Introduction

Clean seeds are important in restoration for many reasons. Germination is more accurately estimated on cleaned seed lots, and until seed tests can predict how many plants to expect, it cannot be known how well establishment protocols work. Cleaner seed lots can be examined for weeds more easily, helping ensure that weeds are not brought onto the restoration site. Cleaned seeds also require less storage space.

Often, however, equipment to clean seeds is too costly for small operations. With a good understanding of the principles of seed cleaning and an average mechanical ability, a person can construct relatively inexpensive devices that in many cases are comparable to high priced equipment. Principles of seed handling will be briefly presented here. More detail is provided in the introductory chapters of the Woody Plant Seed Manual (Bonner and Karrfalt 2008). All procedures and apparatuses discussed here have actually been tried by the author or the author observed them being used by others.

Seed Drying

Texts on seed management universally emphasize controlling seed moisture as the single most important action in preserving seed quality in storage. Therefore, it is necessary to be able to dry seeds rapidly and efficiently. For millennia people dried seed by spreading them out in the sun. This works well if you have enough sun (when you need it) and have the space to spread out the seed. Also, sun drying requires protection from predation, contamination, and wind. Even when done indoors this process is often inadequate. Therefore, effective seed drying often involves pressurized dryers. In a pressurized dryer air is forced through mesh bottom containers of seeds giving uniform and rapid drying with minimal labor because there is no turning of seeds.

Figures 1 and 2 show dryers made using stacks of paint strainers for the dryer trays. Paint strainers come in bucket size and barrel size with a variety of mesh sizes for the bottoms. Using the most open mesh size possible is best to minimize air resistance. Less air resistance allows more trays and more seed on the dryer in one charge. Very small seeds of course require using a very fine mesh. As long as a gentle air flow is felt coming from the top tray of seeds, then the dryer is properly loaded.
The trays need to be sealed tightly together within the stacks. Otherwise, the air will come out the sides of the tray stack since air flow follows the path of least resistance. The small trays must be separated with a collar made from a pail lid. Figure 3 shows how this collar is constructed. The opening in the lid is cut with a sharp utility knife. A piece of quarter inch (0.64 cm) foam weather stripping seals the edges.

The dryer fans must operate against the high resistance of the seeds and trays. High resistance would be 1.5 to 2.0 inches (3.8 to 5 cm) of water column. An induced draft blower motor is a relatively inexpensive (under $150) motor that will do this. The blower motor is mounted in the dryer plenum (bucket, barrel, or box at the base; Figure 4) so it draws air from outside the plenum and forces it up through the stack of trays. The name “pressurized dryer” comes from this pressurizing of the stack of trays.

The final step in making the dryer work is to supply it with dry air; air that is ideally at 30% relative humidity. Some environments naturally are very dry, while in others it is necessary to use supplemental heat, a dehumidifier, or a dehumidifier and an air conditioner in combination. When using one of supplemental methods to dry air, the dryer must be placed in a closed room. It is important to measure the relative humidity of the air entering the dryer. This is done with either a hygrometer or a psychrometer, instruments that can be purchased or that you can make using instructions from the internet.

Extracting Seeds

Extraction is one of the first steps in producing native plant seed. Drying is often part of this because drying makes the fruits or cones open up or become brittle enough to break apart. A shop vacuum works very well to extract aspen or milkweed seeds from the fluff. Starting with a clean vacuum, simply vacuum up the seed with fluff attached (Figure 5). Then open the vacuum canister and lift out the fluff which collects at the top and the extracted seed will be in the bottom of the canister, ready for cleaning.

Rubber palmed gloves or rubber faced blocks and boards work well to rub appendages off of seeds. Kitchen blenders with the blades covered with rubber or plastic tubing make good cleaners for fleshy fruits.
The seed dryers will be needed to dry the finished seeds. Tumbling is another way to separate seeds from the fruit or cone. Figure 6 shows a small homemade tumbler.

### Dimensional Separations

Once extracted, the seeds are usually full of leaves, stems, and other trash. Separating seeds and trash by dimension is one important method. Most dimensional separation is done with screens. There are two basic screening operations, scalping and sieving. Scalping is when the seeds pass through the screen and the trash stays on top. Sieving is when the seeds remain on top of the screen and the trash passes through. Different sizes of hardware cloth, window screens, or kitchen sieves can help. For small seeds and sieving out very fine trash, the paint strainers used with the seed dryers (as described above in the section about drying) are useful and come in 4 different mesh sizes. Ready-made inexpensive screens offer only a limited range of opening sizes. The patient person might use a set of twist drills and perforate some sort of rigid sheet material to make more screen sizes. Hand screens can be purchased for about $50 each and come in over 100 sizes. These are much more expensive than home kitchen utensils but will last for decades if taken care of.

### Weight Separation

Much trash is lighter than the seeds and is taken away when the seed passes into a carefully regulated column of flowing air. There are two ways to move the air, push it or pull it. Blowers push air and aspirators pull air. Aspirators have been relatively simpler to construct compared to blowers so two types of aspirators will be discussed here: the pipe aspirator and the box aspirator.

### Pipe Aspirator

A very simple and easy-to-build aspirator can be assembled from pvc DWV (Polyvinyl chloride, drain waste vent) pipe, a small shop vac, and long neck funnel, and a tray (Figure 7). The neck of the funnel needs to extend to just below the bottom of the pipe fittings. The vacuum cost $20 and the pipe about the same, making the total cost $40. The air gate detail is shown in Figure 8. Use pipe the same diameter as the inlet opening for the vacuum cleaner. Smaller diameter pipe might stress the motor and larger diameter would cause too great a pressure drop to maintain sufficient vacuum. The machine works by turning on the vacuum cleaner, gently feeding seeds down the funnel on the top, and closing the air gate until only trash is lifted and clean seed (more or less) falls out the bottom into the tray. You can then increase the feed rate to as fast as the machine can handle and still deliver the clean seeds to the tray at the bottom. Feeding in too many seeds at once will result in trash caught under the seeds and falling...
down the chute rather than being lifted up into the vacuum. If you find too many seeds in the vacuum, then too much air was used and the air gate needs to be opened up enough to prevent the seeds from being lifted with the trash. One problem that can occur with this aspirator is the buildup of static electricity along the pvc. It may need regular wiping with an antistatic cleaner or window cleaner. Be sure to have the parts thoroughly dried before putting seeds back into the cleaner.

Box Aspirator

A little more sophisticated, but possibly cheaper is a box aspirator (Figure 9). This machine has a wide seed chute that appears to be better suited to smaller seeds that have lots of fluffy trash. Because the chute is wide the seeds can be spread out well for good separation as they enter the air column rather than tangling together. The box aspirator can be made from rigid cardboard, and this might be a good way to start, ensuring the design is correct before investing in a more permanent material such as plywood. The sheets of cardboard are held together with packaging tape. The tape makes a tight seal at all joints which is necessary to maintain the vacuum in the system. The main parts of the box aspirator are the seed chute, the settling chamber, the vacuum control gates, and the vacuum source (Figure 10). The settling chamber is the foundation of the box aspirator to which all other parts are attached. It can be any conveniently sized cardboard box.

Seed Chute

The first step in building the seed chute (Figure 11) is to compute its cross sectional area (width × depth) which will equal the area of the vacuum source inlet. For the vacuum with a 2 inch (5 cm) round inlet, the seed chute will have a cross sectional area of about 3 square inches (area of circle = ). With a 6 inch (15.15 cm) wide chute, the depth can be ½ inch (1.25 cm). Step 2 is to cut the top opening into one side of the settling chamber. Make it 4 to 6 times larger than the area of the chute. In our example, that would be about 2 to 3 inches (5.1 to 7.6 cm) high and 6 inches (15.2 cm) wide. The top opening needs to have the same width as the chute. Step 3 is to attach ½ inch (1.3 cm) thick strips to the outside of the settling chamber to form the top and sides of the chute. The thickness of the strips must match the width of the chute. A deeper chute would need thicker strips to match. In our cardboard box aspirator, the strips were made of two layers of ¼ inch (0.6 cm) cardboard attached to settling chamber with white glue. The final step is to close the chute by attaching a face sheet over the strips that is wide enough to reach completely across the chute and cover the side and top strips. The length of the face sheet should extend at least 4 inches (10.1 cm) below the top of the bottom opening and about 2 to 4 inches (5.1 to 10.1 cm) above the bottom of the chute. Attach another shorter sheet over the chute extending from the very bottom to about ½ inch (1.25 cm) from the bottom of the top sheet. This leaves a ½ inch (1.3 cm) slot in the chute through which seeds are fed into the air column.

Vacuum Source Connection

Cut a hole for the vacuum source into the settling chamber on the side opposite the seed chute. Cut it near the top of the chamber (Figure 12). The connection to the vacuum must be as tight as possible to maintain good vacuum on the settling chamber.
Vacuum Control Gates

These gates (Figure 13) determine the strength of the vacuum in the seed chute and consequently the weight of particles that can be lifted. The vacuum cleaner runs at a constant speed pulling air out of the settling chamber. When the control gates are fully open, there is little to no vacuum in the seed chute. This is because the gates have about twice as much area of opening as the chute. Air draft will take the path of least resistance which will be through the control gates when they are open. The gates are gradually closed, gradually increasing the vacuum in the seed chute until it is strong enough to lift all or most of the light trash and let the seeds fall to the bottom. These gates are rectangular and narrow (1 inch [2.5 cm] wide) and long. This shape allows for more gradual and even changes in seed chute pressure compared to a wider or round opening. The gate doors are made of strips of material (cardboard in this case) 25% wider than the gate width (1 ½ inch [3.8 cm]). Track strips, the same thickness as the doors, are attached parallel to and ¼ inch (0.6 cm) back from the side of the gate opening. These track strips provide a track for the door strips to travel in. The total gate construction is finished by putting strips on top of the track strips that will overlap the track strip by ¼ inch (0.6 cm) to hold the door strip against the side of the settling chamber. Vacuum control gates are located on either side adjacent to the seed chute side of the settling chamber.

Access to the Settling Chamber

Access to the chamber is necessary to remove the light trash that has collected there. This access is provided by a door on one side. In this version of the aspirator, a sheet of cardboard is used as the door and packaging tape serves as the door hinge. The vacuum in the chamber will keep the door closed during operation (Figure 14).

Adjusting the Aspirators

Both the pipe and box aspirators must be precisely adjusted to obtain the best seeds possible and to keep the yield as high as possible. The accuracy of separated seeds from trash is determined by the air pressure in the seed chute. A manometer (Figure 15) is a liquid filled tube that can be attached to the chute to measure the changes in pressure as the air gate is opened or closed. It will quickly help find the best setting and to find it again on future seed lots. An inexpensive manometer can be purchased for about $60 or one can be constructed from plans found on the internet.

Seeds Into the Aspirators

A seed scoop made from a 12 oz (355 ml) drink bottle can be used to feed seeds into the aspirators. It is especially well suited to the pipe aspirator and seeds that do not clump together with the trash. Short quick back and forth motions will scatter the seeds into the funnel and into the air column.

An aluminum pie pan (Figure 16) can be formed into a wide seed feeder for the box aspirator. This works better for seeds that clump with the trash because the uncleaned seeds can be sprinkled in a thin layer across the pan. The pan is then gently tapped to vibrate the seed into the seed chute.

References