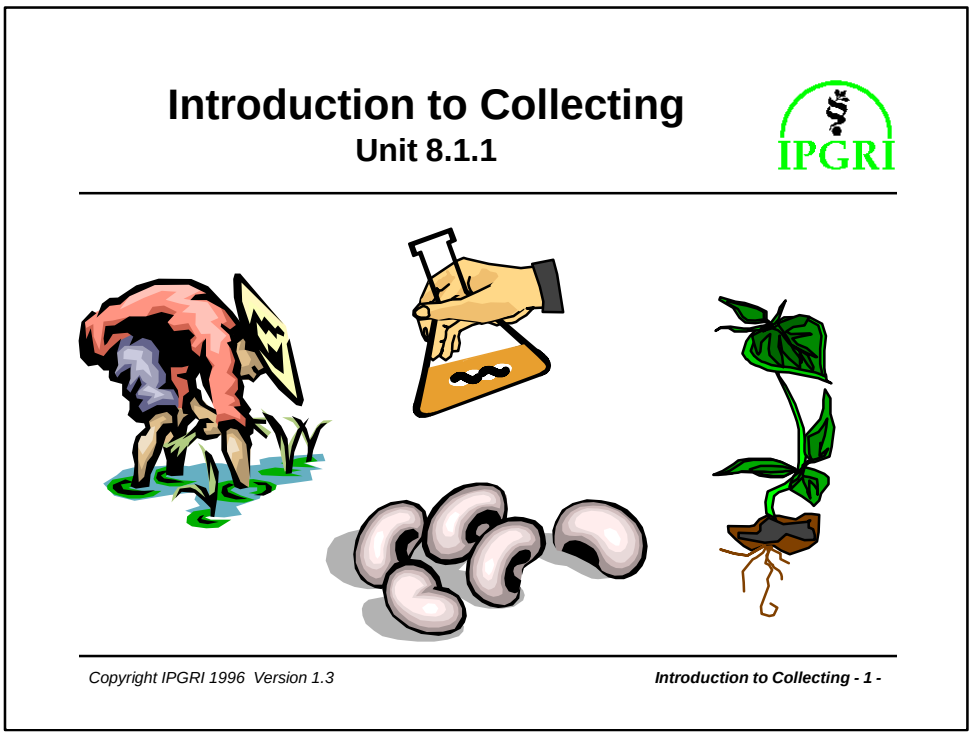

Unit 8.1.1 - Introduction to Collecting

Version 1.3

Training support materials developed by:

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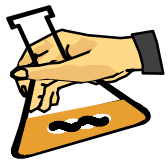
Principal Source: Guarino, L., Ramanatha Rao, V. and Reid, R., Eds. (1995). Collecting Plant Genetic Diversity. Technical Guidelines. CAB International, Wallingford on behalf of the International Plant Genetic Resources Institute (IPGRI) in association with the Food and Agricultural O rganization of the United Nations (FAO), The World Conservation Union (IUCN) and the United Nations Environment Programme (UNEP).

Introduction to Collecting

Unit 8.1.1

- Topics
  - Reasons for Collecting
  - Types of Collecting Missions
  - Dangers of Collecting
  - Ingredients for a Successful Mission
- Objectives



Objectives

(1) Reasons for Collecting

Objective: Following a presentation and discussion of the topic, the trainee will be able to outline five reasons why germplasm is collected.

(2) Types of Collecting Missions

Objective: Following a presentation and discussion of the topic, the trainee will be able to discuss the factors which affect the character (type) of collecting mission undertaken.

(3) Dangers of Collecting

Objective: Following a presentation and discussion of the topic, the trainee will be able to summarise the principal dangers of collecting in respect of ecological damage and personal safety.

(4) Ingredients for a Successful Mission

Objective: Following a presentation and discussion of the topic, the trainee will be able to recall seven important elements in a successful germplasm collecting mission.

Topic 1 - Reasons for Collecting Germplasm

- Topics
  - Reasons for Collecting
  - Types of Collecting Missions
  - Dangers of Collecting
  - Ingredients for a Successful Mission

Reasons for Collecting Germplasm

- Danger of genetic erosion/extinction
- Needed for immediate use
- Diversity is missing from *ex situ* collections
- More needs to be known about it
- Opportunism

Collecting is only part of a conservation strategy

There are some 250,000 plant species in the world today. It is difficult to predict which of these species will be able to fulfill future needs, or even what these needs might be. Therefore, the more plant diversity that is conserved and made available for use, the more likely that future needs will be met. It is impractical however, for purely logistical and financial reasons, to use collecting (with subsequent storage and maintenance) as the only strategy in conserving plant genetic diversity. Usually priorities for collecting are made according to the species and / or geographic regions. The main reasons for collecting germplasm of a particular species from a particular area are:

• **Rescue Collecting** - danger of genetic erosion or extinction of target species

• **Needed for immediate use** - for breeding purposes, immediate planting, land management etc.

• **"Gap Filling"** - diversity missing from *ex-situ* collections e.g. missing taxa, genotypes and under-collected germplasm from particular areas

• **Research Purposes** - more needs to be known about the target species

• **Opportunistic reasons** - fortuitous collecting - germplasm contains striking features or found under unusual circumstances

Rescue Collecting

Causes of genetic erosion:

- agricultural change
- socio-economic change
- over-exploitation
- loss of habitat
- competitors, predators and pests
- natural disasters/pollution

Germplasm collecting is often called for in situations where there is a threat of genetic erosion in a particular area and *in-situ* conservation methods are inadequate or not possible. In such cases, collecting is often called *rescue collecting*. Genetic erosion can be caused by a number of factors including:

• **Agricultural change** - traditional and diverse landraces of the major crop types are seriously threatened by the introduction of uniform, modern varieties. Similarly, locally important food crops are lost by their replacement with exotic staples or cash crops.

• **Socio-economic change** - rural populations abandon agriculture and move to the cities; wars and civil unrest disrupt and disperse the communities which developed and maintained landraces and managed the forests and rangelands.

• **Over-exploitation** - loss of species caused by over-grazing (e.g. forages) or by uncontrolled harvesting in the wild (e.g. medicinal plants, timber species). Over-exploitation can result in the concomitant loss of other species and even complete habitat destruction.

• **Habitat loss** - caused by urban expansion, land clearance, dam and road construction and over-exploitation.

• **Competitors, predators and pests** - introduction of foreign organisms (e.g. plant, insect and microbial species), often through human interference, can have calamitous effects.

• **Natural disasters/pollution** - e.g. drought, floods, disease epidemics and industrial pollution.

Collecting for Immediate Use

- Formal sector - for breeding purposes
- Local communities - for immediate planting
- Non-crop species are also collected
- *ex-situ* collections are a potential source

The formal sector is interested in obtaining germplasm for use in crop breeding or plant introduction and selection programmes. As there is always a need for new traits and combinations of traits to meet new challenges, new germplasm is acquired through collecting or from other *ex-situ* collections. Since biotechnological tools can now facilitate the transfer of genes between different species, there is an increasing interest in the wild relatives of crop species for particular traits.

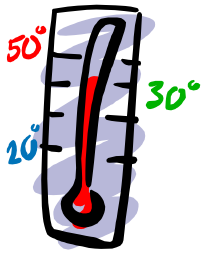
Local communities continually collect germplasm for immediate planting. Examples include exchanging planting material with farmers (a practice dating back millennia) and collecting tree seeds for community forestry projects.

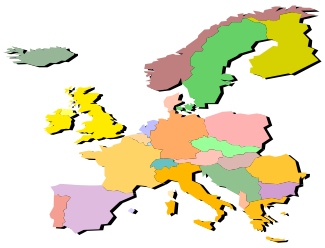
Many non-crop species are targets for systematic collecting owing their importance to communities and their livestock. These include forages, multipurpose trees, wild fruits, medicinal species and species important in land management and habitat restoration.

Ex-situ collections are potential sources of germplasm collected from a particular region. Recollection of material held in such collections would only normally be justified if the material was unavailable (or available in inadequate amounts) or did not reflect the diversity of the target genepool (because of genetic drift or inadequate sampling of the original population).

"Gap Filling" - Collecting for future use

- Under-represented ecological conditions
- Missing taxa and genotypes
- Inadequately covered range of distribution





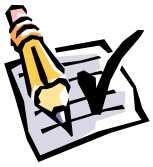
Material not considered especially useful now may become become vitally important in the future owing to changing agronomic problems and priorities and the need to rehabilitate ecosystems which may become threatened in the future.

Priority is given to areas which have been inadequately covered. As genetic variation in genepools is associated with variation in environmental factors, ecological conditions which are not represented are given a high priority along with missing genotypes and taxa.

Also important is that the germplasm should be sampled across the genetic range for that species as some studies have shown random distribution of traits over the geographic range of the species e.g. pathogen resistance found in germplasm growing outside the geographic range of the pathogen.

Collecting for Research Purposes

- Comprehensive knowledge of gene pool
  - mating systems
  - taxonomic boundaries
  - evolutionary relationships
  - how cultivated forms were domesticated
- Development of sampling strategies



Developing a comprehensive knowledge of the target gene pool is often an important motivation for collecting. Germplasm is often needed to resolve particular research problems such as the mating systems of species, their taxonomic boundaries, the evolutionary relationships among taxa and where and how cultivated forms were domesticated. Taxonomically unique, isolated, rare and narrowly endemic species receive particular attention.

Adequate sampling strategies can be developed if there is sufficient knowledge of the distribution of genetic diversity among and within populations. Collecting for research purposes requires however a different approach than for conservation collecting.

Opportunistic Collecting

- *Collecting of non-target taxa due to:*
  - Impressive features
  - Unusual occurrence
  - Novel local uses

Germplasm is sometimes collected on an opportunistic basis during a mission which was originally targeted on quite different species, characters or ecological conditions. Common reasons for this include impressive phenotypic features, occurrence in unusual situations and novel or interesting local uses. Such germplasm collecting can also be an incidental part of other activities such as ethnographic or botanical studies.

Topic 2 - Types of Collecting Mission

- Topics
  - Reasons for Collecting
  - Types of Collecting Missions
  - Dangers of Collecting
  - Ingredients for a Successful Mission

Types of Collecting Missions

The type of collecting mission depends on the purpose of the mission and the strategy used to collect the germplasm

- ***Purpose***
- Multi-species vs. species-specific
- Wild-species vs. crop collecting

- ***Strategy***
- Single visit vs. multiple visit
- Centralized vs. decentralized

The character (or type) of a collecting mission is fundamentally influenced by the *purpose* of the collecting mission. For instance, a collecting mission organized by plant breeders will usually focus on particular genepools or species and will therefore be planned and executed in a quite different way to a collecting mission organized by a national PGR programme which might focus on a long list of target species such as all the forage species of a particular area.

Other influences on the type of collecting mission concern the *strategy* employed to collect the germplasm. Planning and execution of a mission is affected if it is decided to opt for a centralized approach to collecting (e.g. organized and run by a national genebank) or a decentralized approach (involving several groups, e.g. national agricultural infrastructure, NGO's and local people). Also, in certain cases it may be necessary to make more than one visit because of variation in times of fruiting in a region or because a preliminary exploration / reconnaissance mission is needed.

Multi-Species Collecting

Area driven, usually for conservation purposes

Problems

- Difficult to optimize sampling strategy
- Problems of incomplete knowledge
- Differences in maturation times
- Different collecting techniques required

Multi-species collecting missions are *area driven,* that is, a region is selected and as many of the species sampled as possible with as much of their diversity. Commonly they are undertaken for conservation purposes rather than immediate use e.g. in rescue collecting where genetic erosion is threatened. They are planned when there has been no systematic collecting in an area and / or when an area is difficult to reach and return visits would be unlikely.

Multi-species collecting missions have a number of drawbacks which can lead to potentially valuable germplasm being overlooked during collecting. The collector is likely to have a restricted knowledge of many of the species to be collected because of the large number of species involved, resulting in sub-optimal sampling strategies, valuable material being overlooked and incomplete information being documented. It is important therefore to make use of available indigenous knowledge about plants and the environment maintained by local communities.

To avoid some of these problems, multi-species collecting is often focused on a crop category e.g. 'forages', 'root and tuber crops'.

Species-Specific Collecting

Driven by users of the germplasm

- Less complicated to plan than multi-species missions
- More known about distribution of target material
- Collecting team usually more familiar with target material

Species specific (or gene-pool specific) collecting missions tend to be driven by the *users* of the material (e.g. breeders) and are usually less complicated to plan than multi-species collecting missions.

As these missions are more focused than multi-species collecting missions, more is known about the ecogeographic distribution of the target material, maturation times etc. Also, the collectors are more likely to have an intimate knowledge of the genepool and even be familiar with material collected on previous missions. Where the target material is very specific, the collecting team might additionally comprise specialists such as pathologists, entomologists and microbiologists.

Wild Species Collecting

- Narrow collecting window - ripe seeds are quickly shed
- Fruiting times vary between and among populations - repeat visits may be necessary
- Difficult to find - populations often scattered and in remote places
- Commonly outbreeding - can sample fewer sites and fewer individuals

Unlike crop seeds, ripe seeds of wild species are usually quickly shed and not subsequently available to the collector. This means that the time available for collecting (the so-called "collecting window") is quite narrow. Another complicating factor is that there is variation in fruiting times both within and between wild populations which means that repeat visits or longer stays may be necessary.

Compared to crop species, wild species populations are generally more difficult to find because they are often scattered or in inaccessible places. Although collecting sites can be identified with certainty in the planning stage, potential collecting sites can be inferred from an intimate knowledge of the habitat preferences of the target species. This set of habitat preferences (or "search image") contains physical indicators (e.g. rock types) and/or biotic indicators (e.g. associated plant species). The use of accurate search images helps reduce the time spent searching inappropriate areas.

Wild species tend to be outbreeding and therefore it is possible to sample fewer sites and fewer individuals than with crop species. However, taxonomic identification is more difficult and so herbarium specimens are often taken for later confirmation of field identifications.

Crop Collecting

- Wider collecting window
- Difficult to collect both crop and wild species together
- Variety of possible sources
- Indigenous knowledge is essential for locating germplasm

There is a wider collecting window for crop species than wild species because the ripe seeds are not shed quickly and usually stay on the plant. It is however difficult to collect both categories during a collecting mission because of problems in timing and other organizational reasons.

Crop germplasm can be collected from a variety of possible sites, ideally from farmers 'fields, gardens and orchards but also from farm stores, markets and shops. Markets are a particularly useful source of crop germplasm (and information) as they often serve a large hinterland. However, they do not necessarily contain a representative sample of the variation available as the material is frequently a mixture of populations. Also seed viability can be low and certain passport data cannot be recorded such as morphological and sampling details.

Indigenous knowledge is essential to successful crop collecting and compared to wild species collecting, crop collectors usually spend more time at the collecting site talking to local people. Markets can be good sources of information on the genetic diversity in the region they serve.

Single Visit vs. Multiple Visit

Reasons for multiple visits

- Variation in timing of fruiting
- Year to year variation
- Exploration/reconnaissance
- Genetic erosion

Collecting missions are costly in terms of the human and physical resources required and so most collecting missions consist of a single, short visit to the collecting area. There are however several important reasons why repeat visits may be necessary.

• **Variation in timing of fruiting** - due to latitudinal, altitudinal and climatic differences in the target area. A single, short visit could miss early and late maturing material both in and between populations. If there are two growing seasons, material adapted to one season might be missed. In species with indeterminate flowering, fruits produced at different times may be the result of pollination by genetically different sources.

• **Year to year variation.** The genetic variation recovered from a population can vary from year to year as a result of climatic and biotic factors such as rainfall or pest organisms. Some species have alternate flower type in successive years.

• **Exploration/reconnaissance.** For accurate species identification, a preliminary mission can be planned during the flowering period to locate target populations and collect herbarium specimens, the second mission actually collecting the target germplasm (e.g. root and tuber crops). Another purpose could be to collect material for genetic diversity studies (e.g. DNA and isozyme analysis) and use the results to formulate a more efficiency sampling strategy. Similarly, the preliminary mission could collect socioeconomic, ethnographic and ethnobotanical information to help plan a later mission.

• **Genetic erosion** - this can be monitored by on-going genetic diversity studies and by tapping indigenous knowledge.

Centralized Collecting

- Centrally planned and executed missions
  - e.g. national genebank, agricultural research centres
- Emphasis on priority crop species and crop relatives
- Area driven collecting
- Short duration missions; large areas covered

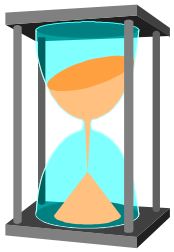
A centralized collecting programme or mission is one that is centrally planned and executed by a formal sector institution such as national genebanks or national / international agricultural research centres. The focus of the programme is usually on priority crop species and their relatives. The collecting missions are area driven with the aim of systematically collecting the crop diversity in a particular target region, usually an administrative sub-division of the country. Missions also tend to be of short duration and because large areas are covered, communities are only visited once. The collectors themselves are crop specialists, often brought in from outside the country and subsequent evaluations are performed in laboratories and research stations.

The centralized approach to collecting has been successful in gathering thousands of crop germplasm samples throughout the world. It does however have a number of practical and scientific drawbacks which make a measure of decentralization desirable.

Problems of Centralized Collecting

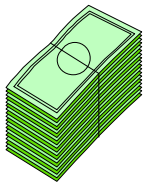
Practical difficulties

- Demanding of resources
- Logistical problems



Scientific issues

- Diversity missed/overlooked



Centralized collecting missions are very costly in terms of human and physical resources required. A fully equipped team including several professionals must be transported to often remote and not easily reachable places and spend long periods away from home, living under often arduous circumstances.

Where staff time and money are not seriously limiting, it can still be difficult logistically to perform more than one mission in a given collecting period as the collecting window may be quite narrow. For this reason it can take many years before a crop is adequately sampled over the whole country.

In conventional crop collecting, repeat visits to a particular region are comparatively rare because of the costs involved and the need visit other unexplored areas. Consequently, genetic diversity from a particular region can be overlooked or missed because of variation in fruiting times (late or early maturing relative to the collecting time) and any year to year variation.

In view of the continuing pace of genetic erosion and urgency of the task at hand, the formal sector is starting to move away from the wholly centralized collecting approach to decentralization of the genetic resources collection programmes.

Decentralized Collecting

- ***Devolving collecting responsibilities onto local experts***
  - agricultural research infra-structure
  - government support services
  - NGO's
  - Local people

It is possible to organize effective collecting programmes that work with local organizations (e.g. extension services, farmers 'organizations, NGO 's etc.). It clearly makes sense to consider working alongside such local experts if they can carry out collecting to the appropriate standards. Local experts will have extensive local ecogeographic and cultural knowledge, they can judge the best time for collecting and will be able to collect throughout the fruiting season and successive seasons. Decentralized collecting programmes can be organized through:

•**Agricultural research infra-structure** - in many countries this is organized on a regional basis and personnel from regional research stations are included in collecting teams for their expertise. With appropriate training, such personnel could be entrusted to do the collecting themselves.

•**Government support services** - e.g. agricultural extension services. Extension workers have a good knowledge of their areas and the farmers and have been used as useful guides and intermediaries in crop collecting teams. They could also be trained to carry out collecting. Provincial universities, colleges and schools are also sources of potential collectors.

•**Non-governmental organizations (NGOs)** - ready-made networks of locally based people and sources of potential collectors.

•**Local people** - through grass-roots organizations, federations or networks and national farmers 'associations.

Topic 3 - Dangers of Collecting

- Topics
  - Reasons for Collecting
  - Types of Collecting Missions
  - Dangers of Collecting
  - Ingredients for a Successful Mission

Dangers of Collecting

- **Damage to populations and habitats**
  - over-collecting
  - introduction of pests and diseases
- **Damage caused after collecting**
  - movement of contaminated germplasm
  - introduction of competitor species
- **Personal Safety**

Careless collecting can cause considerable damage to populations and their habitats both at the target site and sites where the germplasm is subsequently moved.

•O ver-collecting from a small population may prejudice the population ŝ chances of survival and thus collectors unwittingly increase the genetic erosion in the target region.

•Movement of contaminated germplasm can spread pests, diseases or weeds with catastrophic results. For this reason, countries have firm legislation regulating the import and movement of plants, plant material and their products.

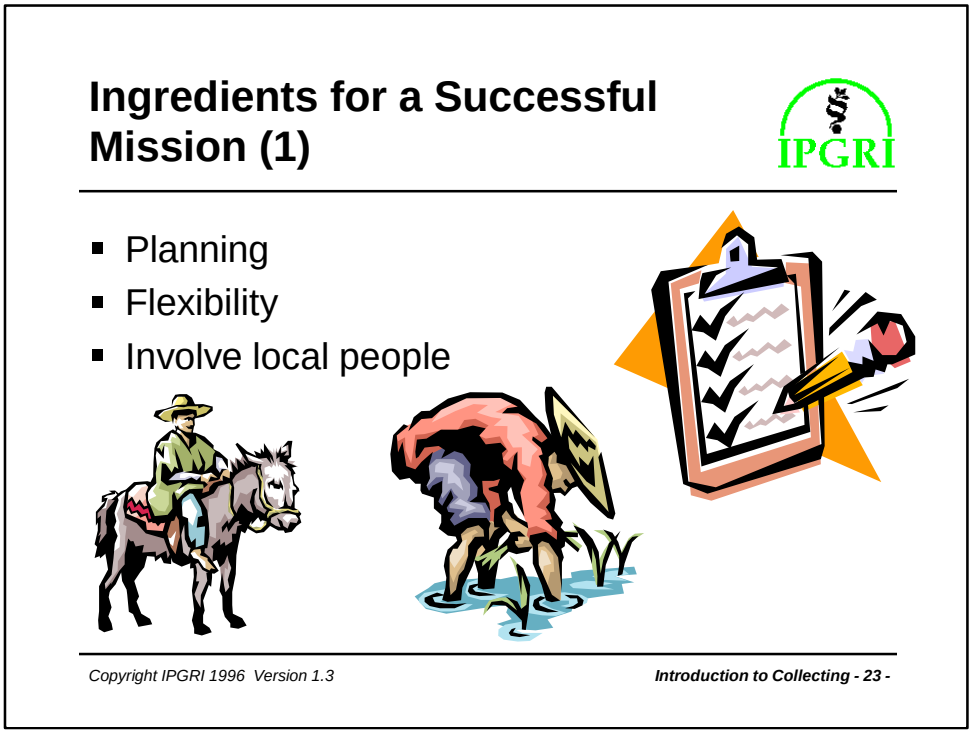
•The introduction of new species can cause the eradication of native species through competition and hybridisation with local species.

Personal Safety

Careful attention to personal safety should be paid at all times. Safety equipment and clothing should be made available and used as appropriate. All equipment and machinery (including vehicles) should be well maintained and operated carefully. Medical supplies should also be taken. When planning itineraries, certain areas may have to be avoided and others require travelling in pairs.

Topic 4 - Ingredients for a Successful Mission

- Topics
  - Reasons for Collecting
  - Types of Collecting Missions
  - Dangers of Collecting
  - Ingredients for a Successful Mission



Planning

Planning is essential to the success of **all** germplasm collecting programmes. Detailed information prior to any mission is required for:

- distribution of the target species
- genetic variation within target species
- breeding system
- fruiting time (and geographical variation)
- seed storage characteristics
- collecting techniques
- background information on physical, biotic and human environment

As much time should be spent planning as collecting

Flexibility

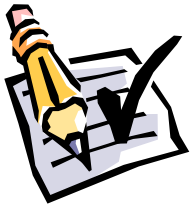
Collecting programmes should be flexible enough to allow missions to be undertaken or postponed at relatively short notice (e.g. in poor seed years). Missions should be flexible enough to make changes in the itinerary at short notice in the field.

Involve local people

The effectiveness of collecting depends on the involvement of local people who have extensive ecogeographic and cultural knowledge. They can assist in deciding on the timing of collecting, in developing a sampling strategy and documenting the collecting.

Ingredients for a Successful Mission (2)

- Develop a search image
- Choose appropriate techniques
- Document the collecting



Develop a search image

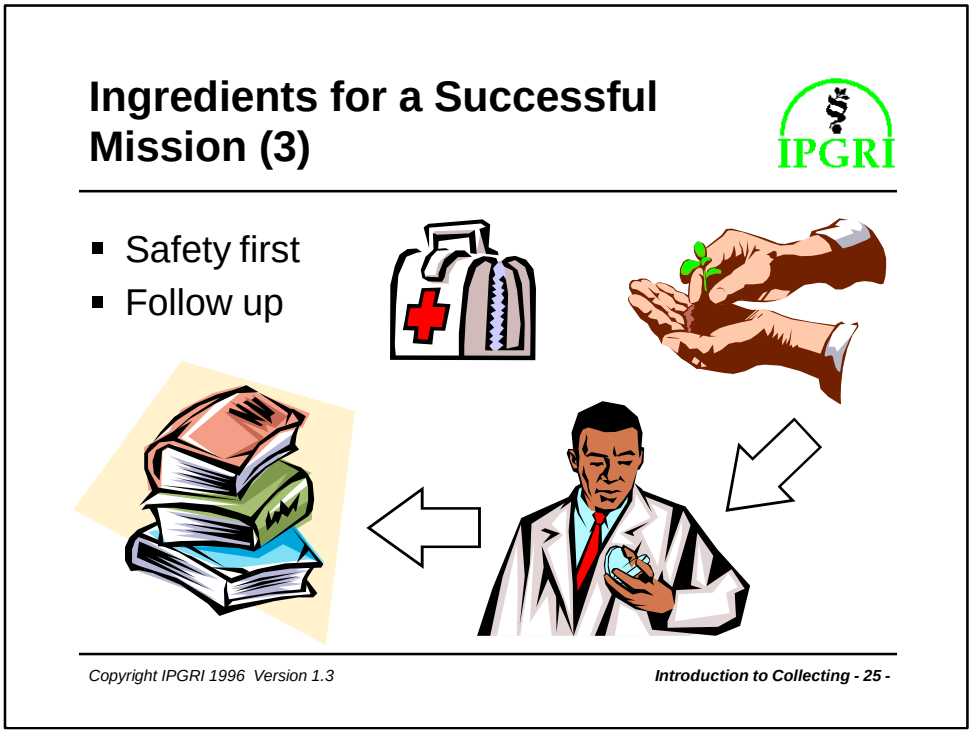
To enable the rapid location of potential collecting sites, a search image should be produced of the habitat preferences of the target species to avoid wasting time on inappropriate sites. It is preferable too that the collecting team should contain an expert capable of rapidly locating and identifying target species and assessing a population's fitness for harvesting.

Choose appropriate techniques

The material collected should be of the highest possible quality and its viability must be maintained subsequently. Therefore, the most efficient harvesting and processing techniques must be used. When the species are not well known, the ability to improvise and develop techniques is important. After processing the material should be examined frequently to detect and deal with any deterioration.

Document the collecting

Collecting forms should be conscientiously filled in at the collecting site together with any additional information as circumstances permit (such as indigenous knowledge). Thorough documenting of germplasm samples considerably enhances their subsequent usefulness and so this should not be overlooked.



Safety first

Careful attention to personal safety must be paid at all times with regard to the use of equipment and machinery and any itineraries taken which might pass through dangerous areas.

Follow up

Upon return from a collecting mission, all germplasm and associated information must be deposited with a genebank for storage and maintenance, voucher specimens deposited in herbaria and identified. A report should be written about the collecting mission and circulated widely so that the scientific community is better informed of the availability of potentially useful material.