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World Interest in Diverse Native Plant Stands

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World interest in diverse native plant stands

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Abstract. The objective of this paper was to provide a brief overview of native plant use and development including examples of native plant research being conducted in Canada. There is increasing interest in native plants in various countries. Currently, native plants are used in reclamation, biomass biofuel production, forage seeding, habitat restoration, and water and soil conservation efforts. Many countries have active programs for native plant preservation and new germplasm development, but seed cost, seed quality, and ease of establishment are still challenges for large-scale use. Many improved native plant germplasms have been released in recent years. In some countries, legislation and/or regulations were introduced to encourage use of native plants by industry such as in mine reclamation.

Keywords: Native plant, forage quality, yield, restoration.

Introduction

In recent years, there has been a renewed interest in the use of native plants for reclamation, wildlife habitat restoration, rangeland seeding, and perennial biomass fuel crop production in the USA, Canada, Australia, and worldwide (Jefferson *et al.* 2002; Smith and Whalley 2002; Vogel *et al.* 2002; Jones, 2009; Schellenberg *et al.* 2012). This increased interest may be attributed to several reasons. First, native plants are adapted to local climates and soil types (Willms *et al.* 2005) and may better adapt to changing climate than non-native species (McKenzie *et al.* 1999; Belesky *et al.* 2002).

In many cases, native plants are seeded as a mixture, and the diverse plant mixture could improve resource utilization (water, nutrient, light, and space) and improve plant community stability (Tilman *et al.* 2001). Second, native plants may be less invasive to neighbouring rangelands than non-native species and enhance plant species diversity (Pritekel *et al.* 2006). Non-native grasses have been shown to disrupt ecosystem function by affecting N cycling and carbon storage, and reducing biodiversity (Wedin and Tilman 1996; Pritekel *et al.* 2006). Third, there is an increasingly ecological and environmental perspective on grassland management by public organizations and private sectors. Fourth, there is the risk of fragmentation and disappearance of native grassland because of grain crop expansion. For example, in the Canadian provinces of Alberta, Saskatchewan and Manitoba, native prairie grasslands have declined 61, 79, and 99%, respectively, mainly due to cultivation for annual crops. If no effective restoration measures are taken, the diverse native grassland will continue to be reduced in extent and species diversity.

Native plants are an important forage source for livestock and wildlife. In the past, there has been a debate on productivity between native and non-native grasses of North America for forage use. Harvest frequency, time of harvest, and origin of seeds could cause yield differences between native and non-native species. In addition, continuous efforts of genetic enhancement in native species has reduced the production difference between native and non-native species. Hoffman *et al.* (1993) showed higher peak yields of western wheatgrass (*Pascopyrum smithii* (Rydb.) Barkworth & D.R. Dewey) monoculture than crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.) in North Dakota. Willms *et al.* (2005) reported higher productivity of native green needle grass (*Nasella viridula* (Trin.) Barkworth) or blue grama (*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths) monocultures than crested wheatgrass and Russian wildrye (*Psathyrostachys juncea* (Fisch.) Nevski) in dark brown soils of the Northern Great Plains. Native plant mixtures (7 and 14 species, mainly grasses) produced a relatively high yield and forage quality in a long-term grazing study in the semiarid Northern Great Plains (Schellenberg *et al.* 2012).

Forage quality of native species varies, and quality can be higher, lower, or similar to non-native cultivated forages in Canada (Jefferson *et al.* 2002; 2004). Many native plants maintain forage quality for late-season grazing in the Northern Great Plains (Jefferson *et al.* 2002). A large proportion of native species used in restoration or rangeland seedings are grasses, but a number of native legumes and shrubs have been released or are under development, which could increase forage quality in mixed forage seedings.

Native plants can provide ecological goods and services such as wildlife habitat, and soil and water conservation. Genetically diverse native plants are increasingly used for reclamation of mine sites, roads, and pipelines. Genetic diversity promotes plant adaptation to new environments and enhances long-term sustainability (Roundy 1999; Rogers and Montalvo

2004). To ensure genetic diversity of native populations, cultivars are often produced by inter-mating or combining numerous plants or accessions from the intended geographical area of use (Booth and Vogel 2006). Seed production, seed quality, and ease of establishment are major limiting factors for expanded use of native materials (Smith and Whalley 2002). In Canada, legislation requires continuous monitoring and regulation to encourage the use of native plant materials in restoration projects.

Native warm-season grasses have shown considerable promise for cellulosic biomass energy crop production in North America. After screening more than 30 herbaceous species (Wright 1994), switchgrass (*Panicum virgatum*, L., a C_4 perennial grass) became the focus of research for high-yielding perennial grass species. Switchgrass has excellent conservation attributes and is compatible with conventional farming practices (McLaughlin 1992). Research on switchgrass has been conducted on its phenology, genetics, and breeding characteristics. Combined with multiple breeding approaches designed to improve productivity (McLaughlin *et al.* 1999), a number of high-yielding switchgrass varieties were released for commercial production.

The United States Department of Agriculture's Natural Resource Conservation Service (USDA-NRCS) has released more native grass cultivars than any other organization in the world (Smith and Whalley 2002). The Plant Materials Program of the NRCS established a systematic process for native plant material development. Funding for the Great Basin Native Plant Selection and Increase Project in the western USA has been provided by the USDA Bureau of Land Management since 2001 and is administered through the USDA Forest Service Rocky Mountain Research Station.

The major objectives of this project are to improve the availability of native plant materials and provide knowledge and technology required for their use in restoring diverse native plant communities across the Great Basin Region. More than 20 federal, state, and private cooperators are involved in this project. In Canada, collaborations were established in the early 1990s between Ducks Unlimited Canada (a conservation organization), plant breeders at Agriculture and Agri-Food Canada (AAFC), and the University of Manitoba. Through this program, approximately 20 pre-variety germplasms were released.

In recent years, only the Semiarid Prairie Agricultural Research Centre of AAFC and the University of Saskatchewan still have active breeding programs for native species. Although previous breeding efforts in Canada were primarily to develop genetically diverse populations for the reclamation industry, considerable recent efforts have been focused on developing native plants with increased biomass and forage quality. Since 1980, a number of native plant material development projects were initiated in Australia that are being led by the Commonwealth Scientific and Industrial Research Organization (CSIRO), New South Wales (NSW) Agriculture, and the University of New England. Similar efforts are underway to preserve and develop native plant germplasm in South America, Asia and some European countries (Ayala *et al.* 2011; Dzyubenko 2011; Goliński and Golińska 2011).

Specific examples from the Canadian experience

During 2001-2004, a grazing study (1.3 and 2.7 animal units/ha) was initiated in the semiarid prairie of western Canada using two native seed mixtures (7 species and 14 species) (Schellenberg *et al.* 2012). The seven-species mixture consisted of cool-season grasses, while the 14-species mixture included an additional five warm-season grasses, a native legume, and a native shrub species. Based on plant count, a successful stand (13 to 17 plants/m^2) was established in 12 of the 16 pastures. The remaining four pastures had plant counts greater than 10 plants/m^2.

The shrubs and June grass (*Koeleria macrantha* (Ledeb.) Schult., a C_3 species) were not observed in the first year. The wheatgrasses formed the largest component of the established species in both mixtures. Total weeds in the forage stand decreased significantly through time. These results show that a seed mixture of native cool-season grasses can be more productive than a combination of native warm- and cool-season grasses under the semiarid conditions of western Canada, but inclusion of warm-season grasses improved forage nutritive value in the late-summer months. This study also showed that re-established native species are suitable for grazing, and species diversity changed less than that of introduced species under grazing. The seeded land has been continuously grazed for 12 years and is still productive. Under this long-term grazing regimen, a dramatic increase of a native legume (purple prairie clover, *Dalea purpurea* Vent.) has been observed.

Jefferson *et al.* (2004) evaluated forage quality in early fall of nine native and one introduced grass species for multiple locations and years in western Canada. Western wheatgrass exhibited the lowest fiber concentrations and highest crude protein and in vitro organic matter digestibility (IVOMD). Western wheatgrass forage was nutritionally adequate to maintain a dry beef cow during the second trimester of pregnancy. Other species would require supplementary energy and protein to meet beef cattle nutritional requirements during fall grazing. Another seven-year study also showed native grasses are compatible with alfalfa (*Medicago stativa* L.). Forage yield and quality are comparable or superior to introduced grasses for late season grazing (Biligetu *et al*. 2013 submitted).

Successful native species mixtures are likely to contain large numbers of species. Typical native mixed prairie grassland communities in Canada contain 4-6 common grasses and 1-9 rarer grasses; grasses contribute the majority of the biomass production, but forbs make up the majority of the diversity (Coupland 1950). Ongoing field and greenhouse trials (Mischkolz 2013; Mischkolz *et al.* 2013; Schellenberg *et al.* 2012) are evaluating the potential of complex native species mixes for this region. The majority of effort is focused on five native grasses (two C_4 and three C_3 species) with high agronomic potential. A combination of highly productive C_3 grasses and drought-tolerant C_4 grasses are expected to provide consistent within-season production (C_4 grasses are more productive later in the growing season) and sustained production in drought years. Two native legume species are also under evaluation because of their N fixation and beneficial nutritional characteristics.

Initial field trials of all pairwise mixtures among all seven species showed that under high-moisture conditions, aggressive C_3 grasses were the most productive (Mischkolz *et al.* in press). As expected, C_4 grasses did not perform particularly well under wet conditions, but C_4 species had little negative effect on total pasture production in mixtures with C_3 species (*i.e*., seeding the C_3 grass at half the rate in monoculture to include a C_4 species). This demonstrates that it is possible to maintain high pasture production potential of a C_3 grass, while also providing for late-season forage from a drought-tolerant C_4 species within the pasture.

Substantial evidence exists that inclusion of many species within a pasture mixture will provide long-term pasture sustainability in a variable environment. Developing more complex mixtures with larger numbers of potential component species is challenging because little information is available concerning the establishment and maintenance of plant communities composed only of species with high agronomic potential. There are, for example, many possible communities varying in species richness, uniformity, and composition that could be developed from even seven species. Mischkolz *et al.* (in prep) developed a modeling approach where a subset of the potential community combinations among seven species (two C_4 grasses, three C_3 grasses, and two legumes) were grown in a greenhouse trial. Those data are being used to develop regression models linking community characteristics (*i.e*., species composition, diversity, and plant trait values) to productivity and identify potentially productive mixtures for subsequent testing. Future field trials are planned to further test and verify the performance of the highly productive mixtures.

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