Seed Processing

Post-harvest processes include drying, pre-cleaning, cleaning, and proper seed storage. The extent of cleaning required after drying will depend on the species, storage conditions, and intended seeding method. Knowledge, skill, and access to specialized equipment are necessary for some of the cleaning steps described, and these factors will determine the quality of the finished product. Most commercial producers of native seed are cleaning seed to a very high quality of purity and germination.

Wooden drying bin with racks for drying bulk bags. Squirrel- cage blower provides ambient air flow.

Drying

Drying is a necessary step for proper seed cleaning and storage for most prairie species. Seed should be dried immediately after harvesting to prevent fungal growth and decomposition. Plastic bags or airtight containers can be used for storage **ONLY** after the seed is properly dried and cleaned. Larger quantities of material will require special bins with screened bottoms and a source of airflow up through the material for it to dry properly. Smaller quantities can be collected in large 100% cotton muslin bags made to fit inside a 30-gal plastic bin. Fill bags loosely with seed heads, tie closed, label, and place in the drying bins. If the material associated with the seed is very green, as is the case with spiderwort, or is damp from a recent shower, it's best to spread the material out on tarps and position several box fans overhead, turning the seed frequently with pitchforks or shovels. Drying may take several days to a few weeks, depending on quantity of material and drying conditions.

Pre-cleaning

Harvested material will require some degree of pre-cleaning to reduce bulk. The extent of pre-cleaning required will depend on the method of seed harvest, intended storage period, and method of planting. Threshing, debearding/deawning, and brushing are considered pre-cleaning methods because they are designed to prepare the seed for later cleaning processes by removing unnecessary appendages and improving seed flow.

Threshing

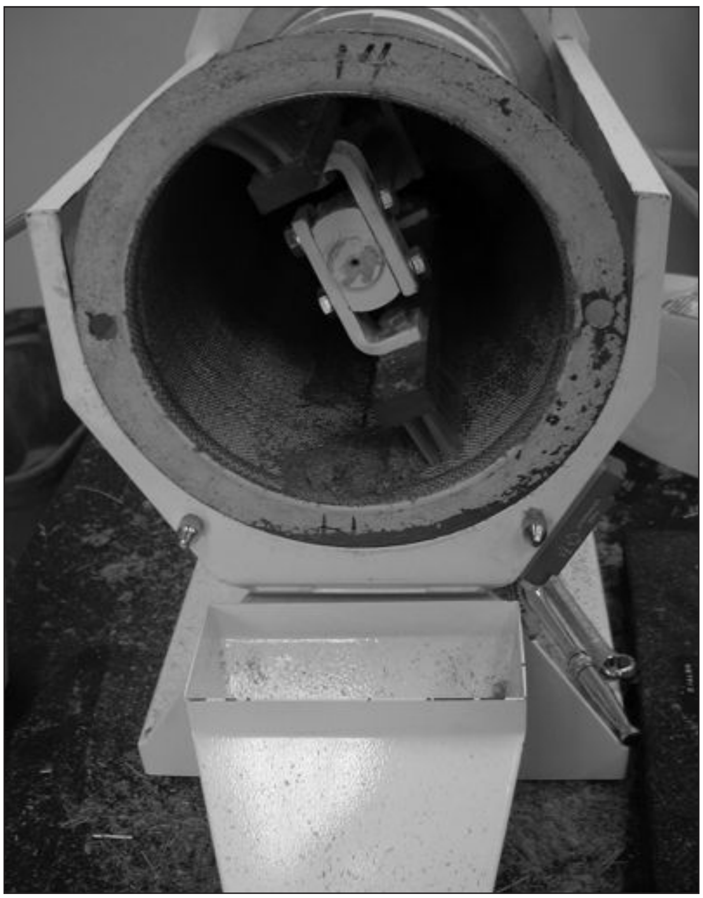
Threshing removes the seed from seed heads, one of the primary functions of a combine harvester. Hand-collected material can be threshed with a variety of machines, including hammer mills, huller/scarifiers, and brush machines. Some growers have adapted older combines (with cutter bars and reel removed for safety) for use as a stationary thresher of hand-collected material. A debearder (see next section) is effective for threshing the dried seed heads of compass plant and dried milkweed pods.

Non-mechanized threshing can be accomplished by stomping on seed heads. Using large plastic tubs, place about a 2-in. layer of bulk material in the bottom and stomp on it with waffle-type boots. Toe kicks to the corners of the tub help break up any stubborn seed heads. Stomped material is then screened through a coarse ½-in. or ¼-in. screen into a second tub. Continue in batches, returning any intact seed heads remaining to the stomping tub. This method is very effective on species of *Baptisia*, *Silphium*, *Helianthus*, *Veronicastrum*, and *Rudbeckia*. *Echinacea* tends to be stubborn and requires machine threshing, unless it's collected late in the season after seed heads naturally begin to break apart.

Big bluestem, *Andropogon gerardii*, discharging from debearder.

Deawning/Debearding

Many species have appendages, such as long awns or “beards” on grasses and pappus “parachutes” on seeds of asters, goldenrods, and other composites. Removing or minimizing these appendages further reduces bulk and improves seed flow for further cleaning. This step requires specialized and costly equipment. Debearding machines consist of a turning shaft with projecting metal teeth (bars) housed in a chamber. As the chamber fills with seed, the bars work the seed against itself, eventually breaking or rubbing the awns off. It’s important, however, to fill the chamber with the proper amount of seed: too little and it’s ineffective, too much and the seed can heat up and be damaged. A continuous flow-type debearder works well for larger quantities of seed, but batch-type debearders are also available for smaller quantities. A small gallon-size huller/scarifier is useful for deawning small individual accessions of seed. This type of machine is very aggressive and only a few seconds of treatment are typically needed.



Westrup Lab Scarifier/Brush machine with housing removed to show brushes and drum screen.

A laboratory scarifier/brush machine is useful for removing the pappus from asters, goldenrods, and blazingstars, but this versatile machine actually has many uses. Its basic action is to rub seeds/seed heads over a drum screen, or mantel, with rotating brushes. Mantels come in various screen sizes, and a variety of brushes is available. However, the machine can also be used as either a deawner or scarifier and is effective in removing the “cotton” from thimbleweed (*Anemone virginiana, A. cylindrica*), threshing seed from hand-collected mints, removing pods from purple prairie clover and leadplant, and deawning smaller quantities of grasses. Heavy canvas beater bars can be installed in place of brushes for a hammer-mill effect.

Cleaning Seed

Refer to Appendix C, Table 1C-4C for screen sizes and settings

Cleaning seed involves several techniques to remove plant fragments, particles, dust, and weed seeds. Proper cleaning will also remove empty, and therefore, non-viable, seed heads. Cleaning techniques involve various ways of sorting using screens, airflow, and specialized machines. The end goal is high quality, pure, filled seed, ready for an official seed test and precision planting.

Screening

Screens are used for sorting by shape and size. Screens are an integral part of fanning mills and air-screen cleaners and are commercially available in a wide range of pore sizes and shapes for these machines. Handheld pan-type screens are handy for small batches. Nested soil sieves are expensive but make excellent durable seed screens. Homemade screens of hardware cloth attached to wood frames are effective for rough cleaning. Depending on the application, screens are classified as scalping, grading or sizing, and sifting, as described below.

Rough screening combined material through 1/2” hardware cloth to remove large stems and leaves.

Scalping removes objects larger, longer, and wider than the desired crop seed. Screens used for scalping have pores larger than the seed. Scalping material through a much larger screen first, and then one closer to seed size is often more efficient, allowing material to flow more freely through each screen.

Grading sorts desired seed, or “crop” seed by size. Any given species’ seed will contain a range of seed sizes. Avoid intentionally grading seed intended for restoration plantings, since selection for seed size can happen in one generation, (i.e. large seeds will give rise to plants with large seeds), and may reduce genetic variability. Likewise, sometimes seeds of a weed species are present that are equal in size and weight to the smaller or larger sizes of crop seed present. If this is the case, it may be a necessary trade-off to scalp off a small fraction of the smaller or larger sizes of crop seed in order to effectively remove the weed species.

Westrup Lab Air Screen Cleaner

Screen pulled out for viewing.

Sifting is the final screening step. Use a screen with pores just smaller than the seed to allow dust, broken seeds, etc. to fall through and yet retain desired seed on screen.

This series of screening processes is effective in concentrating desired seed and removing most other inert, or non-seed material. Empty, non-viable, but otherwise normal looking seed will not be removed by simple screening. This “light” seed is removed with airflow, either by winnowing or aspiration.

Winnowing

Winnowing is a process using horizontally moving air to separate heavy from light particles. Winnowing seed in a gentle breeze can be very effective in removing chaff and light seed. To achieve more control, place a tarp on the floor and an ordinary box fan at one end of the tarp. Pour seed gently in front of the fan. Heavier seed falls closer to the fan than light seed or empty seed. Fine-tune the process by experimenting with fan speed and distance from fan. Once you find the most effective combination, continue to pour the seed in front of the fan in a consistent manner. The seed should now be laying somewhat fanned out on the tarp, with the heavier seed nearer to the fan and light or empty seed further away. Using a thumbnail, push down on the seed coats closest to the fan at first, repeating this test as you gradually move away from the fan. Heavy seed will feel firm and resist being crushed with gentle, downward pressure; empty seeds, on the other hand, will offer little resistance and crush easily. Make a determination where the heavy seed ends and the light or empty seed begins, and draw a line through the pile of seed at this point. Clean, heavy seed can then be swept up and stored for planting, while the rest is discarded.

Aspirating

Aspirating uses vertically moving air to suspend particles in a column. Lighter seeds are either captured in a pocket of the column, as in a South Dakota seed blower, or blown completely out of the column. Heavier seeds drop out of the column. Desired separation is achieved by adjusting airflow in the column. Fanning mills and air/screen cleaners are machines designed to combine the screening and aspiration process and are very efficient once the proper screens and settings have been made.

Separating Seed by Length, Seed Coat, Specific Gravity

Proper weed control during the growing season – especially the removal of weeds from production fields prior to harvest – is the best way to assure a weed-free finished product. Invariably, weed seeds will find their way into the combine and into the crop seed. If weed seeds of the same size, weight, and shape as the crop seed are present, they cannot be removed by simple screening and aspirating alone. Additional separating and sorting techniques will be required and may not always be successful. The following machines/techniques are indispensable for commercial seed cleaning and conditioning necessary to meet federal and state seed laws; however, they require a considerable investment and are not practical for non-commercial use.

• *Length*

Seeds can be separated by length in an indent cylinder. An indent cylinder consists of a dimpled drum rotating nearly horizontally. Seeds small enough to fit in a dimple are picked up and dropped by gravity into a trough suspended in the center of the rotating drum. Material too long to fit in the dimples dribbles out the end of the drum. Thus, two fractions are produced: seed/particles shorter than or equal to the dimples and seeds/particles longer than the dimples. This is a very effective way to sort foxtail, pigweed, lamb's quarters, etc. from longer grass seeds. Drums are available with different size dimples.

• *Shape/Seed coat texture*

Seeds can be sorted by seed coat texture with velvet rollers and belt sorters. As seed is dribbled onto an inclined rotating belt or cylinder, seeds with projections, hairs, or rough seed coats are pulled along on the belt or off over the cylinder, while smooth seeds slide off more quickly, creating a separation between smooth and rough seed types. Belt sorters are also effective in sorting seeds with flat shapes from those with rounded shapes. Flat seeds tend to stay on the inclined belt and are conveyed to a hopper at the end of the rotating belt, while rounded seeds tend to roll off the inclined belt and collect in a different hopper. An example of this would be sorting the rounded seeds of foxtail (*Setaria spp*.) from the flatter seeds of greyhead coneflower (*Ratibida pinnata*).

• *Specific gravity*

Gravity tables are used to sort particles of different size and same density, or particles of same size with different densities. Thus lighter, unfilled, and therefore less dense seeds are separated from heavy, filled seed. Gravity tables are most effective on seed that has been graded to a uniform size using grading screens. The gravity table was effective in sorting lamb's quarter (*Chenopodium spp*.) seed from horsemint (*Monarda fistulosa*).

Literature Cited

Deno, N.C. 1993. Seed germination theory and practice, based on experiments on 145 families, 805 genera, 4000 species. Second Ed. Penn State University. Address all inquiries and orders to Norman C. Deno, 139 Lenor Dr, State College, PA 16801, USA.

Storage

Proper storage of seed is essential to maintain viability (ability to germinate) and vigor (ability to successfully establish in the field). Generally, germination tends to increase slightly in some species stored up to a year after harvest as dormancy mechanisms break down. Germination then declines over the long term due to seed mortality during storage. Proper storage conditions will slow this decline. In controlled environment as defined below, seed with hard seed coats, such as legumes, tend to store longer than grass seeds and may remain viable for decades. However in an uncontrolled environment the reverse situation can occur. Oil based seeds, such as legumes, can quickly degrade within a few years, compared to starch based seeds that degrade more slowly over time *(Figure 2)*.

Seed should always be kept in a cool, dry, rodent-proof place. Seed stored at 60˚F stays viable twice as long as seed stored at 70˚F. Long-term storage requires a more stringent temperature- and humidity-controlled environment. A rule of thumb is that the sum of the temperature (degrees Fahrenheit) and relative humidity (RH) should not exceed 100. An examples would be storing seed at 50˚F and 40% RH or 40˚F and 50% RH, the addition of the two is less than 100. Relative humidity above 40% is especially detrimental to legume (oil based) seeds. As a general guideline, the longevity of seed is halved for each 10-degree increase in storage temperature or 1% increase in seed moisture content during storage. Once seed has been dried properly, moisture resistant containers, such as glass or plastic jars, or 4-mil plastic bags, will help protect it from collecting moisture.

There are other important factors, besides temperature and humidity, that can affect longevity of stored seed. Inert matter can harbor fungal and insect pathogens which might damage seed during storage. Cleaning seed properly and thoroughly will extend viability. Overly aggressive cleaning, however, can damage seed and shorten longevity of stored seed. Care should be taken with brushing/debearding/deawning processes not to excessively damage seed. Seed damaged by overly aggressive debearding may shorten shelf life over the long term, but the benefits include improved germination and seed flow. Improved seed flow facilitates cleaning and seed placement during planting.

Generally, germination tends to increase slightly in some species stored up to a year after harvest as dormancy mechanisms break down. Germination then declines over the long term due to seed mortality during storage. Proper storage conditions will slow this decline.

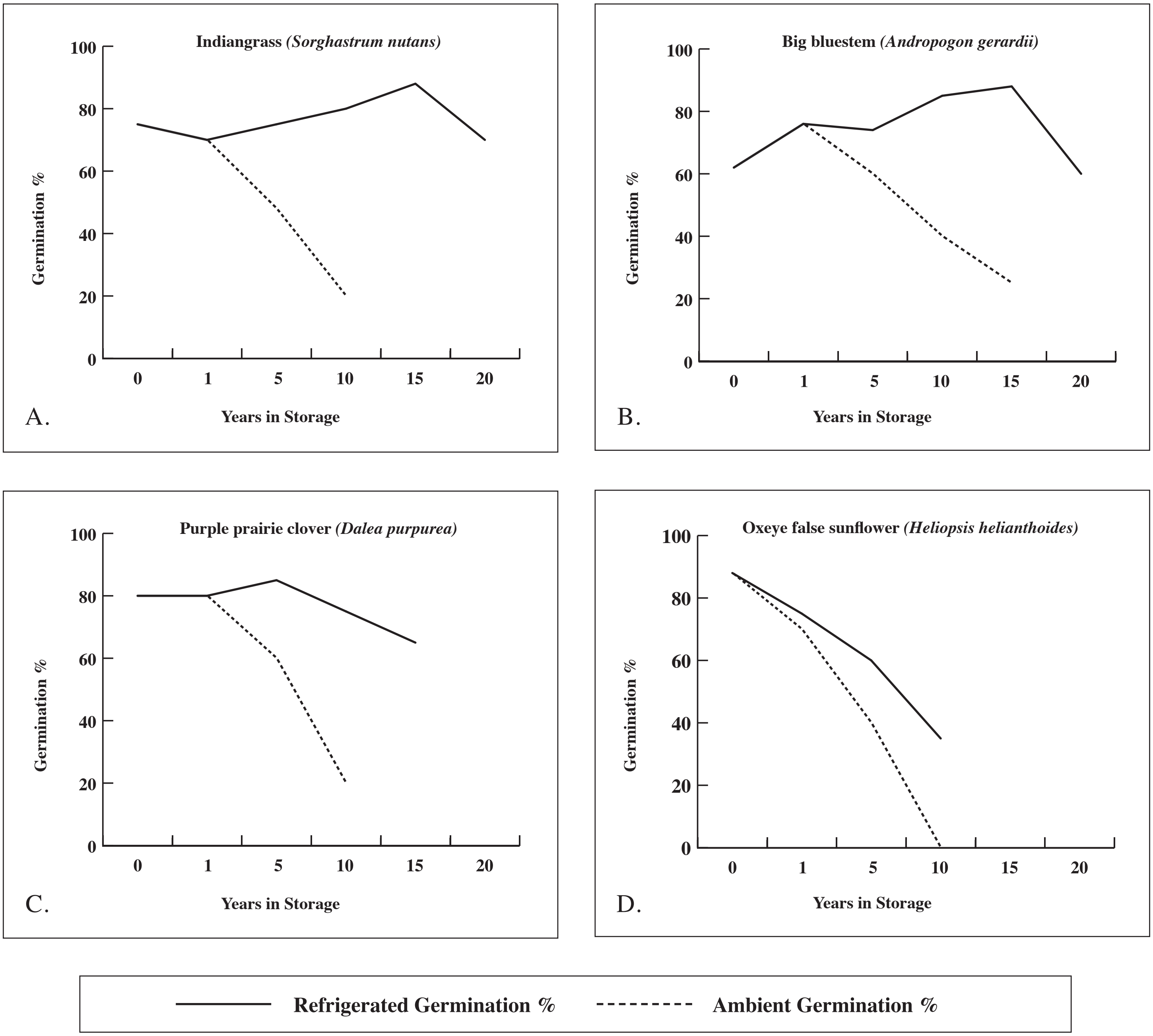


Figure 2. The above graphs illustrate the importance of proper storage conditions for preserving seed viability (germination %) over time. Solid line represents seed viability in controlled conditions of temperature and humidity (refrigerated). Dashed line represents seed viability at room temperature (ambient) conditions. Graph A) Indiangrass *(Sorghastrum nutans)*; B) Big bluestem *(Andropogon gerardii)*; C) Purple prairie clover *(Dalea purpurea)*; and D) Oxeye false sunflower *(Heliopsis helianthoides)*. Note that germination % may increase initially as dormancy mechanisms in the seed break down over time. Viability (germination %) diminishes over time, but much more rapidly when stored improperly. Starched-base grass seed store well over time (graphs A and B). Seed of forb species, such as oxeye, may not store as well long-term due to higher oil content (graph D). Forbs with hard seed coats, such as in legume species, help preserve viability (graph C). Data from a long term seed storage study at USDA NRCS Manhattan Plant Materials Center, Manhattan, KS. (Courtesy of Rich Wynia, Manager, Manhattan PMC).