

Micro-Seedbanking

A Primer on Setting up & Running a Community Seed Bank

THE BAUTA FAMILY INITIATIVE ON CANADIAN SEED SECURITY

Seeds of Diversity Semences du Patrimoine

This booklet is written for community seed banks, but you can use the same techniques for your own personal seed collection at home. Our aim is to guide you to the highest-quality seed conservation methods that can be achieved in a house, office, public library, school, or community center, at a minimum cost.

What is a Micro-Seedbank?

Your collection of seeds, it could be large or small. It could be a personal collection or a shared community collection. Whether you keep your seeds in a shoebox, or a walk-in freezer, you keep them for a reason and you want them to last as long as possible.

This guide will help you learn the basics of how to keep your own collection of seeds secure, viable, and useful for whatever your aims might be. If you're looking beyond your own use, we can help you integrate your seed collection into a larger network of micro-seedbanks, maintained by collectors like you.

Community-based seed collections:

- Create a local supply of seeds for field testing and multiplication
- Provide a concrete way for local growers to learn from each other
- Help preserve the genetic stocks of locally-bred and locally-adapted varieties
- Involve people and communities in the crucial work of conserving and multiplying local seeds

What you'll find in this booklet:

- Storage Conditions
- Drying Seeds for Storage
- Containers for Seed Storage
- Labeling and Seed Information
- Germination Tests

These topics are covered briefly in our book *How to Save Your Own Seeds* but here we give a lot more detail and specific recommendations for community seed projects.

What you won't find in this booklet:

- Growing out the seeds
- Isolation, Minimum populations for multiplication
- Cleaning/threshing

These topics are covered in our book *How to Save Your Own Seeds* instead.

Also not in this booklet:

- How to choose varieties adapted to your region
- Why your community needs a seed bank

These topics are very important, but they need a whole separate resource to address them properly.

Setting up Your Own Micro Seed Bank: A Reality Check

Running a seed bank is a lot more work than most people expect. How much depends on your goals for the project. Will you offer seeds to other growers? Will you distribute information about the seeds? If you only want to keep your own personal seed collection for your own use, you can do so quite easily. Good storage will be your main concern, and the rest is up to you. But for the purposes of this chapter, we're going to talk about a micro-seedbank project that is accessible to at least a community of growers, maybe more, and it will need some procedures to make it work properly.

How will you get the seeds?

This is the easy part. If you want to make a collection of seed varieties, all you really need to do is place orders from several seed companies. At $2 or $3 per package, you can acquire an impressive collection before long. Unfortunately, many people never think beyond this step. So far, this is only 10% of the work of running a micro-seedbank.

How will you store the seeds?

The simple answer is to put them in airtight jars in a freezer (there is a chapter about this later). At small sample sizes, you can get a thousand or more seed samples in a good-sized chest freezer. But, can you find them again?

How will you find the seeds?

You can put 100 packets of seeds in a shoebox, and pretty quickly locate what you want just by sifting through them with your fingers. But what if you have 1,000 samples in jars in a chest freezer? It could take half an hour of searching just to locate each single sample that you want, which could make the whole collection next to useless (what if you needed to find 20 samples at once?) A strictly organized catalogue system, like libraries use for books on their shelves, is essential once you've grown past the “shoebox stage”. And you have to put the seeds back in the right place, or the system won't work.

How will you test the seeds?

Even in a freezer, seeds don't live forever. When will your seeds need to be re-grown or replaced? Only a germination test can tell you that. The usual rule of thumb is to replace the seeds when their germination rate falls to 85% of their original rate. That means you have to test the germination when you first get the seeds, and then test again from time to time. That's easy for a small collection, but how will you manage tests for 1,000 varieties?

How will you re-grow or replace the seeds?

This is the difficult part. Sure, you can make a collection of seed packets pretty easily, but what do you do when they get older and the germination rate starts to fall? If they're common varieties, you could just buy more, but why would you be going to the trouble of seed banking varieties that you can just buy any time? Probably, you're seed banking some of the other 90% of varieties that aren't easy to find. That means you have to re-grow your own supply. If you have

1,000 varieties in your collection, and you need to re-grow them every 10 years on average, that means you have to re-grow 100 varieties every year. If you don't, eventually you'll have a big collection of dead seeds.

Will you distribute seeds to other growers?

If your seed bank is intended to be useful to other growers, how will you distribute seeds to them? More importantly, how will you multiply enough quantity to be able to distribute your seeds? Maybe you got a seed variety by buying a package from a seed company, but those few seeds won't go very far. If you expect to exchange, sell, or use the seeds, you'll have to multiply them.

Will you produce/provide larger quantities?

Some seed projects aim to do field testing, public seed exchanges, etc. Will you have to multiply larger amounts of seeds? How many varieties can you multiply each growing season?

Does anyone else know what is in your collection?

A seed collection is pointless if it is not used, and if you intend people other than yourself to use it then they need to know what you have, and any information that might help them to choose the right varieties for their purposes. Can you keep an accurate inventory on paper, computer, or web site?

How will you back up the seeds?

There are far too many stories about seed collections that have been destroyed by fire, flood, theft, and storms. The work of decades can literally go up in smoke overnight. You might invest in a fireproof vault, or a bombproof bunker, but the most reliable and cheapest security is always obtained by redundancy. Put portions of your seed samples in at least two different locations, and you'll be fine. But it takes some work and planning.

How will you perpetuate your collection?

Finally, the number one reason that seed collections perish is that their owners don't plan for someone to take them over when they can't continue. Illnesses, loss of a job, moving to a different property, old age, family crises; there are many reasons that people occasionally need to let go of a cherished project. But a seed collection is a living thing that few people are able to pick up for you. Without a planned successor to adopt your orphaned collection, your seeds will die in their jars or someone will throw them out.

The good news: You're not alone!

Seeds of Diversity's member seed growers have been collecting seeds for over 25 years, and we've seen what works and what doesn't. Our Seed Library has been designed from the start to help solve these problems and overcome these obstacles. We can help you with seed back-up by arranging for samples to be duplicated in more than one place. We can help make sure that collections are never orphaned, by coordinating growers to adopt varieties that are in jeopardy. We can help you manage your seed information with standardized cataloguing and inventory databases that help you coordinate your collection with other micro seed banks.

Your seeds belong to you, and you get to decide how your micro-seedbank operates. You decide who can get the seeds, on what basis, and how much information you'll publicize. We can help you to do it right, from the start!

Storage Conditions

To store seeds for any length of time, keep them as dry and cold as possible.
You can store your seeds at room temperature, but if you can keep them dry and as cold as a fridge, they will probably last twice as long. If you can freeze them well-dried, they will last for many years.

> You can remember this rule by thinking of what a seed needs to germinate: warmth and moisture. The opposite makes seeds go to sleep (we say they "become dormant"), and when they're dormant they consume their stored food slower and last longer.

Dry is more important than cold

Maybe you've heard stories about seeds that were hundreds or thousands of years old and still germinated. They were found in ancient Egyptian tombs, or in clay pots in caves. In all those stories, the seeds were very, very dry. Egyptian tombs buried in the desert sand, prehistoric seed vessels found in caves in the American south-west desert, even ultra-dehydrated seeds sealed in glass by scientists in the 1800s that still germinated a hundred years later.

You probably won't be able to make your seeds last that long, but dryness is always more important than temperature. Pay careful attention to humidity, condensation, the weather outside, and the time of year (it's much dryer in winter than summer). If you keep your seeds really dry, you don't have to work as hard to keep them cold.

Room temperature

There is a fairly good rule of thumb that you should keep your seeds where the sum of the temperature in degrees Fahrenheit plus the percentage relative humidity is less than 100.

Temperature in °F + % relative humidity < 100

For instance, an air humidity of less than 30% and a temperature of less than 70 degrees F (21 C) are good conditions where seeds are expected to last for a few years on average. This would be a good situation for a seed collection housed in a public library, where people could access the seeds easily from a cabinet without having to get jars out of a freezer.

The formula above is a reasonable rule for discerning the maximum temperature and humidity for seed storage. In other words, if your location breaks this rule, store your seeds someplace else. The formula doesn't work as well if the temperature is low and the humidity is high, because dryness is always more important than temperature. Also, don't be satisfied if you're close within this rule because the colder and dryer you store your seeds, the better.

In a refrigerator, but not frozen

If you have enough space in a fridge to store seeds, the difference in temperature will probably make them last twice as long, compared to room temperature. However, you have to keep them sealed in airtight jars, with dry air in the jars. Fridges are very humid places, with condensation everywhere. Seeds don't last long exposed to that humid air, even though it's cold.

When you open the jars, let them sit at room temperature for a few minutes first, until the glass warms up. Otherwise, condensation can form on the inside of the jar. Try to open the jars in as dry a place as possible, on a dry day, to prevent excess humidity from getting inside while you're moving seeds. If you can schedule your seed work for a winter's day, the air in the room will be much less humid than during the summer.

Frozen storage

Almost all seeds can be frozen with minimal damage, as long as they're well dried. Try this: put a strawberry and a roasted almond in your freezer. Take them out an hour later. The strawberry will melt into a mushy mess, but the almond will be perfectly undamaged. That is because the berry was full of water and the almond (it's a seed!) was dried. When water freezes, it expands and forms sharp ice crystals, which pop the cells in the berry like water balloons. If you freeze a freshly harvested, moist seed it will suffer the same fate, but a well-dried seed can be frozen and thawed with hardly any consequence.

Freezing seeds actually causes a small loss of germination. For example, if a batch of seeds with a 99% germination rate are frozen and thawed, you might expect that rate to drop to 98%. The fact is, however, that the same seeds will lose 1% germination in a few months if they age at room temperature anyway, so if you want to store your seeds for a long time, the benefit of slowing down their aging by freezing outweighs the infinitesimal damage of the freezing.

Keep your seeds safe from:

- High or varying humidity
- High or varying temperature
- Damage by mould (make sure seeds are well-dried before putting them in any sealed container)
- Insects and rodents (they can chew through plastic but not through glass)
- Water damage

Seeds of Diversity's Three Levels of Seed Storage

To give you an idea of why you might choose different strategies for seed storage, Seeds of Diversity stores its seeds in three different ways, for different purposes. Our advice is to practice Level 1 storage for your distributable seeds, Level 2 storage for your backups, and participate in our system that takes care of Level 3 backup.

Level 1

For seeds that are intended for distribution or use within a year or two, there is no need for special treatment or freezing. Keep these seeds at room temperature, as dry and cool as possible, but feel free to store them in paper envelopes or bags. The point is to make these seeds conveniently accessible for distribution, without the need to warm, chill, dehydrate, or otherwise condition the seeds as in Level 2 storage.

Level 2

For seeds that are not available for distribution (due to low quantity or low viability) or that are duplicate backup samples of seeds in Level 1, freezing is the simplest way to keep the seeds viable for a long time. At this level, we focus on keeping a sample viable for 10-15 years with the least overall expense, intended for regeneration at a later date. Long-term security is not an issue if further backup has been made at Level 3, so such expenses as fire-suppression, backup generators, etc, are unnecessary.

Dehydrate seeds with silica gel or similar methods, to an ambient air relative humidity of 15-20%. Store seeds in airtight jars in a freezer, at -10C or colder.

It does not matter if the power fails, and the seeds warm up to room temperature, even for several days. If they are properly dried, they can be thawed and refrozen with very minor loss of germination.

To access seeds, allow the jars to warm up above freezing before opening them. You'll see frost on the outside of the jar right away, and you want to prevent that from happening on the inside, so don't let humid air in while the jar is cold. After removing / replacing the seeds, the air must be dehydrated again. Use silica gel as before.

You can also try to schedule your work in mid-winter, when the ambient air is already very dry.

Level 3

This is the most secure backup, in principle to protect seed samples for the long term and never actually access them unless there is some kind of catastrophe.

We accomplish this level of security by partnering with government seed banks. Seeds of Diversity's standard procedure is to donate 1/3 of every accession to the PGRC seed bank, where seeds are stored in a world-class facility, and available to us through their normal channels.

Drying Seeds for Storage

Dry your seeds in open air on trays or screens, taking care to protect them from wind, weather, and rodents such as mice and squirrels. Indoors is usually best. The seeds should feel dry to the touch within 1 to 3 days at maximum. The best way to hasten dryness is to create good air circulation, especially if the weather is wet and seeds are drying slowly. An electric fan, not blowing on the seeds, but just nearby to move the air around makes a big difference on a humid day.

Many kinds of seed will die in temperatures above 60 °C (140 °F) and some will die in temperatures as low as 40 °C (105 °F). To be safe, keep the drying seeds out of direct sunshine on a hot day, but partial sun or filtered sun is alright. Some people use food dehydrators to dry seeds, but every model is different. If you want to try this, experiment with a few seeds on the lowest setting and test the germination of the seeds afterwards. An oven is not a good place to try to dehydrate seeds, since even the lowest setting is usually far too hot. Seeds dry quickly in plain dry circulating air, so there is really no reason to try to dry them with heat.

For “Level 1” storage (e.g. in accessible containers at room temperature), keep the seeds on screens or trays until they feel dry to the touch, then store in paper envelopes or bags to dry further in a reasonably dry room. At this point the seeds could still contain some moisture, so let them breathe in paper for a few more weeks or months. If you put the seeds in plastic or glass containers too early, the trapped moisture within them can cause them to mould.

For “Level 2” storage (frozen in glass jars) you have to do a bit more work to dry the seeds completely. Start by initially drying them on screens as above, and then finish them with silica gel. You can purchase silica gel in craft stores, hardware stores, and sometimes pharmacies. It is a glass crystal that absorbs moisture, and can be re-used virtually forever.

Put an equal weight of silica gel with your seeds in a sealed container for 2 to 3 days. You should prevent direct contact between the silica gel and seeds. One way is to put them in separate paper envelopes, and the envelopes in a sealed jar. Another way is to put several open containers of seeds and a large open container of silica gel in a plastic tub, with a garbage bag stretched overtop to seal them in.

The silica gel will dehydrate the air, which in turn draws excess moisture from the seeds. After three days the seeds will be well dried enough to freeze them without damage.

Some brands of silica gel contain indicator crystals that change colour when they've absorbed moisture. Once you see the colour change, re-activate the silica gel by drying it for 20 minutes in a hot oven or barbeque. Since it's made of glass, silica gel can withstand any heat that an oven or barbeque can create. Store it in an airtight jar when it's dry.

Here's a tip from the Rural Advancement Fund International, 1986: If you cannot obtain silica gel, try powdered milk. What milk lacks in sophistication it gains in practicability.

Containers for Seed Storage

We highly recommend screw-cap mason jars as the simplest and best way to keep seeds dry, cold, and safe from insect and rodent pests. The jars are airtight and available in several standard sizes from coast to coast.

Glass jars with clamp lids often have thicker rubber seals, which last longer and don't crack when frozen for many years. We recommend these for long-term frozen storage, though since they are more expensive, we prefer the standard screw-top mason jars for regular use and short-medium term storage.

Seeds can also be stored in paper envelopes or bags, or in plastic containers, but paper allows humidity through in the heat of summer, and surprisingly, plastic does too. Plastic molecules are like tangled spaghetti with gaps between them, large enough for water molecules to pass through. Even though plastic containers hold liquid water, they actually allow humidity to pass through. Store seeds in open air in paper or plastic only if the seeds are not meant to last for a maximum length of time. e.g. if you are actively distributing them for people to grow. If the seeds are dry, they will last for a few years without special storage.

Note: plastic breathes, but very slowly. If your seeds are not completely dry, don't seal them in plastic containers or bags - they will mould!

Screw-top Mason Jars

In our seed inventory system we use the following letter codes when we number the boxes. Since each size of box looks different, it's a lot easier to spot the right box on a shelf or in a chest freezer. e.g. If a seed sample is in box E-12, right away you know to look for a 1-litre size box.

A	125ml
B	250ml standard mouth (tall)
C	250ml wide mouth (short)
D	500ml standard or wide mouth (boxes are the same)
E	1L standard or wide mouth
F	1.5L

Several coin envelopes can be easily packed into a wide-mouth jar.
#1 coin envelopes are ideal for small samples of small seeds (e.g. tomatoes).
#3 coin envelopes are ideal for small samples of large seeds (e.g. beans).

Collections of Boxes of Jars of Envelopes

Our inventory system uses three codes to locate each sample of seeds:

- Every seed collection site has a number,
- Every box has a size and number,
- Every jar has a letter.

E.g. “Location 01-D3-A” means:
Seed Library 01 (which is Seeds of Diversity's office in Waterloo)
Box D3, which is a standard Bernardin “D”-size box labelled D3
The jar marked A in that box.

This is a very flexible and efficient system, because jars can be moved between boxes and even seed libraries without having to open or re-label them. Just update the Inventory record in the database with the new location code.

In addition, every sample of seeds is labelled with the variety name and the Inventory number (explained in the next chapter). If a jar only contains seeds, a slip of paper with this information is placed in the jar too. If a jar contains envelopes, every envelope is labelled. **It's crucial to put the label inside the jar so it doesn't get lost or damaged by condensation.** Technically, only the Inventory number is needed because you can use that to look up all the information you need about the contents, but the variety name is a nice convenience, and it's a safeguard against erroneous Inventory numbers. Feel free to add any additional information on the labels that might be useful for the person handling the jars, but make sure all the information is in the database and use it.

Always check the jar cap seal when you open or close a jar. If it looks worn, replace it. The jars have to be airtight to keep out humidity!

Labeling and Seed Information

When you label your seed containers (envelopes, jars, bags) make sure the information is duplicated somewhere else (such as a database or spreadsheet), and protect the labels from damage. With glass jars it is a good idea to put the label inside the jar, so condensation or water damage doesn't make it illegible. With paper envelopes, obviously write directly on the envelope.

Labels should have the following information at a minimum:

- Variety name
- Year that the seeds were harvested
- A code to look up all other information (see “Inventory Number” below)

Any other information can be recorded on the label too, such as the seed weight, origin, characteristics, etc, but in practice these are more useful in an electronic list. The label only needs the information that you use when you're physically working with the container. Once you've used your database to choose a sample to access, you really only need to see the right

inventory code on the container. The variety name and year of harvest are convenient, but they also help to avoid errors if you mis-read the inventory code. This is also the minimal information that you'll need if you have to reconstruct your collection after a database failure.

Accession Numbers

Large seed banks keep track of their seeds by giving each sample an "Accession number". Like the catalogue numbers on library books, these are the keys to all the information about each seed sample, such as their variety name, origin, and date of harvest. Simply put, when you receive a new sample of seeds, give it a new accession number.

The numbers are usually assigned sequentially, but they don't have to be consecutive, just as long as they're unique. Don't try to put any special codes in the accession numbers, such as the year, species, or origin. Seed banks have tried many systems over the decades, and inevitably those special coded systems become complicated. Copying long accession codes is burdensome and error-prone. A simple number is always easiest, and additional information can always be written on labels and entered in spreadsheets beside the accession number.

Here are some of the information fields that we record by accession number. Remember, an accession number refers to an original sample of seeds, and all the information relating to its original condition, not necessarily what happens to it within the collection (that's done by Inventory number).

- species
- variety name
- date harvested (if known)
- date received into collection
- origin (a commercial company, a seed grower, Seedy Saturday swap table, etc)
- location where seeds were grown (if known)
- original weight in grams
- parent accession (if these seeds were grown from another seed sample in this collection)
- other notes

When you re-grow some seeds, should the next generation be a new accession? Some seed banks keep track of different generations using the same accession number, but we recommend using a new one. It keeps the information more clear. So if you send some seeds from accession 547 out for multiplication, and fresh new seeds come back into the collection at the end of the summer, treat them like a new accession with a new number. Just record its "parent accession" as 547, so you can easily see where the planted seeds came from.

Inventory Numbers (also called Batch Numbers)

Once a seed sample is part of the collection, there are many reasons why that accession might be split into different containers. Maybe you want some seeds in a back room for longer-term storage, but others up front for distribution. This adds a complication, because if you record the container's location by accession number, which location is it? Also, you might store one container in a freezer and another in a warm room. Then part of the accession will lose germination faster than another part. How will you record germination tests by accession?

We solve this problem by doing the same thing that larger seed banks do. We use two numbers for every container of seed: one tells us its accession (the origin of the seeds and their condition when they were received), and the other tells us its inventory information (where that container is located, and the weight of seeds in it).

> Most seed collections are simple enough that they don't need this level of complexity. It's really easy to avoid though. You can set up your system so all information is keyed to the same number, accession and inventory alike. This makes things much simpler, though you'll have to create a duplicate accession record if you split a sample into two different locations.
>
> We even support a simplified set-up in our information systems, with a simple option that always makes the inventory number the same as the accession number. Way simpler for smaller collections!

Here's an example of how it works:

1,000 grams of Odawa beans are acquired on Sept 13, 2013. They are given Accession Number 12345 and split into two equal samples. One sample goes in a jar with Inventory number 345 and the other into a different jar with Inventory number 678, which is sent to a partner seed library for backup. The following information is recorded.

Accession ID	Variety	Date acquired	Date harvested	Location grown	Original grams
12345	Bean: Odawa	2013-09-13	2013-09-01	Victoria, BC	1000

Inventory ID	Accession ID	Weight grams	Location of container
345	12345	500	SL 1, box E-12, jar G
678	12345	500	SL 2, box D-3, jar B

Now we know that Seed Library 1 and Seed Library 2 each have 500 grams of Odawa bean, which came from an original sample of 1000 grams grown in 2013 in Victoria. We also know which box and jar to find them.

If Seed Library 2 distributes 200g of its seeds, it must update the record for Inventory #678 so we'll see this:

Inventory ID	Accession ID	Weight grams	Location of container
345	12345	500	SL 1, box D12, jar G
678	12345	300	SL 2, box D3, jar B

Now we have 800g remaining, from the original 1000g shown in the Accession record.

Keep the location up to date! As your collection grows it becomes much harder to find misplaced jars!

You don't have to store your seeds in the order of their accession or inventory numbers. Books on library shelves are stored this way, so if you know the catalogue number you can find the book. It's different with seeds because some samples are large and some are small. Some will fit in large jars, and some will fit in envelopes inside smaller jars. Because of this, it makes much more sense for the inventory numbers to be arbitrary, and for the location codes to be recorded by inventory number.

You can look up a seed in your database, get the location code, and find the seeds quickly. Or you can stumble upon some seeds in a box, see the inventory code on the label, and look up all the information about them. If you move some seeds to a different location, just update the location code in your database.

Germination Tests

Every sample of seeds contains some genetic variation, which ultimately allows plants to adapt to changing conditions. To preserve the rare genes hidden in your seed stocks, you should keep most of the seeds alive, so those genes have the best chance of being perpetuated in the next generation.

The usual threshold for regeneration (re-growing fresh seeds from older seeds) is 85% of the original germination rate. That means we test the germination of every fresh Accession, and repeat that test from time to time. When the germination rate falls to 85% of the first result, the seeds should be re-grown to provide a fresh Accession.

E.g. if an Accession had an initial 95% germination rate, we would re-grow the Accession when its germination rate reached 85% x 95% = 80.75%

Level 1

Seeds at Level 1 will lose germination within a few years, depending on the species, temperature, and humidity. They should not be needed for regeneration (though they can be used for that purpose) but users of the seeds should be made aware of their quality. Occasional germination checks can be made by planting 20 seeds in a pot of soil and watching how many sprout. It is your own policy whether or not you distribute lower-germination seeds, but you should inform recipients of the most recent germination results so they know what they're getting.

Level 2

Germination tests for Level 2 seeds should be repeated about every 5 years until the result falls below the 85% threshold. Then the seeds are scheduled for regeneration. Germination test results are recoded per Inventory number, not per Accession number, because a split accession could have different germination rates in each container.

If there are 1,000+ seeds in a sample, test up to 100 seeds (as resources allow). Place them in rows on a moist paper towel, and roll it up into a cylinder, placed in a paper bag in a warm place. Count and remove the sprouts with tweezers every 2 to 3 days, and re-moisten the paper towel each time. After two weeks, tally the number of sprouted seeds from each sample and calculate the percentage of germination.

If there are fewer than 1.000 seeds in a sample, a smaller test can be done using about 10% of the available seeds. If fewer than 100 seeds are available, you need to grow more anyway.

It is a good practice to do a germination test whenever a new accession is acquired. This gives a baseline for interpreting future germination tests.

> Germination procedures (temperatures, numbers, and the length of time) vary for each species. For more comprehensive instructions, we are preparing a chart.