

The Importance of Seed Quality (Pure Live Seed)

Seed quality is critically important to the success of a restoration! Seed quality is measured as pure-live seed (PLS), which can only be obtained from a seed test by a certified seed testing lab. This is essential for calculating seeding rates for each species, allowing for a balanced mix of grasses, forbs, shrubs, and sedges. Fortunately, seed quality has improved dramatically as growers gain experience and acquire better equipment for producing, harvesting, and cleaning native species. Seed dispersal apparatus like awns on grass seed and hairy parachutes on forb seed are routinely removed. This means the seed lot can be cleaned to greater purity and viability and will flow more efficiently through the seeding equipment.

Pure Live Seed

Quality native seed is sold on a pure live seed, or PLS basis. Three factors are used to calculate the percentage of pure live seed: purity, germination, and dormancy. Purity is a measure of pure, unbroken crop seed units as a percent by weight of the seed lot. Percent germination is determined by placing seed in a germination chamber for an approved time period. Many species, particularly forbs, have dormancy mechanisms that require several weeks of cold-moist stratification to break dormancy, allowing germination to occur. For most native species, no standard protocol exists for breaking dormancy for germination testing purposes. Therefore, any remaining non-germinated seed is tested biochemically with tetrazolium chloride (TZ), a clear compound that stains living tissue cherry red. The analyst determines the potential viability of stained seed – non-germinated seed considered viable by a TZ test is counted as dormant. A seed test showing a high percentage of dormancy is common in many native forb species and some grasses (Figure 2). This should be expected of natives, particularly in seed lots harvested within the past year. A high percentage of dormancy means much of that seed won't germinate until dormancy is broken, either artificially or by natural environmental conditions.

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Lab. Number	12-16-41	
Date	1/16/08	
Kind and Variety	BUTTERFLY MILKWEED (<i>ASCLEPIAS TUBEROSA</i>)	
Purity and Germination analysis of seed sample		
Pure seed	98.00	%
Inert matter	2.00	%
Other crop	0.00	%
Weed seeds	0.00	%
Germination	53.00	%
Hard seed		%
Total germ and hard seed		%
Dormant seed	27.00	%
Tetrazolium		%
Name and no. of noxious weed seeds per lb.	NONE	
(All state noxious count unless otherwise indicated.)		

(Figure 2 Sample seed test of butterfly milkweed (*Asclepias tuberosa*) results noting purity, germination, and dormancy.)



ICIA 2010. Native Seed Directory. Iowa Crop Improvement Association, 4611 Mortensen Road, Suite 101, Ames, IA, 50014.

Reinartz JR. 1997. Restoring populations of rare plants. Chapter 6. In: Packard S and Mutel CF, editors. The Tallgrass Restoration Handbook. Washington D.C.: Island Press. Pp 89-95.

USDA-NRCS 1997. BADLANDS Ecotype Little bluestem, May 1997. <http://www.plant-materials.nrcs.usda.gov/pubs/ndpmcrb7356.pdf> Accessed April 7, 2008.

Young SA. 1995. Verification of germplasm origin and genetic status by seed certification agencies. In: Roundy BA, McArthur ED, Haley JS, Mann DK, composers. Proceedings of the Wildland Shrub and Arid Land Restoration Symposium; 1993 Oct 19-21; Las Vegas, NV. Ogden (UT): U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Calculating Pure Live Seed Amounts

PLS is a measure of the proportion of the viable seed of a species or variety per unit weight for a given lot of seed. PLS for forage crops and turf grass is normally calculated using percent purity and percent germination only, as dormancy is not a significant issue for these types of species. Native species, however, may have a significant proportion of dormant, yet viable seed, particularly among forb species. The native seed trade recognizes this fact and uses all three factors – purity, germination, and dormancy – to calculate the PLS of any given native seed lot per below:

Pounds (#) PLS is calculated as:

$$\#PLS = (\#Bulk) \times (\%purity) \times (\%germination + \%dormant)$$

Where % is expressed as a proportion, i.e. 98% = 0.98

For example, a 50-pound bulk bag of seed that is 98% pure seed, with 53% germination and 27% dormant seed, really contains only 38-pounds of pure viable seed (seed that potentially will germinate):

$$\#PLS = 50\#bulk \times 0.98 \times (0.53 + 0.27) = 38\# PLS \text{ or } 50\text{-pounds bulk} \times 0.7742$$

If however, you request 50-pound PLS bag of that same seed, you would receive a bag weighing 64.58-pound bulk.

$$Bulk \text{ pounds} = \#PLS / [(\%purity) \times (\%germination + \%dormant)] \text{ or } 50\# PLS / 0.7742 = 64.58 \text{ bulk pounds}$$



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Native Seed Source AND Quality

Content by Greg Houseal

PRAIRIE RESTORATION SERIES

Restoring a lost landscape such as tallgrass prairie requires plant material; either seeds, plugs, or rootstock. Emphasizing ecological restoration, resource managers seek to use an appropriate genetic source for restoring prairie vegetation to the landscape. Source should not be confused simply with where the plant material is produced or sold (that is the geographic location of a production field, nursery, or seed dealer). Source refers to the original remnant or genetic source(s), sometimes referred to as the provenance, of the plant material. This source material may be used directly on a restoration site, or propagated to establish a commercial nursery or production field to produce larger quantities of the 'source' material.

Importance of Seed Source

It is important to select a seed source appropriate for the goals and objectives of the prairie restoration (summarized in Table

Considerations for selecting an appropriate seed source that balance ecological and economic realities may include the following:

proximity to remnant prairies that might be negatively impacted by introduced genotypes or species	objective of the planting, i.e., ecological restoration for habitat, biodiversity, aesthetics vs economic use as forage, biomass	budget and time constraints of the project (cost)
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Options for obtaining seed range from harvesting your own, to purchasing either bulk-harvested material or commercially produced seed from native seed producers. These types of seed sources are described below.

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Hundreds of species can now be purchased commercially, either as individual species or custom-mixed for specific site conditions, from moist to dry sites, and from full to partial sun. It is a good idea to review the list of included species to be sure they are native to your area and are of acceptable source for your restoration goals. Expect your seed to be delivered with seed test results attached.

Local Ecotype

The term 'local ecotype' implies that unique, possibly adaptive, genetic traits (more properly, genotypes) may exist in a remnant population. The assumption that local seed is always better adapted to a proposed restoration site than non-local seed should be qualified. A single local seed source may be adequate if a large, genetically diverse population is available and seed is collected from throughout the population. Very small or degraded remnants may lack species or genetic diversity appropriate to the site. Seeds/genetics from other remnants of similar soils and hydrology in the area may be desirable additions for severely degraded remnants. Seed harvested locally from the remnant, or from nearby remnants, is a desirable seed source for plantings intended as genetic buffers (e.g. to conserve local gene pool) of existing remnants. The challenge of this approach is harvesting enough quality seed from a remnant in a single year to seed the new planting; therefore, the seeding may need to be done in phases over successive years (but see section on bulk harvesting).

Restoring Gene Flow in a Fragmented Ecosystem

Developing foundation stock for generating commercial quantities of seed appropriate for restoration, Reinartz (1997) advocates using seed from multiple-source populations as foundation seed:

The new genetic population created by combining genotypes of several relict [remnant] populations will form novel genetic combinations, having the potential to evolve entirely new genotypes in a novel habitat. The multiple sources used for establishing the nursery must all be found in the same local area (at least state or region) as the site where the new population will be created.

An equal amount of seed – or seedling grown transplants – from each population should be planted in the nursery so that all populations contribute roughly equal amounts to the next generation of seed.

Regional Seed Sources

In the Midwest, remnant prairies are scattered, small, and isolated and there may be no local remnant sources of seed over large areas of the landscape. Regional seed sources, pooled from several remnant populations, have a broad genetic base that favor the odds that the right genotypes are present to best establish and persist in reconstructed (planted) prairie. Seed-source regions (or provenance zones) based on geography, landforms, water sheds, species range distribution, and political boundaries have been variously defined and applied to restoration efforts around the Midwest.

Bulk Harvest

Seed can be bulk harvested from prairie with a combine, seed stripper, or flail vac. Diversity will be limited to species in seed at time of harvest and within the cutting height of the combine/ stripper. Bulk harvested material is a mixture of seed, chaff, leaves, and stems. A certified seed test for purity, species composition, and weed content is possible, but tests are costly because of the time required to sort material for analysis. Bulk material harvested from a well-managed stand may contain 10% to 15% seed by weight, so a seeding rate of 10 lbs seed/acre will require 100 to 150 lbs bulk material to be broadcast per acre. Supplementing bulk-harvested material with seed from very low or high growing species, or those that ripen very early or late, is an important consideration since these species may otherwise be unrepresented in the machine harvest. If purchasing bulk material, request a copy of the seed test analysis to be sure of species composition and lack of noxious weeds.

Commercial Seed Sources

We are fortunate in the Midwest to have many native species commercially available, even for large-scale prairie restorations. Providing enough seed for commercial production usually requires growing out source material in nursery or production fields to increase seed quantity. Larger quantity's usually translates into lower cost, depending on market demand, which can fluctuate widely from year to year. Source material (foundation seed) for commercial production may be from one or more original sources, or more commonly, regional source material.

Caring for Remnants When Harvesting Seed

Producers of bulk harvest seed must take great care to control exotic and invasive species in the stand since they cannot be cleaned out of the material after harvest. Care should be used in cleaning any kind of machinery used in harvesting remnants to avoid contaminating these sites with invasive or non-native species and outside sources of native species. If harvesting from a native prairie remnant, avoid the use of whole-site annual burns, herbicides, fertilizers, or other questionable practices that are detrimental to the long-term ecology of remnant prairie.



Source-Identified Seed

Standards for source-identified, or "Yellow Tag" seed, were developed by the Association of Official Seed Certifying Agencies (AOSCA) in the mid 1990's. Source-identified standards provide a "fast-track" plant material release procedure for commercial production of native species for restoring specific plant communities (Young 1995). AOSCA's affiliate state crop improvement associations administer the program for participating commercial native seed producers. Source-identified seed may originate from a single source or from several sources pooled together as a regional source. No intentional selection or testing of traits occurs. Original collection sites are documented, and nursery and production fields are inspected and certified annually. Commercially produced seed is marketed with an official AOSCA yellow certification tag, identifying the source and the producer of the material. Hundreds of native species are now available as source identified seed (ICIA 2010).

As the commercial native seed industry has developed, several Midwest states have adopted source-identified seed programs. Individual states differ in their application of source-identified program guidelines regarding native species, so it's important to check specific policies for the particular state in question.



Cultivated Varieties of Native Species

The USDA Plant Materials Center's (USDA-PMC) develops cultivated varieties, commonly known as cultivars, of several native grass and forb species. Traditionally, an entire plant or seeds from a plant that exhibited a desired characteristic, such as vigor, were collected for further testing. These collections are evaluated for desired traits in common gardens. A selection of individuals or populations is then made for further breeding and increase. Desired traits include good germination, establishment, high forage yield, height, vigor, and winter hardiness. Cultivars may be desirable for pasture, forage or biomass production, but generally are not recommended for prairie restoration either because they have been derived from distant, out-of-state sources; or have been selectively bred for specific traits, often competitiveness and vigor, possibly narrowing their genetic diversity. If cultivars must be used for reconstructions, two or three different varieties should be used to increase the genetic diversity of the planting.

More recently, USDA-PMC plant selections have reflected the trend toward broad genetic based regional seed sources. Badlands "ecotype" little bluestem (*Schizachyrium scoparium*) for example, is a composite of 68 accessions (collections) selected for disease resistance from an initial evaluation of 588 vegetative accessions collected from throughout North and South Dakota and Minnesota (USDA-NRCS 1997). This broad selection of a diverse assemblage of little bluestem populations may be a desirable and appropriate seed source for restorations in those states from which it was derived.

Cultivar material has been developed for a limited number of native species. Many native species that are in demand for restoration can only be obtained through direct harvest from native stands or through the source-identified seed program described above.

Planting Goal	Source Identified		Cultivar
	Local Genotype	Regional Source	
Remnant Restoration	X		
Prairie Reconstruction	X	X	
Forage/Biomass		X	X