from 12 genera of grass forages:**

Genus	Species	English
Andropogon	*gayanus*	Gamba grass
Agropyron	*cristatum, desertorum*	Crested wheat grass
Agrostis	*stolonifera, tenuis*	Bentgrass
Alopecurus	*pratensis*	Meadow foxtail
Arrhenatherum	*elatius*	False oat-grass
Dactylis	*glomerata*	Cock's-foot
Festuca	*corniculatus, subbiflorus, uliginosus*	Bird's-foot trefoil
Lolium	*hybridum, multiflorum, perenne, rigidum, temulentum*	Ryegrass
Phalaris	*aquatica, arundinacea*	Canarygrass
Phleum	*pratense*	Timothy
Poa	*alpina, annua, pratensis*	Meadow-grass, bluegrass
Tripsacum	*laxum*	Guatemalan gamagrass

Other forage crops

Annex 1 of the Treaty covers **3 species from 2 genera of other forages:**

Genus	Species	English
Atriplex	*halimus, nummularia*	Saltbush
Salsola	*vermiculata*	Mediterranean saltwort

Summary

Plant genetic resources for food and agriculture covers domesticated plant species (crops) and varieties, crop wild relatives, and wild food plants.

Plant genetic resources are under threat from a variety of sources, including habitat loss, climate change, economic pressures and technology changes.

It is important to conserve plant genetic resources in order to have the raw materials to develop new crop varieties, respond to new diseases or changes in the environment, restore agricultural systems and cater to new needs and demands.

The two most common ways to conserve plant genetic resources are:

in situ and *ex situ* conservation.

- *In situ* conservation entails conserving plants where they grow naturally or are farmed.
- *Ex situ* conservation entails conserving genetic resources away from their natural habitat or agricultural landscape, such as in genebanks.

At present, about 5 million accessions are conserved in more than 570 genebanks worldwide.