# Seed bank design: seed drying rooms

Technical Information Sheet 11

The effective drying of orthodox seeds prior to cold storage is the key to successful seed banking. Drying prolongs storage life, allows seeds to tolerate extreme temperatures, prevents germination, and reduces attack by predators and pathogens.

For long-term conservation, the aim is to reduce seed moisture status to 15% equilibrium relative humidity (eRH) at 15°C. This is about 3-7% moisture content (on a fresh weight basis), depending on the oil content of the seeds.

A dry room is the most appropriate drying method when you need to dry large quantities of seed at the same time (see Table 1). Dry rooms also provide safe storage prior to seed cleaning and a suitable location to package samples for storage or to warm up frozen samples that have been removed from the cold room.

This information sheet explains how to set up a dry room. Refer to Technical Information Sheet 08 - Low-cost Drying - and Linington (2003) for other drying methods.

### Table 1: Comparing seed drying facilities

| | Drying capacity | Cost (estimated UK prices) |
|---|---|---|
| Purpose-built dry room | in excess of 500L of seed material | £30,000 (converting an existing cold room into a dry room will be cheaper) |
| Bespoke drying cabinet with desiccant dehumidifier unit | 500L of seed material | £15,000 |
| Incubator-dryer | about 100L of seed material | £2,500 - £4,000 (incubator purchase price) |
| Silica gel in a 60L drum | up to 25L of seed materal | £200 |

## Designing a dry room

It is important to obtain specialist advice when creating a dry room. However, seed curators and conservation practitioners should understand the basic principles in order to guide the design. The fundamental principle is to create a sealed room with low relative humidity and a cool temperature (the Millennium Seed Bank (MSB) recommends 15% RH at 15 - 18°C). Good insulation is also important to reduce energy usage in cooling and drying.

The key questions when designing a dry room are:

### What size and shape should the room be?

The maximum volume of material that will need to be dried at any one time will determine the size of room required. A small seed bank might require a volume of around 25m³, whereas an international seed bank is more likely to require a dry room in the region of 125m³.

Assess the likely collection intake per month during a typical year and identify the peak volume of material

Figure 1: Dry room at The Lombardy Seed Bank, University of Pavia, Italy, with collections in ventilated stacked crates.

**Box 1: Seed drying room: worked example**

If the volume of an ‘average’ un-cleaned seed collection (V) = **$0.002m^3$**

Number of collections in dry room during peak period (N) = **500**

Assume that collections are spread in thin layers on paper inserts, within self-stacking crates on trolleys. If collections are to be held in bags, less space is required but drying time will increase.

Height of crate (H) = **0.12m**

Width of crate (W) = **0.4m**

Length of crate (L) = **0.6m**

Proportion of crate filled (P) = **0.25**

(especially if thin-layer drying)

Trolley Height (Z) = **0.3m**

Number of collections per crate (A)

= (H * W * L * P) / V = **3**

(round down to avoid part collections in a crate)

Number of crates (B)

= N / A = **167** (round up)

A stack of self-stacking crates on a trolley should not exceed a height of 2m.

Number of crates in stack (C)

= (2 - Z) / H = **14** (round down)

Number of stacks (D)

= B / C = **12** (round up)

Floor area of stacks (E)

= D * W * L = **$2.88m^2$**

In order to allow sufficient working space (including a table) and good air circulation, crates should only occupy about 25% of the floor area. Therefore, the total floor area will need to be 4 times the area occupied by the crates.

Required dry room floor area (F)

= E * 4 = **$11.52m^2$**

The height of the room is likely to be around 2.5m.

Dry room volume (G)

= F * 2.5 = **$28.8m^3$**

Figure 2: Crates stacked on moveable trolleys in the MSB dry room, with seed collections contained in porous bags.

(for some seed banks, the dry room may need to hold a whole year’s collections (Box 1)). The number of seeds per collection, and the size of these seeds will greatly affect the volume estimations.

Make these estimations on the basis of uncleaned collections, unless the seeds will definitely be cleaned beforehand. Assume that drying will take at least one month.

If the total uncleaned peak seed volume is sufficiently small (less than $25m^3$), one or two incubator-dryers might be a more appropriate option for drying.

It is helpful to mark out the dimensions of the proposed dry room on the ground. Ideally, locate the dry room close to, or attached to, the seed cleaning area and adjacent to the cold room(s). An oblong-shaped room is better than a square one. Supplying dry air at high level on one of the short walls and extracting it at low level from the opposite wall will give a good air flow to most parts of the room.

Depending on the frequency of access to the room and the humidity of the external conditions, an air lock (small lobby) may be required to minimise the entry of humid air into the room when the door is opened. A $2m^2$ air lock will be large enough for at least one person holding a crate to enter easily. Include a secondary (emergency) exit door from the dry room for large dry rooms.

**What materials should be used?**

Ideally, install a new prefabricated structure, either as a stand-alone room or within a larger existing room. Construct walls and ceiling with insulated sandwich panels of a suitable thickness. Doors must be well insulated and windows (including those in the doors) should be double-glazed.

If an existing brick- or wood-built room is to be used, install a moisture barrier (perhaps glazed tiles or plastic sheeting) on all internal surfaces. Install thermal insulation on the outside of the walls (and ceiling). Both will reduce energy usage in maintaining the dry room conditions and the external insulation should help minimise condensation in the walls.

**How is the air dried and cooled?**

The drier must have enough capacity to deliver about six air changes per hour to the drying room. Confirm this with the supplier/installer. Note that refrigeration dryers are not designed to deliver this condition. The MSB recommends a rotary sorption dryer containing a silica gel or lithium chloride drying agent.

If possible, install two dryers, each capable of coping with 66% of the moisture load.

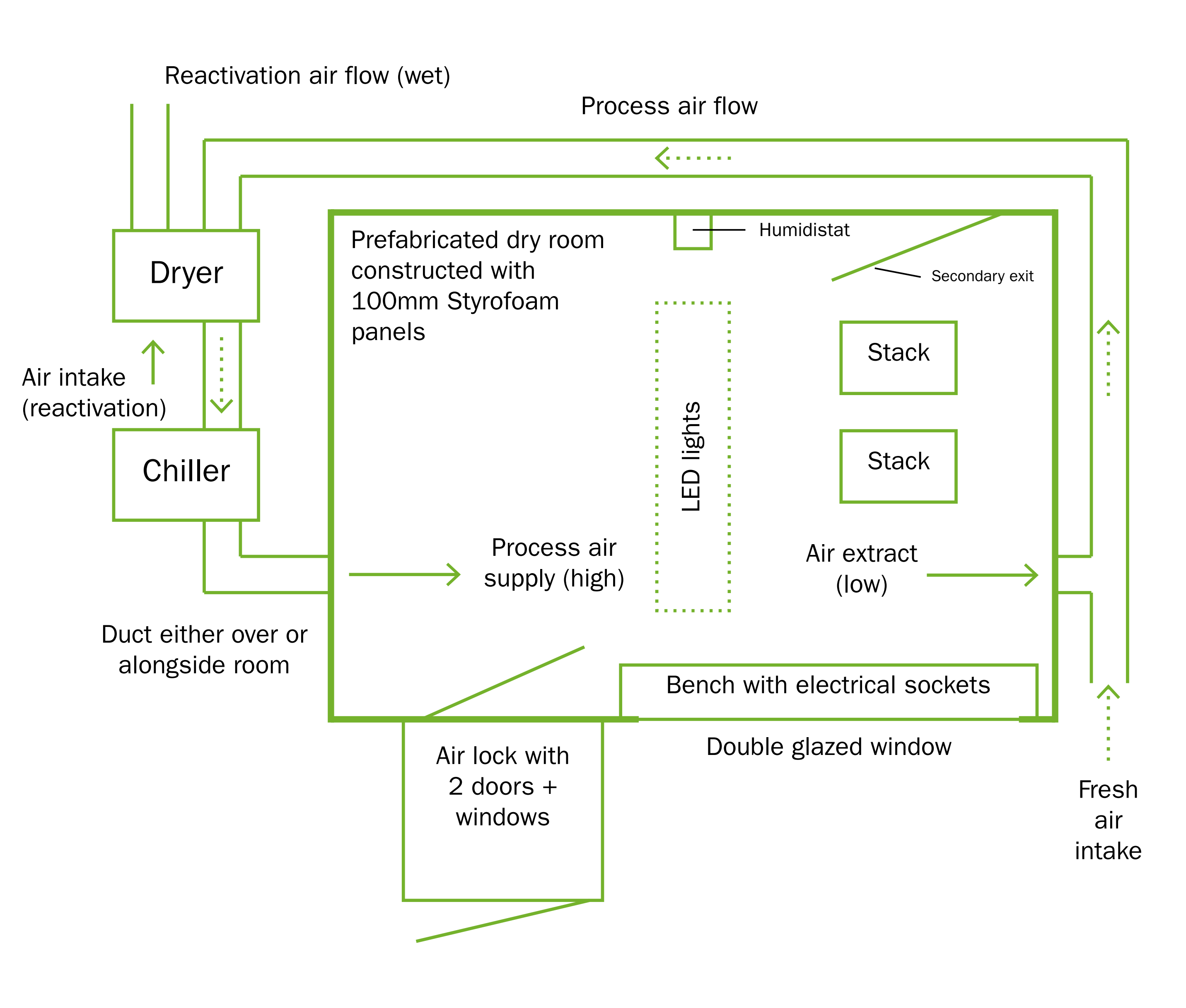


Figure 3: Possible layout of dry room facilities. The direction of airflow is indicated by the arrows.

The dryer creates heat during the drying process and should ideally be placed outside the room (in a ventilated area). Connect the drier to the room via insulated supply and extract ducts, of sufficient diameter not to impede air flow.

This 'process air' dries the room and should be supplied, via a chiller, high up at one end of the room and extracted low down at the other end of the room. The drying agent picks up moisture from the process air and is then re-dried by the second ('reactivation') airflow. Air is drawn into the dryer, heated, and passed over the drying agent. The wet air produced by this process needs to be ducted to the outside of the building.

The location of the controlling humidistat is important. Place the humidistat halfway along one of the longer walls of the room. Construct a map of humidity in the working dry room, using an RH meter to guide where to best locate the stacks of crates for drying.

If the dryer is located within the dry room, ensure that the process air mixes rapidly with the cooling system air. Duct the wet reactivation air out of the room. The chiller will need to be located in the room and be capable of cooling the heat load from the dryer, achieving a room temperature of 15°C. Ensure that the controller for temperature and RH is situated outside the room adjacent to the door.

**What about working conditions for staff in the room?**

A fresh intake of oxygen into the room is required, to maintain safe working conditions for staff. With the exception of very small dry rooms, air entering via the door will not supply sufficient oxygen to the room. Allow for a steady 10% fresh air make-up via the dry-air duct, work into the process airflow.

The supply of fresh air can be shut off when there is sufficient oxygen in the room. This is controlled via a carbon dioxide monitoring device, linked to an automated fresh air intake valve in the process air duct. Seek further technical advice if this option is used.

In order to avoid dehydration, staff should only work in the dry room for a maximum of 2 hours and should then drink plenty of water when leaving the dry room.

Another problem associated with operating a dry room is a build-up of electrostatic charge due to the dry conditions. Use anti-static footwear and/or an anti-static gun, especially when dealing with tiny seeds. All room fixtures should be well-earthed.

## Box 2: What is the likely moisture load?

Apart from the seeds themselves, other sources of moisture need to be taken into account when calculating dry room size. Together, these make up the moisture load, expressed as kilograms per hour. Working to a slight positive pressure, the dryer should be able to maintain the required conditions under the potential moisture load from:

- **Wet seeds**

The moisture status and amount of seeds in the room at any one time will vary, so it is difficult to estimate the exact moisture load.

Unless batches of very wet seeds will be placed in the room at frequent intervals, there is no benefit in designing for a ‘worst case scenario’. The system may fall outside the optimum conditions for a short amount of time, but the dehumidifier will then start to work more efficiently and will rapidly return the room to the desired moisture status.

- **People in the room**

A person carrying out non-strenuous work in a dry room will release approximately 60g water vapour per hour.

- **Moist air entering the room**

Depends on the frequency of door-opening, the size of the air-lock, and the external air conditions.

- **Fresh air make-up**

Depends on the number of people using the room.

- **Permeation through the structure**

This should be negligible.

- **Leakage into the dehumidifier**

Moisture leaking into the dehumidifier is likely to be zero for a well-sealed machine.


## Acknowledgements

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## Further reading


Linington, S.H. (2003). The design of seed banks, pp. 591-636. In: R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard and R.J. Probert (eds), Seed Conservation: turning science into practice. Royal Botanic Gardens, Kew.


Figure 4: Tasmanian Seed Conservation Centre, Australia - dry room with sorption dryer unit and -20°C chiller cabinets for seed storage.

## Equipment specifications*

| Description | Model/Product | Supplier |
|---|---|---|
| Insulation | Panellised panels of a suitable thickness | Local refrigeration company |
| Sorption dryer | Dehumidifying systems | Munters or similar<br>www.munters.co.uk |
| Chilling facilities | Refrigeration unit | Local refrigeration company |
| Plastic Stacking crates | Euro stacking containers (ventilated)<br>Various dimensions available<br>Dollies, ref:91005 | Allibert Handling<br>www.allibertcrateshop.co.uk |
| Lab-based hygrometer | HC2-AW sensor with USB interface, connected to laptop/PC running HW4-E software. Range: 0 to 100% RH, -40 to 85 °C. | Rotronic Instruments (UK) Ltd.<br>www.rotronic.com |
| Data loggers for measuring ambient relative humidity | Tiny Tag and Tiny View data loggers.<br>Range: -30 to +50°C (± 0.2°C); 0 to 100% RH (± 3% RH). | Gemini Data Loggers (UK) Ltd.<br>www.geminidataloggers.com |

*Please note that the above equipment is used by the Millennium Seed Bank 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.