Processing of germplasm, associated material and data

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Introduction

The fieldwork may be over, but no collecting project is over until the germplasm samples and their associated reference materials and data are processed and deposited with the institutions undertaking their conservation and use and all reporting obligations have been fulfilled. Poor handling of the material and data on return to base can undermine the effort put into the difficult and costly task of collecting germplasm. Vegetative material and *in vitro* cultures may rot and seeds will lose viability if they are not properly handled and do not quickly arrive at the recipient gene bank. If information on the samples is incomplete or unreadable because the data forms have not been collated and edited, maintenance and future use of the material are jeopardized.

Time, facilities and funds must be set aside for back-at-base tasks when planning the mission. Arrangements must be made for the eventual distribution of the samples for duplicate conservation, research and use. Once back at base, samples must be split and distributed according to these plans. There are occasions when there may be no arrangements in place for the reception of the collected material or when the agreements made cannot be met. This may be the case for an emergency rescue mission or when the samples collected are too small for splitting. In these cases, the collector must make the necessary arrangements immediately on arrival back at base for follow-up research and conservation of the germplasm or arrange for its multiplication prior to distribution to the agreed recipients.

This chapter will deal in detail with the three major tasks of collectors on their immediate return from the field:

- sorting and preparing germplasm samples and any reference and ancillary specimens;
- collating, completing and editing the collecting data;
- distribution of the germplasm for conservation, study and use.

Reporting, which is a less immediate priority, is treated separately in Chapter 29.

Processing germplasm samples

On returning to base, immediate attention must be given to the germplasm samples since the survival of the material may be at risk. A germplasm sample may consist of seeds, whole plants, vegetative plant parts such as tubers, cuttings or *in vitro* explants or perhaps pollen. Sometimes a collection will include samples of more than one type. In previous chapters guidance has been given as to which parts of a plant to collect in different situations, the sampling strategy to use and how to handle the material in the field. This section describes the procedures to follow and techniques to use in processing and preparing for dispatch the various types of germplasm samples.

The processing required to prepare the germplasm for distribution after a collecting mission will depend on a number of factors:

- *The sample.* The type and condition of the sample at the time of collecting and its subsequent handling during the mission will determine what sort of processing is required and its urgency. The quantity of material collected will govern whether splitting can take place immediately or whether multiplication will be needed first.
- *The mission base.* The location of the base, the climate, and the facilities available will determine which kinds of treatments can be carried out.
- *The receiving institutes.* The whereabouts of the receiving institutes will determine how the samples will be sent on.

Germplasm samples always have data associated with them and may also have different kinds of reference material attached. Dealing with these is covered in separate sections, but it should be seen as an integral and necessary part of the processing of the germplasm.

Orthodox seeds

Seeds begin to age and deteriorate soon after they reach maturity. The rate of deterioration and loss in viability is influenced by a number of factors, most importantly temperature and seed moisture content. As described in Chapter 20, for the majority of species lowering temperature and reducing seed moisture content will increase the life span of the seeds. Species whose seed survival can be controlled in this manner are

termed orthodox. In contrast, many tropical plantation and fruit crops, such as mango and coconut, as well as timber species, are categorized as recalcitrant because their seeds are killed by drying and are short-lived even when moist. These different kinds of seeds need to be handled in quite different ways.

Chapter 20 discusses the effects on the longevity of orthodox and recalcitrant seeds of their maturity when collected, of the climate in the collecting region and of the handling of the samples during the mission. Guidance is also given on ways to minimize loss of viability in the field. Back at base, precautions must be continued to safeguard against a decrease in the viability of the seed samples before receipt and storage at a gene bank. A drop in initial viability, though small when expressed as percentage germination, will result in an appreciable reduction of potential longevity in storage. The precautions to take involve:

- ensuring early drying of seed samples under conditions which optimize the preservation of viability;
- avoiding physical damage to seeds during the cleaning and processing of the samples;
- ensuring quick dispatch of the samples and their protection from high temperature and humidity during transport.

Drying and cleaning seeds

All the samples should be inspected immediately to determine their condition. Priority attention must be given to samples that are moist and those that are infested with pests or show symptoms of diseases.

Drying

Careful consideration should be given at the mission planning stage of the possible effects on the viability of the samples of the temperatures and humidities to which the seeds will be exposed during the mission, at base and in transit to the gene bank. Chapter 20 discusses in detail how ambient temperature and relative humidity (RH) can be used to predict the rate of loss of seed viability. If the climate in the collecting region is unfavourable, then arrangements must be made in advance for the rapid dispatch of samples back to base (or elsewhere) at intervals during the mission for drying.

The more hot and humid the climate, the more unfavourable the conditions are for drying seeds. At a RH of more than 75%, the equilibrium moisture content of non-oily seeds will be >13% and that of oily seeds >9%. Since viability loss in orthodox seeds is greatest at intermediate moisture contents of 15–30%, it is critical that the seeds stay at these dangerous moisture levels for the shortest possible period. Therefore, the samples must immediately be put under an artificial system of drying to quickly lower moisture content to the safer level of 15% or less. The alternative option of keeping seeds fully hydrated, aerobic and

dormant is not usually practical, except possibly in the case of dormant seeds inside fleshy fruits.

In drier climates, where the RH is <50%, samples may be dried under ambient conditions to the relatively safe moisture content levels of <15%. Drying is most efficient if the seeds are arranged in thin layers with good ventilation (Cromarty *et al.*, 1982; Cromarty, 1984). The cloth or paper collecting bags containing pods, seeds in heads and fruits awaiting cleaning should be laid out on racks in a breezy place in the shade. The samples must be kept away from extreme heat. Serious reduction in longevity can result from the seeds overheating in direct sun, particularly when seed moisture content is high. At the end of each day, the bags should be gathered up and packed in closed containers to prevent them reabsorbing moisture as humidity increases at night. Once seed moisture content has dropped below 15% and the seeds detach easily from the inflorescence and fruit structures, the samples can be cleaned, as described below.

After cleaning, the seeds can be exposed to further natural drying laid out in trays or hung out on racks in cloth or net bags. Eventually, they will attain a moisture content in equilibrium with the ambient RH, but this can take time, particularly if the seeds are large and aeration poor. Once a safe seed moisture content has been reached, it is preferable to pack and dispatch the samples for further drying under optimal conditions at a gene bank.

Artificial drying will be necessary if conditions at base are too humid for the samples to dry naturally to a safe moisture content or if the seeds are to be processed at base for immediate conservation and hence must be dried down to the very low moisture levels preferred for storage.

Hot air is a common method of drying seeds, but it is not recommended for genetic resources conservation. High drying temperature has a detrimental effect on viability, especially when the seeds are moist. In tropical environments hot-air driers are anyway unable to dry seeds sufficiently because the moisture content of ambient air is too high. The recommended alternative is to dry seeds by dehumidification at low temperature. Cromarty *et al.* (1982) describe the design and operation of a special cabinet or room able to maintain conditions of low temperature (15–25°C) and RH (10–15%).

Probably the most feasible approach for most base locations, however, is to dry the seeds by using a desiccant like silica gel. Zhang and Tao (1989) describe the use of silica gel for drying seeds for genetic conservation (see also Chapter 20). General instructions are to use a ratio of seeds to silica gel of 3 : 2 and place the seeds in a thin layer just above the dehydrated gel, inside a desiccator or any suitable container with a moisture-proof lid and large area : volume ratio. Zhang and Tao (1989) report periods of two days to two weeks (depending on seed size) to dry seeds from >15% moisture content to <7%.

In order to monitor and manage the seed drying process, it is

necessary to measure seed moisture content. Cromarty *et al.* (1982) and Hanson (1985) describe the method in detail.

Cleaning

Samples are often brought back to base with the seeds still in the heads (inflorescences), pods or fruits, and require threshing or extraction and cleaning in preparation for sample splitting, packaging and distribution. To minimize the risk of transmitting pests and disease, seed samples must be cleaned to eliminate soil, plant debris and seeds of noxious weeds and parasites. Legume seeds should be extracted from pods for international distribution (Frison *et al.*, 1990). Chapter 17 deals with these phytosanitary issues more fully.

Seeds detach more easily from dry inflorescences and the risk of mechanical damage is lessened if the seeds are neither too wet nor too dry. It is thus best to thresh and clean seeds when their moisture content is in the range 12–14%. Threshing and cleaning by hand is recommended as the safest and most practical way of processing genetic resources samples, which are typically small and need special care to minimize risks of damage, viability loss and mixing or contamination among samples (Chapter 20). Manual threshing normally involves rubbing, beating or breaking up the dried inflorescence and fruits. It is sometimes best done with the samples still inside the cloth collecting bags. More robust methods are needed in some cases: the pods of *Acacia* species may need gentle pounding, for example (Doran *et al.*, 1983; see also Chapter 23). In some species, it is difficult to free the seeds entirely from the fruit, for example the spikelets of wild grasses such as *Pennisetum* and the tight-fitting pods of some legumes species. In these cases, if there are no plant health risks or restrictions, it may be best to send the samples for seed extraction at the recipient institute, which will have the necessary experience and specialized equipment. Chaff and debris are removed by winnowing and sieving. Again, manual methods are usually the best. Flotation techniques are not recommended for seeds destined for long-term conservation. Though their use is also not recommended for genetic resources conservation, if mechanical threshers and seed cleaners are employed, great care must be taken not to lose seeds and to clean the equipment between samples to safeguard against contamination. Air-screen cleaners, air separators and specific-gravity separators are described and discussed in Young and Young (1986).

As a general rule, seeds should be extracted from fleshy fruits as soon as possible after harvest, and this may in fact have been undertaken in the field during the mission. However, inside ripe, sound, fleshy fruits, seeds are in a fully imbibed state and will maintain their viability for long periods if prevented from germinating by dormancy. If, on arrival at base, the fruits are undamaged, they can be left moist and whole while awaiting cleaning, or even dispatched in this state for seed extraction at the recipient gene bank. For transport, the whole fruits

must be packed to keep them cool, moist and well aerated, since oxygen is required for hydrated seeds to maintain their viability.

In some species, some seeds may germinate, either because they have no dormancy or because dormancy has been broken. If this occurs or is likely, the seeds must be extracted from the fruits as soon as possible. If fruits are dried up, decomposed or damaged, they must also be cleaned quickly. Great care must be taken not to damage seeds when extracting them from fruits. Once seeds are removed from fruits they must be dried quickly to safe levels below 15% and as close as possible to the recommended moisture content for storage (3–7%). If delays in drying the seeds are likely, the samples should be maintained temporarily as whole fruits to avoid seeds remaining at damaging moisture contents. Notes on the cleaning of different types of fleshy fruits are given in Ellis *et al.* (1985) and in Chapter 23. Generally applicable instructions are (after Hawkes, 1980):

1. open the fruits with a knife or by hand and carefully tease or squeeze out the seeds;
2. remove pulp and gelatinous coatings by washing in water, if possible, and then draining, or otherwise by blotting;
3. put the seeds out to dry in the shade
4. remove any remaining gelatinous material when the seeds are dry.

Some fruits contain poisonous substances, which can irritate the skin and worse. Ellis *et al.* (1985) suggest the use of light plastic gloves when handling such material.

Seed treatment and phytosanitary inspection

Chemical treatments may adversely affect seed viability and should be avoided if possible and where quarantine regulations allow. However, treatment of samples that have become infested with insects may be unavoidable in order to save at least some material. If samples are treated, the packets should be clearly labelled with the name of the chemical used, as some products are hazardous to health and special precautions must be taken when handling seeds treated with them.

The dried, cleaned and treated (where required) seed samples should then be inspected and certified by the plant protection service in the country of origin. Arrangements for this should be made at the mission planning stage (Chapter 17).

Packaging and dispatch of seed samples

Once the samples have been dried to a safe seed moisture content level and cleaned and phytosanitary controls have been undertaken, their sharing out, packaging and dispatch should proceed as quickly as possible.

Sharing out

Seed samples may need to be split and shared out among various institutions. This will follow the distribution protocols laid down at the mission planning stage. Care is needed to avoid contamination among samples and ensure accurate transcription of collecting numbers on to the different packets. Each sample should be thoroughly mixed before splitting.

If the samples are very small or their viability is suspected to be very low (because the seeds are immature or in poor condition), it will not be possible to meet the sample splitting requirements. Interim multiplication or regeneration of these samples will then have to be arranged (see below). To guard against loss in transit, each sample to be dispatched may be split into two and each half sent in a separate shipment.

Packaging

The samples must be protected from high humidity, high temperature and mechanical damage during transport. Sample packaging should be moisture-proof to prevent dry seeds taking up moisture at high ambient RH. This is particularly important if the samples are likely to transit through a humid tropical area. Aluminium foil plastic pouches are practical, especially if the samples are being sent directly to medium- or long-term storage and will not need further processing. However, they need to be heat- and pressure-sealed with a special machine. The laminate must be sufficiently robust to guard against moisture ingress and puncture by the seeds inside. The following specification is recommended: 17 g m^{-2} polyester; 33 g m^{-2} aluminium; 63 g m^{-2} polyethylene. For bulky samples and very large seed quantities, containers should be made of rigid plastic or metal and have tight-fitting lids that seal hermetically. If there is a risk of moisture ingress through the packaging, then a small quantity of silica gel in a cloth packet can be put inside with the seeds. Seeds have also been moved for short periods in simple plastic zip-locked bags, and this may be a more cost-effective option if further seed processing will be needed at the receiving institute.

During transport, the seeds must be prevented from moving about and being damaged or breaking out of their bags. Legume seeds are particularly vulnerable to damage of the seed-coat and wounding of the embryo. Room inside the sample packages should be kept to a minimum by sealing the bags tightly or plugging excess space in containers with cotton wool or paper. The sample bags or containers should be packed firmly into crates or boxes so that they do not shift about.

Dispatch

If seed samples are to be duplicated in several collections for safety, as generally recommended, they will have to leave the country of collecting. The phytosanitary and other regulations governing the export of seeds from the country of origin and their import into the countries of the

recipient gene banks should be investigated at the mission planning stage. This is discussed in Chapter 17.

Samples should be sent to recipient organizations by a fast and secure means. This is discussed in Chapter 20. For international destinations, shipment should be by air. Air freight, recorded express airmail or air couriers are the alternatives: cost, time in transit and reliability will need to be taken into account in deciding. Precautions must be taken to minimize the time the samples spend in customs or awaiting delivery to the recipient. The documentation for the export, import and quarantine clearance of the shipment must be prepared in advance. Notice by Telefax or telex to the recipient institute of the date of dispatch, flight(s), airway bill number and number of boxes in the consignment will facilitate its speedy reclaim from the airport and early tracing in the event of a problem.

Each box or crate in the consignment must be clearly labelled with the address of the institute of destination, including telephone number. The boxes should also be marked as follows:

> SEED SAMPLES OF NO COMMERCIAL VALUE FOR SCIENTIFIC PURPOSES ONLY. FRAGILE.

They should be marked as perishable only if the seeds have been dried, because such a label may result in refrigeration of the consignment at customs. A label stating that material does not contravene the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) may also be necessary. Each shipment should be accompanied by:

- a letter describing the contents: i.e. listing species and number of samples of each; describing the condition of the samples (stage of drying and cleaning); and notifying of any chemical treatments (which samples treated and what chemicals used);
- a note of any special handling instructions;
- the passport data;
- the phytosanitary certificates.

Recalcitrant seeds

When recalcitrant seeds are to be collected, arrangements must be made at the mission planning stage to ensure the rapid receipt and early planting of the seeds by the recipient institutes. For very short-lived species, special procedures will have been followed during the mission to keep the seeds viable. These involve keeping the seeds moist, as near the fully imbibed state as possible, but in aerobic conditions and able to respire. The seeds may have been left within the fruits in the fully imbibed but dormant state, in which case they will probably need to be extracted back at base prior to dispatch (see above). If they have already been extracted and kept moist in plastic bags or charcoal, back at base these samples must be packed in suitable containers for transport and dispatched to the recipient organization as quickly as possible, allowing no

more than one month between collecting and receipt. Temperatures below 20°C or much above ambient should be avoided. Marking consignments as perishable may risk their refrigeration by customs authorities.

Vegetative plant parts

Crops that are propagated vegetatively, woody perennials and species that produce few or no seeds may need to be collected as vegetative plant parts. The collecting of vegetative material and its handling in the field are dealt with in Chapters 21, 22 and 23. Back at base, these plant parts must be prepared for transport and distribution. For transport, vegetative organs should be wrapped in semiabsorbent material and packed firmly, but not too tightly, into a box or carton. A filling such as hay or crumpled paper can be added to protect against shocks.

The movement of vegetative material from one country to another entails a great risk of the transmission of diseases and pests. Whole plants and storage organs constitute the highest risk, stems and budwood a lesser risk. For *in vitro* culture, the risk is less still, but it is only through treatment therapy and indexing that there can be any assurance that the material is pathogen-free (IBPGR, 1988). Where treatment of the material or its *in vitro* culture is not sufficient or feasible, it may be necessary to organize quarantine in a third country (Chapter 17).

In vitro *material*

The techniques for *in vitro* collecting and the processing of *in vitro* material at the receiving laboratory are described in Chapter 24. At the mission planning stage arrangements should be made with a specialized laboratory for receipt and processing of the cultures prior to the eventual deposit of the accessions in gene banks. If there is no *in vitro* laboratory at the mission base or close by and the cultures have to be sent long distances, special care is needed in packing and transporting the culture vessels in order to avoid damage or deterioration of the material. Many of the guidelines for the packing and dispatch of seed samples are also relevant to the handling of *in vitro* material. When the laboratory is outside the country of collecting, the cultures must first pass through appropriate plant health testing and quarantine procedures.

As with all samples, the labelling of the culture vessels should be checked for legibility and the identifier (collecting number) verified against the corresponding collecting data form. The data forms should bear the name and address of the laboratory processing the cultures.

Processing reference samples

To obtain more information about the germplasm, the germplasm collector may also have gathered different kinds of reference material, including:

- herbarium voucher specimens;
- *Rhizobium* samples;
- soil samples;
- specimens of pests and pathogens;
- photographs of the plants or collection site.

Herbarium voucher specimens

The reasons for taking voucher specimens and the techniques for collecting them are covered in Chapter 27. Back at base, these voucher specimens and their associated documentation must be sorted and prepared for dispatch.

As with the germplasm samples, the amount and type of processing to do back at base will depend on the condition the specimens are in on leaving the field and on what is necessary to make sure that they will reach their destination in an acceptable state. As a rule, voucher specimens are sent to a herbarium with which a prior agreement has been made for their conservation. The essential tasks back at base are to:

- dry and treat the specimens;
- sort, label and pack the replicate specimens for dispatch;
- assemble information on the specimens and label them;
- record that voucher specimens have been taken and where they have been sent.

The first task is to *dry and treat* the specimens. Specimens of whole plants usually come in from the field either still in presses or in bundles, having been dried. Specimens that still contain moisture will have to be dried and bundled prior to dispatch. Specimens dried in the field or back at base are often subject to insect attack while they are being processed and in transit to the herbarium of destination. If the equipment is available at base, the specimens can be fumigated or given a low-temperature treatment to rid them of insects, larvae and eggs. Often, a simple treatment using formalin or a spray insecticide will suffice until the specimens can be properly treated on arrival at a herbarium. See Chapter 27 for further details on treatment and packing.

There may well be large numbers of replicate specimens to *sort, label, pack and distribute*. If the populations sampled were highly diverse, several voucher specimens, representing the range of morphotypes visible, may have been taken from each population (Hawkes, 1980). There will be voucher specimens to distribute with each germplasm subsample. In addition, it is standard practice to deposit a full set of specimens at the national herbarium in the country of collection and at any other herbarium that specializes in the flora of that part of the world. Usually it is to one of these international herbaria that specimens requiring taxonomic verification will be sent.

Replicate specimens must be examined to make sure that they are correctly labelled with the same number and are as complete as possible, with leaves, flowers and fruits. If there are insufficient flowers or fruits

for replication, then the location of other, fuller replicates must be recorded on the collecting data forms or herbarium labels so that other botanists can request them on loan if need be.

The numbering of specimens needs careful checking back at base. In the field, a voucher specimen may be labelled with the same collecting number that was assigned to its corresponding germplasm sample. However, a separate numbering series will sometimes be used for herbarium specimens if, for example, they are part of a wider botanical survey that has set standard identification descriptors. Back at base it is important to ensure that, whatever numbering system is used, voucher specimens can be correlated with germplasm samples and the correct numbers are recorded on the corresponding collecting data forms.

Voucher specimens must be accompanied by adequate *documentation* for them to be accepted for identification or registration by a herbarium. The documentation of voucher specimens is reviewed in Chapter 27. Many of the relevant data descriptors will have been filled in on the collecting data form, but additional information on the specimen's appearance, such as flower structure and colour, may have been noted in a separate field book. Back at base all the information on each specimen must be collated. Copies of the collecting data forms, or the relevant data transcribed from them, must be compiled with any supplementary information recorded in the field. The International Plant Genetic Resources Institute (IPGRI) collecting form software (Box 28.1 below) provides for the production of herbarium labels from the computerized germplasm collecting forms.

Drawings may have been made or photographs taken to illustrate certain features of the plants, particularly those that are not observable in dried material, or attributes of their habitats. This must be noted on the collecting forms and herbarium labels, and copies should be distributed with each replicate specimen or, in the case of photographs, arrangements made to send on copies after the film has been developed.

Rhizobium *samples*

Collecting root nodules for the isolation of *Rhizobium* is generally considered an integral part of the collecting of many leguminous species. Having the strains that are genetically and geographically associated with the samples will ensure effective nodulation when the plants are evaluated in a new environment. *Rhizobium* specimens may also be important for the successful maintenance of wild legume species. Details of collecting methods are given in Chapter 26.

Rhizobium samples may be collected in the field as excised root nodules preserved in tubes containing a desiccant or as specimens of soil and root material. On arrival back at base, these samples must be sent on as soon as possible to a laboratory for the isolation, testing and storage of the *Rhizobium*. Arrangements to handle the *Rhizobium* samples should be made at the planning stage with an appropriate laboratory.

Each container of nodules or soil must be checked to make sure that it is clearly and correctly labelled with a collecting number. This may or may not be the same as the collecting number of the associated germplasm sample, though the former procedure is preferable. It should be verified that the corresponding collecting data forms record that a *Rhizobium* sample has been gathered, what its collecting number is and where it has been sent.

Prior to transport, the desiccant should be renewed in the nodule tubes and these or the containers of soil carefully packed to prevent breakage and exposure to humidity during transit. The consignment should include copies of the corresponding collecting data forms or a list of the essential descriptors that identify the species and collecting project.

Each subsample of germplasm distributed should be accompanied by a specimen of its corresponding *Rhizobium* strain, assuming that the receiving institute has the facilities for maintenance of the microbial material. More usually, perhaps, samples are sent to a central laboratory, which then supplies subsamples on demand to institutes maintaining the associated germplasm.

Soil samples

The majority of the soil descriptors on the collecting data form will have been filled in by visual observations or from field measurements using soil colour charts, portable pH meters, etc., as described in Chapter 19. However, more comprehensive information about the soil in which a plant is growing may be needed in order to help establish relationships between the occurrence of a species or ecotype and particular soil conditions. In these cases, specimens of the soil will have been taken at key collection sites for detailed determination of soil physical and chemical properties. Soil samples should be about 500 g in weight, packed in cotton or plastic bags and labelled with the germplasm collecting number or collecting site number.

During the planning stage, contact should be established with a local (government or private) laboratory for the subsequent analysis of soil samples. Sending the samples out of the country for analysis may be necessary in some cases, but this will incur quarantine problems and heavy transport costs.

Back at base, the soil samples must be checked before delivery to the laboratory for any errors in numbering, illegibility of labels and damage to bags. Included in the delivery will be a listing of the analyses to be performed. The types of tests to be done will have been decided in advance in discussion with a soil scientist but will also depend on what the laboratory is equipped to perform. The analyses performed may include pH, N, P, trace elements, organic matter, anion exchange capacity, conductivity and texture.

The results of soil analyses must be transcribed from the analysis sheets provided by the laboratory to the individual collecting data forms

of all the germplasm samples taken from each site tested. The result sheets of the soil sample analyses can be included in the mission report.

Photographs

Photographs may have been taken in the field to illustrate the plants, the places they grow and the people that use them. As mentioned above, photographs can be useful in recording plant characters that will not be visible in dried voucher specimens, such as flower colour. They can also be used to portray the specific habitat where a population was found growing and panoramic views of the collecting site can aid recognition on subsequent visits. Such reference photographs should be labelled with the collecting number of the germplasm sample or the site number to which they correspond and should be copied for distribution with the germplasm and voucher specimens. Accessible and secure storage of the print negatives and transparency originals, usually in the photographic library of the collecting institute, should be arranged. Photographs are often used to illustrate the mission report and any ensuing articles about the expedition findings. For these purposes, black-and-white or colour prints are preferable since they can be reproduced in publications more successfully than transparencies.

Specimens of pests and pathogens

Dealing with specimens of pests and pathogens is described in Chapter 17. Much the same points need to be considered with regard to such specimens as with voucher botanical specimens and other reference material. Specifically, care should be taken to ascertain that each reference sample has been given a number which clearly associates it with a germplasm sample and that this has been noted on the collecting form along with the method by which the reference sample will be named (e.g. the name of the institute where it will be sent for identification). Clearly, when the mission is international, the usual conventions regarding the deposition of reference material in the country of collecting also apply to pest and pathogen samples.

Processing collecting data

Chapter 19 discusses the type of collecting information to be gathered in the field and shows how to fill in the collecting form. Back at base, the collecting data must be processed and prepared for distribution with the germplasm samples. The collecting data forms must be completed, checked for errors, made legible and duplicated as necessary. Once the samples are split and dispersed among different institutions, it becomes much more difficult to match data to samples and register additions and corrections. All this is best undertaken by the collector (at the very least, it should be checked by the collector), to minimize transcription errors.

Editing the collecting data forms

The procedures to follow in processing the collecting information and preparing the data forms for distribution with the germplasm samples are:

- sorting and checking the forms;
- completing the forms;
- adding information from reference sources;
- checking the botanical names and local words.

Sorting and checking the collecting forms

The unique collecting number assigned to a germplasm sample at the time it is collected will be recorded on its accompanying collecting form. The data forms and samples must be sorted and compared to ensure that their numbers correspond and that there are no errors or discrepancies in the numbering sequence.

For whatever reason, a number in the sequence may not have been assigned. Also, samples may have been lost. This is not a problem in itself, but to avoid possible confusion any missing numbers should be clearly pointed out to recipients of the germplasm samples. On the other hand, any differences in numbering between the data forms and the samples to which they relate, or the allocation twice of the same number, must be traced and corrected before material and data are distributed. These types of errors can lead to confusion, which may be difficult to rectify once the samples are dispersed among different institutes. If a diary or separate field book has been kept, this can help in resolving discrepancies.

Completing the collecting forms

Some collecting data descriptors may not change for the whole duration of the mission, for example country of collecting and collector's name. Others remain constant for a day (date of collecting) or several days (province, ethnic group). To save time in the field, these descriptors may have been entered on just the first form of the mission, of the day or of the start of work in a new region. Back at base these data descriptors must now be copied across all relevant collecting forms to complete each data form.

Often, more than one sample is collected at a site. In the field, the site descriptors may have only been completed on the data form of the first sample collected at that site, with just a site number recorded for the other samples to provide a way of referring back to the first form. Back at base, the site data must be entered on the collecting forms of all samples taken at the same place and bearing the same site number. It is very important that each germplasm sample is accompanied by a complete set of collecting data because samples of different species are

often distributed to different institutes and each recipient requires all the information.

Adding information from reference sources

The location of a collecting site is described both by reference to the nearest village or some other feature and by its coordinates (longitude, latitude, map grid reference) taken from a map. Sometimes, to save time in the field, only the former is recorded, or site location is simply marked on a map. It will then be necessary to read off the coordinates back at base and enter them on the collecting forms.

Some types of information about the collecting sites can only be recorded on return to base because they require consulting reference sources. For example, climate descriptors such as annual rainfall and mean annual temperature have to be completed with data taken from reference records and maps which it is not always feasible to take to the field. Reference to the sources used must be made on the collecting forms. Chapter 9 describes sources of environmental data.

Checking taxonomic designations and local words

The data forms must be checked for consistency and accuracy in the use of the scientific names of plants. Floras, checklists, etc. should be used to check the taxonomic designations of wild species (Chapter 10). For cultivated species, Schultze-Motel (1986) is a good source. Where the taxonomic identification of a sample is uncertain and confirmation is to be sought, this should be noted on the collecting data form under the relevant descriptor or as a remark, together with the address of the institute to which the voucher specimen is being sent. Species identification takes time and confirmation is likely to be received only after the germplasm samples have been received by the institutes charged with their conservation, study and use. Therefore, it is important that it be clearly indicated on the relevant collecting forms that verification of sample taxonomic identifications has been sought, so that the recipients of the samples are able to follow up on any eventual alterations in the data initially entered on the forms.

The spellings of words in local languages or dialects for places, people, vegetation types, plants, crop varieties, soils, etc. should also be checked for confusing spelling variations of the same word. In general, a standard (or at least consistent) transliteration of repeatedly occurring foreign words should be decided on, and adherence to the standard should be checked at this stage. Lexicons, gazetteers and dictionaries may be useful, and any reference works used should be noted.

Computerization of the data

Computerizing the data has many advantages. It facilitates all the procedures described above for editing the collecting data forms: sorting,

completing, adding information, checking and copying the forms are made easier and quicker. Clean, readable data forms can be produced quickly. In computerized form the data can be added to the documentation systems of recipient institutes and central crop databases more readily and with less risk of transcription errors, assuming that software and hardware are compatible, a point that should be verified early on. Furthermore, later amendments and additions to the information, for example verification of voucher specimens and the identification of pests, can be more easily registered and communicated. Computerization also facilitates analysis of the data and report generation in general.

If computerization of the forms is not possible, they should be typed or care should be taken to write them out very clearly. To aid in the computerization of collecting data, IPGRI has developed database software that mimics the format of the IPGRI collecting form. This software is freely available to interested germplasm collectors and details of its specifications and how it can be obtained are in Box 28.1.

Data duplication and dissemination

Its associated collecting data must always accompany each germplasm sample wherever it is sent. Each germplasm sample is generally split and the subsamples are dispersed among different national and international institutes for study, use and safety duplicate conservation. In whatever way a sample is split and distributed, each of the subsamples must be accompanied by a copy of the complete collecting data form. The data can be dispatched as hard copy (computer-generated, typed or handwritten) or on diskette, both if possible.

If conditions during the mission are unfavourable and facilities at base limited, or if the species or type of plant material collected is short-lived, it will be necessary to dispatch the samples to specialized institutes for their processing and preservation at intervals during the mission or as quickly as possible on arrival back at base. Under these circumstances, there may be insufficient time to complete the processing of the collecting data and prepare the forms for distribution with the samples. However, a minimum number of essential data descriptors must accompany the samples; otherwise there can be problems later in matching the germplasm samples to their corresponding collecting data. The collecting number plays a crucial role in this. The descriptors that are considered essential to accompany the samples are listed in Box 19.1 of Chapter 19.

Germplasm distribution

The germplasm samples, together with their collecting data and any reference specimens, will be distributed to gene banks, other institutes and scientists according to arrangements made at the planning stage. In international collecting, these agreements will include the standard

Box 28.1
IPGRI Collecting Form Management System

Introduction
The Collecting Form Management System (CF) is available from IPGRI free of charge to interested germplasm collectors. The system:

- provides a convenient and standard way to record and update information on collected germplasm and herbarium specimens in a manner that mimics the IPGRI collecting forms for both wild and cultivated material;
- allows additional site details to be recorded and updated in a file linked to the germplasm data;
- allows the printing of completed collecting forms for germplasm samples;
- allows printing of completed herbarium specimen labels;
- allows printing of completed site forms;

Hardware and software requirements
- An IBM[1] PC, XT, AT, PS/2, 386 or IBM-compatible computer.
- MS-DOS[2] version release 2.0 or higher.
- Minimum 512 kb RAM.
- One floppy disk drive.

Description
All database files are constructed using dBASE III Plus[3] and can be accessed using that software. The execution programme is menu driven (help fields give the allowed choices for each field) and has been compiled in CLIPPER (compiled version of dBASE III programmes). There are various time-of-entry checks for data-inputting errors.

Distribution of software
The software can be obtained from IPGRI headquarters upon request. It is distributed on a single 360 kb 5.25" diskette and accompanied by a user manual. Other disk sizes may also be obtained by clearly specifying the size and density that are needed.

[1] IBM is a trade mark of IBM Corp.
[2] MS-DOS is a trade mark of Microsoft Corp.
[3] dBASE III Plus is a trade mark of Ashton-Tate Corp.

procedure of depositing a part of each sample with an institute in the host country and sending subsamples of each accession to other gene banks, usually outside the country of origin, for security duplicate conservation. Third-country quarantine may be necessary in some cases. A number of national, regional and international gene banks have accepted responsibility for global or regional base collections of particular crops. At the mission planning stage, collectors should find out which gene banks are holding base collections of the species that are to be collected. This information is available from the Food and Agriculture Organization (FAO) and IPGRI. The gene banks should be contacted in advance and arrangements made for the deposit of subsamples at the end of the

mission. Any quarantine restrictions or import regulations must be confirmed at this stage. It is recommended that each germplasm sample be duplicated in at least two base collections.

The final destinations of the subsamples must be decided well in advance so that the necessary import and other documents may be prepared. Sometimes this is not possible, for example if species are collected that were not part of the original objectives of the project. If the required arrangements cannot be made immediately on return to base, it may be necessary to send the samples to an intermediate destination for a period.

Seed samples too small to split or of poor initial quality will have to be multiplied prior to distribution and conservation. Usually, one of the gene banks that has agreed to conserve the germplasm will be able to carry out the multiplication and then undertake to forward subsamples to the other final destinations. The institutions which could undertake any interim multiplication should be identified at the mission planning stage. *In vitro* and vegetative material may also require interim processing. This may involve the preparation of new cultures or could entail seed production or the generation of fresh vegetative material (Chapters 21 and 24).

Follow-up study and use

Collecting may have been carried out as part of an active breeding, selection or research programme, with the material being used immediately. However, even in emergency rescue collecting, it will be important to make sure that the germplasm is rapidly studied. Follow-up research on the viability of the material and the diversity it represents is important for its management in conservation, for the targeting of subsequent collecting of the same gene pools and regions and for the assessment of the value and possible uses of the germplasm. Collectors must ensure that interested scientists and institutes both nationally and internationally are informed of the results of their work and the location of the germplasm, so that study and use of the material can begin as quickly as possible. Report writing and other methods of information dissemination are discussed in Chapter 29.

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