Creating a Reclamation Cultivar - Factors to Consider and Processes?

by

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2015 Native Prairie Restoration & Reclamation Workshop
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The need for cultivars

Definitions

Cultivar development process

Commonly asked questions, e.g. how local is local? Ecovar vs. cultivar, genetic pollution, plant diversity, plant collection and selection, seed transfer

Cultivars released by AITF

Conclusion
Uses of Native Cultivars

Over the last 30 yrs., there has been an increased interest in using native plants for reclaiming both natural and man-made disturbances.

E.g. resource extractions, recreation, increased salinization and drought.
Obstacles to Meeting Revegetation Goals

- Limited range of locally sourced species
- Volume & quality of native seed commercially available
- Type of plant materials available
- Integrity & performance under various environmental/site conditions
- How to use these native species?
- Cost
Cultivar - Hybridization followed by backcrossing and the fixing of those backcrosses.
Uniformity - is a desirable characteristic of hybrid seed production systems = narrow genetic base.

It is a group of individuals within a species, which are distinct in form or function from other similar arrays of individuals – meaning that a variety may undergo some selection process in order to achieve a demonstrated commercial value.

A “cultivar” is basically a variety that is cultivated.
Example of Traditional Breeding

DONOR PARENT
Rust Resistant Variety
RR (resistant)

RECURRENT PARENT
Adapted Variety "A"
rr (susceptible)

BACKCROSSING
trail = dominant

RR

x

rr

F1 progeny = All Rr

BC1 progeny = 1 Rr : 1 rr

Select for crossing

BC2 progeny = 1 Rr : 1 rr

BC3 progeny = 1 Rr : 1 rr

BC4 progeny = 1 Rr : 1 rr
Ecovars are the offspring of native plants that have been specially selected from a larger population for their ability to survive and reproduce in specific regions of the Canadian Prairies (DU, 2002). Ecovar™ - an intermediate step between a true native plant and a cultivar

Ecotype - an ecological sub-unit to cover the product arising from geno-typical response of an ecospecies to a particular habitat. Based on genetics, morphology, phenology, physiology, habitat - Discrete entities, genetically variable reflecting adaptation to different habitat
The level of selection within a species will depend on the plant breeder’s goal, such as improved yield or biomass or disease resistance. This is why “plant breeding” or “plant development” is referred to as the art and science of changing and improving the heredity of plants. The plant breeder develops strategy to:

- Recognize morphological, physiological or pathological traits that are important for adaptation, yield, dry matter production and quality of the crop species.
- Design techniques that will evaluate the genetic potential for these traits.
- Search for new sources of genes for the desired traits that may be utilized in the breeding program.
- Combine the genetic potential for these traits into an improved variety or cultivar.
The processes in the previous slide apply mostly to agricultural crops of economic importance.

Native plant varieties can be regarded as the result of little or single improvement, if someone regards the movement of a plant from its natural environment into a field as improvement.

Keys to a good variety for reclamation/restoration, other than being native to the area being restored, is based on the variety’s ability to establish well and be a reliable seed producer. Both of these elements are fundamental for a variety to be commercially successful.
Cultivar Development Process at AITF

- Collect and maintain as much variability as practically possible.

- Test collected native plant materials (germination, common garden).

- Determine performance/adaptation of these populations (lines) through at multiple locations – outcome driven.

- Compare the plant materials to common seeds or those already on the market, but from a different origin.

- Evaluate these plant materials in native seed mixes under different reclamation or habitat improvement conditions.

- Develop technologies (seeding techniques, weed control, seed processing) to propagate and cultivate these native species under field conditions; and

- Release the plant materials as named varieties to the seed industry for commercial production and distribution.

Seed Collection
Considerations in seed/Plant Collection

Understand the genecology of species in question, which provides information on the pattern and extent of phenotypic and genotypic variation within populations and among populations of that species.

The variability may be related to the distribution of continuous or disjunct environmental factors such as soil type, and altitude, exposure or latitude with their associated factors of precipitation, temperature and photoperiod.

The relative contribution of genetics and environment to variation to taxonomic characters and physiological traits must be understood.

Restructure and or rationalise collections based upon results delivered through research (genotyping, phenotyping)
Considerations in seed/Plant Collection

- Wei, R.P., and F. C. Yeh (1999) – using effective population size, optimum gain can be obtained.


Provenance Testing

By increasing the frequency of favourable genes in a population (selection), can there be a well performed variety with minimum loss of genetic variability?

Progeny rows of Canada wild rye, blue flax and wild bergamot
Provenance/Multi-environment Testing

Vegreville 640 m

Pincher Creek, 1554 m

Beaverlodge 730 m

Mountain Park 1800 m
These plots are established and maintained according to Canadian Seed growers Association - Circular 6 guidelines for pedigreed seed crops in Canada. Growers wishing to produce pedigreed seed should understand these requirements and comply with them.

The plant lines are named and registered with CSGA. They should bear full plant description and any distinguishing features they may have.

They are released to seed companies for seed production and marketing.

The named varieties are sold as certified seed, a superior seed grade over common seed.

Caution: A grower should not use the certified seeds for further multiplication. To maintain the genetic diversity of a cultivar, a grower should revert to breeder seeds.
In Canada, the handling of native plant seed falls under the Canadian Seeds Act and Regulations (1996). Pedigreed seed classifications are:

- breeder
- foundation
- certified

Seeds that do not measure up to the strict standards for pedigree status are collectively sold as Common #1 or Common #2, depending on the level of weed seed contamination.

Pedigreed Seed Crop Production (Circular 6)

http://seedgrowers.ca/
**FOUNDATION, REGISTERED AND CERTIFIED PRODUCTION OF GRASSES**

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**Canadian Seed Growers' Association**

**ASSessment Checklist**

Breeder Seed Production Quality Management System (QMS)

<table>
<thead>
<tr>
<th>NAME and ADDRESS of Plant Breeder and/or Establ.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE:</td>
</tr>
<tr>
<td>Assessment No.:</td>
</tr>
</tbody>
</table>

**Documentation Review**

Clients Documentation related to Area/Activity (GISP's, SW's etc) conformance with:

- CSGA Regulations and Procedures for Pedigreed Seed Crop Production (Circular 6) including the maximum plot size of 2.5 acres; and
- CSGA Regulations and Procedures for Breeder Seed Crop Production

**Personnel Interviewed:**

**Documents Verified:**

- Plant Breeder's own:
  - QA Manual
  - Breeder Seed Production Procedures
  - Other procedures (attach list)

**Records Verified:**

<table>
<thead>
<tr>
<th>Element No.</th>
<th>Review of: Documents</th>
<th>Addressed (Yes/No)</th>
<th>Records Addressed (Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous Land Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Isolation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection / Roguing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer and Storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed Labeling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training and Qualifications</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessor Comments:**

**Assessor Signature:**

**Assessor Name / No.:**

**Appendix A - Documents**

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# Seed Crop Inspection Report (CFIA)

## Seed Analysis

### Report of Seed Analysis

**Government Accredited Laboratory**

**Accreditation No.** 106B

**This designates that a sample of**

- **C. davidiana**

**was received from:**

- **Alberts Research Council**
  - **Nisku, Alberta Canada**
  - **T8B 7N5**
  - **Tel: 780-565-3435**
  - **Fax: 780-565-3438**
  - **E-mail: test2006@compuserve.com**

**Seed Analysis**

- **WEED SEEDS, No. PER. **
- **GRAMS:**

<table>
<thead>
<tr>
<th>NOXIOUS WEED SEEDS</th>
<th>OTHER WEED SEEDS</th>
<th>OTHER CROPS SEEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibited Noxious</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary Noxious</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Secondary Noxious</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

- **Total Noxious:** 0.0
- **Total Weed Seeds of all Kinds:** 7.3

- **Total Other Crop Seeds:**
  - **Sesame:** 0.0
  - **Brassica:** 0.0
  - **Sorghum:**

### Seed Analysis Details:

- **Pollen:**
  - **Vespertillum:** 0.0
  - **Oenothera:** 0.0
  - **Fagopyrum:** 0.0

### Seed Analysis:

- **Date:** Jan 20, 2001

**Senior Member of**

- **Brenda Winnicki**

**Accredited Analyst**

The responsibility for any seed sold under this Report with respect to Grade or any other specification rests entirely with the seller.
AITF has Released 23 Varieties

Certified seed provides assurances regarding purity (freedom from weeds) and seed viability and performance - important considerations for reclamation and revegetation success.
Collected, Performance Tested and Commercial Released
<table>
<thead>
<tr>
<th>Varietal Release</th>
<th>Soils Adaptation</th>
<th>Origin</th>
<th>Marketing company</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;AEC Highlander&quot; slender wheatgrass</td>
<td>Black chernozem, Brown, Dark brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AEC Hillcrest&quot; awned wheatgrass</td>
<td>Black chernozem, Brown, Dark brown</td>
<td>Crownest Pass</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AEC Mountaineer&quot; broad-glumed wheatgrass</td>
<td>Mountain soils, nutrient poor soils</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AEC Glacier&quot; alpine bluegrass</td>
<td>Black chernozem, Brown, Dark brown</td>
<td>Lower elevation in the Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AEC Blueridge&quot; alpine bluegrass</td>
<td>Black chernozem, Brown, Dark brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Sentinel&quot; spike trisetum</td>
<td>Black chernozem, Brown, Dark Brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Plateau&quot; Rocky Mountain fescue</td>
<td>Black chernozem, Brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Mountain View&quot; June grass</td>
<td>Black chernozem, Brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Vista&quot; alpine fescue</td>
<td>Black chernozem, Brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Grouse&quot; green needle grass</td>
<td>Black chernozem, Brown</td>
<td>Rocky Mountains of Alberta</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Metisko&quot; awned wheatgrass</td>
<td>Sandy, Brown, Dark brown</td>
<td>Metiskow</td>
<td>No supplier, breeder seeds available at AITF</td>
</tr>
<tr>
<td>&quot;ARC Porter&quot; Indian rice grass</td>
<td>Sandy, Dark brown</td>
<td>Wainwright – Ribstone Creek</td>
<td>No supplier, breeder seeds available at AITF</td>
</tr>
<tr>
<td>&quot;ARC Prairie&quot; June grass</td>
<td>Black chernozem, brown, sandy</td>
<td>Wainwright area</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Centennial&quot; Canada wild rye</td>
<td>Sandy</td>
<td>Wainwright area</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Hillbilly&quot; nodding brome grass</td>
<td>Sandy, Parkland</td>
<td>Wainwright area</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Butte&quot; Rocky Mountain fescue</td>
<td>Sandy</td>
<td>Near Waterton Lake National Park</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;ARC Aspen&quot; Canada milk vetch (legume)</td>
<td>Sandy/Parkland</td>
<td>Vegreville</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AITF Bison&quot; Plains rough fescue</td>
<td>Black Chemozem, Brown</td>
<td>Northern fescue region</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AITF Badlands&quot; blue grama grass</td>
<td>Brown soil</td>
<td>Hand Hills, Hanna</td>
<td>Brett-Young Seeds</td>
</tr>
<tr>
<td>&quot;AITF Battle bend &quot; tufted hair grass</td>
<td>Sandy/Parkland, stabilisation of tailings sand</td>
<td>Wainwright area</td>
<td>Negotiation</td>
</tr>
<tr>
<td>&quot;AITF Painted Skies&quot; Rocky Mountain fescue</td>
<td>Sandy/Parkland</td>
<td>Wainwright area</td>
<td>Negotiation</td>
</tr>
<tr>
<td>&quot;AITF Cascade&quot; Hairy wild rye</td>
<td>Mountains/Upper Foothills</td>
<td>Jasper/Hinton</td>
<td>Brett-Young Seeds</td>
</tr>
</tbody>
</table>
Varieties - How Local is Local?

- Less than 330 km north or south and 160 km east and west (Welch, Rector & Anderson, 1993)
- No more than 100 m for herbaceous plant
- No more than 1 km for woody shrubs is recommended for fear of genetic pollution (Linhart, 1993)
- Linhart (1993) states that plants introgress and dilute the gene flow of native populations which creates hybrids that are poorly adapted to local conditions
- Whisenant, (1999) – strict distance requirements are neither practical nor supported by genetic or evolutionary evidence
Most plants are cross pollinating.

Natural selection where the unfit do not persist

Strongly out-crossed, wind pollinated species have fewer differences between populations than self pollinating species (T. Jones, 2003).

Actually, hybrids are occasionally more fit and are better adapted to local conditions.
Autopolyoids: ecological significance
bluebunch wheatgrass (tetraploid) is dominant in Washington & British Columbia. In contrast, Basin wildrye (2n=28) exists as a tetraploid in most of its range but also exists as an auto-octoploid (2n=56) in the northwest part of its range, i.e. B.C, Washington, parts of Oregon & Idaho.

Thickspike wheatgrass arises from hybridization of bluebunch wheatgrass (Pseudoroegneria spicata) and a barley species (Hordeum sp.)

Jones, 2003
A biological system has different strategies in order to survive:
- maintain viable populations
- highly mobile, e.g. trees producing massive amount of pollen
- movement of animals, birds, wind

Species rely on phenotypic plasticity to survive in extant locations, on genetic adaptation to modify their local phenotypic optimum or on migration to new suitable environmental conditions.
Liatris punctata

Stipa commata
Native Plant Certification (NPC) - a voluntary quality control process for native plant identification. Its purpose is to verify the origin (of collection or production) of native plant reproductive materials which have not been released as a variety.

Changes in methods and operations have taken place over the years, but the aims and objectives of the CSGA – to improve pedigreed seed production and usage – have not changed.
Introduction / Purpose

The Native Plant Certification (NPC) is a voluntary quality control process for native plant identification. NPC’s purpose is to verify the origin (of collection or production) of native plant reproductive materials which have not been released as a variety. The term “reproductive material” refers to native plant parts such as seeds, seedlings, cuttings, transplants or other forms. NPC does not mandate specific sources of reproductive material for specific uses, nor guarantee the performance or quality of the plant material. The NPC Program documents the identity of plant material and verifies that it is from a designated geographic location and / or selected for specific characteristics.

-[ ] NPC is recognition that native plant material is desired as is without hybridizing or changing.
-[ ] Source identified, field of origin inspected, nursery plots inspected.

Established native stands for certification as; (generation $G_0$):

1. Registration will be made with CSGA.
2. Seed or plant material harvested.
3. Native species eligibility will be documented through Native Plant Origination Form and supplied to CSGA.
4. A map of native species site location will be submitted to CSGA.
5. Seed conditioned.
6. Seed testing for germination and mechanical purity.
7. All records pertaining to species collection, selection, harvest, and conditioning will be audited by inspectors recognized by CSGA.
8. Spot-checking of collection sites will be performed as determined by CSGA.
9. Labeling and final Source Identified or Selected certification.

A) Production site for certification as Source Identified (generation $G_1$ to $G_3$) and Selected class.

1. Seed or plant material.
2. Application for Crop Inspection will be made to CSGA by the deadline date for forage crops.
3. A map of production location to be inspected will be enclosed.
4. Native species eligibility will be documented through Native Germplasm Ordination Form, supplied to CSGA with initial application. If plant material has been purchased, a seed tag must be attached.
5. Production fields will be isolated according to Native Plant isolation standards.
6. Production field will be inspected by CSGA inspector.
7. Seed or plant material harvested.
8. Seed conditioned.
9. Seed testing for germination and mechanical purity.
10. Labeling and final Source Identified or Selected certification tagging.
Conclusion

- When developing a cultivar, one should ask “what is the end use goal or expected outcome?

- The native seed growers/users should familiarize themselves with the utility of these terms: genotype, provenance testing, inbreeding, genetic drift, adaptation.

- Familiarize with Circular 6 - requirements to produce pedigreed seed crops in Canada; should understand these requirements and plan their operations to comply with them.
The challenge: our actions (improper collection of materials, lack of understanding) may contribute to the inability of a particular variety to respond to change in its environment.

Consider: Altitude, Latitude, Natural seed dissemination

CSGA allows pedigreed seed growers to only produce certified seeds from a stand for three years and breeder seed for five years if the stand is good.
When choosing a native variety/cultivar in a revegetation/reclamation project, consider the following:

- Select those that are adapted to the ecoregion, and also is a good performer, in terms of establishment and produce viable seeds.

- Find out the origin of the cultivar/ecotype/ecovar™ or common seed that you are using.

- Use clean seed - check the seed analysis reports and watch for unwanted weed seeds. Visit the growers if possible.

- Seedmix design
AITF’s Native Plant Program has contributed significantly to reclamation/restoration of disturbed landscapes, through increasing the availability of native seed on the commercial market and for the resource industry to meet regulatory requirements.

This reduces the spread of unrestricted wild harvesting that can lead to degradation of the remaining natural habitats or the importation of undisclosed varieties that can lead to reduced diversity of the ecosystem.
Thank You

This program would not have been possible without the support of:

- Alberta Innovates Technology Futures
- Alberta Environment & Sustainable Resources Development
- Alberta Agriculture & Rural Development
- Alberta Agricultural Research Institute (now AI-Biosolutions)
- Agriculture & Agrifoods Canada
- Parks Canada
- Petroleum Technology Alliance of Canada
- Brett-Young Seeds
- Talisman Energy
- Husky Energy
- Shell Canada
- Trans-Canada Pipeline

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