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The Evolving Understanding of Grassland Restoration Seeding Protocols

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Grasslands provide many ecological services including reduction in soil erosion, improvement in soil and water quality, and increased wildlife habitat for certain specialized grassland species. Permanent grassland acreage has been declining in the United States since the late 1940's. According to a study by the US Department of Agriculture (USDA)'s Economic Research Service, 60% of the land acreage in the contiguous U.S was grassland in 1948. By 2002, that figure had dropped to 44% (Wedin and Fales 2009) due to urban and suburban development, agriculture, and encroachment of woody vegetation. With this recognized loss of grassland and associated habitat, native grassland establishment has been promoted and cost-shared by the federal government in the last 25–30 years to recapture many of these ecological services associated with permanent grasslands.

Grassland restoration in the United States was accelerated through the passage of the 1985 Farm Bill which authorized the establishment of the Conservation Reserve Program (CRP). CRP is a voluntary program available to agricultural producers to help them use environmentally sensitive land to plant long-term, resource conserving covers such as native grasses to provide for improved wildlife habitat, control soil erosion, and to improve water quality. The 25-year legacy of the CRP Program has resulted in over 32 million acres planted in permanent cover. Through successive Farm Bill authorizations, other USDA programs have been added to the portfolio such as the Wildlife Habitat Incentives Program (WHIP), Wetlands Reserve Program (WRP), Environmental Quality Incentives Program (EQIP), and the Conservation Security Program (CSP). These programs have encouraged landowners to establish native grasses by providing cost-share assistance for establishment. Additionally, a US Fish and Wildlife Service Program, "Partners for Wildlife" complements many of the USDA Programs on private working lands.

At the inception of the CRP, a huge demand was created for native grass seed. The USDA's Natural Resources Conservation Service (NRCS) Plant Materials Program has been the primary conduit for getting native grass seed into the commercial market place for the USDA Conservation Programs. The major volume of native grass seed being produced commercially at the time in large quantities was in older established grass varieties. These were mostly developed from the 1940's through the late 1970's for livestock forage and erosion control. Some commonly available cultivars included Blackwell, Cave-in-Rock, and Kanlow switchgrass (*Panicum virgatum*) as well as Cheyenne, Tomahawk, and Nebraska 54 Indiangrass (*Sorghastrum nutans*). Available cultivars of bluestem varieties included Kaw and Niagara big bluestem (*Andropogon gerardii*) and Aldous and Camper little bluestem (*Schizachyrium scoparium*). Most of these cultivars were developed by the USDA-NRCS Plant Materials Program in cooperation with a land grant university and/or the USDA-Agricultural Research Service. A majority of these varieties are Midwestern in origin but have been shown to have a wide geographic and climatic adaptation.

Originally, seedings of native warm season grasses in the Northeastern and Middle Atlantic region of the country were originally looked upon with much skepticism by most landowners since they were accustomed to seeding introduced cool season turf and pasture grasses. In the early to mid- 1990's, native grass seed mixtures were extremely "heavy" on use of native warm season grasses and "light" on forbs (wildflowers and legumes) (Dickerson et al. 1997). Competitive, introduced legumes such as white clover (*Trifolium repens*) and birdsfoot trefoil (*Lotus corniculatus*) were included in some of the earlier seed mixtures for diversity. These species were readily available and inexpensive and were thought to compete well with the native grasses. However, these legumes proved to be too competitive resulting in poor and/or slower establishing grass stands. Also, a predominance of smooth seeded grasses such as switchgrass, deertongue (*Dichanthelium clandestinum*), coastal panicgrass (*Panicum amarum var. amarulum*) and the lovegrasses (*Eragrostis* spp.) were preferred since they could be seeded with conventional seeding equipment. However, as time went on, native grass drills which handled long awned or bearded seeds, such as the bluestems and Indiangrass, have become more commonplace and available for rent through local Conservation Districts or State and Federal wildlife management agencies or farm equipment rental companies (Figure 1). This has allowed for a more diverse planting of grass species.

In the late 1990's to early 2000's, customized seed mixtures of native grasses were beginning to be refined and incorporated into the NRCS's Field Office Technical Guide. This guide specifies the "how-to" of conservation practices such as riparian buffer and filter strips, creating early successional habitat, and controlling erosion on critically eroding lands. Through NRCS Plant Materials Center studies and plantings, results are integrated into revisions of conservation practices and planting recommendations. For example, it was recognized by the wildlife community that many of the earlier native grass stands were too dense for optimal wildlife use, especially when switchgrass was used. Discussions ensued as to how to manage these sites through light disking or strip tilling, as well as adjustments to seed mixtures. Seeding rates for native grasses were lowered and more wildflowers were added to the mixtures.

Also in the last fifteen years, the Plant Materials Program of NRCS has adopted a new plant selection release model that "fast tracks" local ecotypes into the commercial seed market. These pre-varietal, 'natural track' selections include source identified, selected, and tested plant material. These materials are not genetically manipulated but are composites or selections from natural collections. This allows the Plant Materials Program to collect, establish, and increase seed production of locally adapted species for general conservation purposes such as grassland establishment based on physiographic region or plant hardiness zone in a 2 to 6 year time frame. The traditional cultivar releases, which were developed for specific purposes (i.e. forage, wildlife habitat, erosion control) can take 10–15 years of testing before being released to commercial growers. Although the commercial availability of these ecotype selections has increased in more recent years, the major limiting factor has been getting more seed producers to establish larger scale production. Expansion is risky because of unknown future needs. This keeps the cost of restoration with local ecotypes fairly high. However, in the Northeast alone, several large landfill closure projects, including Fresh Kills landfill on Staten Island, NY, will create a localized demand for large quantities of native seed for the next 10 years or so. Also, coastal grasslands that were damaged or destroyed from the most recent major storms will need to be restored with locally adapted plant material (Figure 2).

The science of seed mixtures for grassland restoration is evolving to allow us to become more sophisticated in tailoring seed mixtures to soil and site conditions and intended purpose. One example of this process involves

using native warm season grass mixtures for critically eroding sites. It was once thought that a choice had to be made between using a cool or a warm season grass mixture. An NRCS-Plant Materials Program study in New Hampshire and Vermont in the 1980's looked at various separate warm/cool season seed mixtures for sand and gravel mine stabilization (Godfrey and Dickerson 2003). The seeding mixtures were selected based on the predominant amount of fine or coarse textured soils on the site. This research showed that the finer textured the soil, the more likely a cool season mixture would succeed. Conversely, the coarser textured the soil, the more likely a warm season mixture would provide adequate long term cover. Generally the warm season grasses were thought to establish too slowly for erosion control purposes. However, by adding nurse or companion grasses such as Virginia wildrye (*Elymus virginicus)* and/or Canada wildrye (*Elymus canadensis*), as well as the introduced fine fescue group of hard (*Festuca brevipila*), red (*Festuca rubra*), and/or sheeps (*Festuca ovina*) fescues an "ecological bridge" was created between the cool and warm season grass groups. These quicker establishing, non-competitive cool season grasses provide for erosion control while the slower, longer lived native warm season grasses become fully established. The "fine tuning" of the ratios of cool to warm season species in a mixture continues as we add or substitute different companion grasses or "change up" mixtures for different applications. The most current information on seed mixtures for various conservation applications is available on each state's NRCS website.

Most recently, increased emphasis has been placed on creating pollinator habitat on farms by seeding/planting a high diversity of wildflower species that have bloom times ranging from early spring to fall. This creates challenges for successful establishment of everything from adequate weed control to proper placement of a wide range of seed sizes. Currently, the NRCS Plant Materials Centers are actively involved in developing seeding and weed control methodologies for pollinator conservation initiatives.

The science of seed mixtures for grassland restoration has come far in the last 30 years, resulting in more successful and biologically diverse restored grasslands. Future questions to be answered include:

> Would it benefit the restoration community to be proactive in determining the northern adaptation of southern species in response to climate change or allow this plant migration to occur naturally?
>
> Will government subsidized conservation programs for landowners and agricultural producers continue to create a market for local ecotype plant species, and how will this affect the cost of grassland restoration?
>
> How diverse grassland plant communities be created to balance pollination services and weed control?

In working toward collaboration and communication between practitioners and researchers, the Native Grasses for the Eastern US workshop was convened in 1997. This resulted in a series of eight multi-day meetings, called the Eastern Native Grass Symposium, held biennially since 1999. The Eastern Native Grass Symposium features a special emphasis on native grass species and their associated forbs in working landscapes of the eastern United States and Canada. Topics such as biofuels, ecosystem restoration, forages, seed production, landscaping, land reclamation (mines, landfills, etc.) are featured. Additionally, extensions of these topics include how native grasses impact wildlife and domestic animal management. The next meeting will be held at Mississippi State University (Starkville, MS), 7–9 October 2013.

Sources of Additional Information:

Field Office Technical Guide (FOTG) County Locator:

efotg.sc.egov.usda.gov/efotg_locator.aspx

The Eastern Native Grass Symposium: www.pss.msstate.edu/eastern_native_grass/

Eastern Native Grass Proceedings: nativegrasses.utk.edu/publications/default.htm

NRCS-USDA Plant Materials Centers:

www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/plants/centers/

References

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Godfrey, R.G. and J. Dickerson. 2003. *Vegetating Vermont Sand and Gravel Pits.* Colchester, VT: USDA-NRCS.

Wedin, W.F. and S.T. Fales. 2009. *Grassland: Quietness and Strength for a New American Agriculture.* Madison, WI: American Society of Agronomy, Crop Science Society of America, Soil Science of America.

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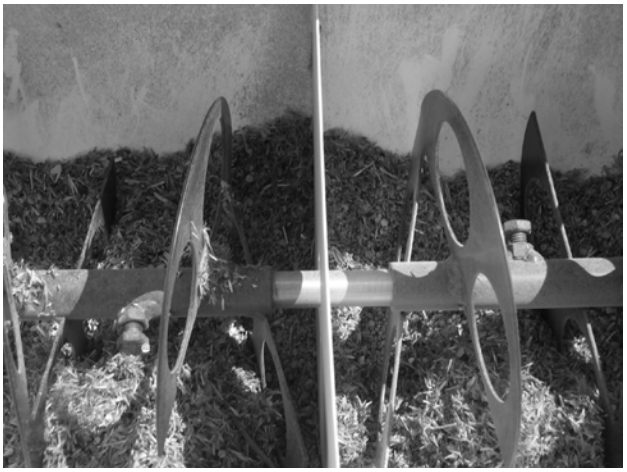

Figure 1. Native grass drill seed box. Native grass drills are designed to handle bearded seeds (bluestems and Indiangrass) and smooth seeds (switchgrass). Drill seeding significantly increasing germination and emergence success.

Figure 2. Harvesting coastal little bluestem seed. Seed mixtures tailored to environmental conditions are increasingly important in grassland restorations. USDA Plant Material Centers collect and test accessions for use in specific soil conditions.