General Comments

'Before collecting, we need to define the targeted species, compile information on them and the sites where they are found, and confirm if financial resources for the expedition are available. We also need to determine a collecting strategy for the samples, envisage how they would be handled in the field so that they survive until they reach the conservation site, and decide how to document them during collection. Furthermore, we also need to request permits from the responsible authorities and respect the regulations established by the country where the collection will be made. Once the permits are obtained, the trip's logistics can be prepared' (Jaramillo and Baena 2000).

Information on the Module

This module contains three lessons, each having its own rapid evaluation and tasks.

Objectives

When you have completed the module you should be able to:

- Define the criteria that should be considered when acquiring plant germplasm
- Describe the procedures for acquiring plant germplasm
- Describe the legal requirements for access and quarantine, when introducing germplasm

Lessons

1. Plant germplasm acquisition: criteria
2. Plant germplasm acquisition: procedures
3. Germplasm introduction: transfer regulations and quarantine measures

Bibliography

Throughout this module, a bibliography is provided for each section, that is, the *General Comments* and each *Lesson*. The bibliographies follow a format of two parts:

1. *Literature cited*, which includes those references cited in the text itself. Some of these citations were used to develop the original Spanish-language course on *ex situ* conservation and may therefore appear in Spanish or Portuguese. However, where practical, references to the English versions of the original Spanish-language documents are provided.
2. *Further reading,* which is a list of suggested readings in the English language, with few exceptions in French. Most of them cover in depth the topics included in this module.

A list of *Acronyms used in the bibliographies* is also given. The idea is to save space by not having to spell out each institution's full name each time it appears in the references.

Acronyms used in the bibliographies

CGRFA	Commission on Genetic Resources for Food and Agriculture
COSAVE	Comité de Sanidad Vegetal del Cono Sur
EPPO	European and Mediterranean Plant Protection Organization
EUCARPIA	European Association for Research on Plant Breeding
FAO	Food and Agriculture Organization of the United Nations
IBPGR	International Board for Plant Genetic Resources
ICA	Instituto Colombiano Agropecuario
ICUC	International Centre for Underutilized Crops
IPGRI	International Plant Genetic Resources Institute (now Bioversity International)
IPPC	International Plant Protection Convention
IUCN	The World Conservation Union
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria
SCBD	Secretariat of the Convention on Biological Diversity
UNEP	United Nations Environment Programme

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Next Lesson

In the first lesson of the next module, you will study the criteria used for acquiring plant germplasm.

Lesson 1 Plant Germplasm Acquisition: Criteria

Objectives

- To briefly analyze the process of establishing priorities for acquiring plant germplasm
- To propose the basic decision-making criteria for acquiring plant germplasm for its conservation

Introduction

The selection of species for conservation is based on interpretations that, in fact, give rise to subjective valuations. To minimize subjectivity, those who select priority species should sustain their decisions and confirm that the species selected do indeed respond to the proposed objectives. Germplasm may be acquired for many reasons, or combinations of reasons, such as protection, study, improvement, distribution, or completion of an existing collection (Engels et al. 1995). However, an exhaustive analysis should first be done to contribute the elements needed for deciding on what materials to acquire. Establishing priorities is a complex process that includes a range of choices from selecting an analytical method to choose a geographical area to selecting and applying criteria for sampling one population rather than another. However, feasibility—that is, the probability of success of a conservation objective in a given social and political environment—is key to determining priorities and assigning resources.

Criteria for Acquisition

To acquire germplasm to conserve it, we need to think about how it will be used. This is known as its **value of use,** that is, its real or potential benefit for food, agriculture, industry, research, or crop improvement (Jaramillo and Baena 2000). A species' value of use determines the interest, commitment, and priority to conserve it (Jaramillo and Baena 2000; Maxted et al. 1997).

Undoubtedly, another important aspect to consider is the level of international commitment, legally binding, of the countries that ratified the Convention on Biological Diversity, which has been international law since 30 December 1993. The Convention governs the conservation of biodiversity, the sustainable use of its components, and the just and equitable participation in the benefits derived from its use (SCBD and UNEP 2003).

When germplasm is acquired for its conservation, the criteria related to value of use should be considered. These are listed below:

The species' state of conservation

This criterion takes into account that very serious projects have already been established and that excellent germplasm collections are held under *ex situ* conservation. Acquiring more materials to add to such collections implies making an *ex ante* evaluation to orient acquisition for such collections. Thus, a species is assessed for the sufficiency of its representation in collections so that conservation activities do not duplicate already existing ones. Furthermore, the quality of available information on the materials should be taken into account. Often, genetic variability or data have not been collected and therefore have never become part of the variability conserved nor of the information kept with the materials.

For example, maize, rice, and wheat have been collected over decades, whereas other germplasm has not such as Andean roots and tubers like ulluco (*Ullucus tuberosus*), sweet potato (*Ipomoea batatas*), isaño (*Tropaeolum tuberosum*), and arracacha (*Arracacia xanthorrhiza*), or promising Neotropical fruit trees such as cherimoya (*Annona cherimola*), papaya (*Carica papaya*), guava (*Psidium guajaba*), jaboticaba (*Myrciaria cauliflora*), cashew (*Anacardium occidentale*), and borojó (*Borojoa patinoi*). Even Africa, a very rich region in terms of biodiversity, has a surprisingly low 6% of the world's total accessions conserved *ex situ* and only 10% of germplasm banks (FAO 1997). This situation suggests that a lot of germplasm is still to be collected, especially of useful species.

For preliminary evaluations, ecogeographic data (Maxted et al. 1997) can be used after careful and duly planned consultations to identify possible collections and assign conservation priorities. Analyzing ecogeographic data is easier when geographic information systems (GIS) are used (IPGRI 2001). A GIS is a system of databases dedicated to the graphic management of geographically referenced spatial data (such as the coordinates of a site or topography), together with logically related non-spatial data (such as the species' name or its morphological characters).

A GIS is also a highly flexible cartographic system that can easily compare a broad range of geographic, ecological, and biological data sets. Once digitized, the cartographic data of maps (often at different scales), aerial photographs, field studies, and remote sensing can be handled and analyzed in various ways. A GIS facilitates understanding of the characteristics of sites where either data had not been recorded during a collection, or data will be used for future collections to locate areas with certain combinations of ecological characteristics.

Urgency for conservation

The importance of a species for conservation depends on how threatened it is, with priority being given to those in danger of extinction. The level of threat faced by the targeted population can be determined by consulting the *IUCN Red List of Threatened Species*™, the IUCN's 2001 list of categories of risk (Glowka et al. 1994; Jaramillo and Baena 2000) (Table 1), or the national entities monitoring at-risk species.

Biological importance of the species with respect to other useful species

Although some species apparently do not benefit humanity, they interact ecologically with others that do. For example, the interdependence between species of a plant succession of a forest is such that the disappearance of some may endanger the existence of others, including those useful to humans.

Contributions in terms of genetic variability

The selected species should be genetically different from others already conserved and confirmed to possess a genetic variability that is not being conserved. Although samples should not be acquired of already existing germplasm, it may be appropriate to seek diversity and thereby enrich what is poorly or not represented in the collection.

Table 1. Categories of plant species in danger of extinction, according to the degree of threat that they face at a given time.

Category	Denomination	Description
1	Extinct	A plant taxon is considered extinct when the individuals composing it are known with certainty to have died.
2	Extinct in the wild	A plant taxon is considered extinct in the wild when it is known only as a crop. It is also presumed extinct in the wild when surveys of habitats (exhaustive, at appropriate times, and throughout its historic range) do not record any individuals.
3	Critically threatened	When the risk of extinction of a species in the wild and in the immediate future is extremely high.
4	Endangered	When the risk of extinction of a species in the wild and in the immediate future is high.
5	Vulnerable, dependent on conservation	When removing a species from continuous conservation would expose that species to the category of 'threatened' within 5 years.
	Vulnerable, close to endangered	When a species that is not classified as dependent on conservation but is close to being classified as such.
	Vulnerable, of lesser concern	That species which does not fall in either of the previous two subcategories.
6	Species with deficient documentation	When the information that exists on a species' distribution and/or state of its populations does not reliably indicate the risk of extinction to which this species is exposed. A species in this category may be either threatened or at low risk.
7	Not evaluated	When a given species has not been evaluated for its level of vulnerability.

SOURCES: Glowka et al. (1994); Jaramillo and Baena (2000).

Potential usefulness of the species

Species that contribute to the satisfaction of basic needs (e.g., food, medicines, and housing) will have greater priority for conservation than others such as ornamentals or those considered as undesirable (e.g., crop weeds).

Relative cost of conservation

The capacity of the conservation unit for handling materials to be acquired must be considered. 'Capacity' refers to the availability and continuity of human, physical, and financial resources to conserve a collection of materials over the medium and long term. Often, *ex situ* conservation projects start with very ambitious collection activities that do not consider their relatively limited capacity. As a result, within a few years, collections are lost through inadequate and untimely processing. In this sense, collection would not be an end in itself, but would be part of a process. The next stage is to use the acquired variability, which, in fact, depends on the collection's quality.

When faced with two equally priority species and a limited budget, cost will determine which will be conserved. The criterion is also applied to the cost of conserving one species versus another or others and to whether the targeted species can be conserved alone or with others of interest.

Cultural importance to the community

The aesthetic, symbolic, or cultural value of a species for a community (i.e., the role that it fulfils in cultural or religious activities) may determine whether it should be conserved. Examples are plants used as national emblems such as the Quindío wax palm (*Ceroxylon quindiuense*), Colombia's national tree (Jaramillo and Baena 2000); the baobab tree (*Adansonia digitata*), also called Muuyu, emblematic of Africa, a rich reservoir of mythology, folklore and medicines (ICUC 2002) or the forests and jungles that are conserved for their beauty.

Evaluating the Lesson

After this lesson, you should understand the complexity of prioritizing and establishing criteria for acquiring plant germplasm for conservation.

Before beginning the next lesson, complete, in writing, the following tasks:

- Prepare a list of plant species of your country or region that are in danger of extinction according to the categories listed in Table 1 of this lesson.
- Establish a plan of germplasm acquisition, taking into account the criteria discussed in this lesson.

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Next Lesson

In the next lesson, you will examine methods and procedures for acquiring plant germplasm.

Lesson 2 Plant Germplasm Acquisition: Procedures

Objectives

- To describe the procedures by which germplasm is acquired
- To indicate how species targeted for conservation are collected
- To describe the management of acquired germplasm

Introduction

Once the criteria for germplasm acquisition are defined, the next step is to acquire it, using standard procedures. However, before making the final decision, the curator or collector should remember that if acquisition is done from a another country, international agreements exist that are currently in force such as the Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA; FAO–CGRFA 2004), and the FAO and IPGRI's *Technical Guidelines for the Safe Movement of Germplasm* (FAO and Bioversity International 1989–2007). These agreements should be considered, especially with respect to the sovereignty of countries over their plant genetic resources (PGRs). The CBD, in accordance with the Charter of the United Nations and the principles of international law, states that nations have the sovereign right to exploit their own resources according to their own environmental policies. However, they also have the obligation to ensure that the activities carried out within their jurisdiction or under their control do not damage the environment of other nations or areas outside their national jurisdiction (United Nations 1993, CBD *Article 3: Principle*). Furthermore, in recognition of the sovereign rights of nations over their natural resources, the faculty to regulate access to genetic resources corresponds to the national governments and is subject to national legislation (United Nations 1993, CBD *Article 15: Access to Genetic Resources*).

With respect to conservation, exploration, collection, characterization, evaluation, and documentation of PGRs for food and agriculture, Article 5 of the ITPGRFA (FAO–CGRFA 2004) indicates that each contracting party shall follow national legislation in cooperation with the other contracting parties involved. That is, an integrated approach shall be adopted to explore, conserve, and sustainably use PGRs for food and agriculture. In particular, the parties involved shall:

- Conduct studies and inventories of PGRs for food and agriculture, taking into account the situation and degree of variation of existing populations, including those of potential use and, where feasible, evaluate any threat to them.
- Promote the collection of PGRs for food and agriculture and of relevant information on those that are threatened or are of potential use.
- Promote or support the efforts of farmers and local communities oriented towards organizing and conserving PGRs for food and agriculture on their farms.
- Promote the *in situ* conservation of wild plants related to cultivated ones and of wild plants used for food, including in protected areas; and support, among other things, the efforts of indigenous and local communities.
- Cooperate in promoting the organization of an effective and sustainable system of *ex situ* conservation, paying due attention to the need for sufficient documentation, characterization, regeneration, and evaluation; and promote the perfection and transfer

of appropriate technologies to improve the sustainable use of PGRs for food and agriculture.
- Supervise the maintenance of viability, degree of variability, and genetic integrity of collections of PGRs for food and agriculture.

Ways of Acquiring Germplasm

Germplasm of interest can be obtained through exploration and collection, exchange, donation, and agreements or conventions. For practical reasons, attempts should be made to obtain the desired materials without resorting to sites of origin. That is, use should be made of donations or exchanges with institutions that hold these materials. When this is not possible, then the materials must be collected from sites where populations of the species of interest exist.

Acquisition through exchange and donation

The exchange of germplasm is a traditional practice between researchers. Many accessions that today are part of major collections were obtained through exchange or donation. Similarly, materials lost in wars and natural disasters, or through negligence have been recovered by these means.

To exchange or receive germplasm by donation, the interested party requests it from the party holding it. Germplasm transfer is made effective through signing an agreement among the parties, in which both the terms of transfer and use of the materials (e.g., conservation, research, or production of commercial varieties) are stipulated. These agreements are known as 'material transfer agreements in genetic resources exchange' or MTAs (Barton and Siebeck 1994).

Agreements for germplasm transfer should respect the treaties on access to genetic resources held by the countries involved. Because germplasm transfer implies plant health risks, exchange or donation should be made through authorized institutions and according to what is stipulated in the International Plant Protection Convention (FAO 1997).

Acquisition through exploration and collection

Exploration and collection consist of going to the field to seek and collect the genetic variability of cultivated and wild species that cannot be obtained from germplasm banks, botanic gardens, or other collections (Hawkes 1980; Querol 1988).

The reasons for collecting can be various, but the priorities established are based on the species of interest and/or on regions with a broad genetic diversity of the desired material. A collection is justified, for example, when, in a given area, species of interest are endangered, when they are significant for research or use, or when the variability of the targeted species in *ex situ* collections has been lost or is insufficient. Sometimes, the opportunity for collecting the material can justify collection. Other times, as part of an expedition, germplasm that is not targeted by the mission may be collected, provided that its characteristics will be useful (Engels et al. 1995; IPGRI 1996b; Querol 1988). In any case, the objective for conservation should not be lost sight of.

Before collecting, we need to define the targeted species, compile information on them and the sites where they are found, and confirm if financial resources are available for the expedition. We also need to determine a strategy for collecting samples and handling them in the field so that they will survive until they reach the site of conservation. Finally, we need to know how the samples will be documented during collection. Furthermore, we need to respect international codes and regulations (Box 1) or those established by the country where collection will take place, and request permits from the responsible authorities (Box 2).

Box 1

International Code of Conduct for Plant Germplasm Collecting and Transfer (Summary)

The International Code of Conduct for Plant Germplasm Collecting and Transfer aims to promote the rational collection and sustainable use of genetic resources, to prevent genetic erosion, and to protect the interests of both donors and collectors of germplasm. The Code, a voluntary one, has been developed by FAO and negotiated by its Member Nations through the Organization's Commission on Plant Genetic Resources. The Code is based on the principle of national sovereignty over plant genetic resources according with the Convention on Biological Diversity and sets out standards and principles to be observed by those countries and institutions that adhere to it.

The Code proposes procedures to request and/or to issue licences for collecting missions, provides guidelines for collectors themselves, and extends responsibilities and obligations to the sponsors of missions, the curators of genebanks, and the users of genetic material. It calls for the participation of farmers and local institutions in collecting missions and proposes that users of germplasm share the benefits derived from the use of plant genetic resources with the host country and its farmers.

The primary function of the Code is to serve as a point of reference until such time as individual countries establish their own codes or regulations for germplasm exploration and collection, conservation, exchange and utilization.

The Code describes the shared responsibilities of collectors, donors, sponsors, curators and users of germplasm so as to ensure that the collection, transfer and use of plant germplasm is carried out with the maximum benefit to the international community, and with minimal adverse effects on the evolution of crop plant diversity and the environment. While initial responsibility rests with field collectors and their sponsors, obligations should extend to parties who fund or authorize collecting activities, or donate, conserve or use germplasm. The Code emphasizes the need for cooperation and a sense of reciprocity among donors, curators and users of plant genetic resources. Governments should consider taking appropriate action to facilitate and promote observance of this Code by sponsors, collectors, curators and users of germplasm operating under their jurisdiction.

The Code recognizes that nations have sovereign rights over their plant genetic resources in their territories and it is based on the principle according to which the conservation and continued availability of plant genetic resources is a common concern of humankind. In executing these rights, access to plant genetic resources should not be unduly restricted. The Code provides a set of general principles which governments may wish to use in developing their national regulations or formulating bilateral agreements on the collection of germplasm. The Code is addressed primarily to governments. All relevant legal and natural persons are also invited to observe its provisions, in particular those dealing with plant exploration and plant collection, agricultural and

(Continued)

Box 1. (Continued.)

botanical activities and research on endangered species or habitat conservation, research institutes, botanical gardens, harvesting of wild plant resources, agroindustry including pharmaceutical plants and the seed trade. The provisions of the Code should be implemented through collaborative action by governments, appropriate organizations and professional societies, field collectors and their sponsors, and curators and users of plant germplasm. FAO and other competent organizations are invited to promote full observance of the Code.

The Code should enable national authorities to permit collecting activities within its territories expeditiously. It recognizes that national authorities are entitled to set specific requirements and conditions for collectors and sponsors and that sponsors and collectors are obliged to respect all relevant national laws as well as adhering to the principles of this Code.

The Code is to be implemented within the context of the FAO Global System on Plant Genetic Resources, including the International Undertaking and its annexes. In order to promote the continued availability of germplasm for plant improvement programmes on an equitable basis governments and users of germplasm should endeavour to give practical expression to the principles of farmers' rights. The Code is to be implemented in harmony with: **(a)** the Convention on Biological Diversity and other legal instruments protecting biological diversity or parts of it; **(b)** the International Plant Protection Convention (IPPC) and other agreements restricting the spread of pests and diseases; **(c)** the national laws of the host country; and **(d)** any agreements between the collector, host country, sponsors and the gene bank storing the germplasm.

SOURCE: FAO (1994).

Once the permits are obtained, the trip's logistics are prepared. Exploration and collection are complex activities that put at stake many resources (biological, physical, economic, and human) and require planning (IPGRI 1996a, b; 2001a, b). To understand the objectives of an expedition for collecting PGRs, planning should include the following:

- Regions to visit and crops to collect
- The human collection team
- The route to follow
- The time of the expedition
- Equipment

Acquisition through agreements

The germplasm can also be acquired through interinstitutional agreements, where conditions are fixed according to negotiations among the interested parties and which stipulate both the terms of transfer and use of materials.

Collecting Targeted Species

Once the targeted species are selected, the collector defines the sampling strategy (Brown and Marshall 1995; IPGRI 2000), which will determine how maximum variability will be obtained in the least amount of time. Defining a sampling strategy involves:

- Locating the collection site or sites
- Defining the frequency with which samples will be collected, that is, how often will stops be made to collect
- Defining the methodology by which samples will be collected

Box 2

International Code of Conduct for Plant Germplasm Collecting and Transfer (Chapter III Collectors' Permits. Articles 6, 7, 8)

- **Authority for issuing permits.** States have the sovereign right, and accept the responsibility, to establish and implement national policies for the conservation and use of their plant genetic resources and, within this framework, should set up a system for the issuance of permits to collectors. Governments should designate the authority competent for issuing permits. This authority should inform proposed collectors, sponsors and the other agencies of the government's rules and regulations in this matter, and of the approval process to be followed, and of follow-up action to be taken.

- **Requesting of permits.** To enable the permit issuing authority to arrive at a decision to grant or to refuse a permit, prospective collectors and sponsors should address an application to the issuing authority to which they: **(a)** undertake to respect the relevant national laws; **(b)** demonstrate knowledge of, and familiarity with, the species to be collected, their distribution and methods of collection; **(c)** provide indicative plans for the field mission—including provisional route, estimated timing of expedition, the types of material to be collected, species and quantities—and their plans for evaluation, storage and use of the material collected; where possible, the sort of benefits the host country may expect to derive from the collection of the germplasm should be indicated; **(d)** notify the host country of the kind of assistance, that may be required to facilitate the success of the mission; **(e)** indicate, if the host country so desires, plans for cooperation with national scholars, scientists, students, non-governmental organizations and others who may assist or benefit from participation in the field mission or its follow-up activities; **(f)** list, so far as it is known, the national and foreign curators, to whom the germplasm and information is intended to be distributed on the completion of the mission; and **(g)** supply such personal information as the host country may require.

- **Granting of permits.** The permit issuing authority of the country in which a field mission proposes collecting plant genetic resources should expeditiously: **(a)** acknowledge the application, indicating the estimated time needed to examine it; **(b)** communicate to the collectors and sponsors of the proposed collecting mission its decision. In case of a positive decision, conditions of collaboration be established as soon as possible before the mission arrives in the country, or begins fieldwork. If the decision is to prohibit or restrict the mission, whenever possible, the reasons should be given and, where appropriate, an opportunity should be given to modify the application; **(c)** indicate, when applicable, what categories and quantities of germplasm may or may not be collected or exported, and those which are required for deposit within the country; indicate areas and species which are governed by special regulation; **(d)** inform the applicant of any restrictions on travel or any modification of plans desired by the host country; **(e)** state any special arrangement or restriction placed on the distribution or use of the germplasm, or improved materials derived from it; **(f)** if it so desired, designate a national counterpart for the field mission, and/or for subsequent collaboration; **(g)** define any financial obligation to be met by the applicant including possible national participation in the collecting team, and other services to be provided; and **(h)** provide the applicant with the relevant information regarding the country, its genetic resources policy, germplasm management system, quarantine procedures, and all relevant laws and regulations. Particular attention should be drawn to the culture and the society of the areas through which the collectors will be travelling.

SOURCE: FAO (1994).

- Defining the sample's optimal size, so that the number of collected seeds and/or propagules will represent the genetic variability available. The collector should not forget to ensure the sample's representativeness with regard to available genetic variability, as any genetic variability not sampled will never be part of the conserved variability. The sampling strategy is defined according to statistical procedures, requiring that the collector take advice from specialists in this matter.

Taking samples during collection

To take samples, the collector should bear in mind that collection as such is not separable from other activities. Sampling should consider the biology of reproduction of the targeted material (e.g., allogamous or autogamous plants, plants of intermediate regimes, and plants of asexual reproduction). The collector should take into account the physiology of the conservation organs because, where this is unknown, the collection of seeds or plant parts may not be successful.

Regardless of the type of propagule that is collected, the collector must take into account those important aspects that directly influence sampling quality. For instance, the same number of samples should be collected from each plant, preferring those that are in good health and in good physical condition; and the samples' moisture content and temperatures should be controlled to prevent their drying up or rotting and, thus, affecting their viability (Guarino et al. 1995; Hawkes 1980).

If the objective is to collect seeds, then fruits should be harvested because these will keep the seeds viable for longer. Seeds can then be extracted manually.

The collected seeds should be fully mature so that they tolerate desiccation without losing viability. For plant parts, fresh propagules and buds should be collected so that they can be regenerated later. Samples can also be collected as complete plants, tubers, rhizomes, or stakes.

Plants may be collected in any container, provided that it is safe and easy to transport. Tubers, rhizomes, and stakes should be placed in plastic bags. Another type of sample is to collect *in vitro,* as discussed below.

Sample characteristics

The samples acquired should be healthy, represent the diversity targeted and be well documented so that they can enter, without problems, the conservation system of the receiving country and can be later used. The country of origin and, especially, the receiving one, should ensure that the transferred sample is healthy. Accordingly, the germplasm that enters a country must be submitted to sanitary inspection and quarantine (FAO and Bioversity International 1989–2007).

In vitro *collection*

In vitro collection consists of taking and transporting *in vitro* to the laboratory viable plant tissues known as explants (e.g., buds, meristems, and embryos). The explants are extracted, sterilized, and planted onto a culture medium. *In vitro* collection is practised with species whose samples are difficult to manage such as those of vegetative reproduction or

non-orthodox (recalcitrant) seed, or when restrictions exist for transporting plant parts. It has been used to collect coconut (*Cocos nucifera*), cotton (*Gossypium* spp.), cacao (*Theobroma cacao*), *Prunus*, *Vitis*, grasses, and forages (Withers 1995) and cassava.

Handling Acquired Materials according to Germplasm Type

Acquired materials are handled according to their germplasm type. Seeds (orthodox or recalcitrant) are identified, conditioned (cleaned and dried), and temporarily stored for later characterization and increase. Plant parts are identified and conditioned, using specific procedures, and processed according to requirements for propagating the materials. The necessary procedures for pre-storage and later temporary storage are also carried out.

Care during collection

Collections should be carried out carefully, as carelessness or neglect during the activity's development may damage plant populations and their habitats. This occurs, for example, when large samples are collected from small populations, contaminated germplasm is transported, or species introduced that can displace natives through competition and/or hybridization.

Respect of customs, knowledge, and beliefs of the communities dwelling in the collection site will guarantee collaboration during the expedition and in the future. Safety measures should be taken with respect to the personnel who carry out the collection, especially for medical emergencies. Equipment should be handled with care and given due maintenance.

Documenting samples during collection

Documentation of the samples as they are being collected is fundamental for their identification, characterization, and later use. It should not be forgotten that data that have not been obtained can never be an integral part of either information or of the genetic variability conserved (Painting et al. 1995).

Identifying samples in the field is as important as documenting them. In this case, stickers can be placed on them, duly labelling them with sample number, place of origin, collector's initials, and identification number from the respective recording card. Samples could also be usefully collected for herbaria; photographs taken of the collected materials; and ethnobotanical, ecological, and geographic data (e.g., altitudes, latitudes, heights above sea level, and slopes) also taken (Guarino et al. 1995; Hawkes 1980; Querol 1988).

Passport data and collection data are taken during collection and recorded on cards or formats designed for this purpose (see *Module 6: Germplasm Documentation*). The information includes mainly:

- The consecutive number of the collection card
- Genus
- Species, subspecies, and/or variety of the botanical material
- Place, province, and country of collection of the sample
- Name or names of the collector or collectors
- Collection date

Conditioning and storing samples during collection

The collected samples should be kept viable until they arrive at the conservation site. They must be conditioned to prevent their damage or contamination.

Conditioning includes cleaning the samples, drying them if they are orthodox seeds, or maintaining their moisture content if they are plant parts or recalcitrant or intermediate seeds.

Cleaning consists of removing all contaminants from the samples such as stones and soil residues; insects; seeds that are infected, damaged, or are from other species; and plant residues. Drying consists of reducing the moisture content of seeds for storage, using silica gel, equipment for circulating dry air, or spreading them out in thin layers in the shade, in cool and airy places.

The conditioned samples should be stored until they are taken to the conservation site. Orthodox seeds are stored in cloth bags, away from light, or in containers that permit the circulation of dry air. Recalcitrant and intermediate seeds and plant parts should be maintained in humidified containers such as newsprint or paper towels, sawdust or sand, or humid inflated plastic bags, changing the air frequently. They can also be stored in polystyrene iceboxes or car refrigerators.

To prevent materials losing their viability during collection, partial shipments of samples should be made where possible to the conservation site. The materials must be sent in accordance with the *International Code of Conduct for Plant Germplasm Collecting and Transfer* (FAO 1994), being clearly identified and accompanied by instructions for handling and documentation.

Temporary storage

After conditioning, the seeds should be stored at the established conservation site to ensure their availability for increase, characterization, and other procedures characteristic of *ex situ* conservation.

Evaluating the Lesson

After this lesson, you should be familiar with the procedures involved in acquiring germplasm, collecting samples of species targeted for conservation, and managing the acquired germplasm.

Before going on to the next lesson, prepare a brief, in your own words, on the following themes. Write a maximum of one page per item.

- If you have had personal experience in applying procedures for acquiring germplasm, then:
  - Briefly describe your experience, including purposes, achievements, and the difficulties you had.
  - Prepare a list of suggestions that would be useful for other colleagues who have not had the experience, but are interested in taking it up.
- If you have not had the experience or have not participated in explorations and collections, briefly describe those procedures that would be the most relevant for germplasm acquisition, including aspects of sample management and documentation.
- Carefully read Box 3, form an opinion on the subject, and suggest the merits or drawbacks of its application.

Box 3

International Code of Conduct for Plant Germplasm Collecting and Transfer (Chapter IV Responsibilities of Collectors. Articles 9, 10, 11)

- **Pre-collection.** Upon arrival in the host country, collectors should acquaint themselves with all research results, or work in progress in the country, that might have a bearing on the mission. Before fieldwork begins, collectors and their national collaborators should discuss, and to the extent possible, decide on practical arrangements including: (i) collecting priorities, methodologies and strategies, (ii) information to be gathered during collection, (iii) processing and conservation arrangements for germplasm samples, associated soil/symbiont samples, and voucher specimens, and (iv) financial arrangements for the mission
- **During collection.** Collectors should respect local customs, traditions, and values, and property rights and should demonstrate a sense of gratitude towards local communities, especially if use is made of local knowledge on the characteristics and value of germplasm. Collectors should respond to their requests for information, germplasm or assistance, to the extent feasible. In order not to increase the risk of genetic erosion, the acquisition of germplasm should not deplete the populations of the farmers' planting stocks or wild species, or remove significant genetic variation from the local gene pool. When collecting cultivated or wild genetic resources, it is desirable that the local communities and farmers concerned be informed about the purpose of the mission, and about how and where they could request and obtain samples of the collected germplasm. If requested, duplicate samples should be also left with them. Whenever germplasm is collected, the collector should systematically record the passport data, and describe in detail the plant population, its diversity, habitat and ecology, so as to provide curators and users of germplasm with an understanding of its original context. For this purpose, as much local knowledge as possible about the resources (including observations on environmental adaptation and local methods and technologies of preparing and using the plant) should be also documented; photographs may be of special value.
- **Post-collection.** Upon the completion of the field mission, collectors and their sponsors should: **(a)** process, in a timely fashion, the plant samples, and any associated microbial symbionts, pests and pathogens that may have been collected for conservation; the relevant passport data should be prepared at the same time; **(b)** deposit duplicate sets of all collections and associated materials, and records of any pertinent information, with the host country and other agreed curators; **(c)** make arrangements with quarantine officials, seed storage managers and curators to ensure that the samples are transferred as quickly as possible to conditions which optimize their viability; **(d)** obtain, in accordance with the importing countries' requirements, the phytosanitary certificate(s) and other documentation needed for transferring the material collected; **(e)** alert the host country and the FAO Commission on Plant Genetic Resources about any impending threat to plant populations, or evidence of accelerated genetic erosion, and make recommendations for remedial action; and **(f)** prepare a consolidated report on the collecting mission, including the localities visited, the confirmed identifications and passport data of plant samples collected, and the intended site(s) of conservation. Copies of the report should be submitted to the host country's permit issuing authority, to national counterparts arid curators, and to the FAO for the information of its Commission on Plant Genetic Resources and for inclusion in its World Information and Early Warning System on PGR.

SOURCE: FAO (1994).

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Next Lesson

In the next lesson, you will learn about the legal requirements of access and quarantine, with reference to germplasm introduction.

Lesson 3

Germplasm Introduction: Transfer Regulations and Quarantine Measures

Objectives

- To indicate the requisites implied in germplasm transfer
- To describe the procedures for transferring plant germplasm
- To describe examples of agreements on plant protection and the factors that must be considered when adopting quarantine measures

Introduction

For national and international crop improvement programmes, which constantly need germplasm, its collection, conservation, use, and global distribution are essential. However, because of its very nature, germplasm can be affected by pests and pathogens which are not globally distributed or reported that threaten their integrity. This resource, which constitutes a treasure, merits conservation and protection against exotic organisms that have high destructive potential.

Moving germplasm from one country to another, or from one region to another within a country, involves plant health risks. Such movement is therefore subject to legislation. The parties interested in moving a given germplasm agree on terms of transfer to ensure its legality and that the transported germplasm is healthy. Such agreements must adjust to international regulations that regulate access, safe transfer, and the rights and responsibilities of each party with respect to the use of the transferred germplasm.

Before introducing germplasm to a country, requirements must first be met. These include:

- Submitting an official application to the entity responsible for the PGRs of the country in which the germplasm is to be acquired
- Observing requisites according to established regulations
- Signing agreements on the transfer of PGRs
- Determining specific procedures for moving or transferring the materials.

Once the transactions for acquisition are fulfilled and the germplasm is available, it should be transferred and introduced into the respective bank. When transfer must occur across country borders, then that transfer or movement is achieved through agreements that adjust to current international regulations as expressed in instruments such as the Convention on Biological Diversity (CBD) (Glowka et al. 1994), the International Code of Conduct for Plant Germplasm Collecting and Transfer (ICCPGCT), the International Plant Protection Convention (IPPC), FAO and IPGRI's *Technical Guidelines for the Safe Movement of Germplasm* (FAO and Bioversity International 1989–2007). When the germplasm is acquired from within the country, then transfer to the respective banks is subject to regulations established by that country.

Germplasm Transfer

Germplasm transfer is effected by the interested parties signing an agreement. The agreement should stipulate both the terms of transfer and use of the material (e.g., conservation, research, or production of commercial varieties). An example of these agreements for the transfer of genetic resources (Barton and Siebeck 1994) is that established between the International Center for Tropical Agriculture (CIAT), FAO, and the CGIAR (Figure 1).

MATERIAL TRANSFER AGREEMENT
FOR PLANT GENETIC RESOURCES HELD IN TRUST
BY CIAT[1]

The plant genetic resources (hereinafter referred to as the "material") contained herein are being furnished by the international Centre for Tropical Agriculture (CIAT) under the following conditions:

CIAT is making the material described in the attached list available as part of its policy of maximizing the utilization of material for research, breeding and training. The material was either developed by CIAT; or was acquired prior to the entry into force of the Convention on Biological Diversity; or if it was acquired after the entering into force of the Convention on Biological Diversity, it was obtained with the understanding that it could be made available for any agricultural research, breeding and training purposes under the terms and conditions set out in the agreement between CIAT and FAO dated 26 October 1994.

The material is held in trust under the terms of this agreement, and the recipient has no rights to obtain Intellectual Property Rights (IPRs) on the material or related information.

The recipient may utilize and conserve the material for research, breeding and training and may distribute it to other parties provided such other parties accept the terms and conditions of this agreement.[2]

The recipient, therefore, hereby agrees not to claim ownership over the material, nor to seek IPRs over that material, or its genetic parts or components, in the form received. The recipient also agrees not to seek IPRs over related information received.

The recipient further agrees to ensure that any subsequent person or institution to whom he/she may make samples of the material available, is bound by the same provisions and undertakes to pass on the same obligations to future recipients of the material.

CIAT makes no warranties as to the safety or title of the material, nor as to the accuracy or correctness of any passport or other data provided with the material. Neither does it make any warranties as to the quality, viability, or purity (genetic or mechanical) of the material being furnished. The phytosanitary condition of the material is warranted only as described in the attached phytosanitary certificate. The recipient assumes full responsibility for complying with the recipient nation's quarantine and biosafety regulations and rules as to import or release of genetic material.

Upon request, CIAT will furnish information that may be available in addition to whatever is furnished with the material. Recipients are requested to furnish CIAT with related data and information collected during evaluation and utilization.

The recipient of material provided under this MTA is encouraged to share the benefits accruing from its use, including commercial use, though the mechanisms of exchange of information, access to and transfer of technology, capacity building and sharing of benefits arising from commercialization. CIAT is prepared to facilitate the sharing of such benefits by directing them to the conservation and sustainable use of the plant genetic resources in question, particularly in national and regional programmes in developing countries and countries with economies in transition, especially in centres of diversity and the least develop-countries.

The material is supplied expressly conditional on acceptance of the terms of this Agreement. The recipient's acceptance of the material constitutes acceptance of the terms of this Agreement.

1. The attention of the recipient is drawn to the fact that the details of the MTA, including the identity of the recipient, will be made publicly available.
2. This does not prevent the recipients from releasing the material for purposes of making it directly available to farmers or consumers for cultivation, provided that the other conditions set out in this MTA are complied with.

Figure 1. Material Transfer Agreement between FAO, CIAT, and the CGIAR.

Germplasm transfer agreements should respect the treaties on access to genetic resources that the involved countries have. As germplasm transfer implies plant health risks, any exchange or donation should be made through authorized institutions and according to what is stipulated in the International Plant Protection Convention (FAO 1997). In this case, each country commits itself to adopting the legislative, technical, and administrative requisites to act effectively and jointly to prevent the dissemination and introduction of pests of plants and plant products and to promote appropriate measures to combat them.

Procedures for Plant Germplasm Transfer

Before importing

All plant materials and plant products and by-products should meet certain plant health requirements for their importation. An exception would be those products that, by their physical constitution and the processing to which they had been submitted, do not pose plant health risk.

In general, before shipping, interested parties should present before each country's official agency responsible for preventing plant health risks an application, permit, or plant health importation certificate. Figure 2 shows an example.

In some cases such as that of Colombia, to import wild flora, an approval issued by the Ministry of the Environment must also be attached to the request. The movement of cassava germplasm from African countries to America is not allowed in the form of vegetative plant parts, unless they are *in vitro*. Such measures help prevent the introduction of pests or diseases that are, as yet, unreported in the respective countries.

Once the interested party obtains the requisite plant health documents for importing plant materials, that party requests its registration of importation from the respective ministry or office. A copy is sent to the exporting country so that the health authority there can issue the plant health certificate (Figure 3) in accordance with the requirements demanded by the receiving country.

The requisite plant health document is issued per species and per shipment, and has a determined validity for the respective country. For Colombia, such a document is valid for 90 days. The Colombian Institute of Agriculture and Livestock (ICA) is empowered to suspend it should a quarantine pest be found that would affect national production.

Procedures after acquisition

According to the regulations of the ICCPGCT, once the field mission is concluded, the collectors and their sponsors should:

- Submit, on a timely basis, their samples of plants and any associated symbiont, pest, and microbial pathogen that may have been collected to treatment for conservation; the pertinent passport data must be prepared at the same time.
- Deposit duplicates of all collections and associated materials, as well as records of all corresponding information, in the host country and with agreed-upon persons in charge.
- Arrange with quarantine officials, directors, and those in charge of seed deposits to ensure that the samples are transferred with the greatest possible speed to a place where conditions for viability are optimal.

Country logotype
Name and logotype of the official phytosanitary service

Logotype of the Andean Community

PHYTOSANITARY CERTIFICATE FOR IMPORT

Certificate No. _____

1. Importer or proprietor of the import

--Name or business name: _____

--Commercial or residential address: _____

2. Name of product (plant/plant product/regulated article)

--Scientific name (where original): _____

3. Quantity, weight, and type of container (where applicable)

--In kilos or units: _____

4. Origin and, where applicable, place of production: _____

5. Country of origin/reexportation: _____

6. Point of shipping or departure: _____

7. Point of entry or entry customs: _____

8. Means of transport: _____

9. Use or destiny: _____

10. Phytosanitary requisites: _____

11. Observations: _____

12. Place and date of issue of permit: _____

13. Name, position, and signature of functionary authorized to issue permit:

_____

_____

_____

14. Seal or security code (optional):

****

Valid for 90 calendar days for the entry of the product, starting from the day of issue and for only one shipment.
--Whatever amendment or addition shall invalidate this document
--The Competent Authority reserves the right to annul the validity of this Phytosanitary Permit or Document for Import on the appearance of quarantine pests in the exporting Country
--This document is not transferable.

Figure 2. An example of a plant health certificate for import (taken from the Andean Community 2004).

agriculture
Department:
Agriculture
REPUBLIC OF SOUTH
AFRICA

PGT 3–o–BIJ1t1

ARG13/007

PHYTOSANITARY CERTIFICATE

PLANT PROTECTION ORGANISATION OF THE REPUBLIC OF SOUTH AFRICA

To: Plant protection organisation(s) of .....

I. DESCRIPTION OF CONSIGNMENT

Name and address of exporter ..... TI .....

Declared name and address of consignee .....

.....

Number and description of packages .....

.....

Distinguishing marks .....

.....

Place of origin .....

Declared means of conveyance ..... Declared point of entry .....

Name of produce, quantity declare and purpose .....

CANCELLED

Botanical name of plants .....

This is to certify that the plants, plant products or other regulated articles, described herein have been inspected and/or tested according to appropriate official procedures and are considered to be from the quarantine pests specified by the importing contracting party and to conform to the current phytosanitary requirements of the importing contracting party, including those for regulated nonquarantine pests. They are regarded to be practically free from other pests.

II. ADDITIONAL DECLARATION

.....

.....

.....

.....

.....

.....

CANCELLED

III. DISINFESTATION AND/OR DISINFECTION TREATMENT

Date ..... Treatment .....

Chemical (active ingredient) ..... Duration and temperature .....

Concentration ..... Additional information .....

Place of issue ..... Name of authorised officer .....

Figure 3. An example of a phytosanitary certificate from the Republic of South Africa.

- Obtain, in accordance with requirements of the importing countries, the plant health certificate or certificates and other documentation needed to transfer the material collected.
- Warn the host country and the FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA) of any imminent threat or sign of rapid genetic erosion with regard to plant populations, and to formulate recommendations to remedy the situation.
- Prepare a joint report on the collection mission, indicating places visited, identifications confirmed, passport data of the samples of collected plants, and the place or places to be used for their conservation. Copies of the report shall be delivered to the authority that grants permits for the host country, to national counterparts and persons in charge, and to FAO. This last shall report to the CGRFA and include the report in the World Information and Early Warning System on PGRFA (WIEWS; FAO 1994).

Nationalization

On their arrival, the imported plant materials must be accompanied by their respective plant health certificates issued by the health authority of the country of origin. These certificates should be adjusted to the plant health requisites indicated in the plant health documents for importation.

The importer should request plant health inspection from the inspection and quarantine service of the plant health organization in the place of entry (sea or river port, airport, or border control). The importer should also present the original plant health certificates from the country of origin and the plant health documents that accompany the materials. Once the documentation has been reviewed and the inspection conducted, the corresponding plant health certificate for nationalization will then be issued, or not, as the case may be.

Procedures after nationalization

After the material has been introduced into the country, the respective bank determines the risk of transporting plant pathogens during the germplasm's movement. It establishes flow charts that show where quarantine inspection and plant health control play essential roles in the procedures (Figures 4 and 5).

The effectiveness of these measures depends on the seriousness and professionalism that had been applied, logistical support, availability of skilled technical personnel, and availability of specific information on plant pathogens or pests and their potential risk. Political and institutional will to apply the measures is also necessary if regional and international agriculture is to be protected. The simple inspection or visual examination that is frequently practised by quarantine services should be regarded as insufficient for keeping pathogens or pests out of a country.

Necessarily, quarantine often consists of officially confining the regulated articles (e.g., plant materials) for observation or research, or for inspection, testing, and/or additional treatment. This is the most effective measure for control and widely applied throughout the world. It encompasses all those activities designed to prevent the introduction and/or dissemination of quarantine pests or ensure their official control.

Quarantine is a governmental measure to control the entry of plants, plant parts, or any plant product, soil samples, and live organisms into a given country to prevent the introduction or dissemination of pests, pathogens, and weeds (Nath 1993). It includes inspection to detect pests and pathogens, treatment or cleaning of the samples, and their certification and release if no danger exists, or their destruction if they are highly contaminated or no technology is available to clean them.

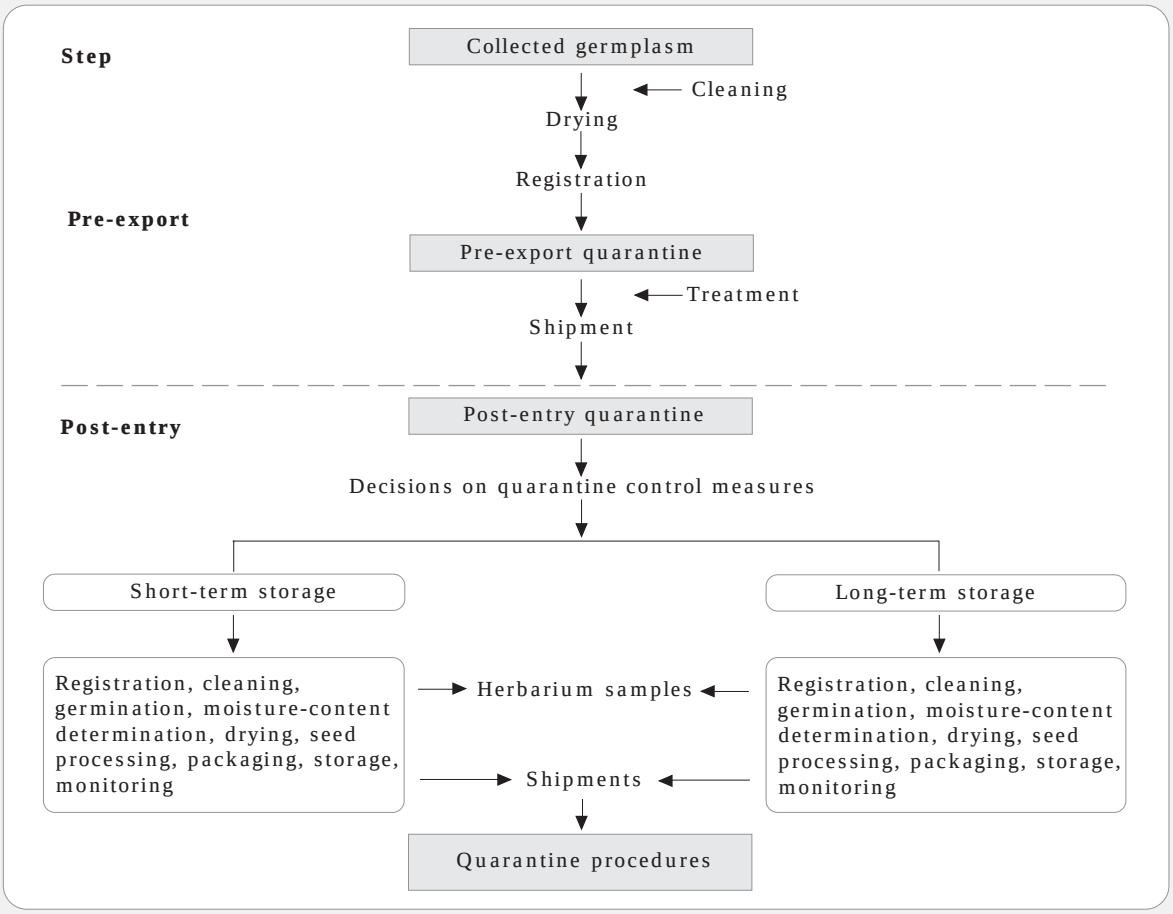

Figure 4. Flow chart for managing collected germplasm (from Gerard 1984).

The principal risk in moving germplasm is the transfer or accidental introduction of pests and pathogens associated with the plant materials. To minimize this risk, effective procedures must be applied to guarantee that the mobilized material is free of pests of quarantine interest. 'Quarantine pest' is understood to have economic importance for the area at risk, even if the pest does not exist or, if it does exist, is confined and under official control. A quarantine pest may be of any species, race, or biotype of any harmful animal or plant, or pathogen for plants or plant products (IPPC 1995). A very useful tool in minimizing risk is the Technical Guidelines for the Safe Movement of Germplasm by FAO and Bioversity International (1989–2007), which deal with many species or groups of species.

Plant Protection Agreements

The reduction of plant health risks in the international movement of plants and plant products is a matter of vital importance, with the responsibility belonging to countries. According to the IPPC, to combat pests of plants and their products, each country must take the steps necessary to establish, in the best possible way, a national organization of plant protection. The responsibilities of such an organization would include:

Figure 5. Flow chart for multiplication in germplasm banks (from Gerard 1984).

- The issue of certificates based on the plant health regulations of the importing country for shipments of plants, plant products, and other regulated articles.
- The monitoring of cultivated plants, including in cultivated lands (e.g., fields, plantations, nurseries, gardens, greenhouses, and laboratories), and wild flora; and of plants and plant products in storage or transport. The specific purpose is to report on the presence, outbreak, or dissemination of pests, and combat them. Reports may also have to be presented on request.
- The inspection of shipments of plants and plant products that circulate in the international traffic. Where appropriate, other regulated articles may be inspected, particularly to prevent the introduction and/or dissemination of pests.
- The disinfestation or disinfection of shipments of plants, plant products, and other regulated articles that circulate in international traffic to meet plant health requirements.

- The protection of at-risk areas and designation, maintenance, and monitoring of areas free of pests and of areas with limited prevalence of pests.
- The analysis of pest risk.
- The maintenance of plant health security of shipments after they have been certified in terms of composition, substitution, and re-infestation before export.
- Personnel training and education.

Plant protection organizations and their guidelines

At present, following the IPPC guidelines, Latin America has several organizations responsible for plant protection. These include:

- The Plant Protection Committee of the Southern Cone (COSAVE, its Spanish acronym), which is a regional organization created through agreements among the governments of Argentina, Brazil, Chile, Paraguay, and Uruguay.
- The Andean Agricultural and Livestock Health System, which forms part of the Andean Subregional Integration Agreement (also known as the 'Cartagena Agreement'), of the Andean Community, which is constituted by Bolivia, Colombia, Ecuador, Peru, and Venezuela.
- The International Regional Organization for Plant and Animal Health (OIRSA, its Spanish acronym), formed by Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, and the Dominican Republic. It was created to advise, coordinate, and cooperate with national services for agricultural and livestock quarantine of the ministries of agriculture and livestock of the member countries. The goal is to prevent, where possible, the introduction and establishment of new pests in the region.

North America and Europe also have plant protection organizations:

- The North American Plant Protection Organization (NAPPO) is a regional organization of plant protection that coordinates efforts between Canada, USA, and Mexico. It aims to protect these countries' plant resources against the entry, establishment, and dispersion of pests of regulated plants, while facilitating trade among them and with other regions.
- For Europe, the entity responsible for plant protection is the European and Mediterranean Plant Protection Organization (EPPO). It has 45 members and covers almost all countries in Europe and the Mediterranean Region. EPPO aims to protect plants, develop international strategies against pest introduction and dissemination, and promote effective and safe methods of control.

Plant protection organizations in Africa include:

- Inter-African Phytosanitary Council (IAPSC) with 54 members
- National Plant Protection Organisation (NPPO) of the Republic of South Africa

The above-mentioned organizations have established and harmonized plant health standards and procedures that should be taken into account when moving germplasm. Some of these are:

- Decision 515 of the Andean Agricultural and Livestock Health System (Comunidad Andina 2004)
- Plant Health Requirements Harmonized with Category of Risk for the Entry of Plant Products (COSAVE 2003)

- Model Manual for the Application of Technical Measures of Agricultural and Livestock Quarantine (OIRSA 2004)
- General Procedures for Plant Quarantine (Costa Rica) (Servicio Fítosanitario del Estado 2004)
- Guidelines for the Import and Export of Plants, and Products and By-products of Plant Origin (Colombia) (ICA 2004)
- List of Pests Recommended for Regulation as Quarantine Pests (EPPO 2006)

The IPP has an special web page dedicated to Africa in which there are about 12 documents, mostly handouts very useful to familiarize with the phytosanitary situation on this continent.

Furthermore, international organizations such as IPGRI (now Bioversity International) have published technical guidelines for moving germplasm of *Acacia* spp., *Allium* spp., edible aroids, sweet potato, cacao, sugar cane, small grains, citrus fruits, coconut, *Eucalyptus* spp., stone-fruit trees, strawberries, legume grains, *Musa* spp., yam, potato, *Pinus* spp., vanilla, grape vine, and cassava (FAO and IPGRI 2004; FAO and Bioversity International 1989–2007). The guides contain useful information for germplasm transfer.

Factors to consider when adopting quarantine measures

To guarantee safe germplasm movement in international exchange and adopt quarantine safety measures, the following must be done:

- Estimate the 'favourability' of risk through the risk-to-benefit ratio. The 'favourability' of an importation is determined by assessing the associated risk against the benefit of the importation. The benefit should exceed the potential cost of the adverse consequences if a pest or pathogen of quarantine importance enters and becomes established.
- Estimate the cost-to-benefit ratio to determine if the benefit derived from implementing a quarantine activity or programme exceeds the cost of applying it.
- Assess the pathogen type of a given pest in terms of its potential for direct destruction or for rapid epidemiological dispersion, even if it is not present in the area targeted for protection or is restricted to areas under effective control.
- Consider the regions from where the germplasm proceeds, with special reference to centres of origin, experiment stations, or other places generating risk.
- Consider the susceptibility of materials, including wild ones, to ranges of pathogens.
- Get acquainted—and this is crucial—with all the existing laws and regulations followed by the importing country. Such knowledge will prevent the destruction of samples through ignorance of simple bureaucratic procedures.

Evaluating the Lesson

After this lesson, you should be familiar with the legal requirements involved in germplasm transfer, transfer procedures, and plant health agreements. You should also have some understanding of the issues involved in adopting quarantine measures related to the safe transfer of germplasm.

This lesson finalizes Module 2 of the course but, before going on to the next module, you should prepare a brief in your own words on the following themes. Write a maximum of one page for each theme.

- If you have had experience in legal transactions for germplasm transfer, then:
  - Briefly describe the transactions that were carried out and indicate those entities and organizations involved; and
  - Express your opinion on the effectiveness of the procedures followed for reducing the risk of inadvertently introducing pests (i.e., pathogens, insects, and other agents) of quarantine interest to your country.
- If you have not had experience with legal transactions for germplasm transfer, then briefly describe what would be the procedures to follow for the safe international transfer of germplasm.

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Next Module

In the lessons of the next module, you will study germplasm conservation.