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Farming for Restoration: Building Bridges for Native Seeds

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In both Europe and the United States, a shortage of native plant material frequently precludes successful restoration. Native plant materials are needed to restore ecosystem functioning and services, provide for in situ conservation of biodiversity (e.g., Hobbs and Cramer 2008), maintain genetic diversity (Bischoff et al. 2010), and afford resistance to invasive species. Long-term stewardship goals are to create diverse, resilient systems with

the genetic diversity and structure to facilitate adaptation to climate change and other environmental perturbations (e.g., Johnson et al. 2010). Commercial seed mixtures of non-native species and genetically uniform varieties threaten local diversity. Consequently, efforts to develop native seed sources are receiving considerable attention.

During the 7th Society for Ecological Restoration European Conference in Avignon, a special session focused on the successes and challenges of producing and using native plant material on a regional scale. European and American participants highlighted common issues encountered in developing native seed supplies (Figure 1), creating new market niches, and adapting seed certification procedures for use with native materials with the goal of sharing effective solutions and devising new approaches. Here we share the key findings and next steps outlined in this special session.

Several biological and technical challenges hinder the development of native plant programs at local or regional scales, such as: 1) identifying species-specific seed zones derived from ecological studies and provisional seed zones based on climatic and environmental variables (Johnson et al. 2010); 2) developing genetically diverse, ecologically adapted materials (Johnson et al. 2010); 3) formulating strategies to track plant materials from wildland harvest through agricultural production as well as to manage stock seed or other types of plant materials (Figure 2); 4) developing seed technology for diverse woody and herbaceous species; 5) understanding pollinator requirements and potentially managing wild pollinators in seed fields; 6) identifying cultural practices, including pest and disease control, for maximizing seed production; and 7) developing effective strategies and equipment for reestablishing native plant communities (USDI BLM 2009). Major political and economic obstacles include sustaining funding for research and development, creating new market niches for seed growers, and creating and maintaining collaboration among researchers, seed regulatory agencies, the private seed industry, and private and public end users.

One of the main topics in the session was the limited European production of native plant material owing to high costs and lack of propagation experience. Native seed production is often organized by local nongovernmental organizations (NGOs) or very small companies, and seed quantities and range of species are limited. Moreover, the lack of administrative support for native plant material leads to widespread use of low-cost commercial seed mixtures containing horticultural and agricultural cultivars and wildflower seeds of unknown or nonlocal origin. Use of easily propagated and widespread cultivars ensures the continuous availability and affordability of these mixtures but ignores the importance of local genotypes. Conrad (2007) and Tischew and others (2010) evaluated grassland restorations to counteract impacts of infrastructural projects on natural systems in Germany. Approximately



Figure 1. Example of regional production of native seeds in Wetzlar, northern Germany: propagation of sage (*Salvia pratensis*), ox-eye daisy (*Leucanthemum vulgare*), and mouseear hawkweed (*Hieracium pilosella*). Photo courtesy of Markus Wieden, Wildsaaten Wetzlar.

70% of the projects used standardized commercial seed mixtures. However, using these mixtures did not help to reach the species-richness objective. Deficits in grassland restoration projects owing to the use of non-native seed mixtures have been well documented (Kiehl et al. 2010).

In the future, restoration, as well as revegetation of grasslands outside cities or agricultural areas, should be accomplished only with seeds of local origin produced regionally or harvested from local species-rich near-natural grasslands. To facilitate this objective, legal support must be secured. The German Law for Nature Conservation demands that only species of local provenance will be used after 2020 in restoration and revegetation projects, thus confining the use of nonlocal ecotypes and cultivars to cities, agriculture, and forestry.

In recent years, the European Union (EU) has supported several major projects to expand propagation and use of native plants in ecological restoration. One example is the project “Seminatural Grassland as a Source for Biodiversity Improvement” (www.salvereproject.eu), a collaboration of 8 partners from 6 EU countries. Main objectives are the development of best practice methods for harvesting seed mixtures from species-rich seminatural grasslands and optimization of near-natural revegetation methods for restoration or establishment of species-rich grasslands.

For those few European countries where wild seed is marketed, availability and demand are both low. Most seed is not certified; consequently, the danger of a grey market without proof of indigenous origin is growing. It is crucial to define transnational seed zones and quality assurance standards for collecting, producing, selling, and using native seeds, thus requiring a certification system with control mechanisms and the power to impose sanctions. At the moment, only Germany and Austria have certification systems for native seeds.

Unfortunately, with the new EU Commission Directive 2010/60/EU, trade with regional ecotypes will become increasingly difficult in Europe because the directive states that only 5% of the traded cultivars can be sold as “wild” seeds to avoid competing with commercially-produced cultivars. This restriction would be controlled by EU member states, resulting in a major administrative effort. Moreover, the new directive allows the propagation of wild seeds outside their region of origin. If seeds are propagated at considerable distances from their source, cross-pollination with nonlocal ecotypes and adaptation to climatic conditions at the propagation site (rather than the restoration site) are likely. In addition, propagation in foreign countries hampers effective certification, and the unintended import of invasive non-native species cannot be prevented completely. Finally, annual variations in harvests from species-rich native grasslands preclude compliance with standardized reporting and yield regulations, thus hampering local restoration efforts. To overcome these new obstacles, policy makers, growers of wild seeds, and restoration practitioners must work together to find practicable solutions when the new EU directive is translated into national law.

Participants from the United States focused on the federal Native Plant Materials Development Program (NPMDP), which was created in 2001 to provide plant materials for restoration on federal public lands (USDI 2002, USDA 2002). Primary goals are to supply and manage native plant materials through research and collaboration with the private-sector native seed industry.

As an example, the United States Bureau of Land Management (BLM) NPMDP supports programs primarily on arid and semiarid lands of the interior western United States where BLM lands are concentrated (USDI BLM 2009). Seven regional programs focus on long-term research and development of plant materials for specific biogeographic areas. The Great Basin Native Plant Selection and Increase Project, one of the earliest regional programs, focuses on research required to develop seed zones, plant materials appropriate for these zones, cultural practices for agricultural seed production, and wildland seeding strategies.

Despite the considerable progress made in the United States over the last decade, several challenges persist. Acceptance of native species and genetically diverse, regionally appropriate plant materials by federal agencies continues

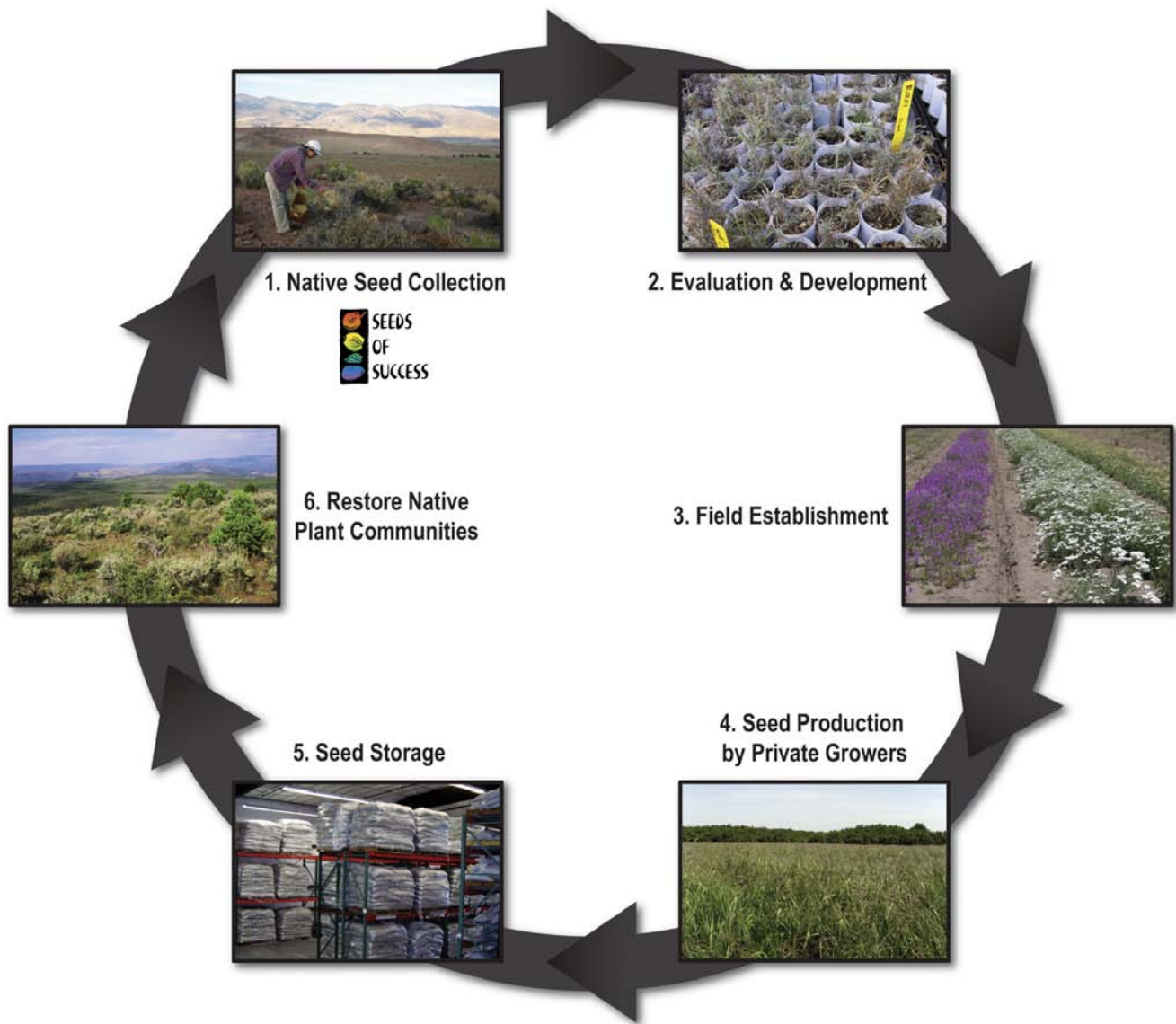


Figure 2. Steps in native plant materials development. Courtesy Peggy Olwell, U.S. Department of the Interior Bureau of Land Management.

to increase but is hindered. This is in part owing to a lack of experience in using these materials and a history of seeding commercially available cultivars of non-native and native species. Seeds of many native grasses and most native herbs cannot be collected from wildland stands in adequate quantities for immediate use, but must often be produced in agricultural fields because of extensive non-native species invasions and plant community fragmentation. This necessitates development of species-specific cultural practices for seed production and delays the availability of larger quantities of seed. Seed growers are often reluctant to take on new species because of production and marketing uncertainties, which occur because seed purchases are driven by fluctuating budgets and in the Intermountain West by unpredictable seed demands for postfire seedings. The location and total area burned annually vary widely, making it difficult to predict the market for specific regional materials from 1 year to the next. Efforts to overcome these problems

include increased seed warehousing, contracting for production of materials with narrower distributions, and encouraging development and use of regional materials by multiple users. A national system for certification of wildland-collected and agriculturally produced native seed is in place and continues to undergo modification as needs for native plant materials increase and approaches for their development and maintenance evolve. Although uncertified seed continues to be sold, certification is increasingly used for marketing of native species, providing greater assurance of seed origin and providing practitioners with a tool for improving their ability to purchase seed that will be adapted to the planting site.

Member states of the EU can learn from the United States how the use of wild seed can be embedded into governmental schemes. In Europe, the demand for local ecotypes for restoration and revegetation is currently from idealistic scientists and practitioners or NGOs. Restoration

is small scale and in most cases funding comes from scientific or applied research projects. Hence, restoration goals are often highly ambitious with regard to species-rich site-specific plant community assemblies. However, strategies for large-scale restoration projects are needed. In Europe and in the United States there is a need to evaluate and share effective techniques for reestablishing native vegetation in diverse ecosystems. Use of native hay, for example, has received little use in the United States and could be tested in appropriate areas. In both Europe and the United States, certification of native seed and plants across biogeographic regions, developing new market niches for growers, and providing increased stability in demand are all critical issues to increasing the availability and expanding the use of native materials. Tools to aid in selection of appropriate plant materials for restoration in light of climate change, issues of ex situ and in situ conservation of species and communities and discussions surrounding assisted migration are all critical to the future of ecological restoration on both continents.

In the future, the EU and the United States need to share local, regional, national, and international approaches and policies regarding the development and use of native plants at all levels. In addition, we must improve communication with the public, growers, and users to improve our understanding of native plant materials and healthy native ecosystems.

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Manipulating Internal System Feedbacks to Accelerate Reed Canarygrass (*Phalaris arundinacea*) Control: From Theory to Practice

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Reed canarygrass (*Phalaris arundinacea*) displaces indigenous species and creates extensive monocultures that frustrate restoration efforts. Restoration gains are typically short-lived at sites heavily impacted by this species, but suppression may be feasible at sites in the early stages of invasion (Annen et al. 2008). However, even under these conditions, reversal of invasion and replacement of reed canarygrass by desired endpoint species may require 5 to 6 consecutive growing seasons of effort (pers. obs.).

State and transition models predict that internal feedbacks maintain vegetation in one state (reed canarygrass monoculture) rather than an alternate state (remnant sedge meadow). Local and landscape-scale disturbances make sites vulnerable to reed canarygrass invasion, while feedbacks maintain the invaded state and resist restoration to a pre-invasion state. In other words, invaded states are internally reinforced by indirect feedbacks involving interactions among disturbances and species characteristics (Zedler 2009). Litter accumulation is one example of a feedback mechanism that maintains reed canarygrass dominance. Senescent reed canarygrass litter has a suppressing effect on competing species. As reed canarygrass increases in abundance and comprises a greater proportion of a site's standing crop, more litter accumulates each subsequent growing season, which further hinders emergence of competing species. This feedback cycle helps maintain reed canarygrass dominance and must be broken for restoration to be successful. Using fire to disrupt litter feedbacks is relatively easy compared to uncoupling other feedbacks that maintain a reed canarygrass-dominated state (e.g., hydrological disturbance). Nevertheless, Herr-Turoff (2005) documented that sethoxydim herbicide applications were more effective when disturbances were addressed prior to initiating chemical control efforts. Consequently,