

Immature or mixed collections

Immature seeds (eRH typically 85-100%) will not yet have acquired maximum storage potential. With careful handling, they can be ripened until they reach maximum longevity.

Mixed collections need to be handled in a way that allows immature seeds to continue ripening but minimises undue ageing of mature seeds.

Ideally, and if time permits, divide mixed collections and handle the ripe and immature portions separately.

If fruits look close to natural dispersal – changes in colour, fruits dehiscent, etc. – it is probably safe to dry them using one of the methods described above.

When seeds don't appear to be close to natural dispersal, it is safer to dry them slowly for 1-2 weeks, under natural conditions. Don't remove seeds from fruits, or fruits from branches or stems. If ambient conditions are particularly dry or hot, you may need to slow the drying rate down, for example by enclosing the fruits in a permeable bag or ventilated container.

Very immature seeds (eRH around 100%) are not fully desiccation tolerant and need particular care as rapid drying and/or high temperatures may kill them. It is imperative that these seeds are given the opportunity to continue maturation and ripening.

Once seeds have reached full ripeness treat them as other collections and dry them fully, as soon as possible. It is especially important to process fleshy fruits as soon as they are ripe as seeds left within ripe fleshy fruits may begin to age.



Above and below: *Sansevieria* collection before and after ripening. Note colour change as fruits reach maturity.



Additional notes

Park the collecting vehicle in the shade, or at the very least, shade the windscreen.

- Never leave collections inside a closed vehicle in strong sunlight or high temperatures.

Ensure that seeds are not physically damaged during post-harvest operations as this reduces long-term storability.

Once transferred to the seed bank, collections can then be dried to around 15% eRH (4-7% mc depending on seed oil content), the recommended moisture level for long-term conservation of orthodox seeds.

- Never freeze collections until the seeds are fully dry.

Right: Seed collections spread out on newspaper in an air-conditioned room, during a collecting trip.

Planning ahead

Look up the long-term climate data for a particular region when planning a collecting trip.

If conditions are likely to be humid and/or hot at the time of collection, you will need to plan carefully how you will handle seeds, especially during longer trips.

It may be better to arrange to ship collections back on a daily basis if this is possible. If not, you will need to pack silica gel or some other kind of desiccant in order to dry seeds during the trip.

Further reading

Probert, R.J. (2003). *Seed viability under ambient conditions and the importance of drying*, pp. 337-365. In: R.D. Smith, J.D. Dickie, S.H. Linington, H.W. Pritchard and R.J. Probert (eds), *Seed Conservation: turning science into practice*. Royal Botanic Gardens, Kew, UK.

Smith, R.D. (1995). *Collecting and handling seeds in the field*, pp. 419-456. In: L. Guarino, R.V. Rao and R. Reid (eds), *Collecting Plant Genetic Diversity: technical guidelines*. Commonwealth Agricultural Bureaux International, Wallingford, UK.



Equipment specifications

Description	Model/Product	Supplier
Portable relative humidity logger with mini probe	HygroClip SC04 sensor with HygroLog-D unit. Battery operated. Range: -40 to +100°C (± 0.3°C); 0 to 100% RH (± 1.5%RH).	Rotronic Instruments (UK) Ltd. www.rotronic.com
Data loggers for measuring ambient relative humidity	Tiny Tag and Tiny View loggers. Range: -30 to +50°C (± 0.2°C); 0 to 100% RH (± 3% RH).	Gemini Data Loggers (UK) Ltd. www.gemini dataloggers.com

Please note that the above equipment is used by the Millennium Seed Bank Project and has been chosen carefully using our many years' experience. The list of suppliers is for guidance only and does not represent an endorsement by the Royal Botanic Gardens, Kew. The manufacturer's instructions must be followed when using any of the equipment referred to in this Information Sheet.

The effort put into collecting high quality seeds may be wasted if you don't handle collections carefully afterwards. By following these practical guidelines you will be able to avoid unacceptable loss of viability during collecting trips and ensure that seeds arrive at the seed bank in good condition.

Are all the seeds fully ripe?

Seed collectors should assess seed maturity prior to collection (see [Technical Information Sheet 02](#)) and ideally, avoid collecting immature seeds. In practice, however, collections often contain a range of seed maturities, from seeds that have only just reached maximum dry weight through to those at natural dispersal.

If your collection contains more than 10% immature seeds, follow the guidelines overleaf for immature or mixed collections.

How dry are the seeds?

Even when seeds are fully ripe, their moisture status at the time of collection may be high enough to place them at risk of deterioration through ageing or mould.



Above: A hygrometer can be used in the field to measure seed eRH and ambient conditions, informing post-harvest handling decisions.

A "safe" moisture level for collections in the field is around 50% equilibrium relative humidity (eRH). Collectors need to take measures to promote drying of damp collections and ensure that moisture levels of drier collections do not rise. Seed life span approximately doubles for every 10% reduction in seed eRH.

What are the ambient conditions?

The rate at which seeds age during the post-harvest period depends on the ambient relative humidity (RH) and temperature.

RH has a greater impact on seed longevity than temperature. For example, seeds will die faster under ambient conditions of 24°C and 70% RH than in a warmer, but drier, environment of 30°C and 50% RH. As a general rule, an ambient daytime RH of 50% or less will help to maintain seed quality. Remember that RH rises as the temperature falls; a 10°C overnight fall in temperature could cause dry collections to absorb enough moisture to place them at high risk of ageing.

Even if you are not able to measure seed moisture status or ambient RH and temperature you can still make informed decisions about post-harvest handling.

What is Relative Humidity (RH)?

Water is held in the air as water vapour. The amount of water vapour in the air at a given temperature is expressed as relative humidity.

$$\% \text{ RH} = \frac{\text{water in a given mass of air}}{\text{max. amount of water that could be held}} \times 100$$

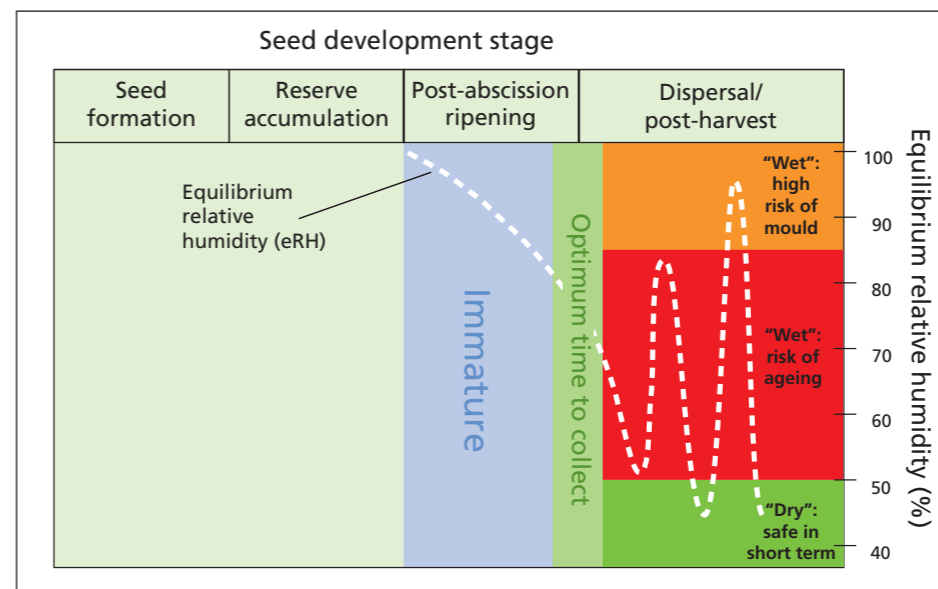
What is moisture content (mc)?

Seeds are weighed before and after oven drying. Moisture content is expressed as weight of water removed, divided by either the fresh weight or the dry weight of seeds x100. The main disadvantage of this method is its destructive nature.

What is equilibrium Relative Humidity (eRH)?

Seeds will gain or lose moisture depending on the RH of the surrounding air, eventually reaching equilibrium. eRH is a measurement of the RH of the air at this equilibrium point. The measurement of eRH is faster than the traditional gravimetric moisture content method and is non-destructive (see [Technical Information Sheet 05](#)).

Below: Effect of post-harvest seed moisture status on seed quality. The dotted line shows typical fluctuations in equilibrium relative humidity with ambient conditions.



Summary of recommendations for effective post-harvest handling of seeds

Seed Maturity Stage	Seed Moisture Status	Ambient Conditions				
		"Dry" (daytime RH < 50%)	"Humid" (daytime RH > 50%)			
Immature	85 - 100% eRH	Hold intact fruits under shaded, ambient conditions for 1-2 weeks*	Transfer to seed bank as soon as possible OR Dry with desiccant OR Place in air-conditioned room			
				<table border="1"> <tr> <td rowspan="2">Natural dispersal</td> <td>"Wet" > 50% eRH</td> <td>Dry in thin layer, in well ventilated location. Minimise moisture absorption at night.</td> <td rowspan="2">Transfer to seed bank as soon as possible OR Dry with desiccant OR Place in air-conditioned room</td> </tr> <tr> <td>"Dry" < 50% eRH</td> <td>Hold in loosely packed bags in a well ventilated, shady location. Minimise moisture absorption at night.</td> </tr> </table>	Natural dispersal	"Wet" > 50% eRH
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* Remove seeds from fleshy fruits as soon as morphological signs (e.g. fruit colour) indicate that they are fully ripe. Allow to dry slowly under ambient conditions before transferring to a cool dry-room.

Fleshy fruits

Fleshy fruits are best kept in aerated plastic bags until they can be processed. Open the bags daily to avoid mould and possible fermentation.

Over-ripe fleshy fruits, or those that have been damaged or crushed during collecting may require partial or full cleaning. Remove as much flesh as possible from the fruits, using a sieve and cool running water.

Leave the seeds to air-dry on a fine wire mesh or thick filter paper before packing them into cloth bags.

Allow the seeds to dry slowly under ambient conditions for 1-2 weeks before transferring to seed bank dry-room conditions (15°C, 15% RH).



Above: Fleshy *Solanum* fruits collected at full maturity.

- Make sure that the correct label remains with the collection during drying and re-packing.

If ambient conditions are not suitable for drying, use a desiccant such as silica gel (see box). Alternatively, spread collections in a thin layer in an air-conditioned room.

If none of these options is feasible, get the seeds back to the seed bank as soon as possible, where they can be dried to safe moisture levels.

Right: Using dried maize to dry a seed collection in a sealable bucket. Some low-technology relative humidity indicators have been added to monitor the moisture level inside the bucket.

Below: *Solanum* fruits being cleaned in the field. The fruits are squashed in a nylon mesh bag to remove juice and pulp. The seeds will be further cleaned when they begin to dry.



Drying with desiccants

Any hygroscopic substance (silica gel, dried seeds such as rice or maize, charcoal, etc.) can be used to remove moisture from seeds, providing that the eRH of the desiccant is lower than the eRH of the seeds. If seeds are very wet it is better to dry them for 2-3 days under ambient conditions before using the desiccant. This can be done even if the daytime ambient RH is relatively high (70-80%).

Once the bulk water has been removed, transfer the seeds to a sealed container with the desiccant, allowing seed moisture to be reduced to a safe level (~30% eRH). Use a silica gel:seed weight ratio of 1:1 To dry seeds to the same level using charcoal, use a weight ratio of 1:3.

Change the drying agent regularly to speed up drying time. Regenerate desiccants in the sun during the day and then use them to maintain seed drying at night, in sealed containers.



- Take note of the prevailing weather conditions - if it has recently rained, seeds may be wetter than expected.

- Observe seed and fruit morphology - seeds enclosed within indehiscent fruits may be at a high moisture level.

- Seeds which have only just reached the point of natural dispersal may be at a high moisture level, even if ambient conditions are dry and warm.

Depending on seed moisture status, ambient conditions and seed maturity, handle collections as follows:

"Dry" (<50% eRH), fully mature seeds

Seeds within dehiscent fruits, collected in dry climatic conditions, may have already dried down to a safe level.

If ambient conditions are favourable:

- Loosely pack dry seeds in labelled bags and keep in a cool, well ventilated place.

- Spread bags out so that air circulates freely and place them in the shade - under the vehicle may be a good place - until all other fieldwork is complete.

- Dry seeds may need to be packed away at night to minimise moisture absorption.

- Similarly, if weather conditions change (e.g. rainfall) and ambient RH rises, protect collections from absorbing moisture.

"Wet" (50-100% eRH), fully mature seeds

Seeds which have only recently reached natural dispersal (especially if they are tightly enclosed within indehiscent fruits) or seeds collected during the rainy season will be within this moisture range.

Wet seeds need to be dried as soon as possible. If ambient conditions are suitable (RH < 50%):

- Spread seeds out in a thin layer on newspaper in partial shade.

- Raise seeds off the ground if possible to allow air circulation.

- Re-pack seeds at night and place them within the vehicle to minimise moisture absorption as ambient RH rises.