National FS Objective

Forage Crop Improvement for the Canadian Livestock, Forage, Bio-energy and Conservation Industries.
Forage Breeding In Canada

Dr. Yousef Papadopoulos
Red Clover, Birdsfoot trefoil
Red Clover Genetic Adaptation

- NE-1010 Trial (multi-sites).

- Breeding strategies to expand the adaptation of red clover.

- Selection for general adaptation of red clover: Evaluating the theory of general vs regional adaptation in red clover.
Progress In Trefoil Breeding

- Improved Establishment – Seedling Vigour (First Growth Vigour).
- Management – Performance Under Hay and Grazing.
- Seasonal Yield Distribution: Improved – Pasture Regrowth and Seasonal Biomass Distribution.
- Feed Efficiency – Chemical Composition (Phenolic Compounds and Condensed Tannins).
Progress In Alfalfa Breeding

• long-term persistence.
• Evaluation and selection for adaptation to acidic soil conditions.
• Intensive selection under grazing.
• Adaptation to climate change (Floodling Tolerance….)
Forage Mixtures And Nutrient Cycling

• Contribution of forage legumes to soil NO3- when grown in mixture with grasses compared to an unfertilized pure grass stand.

• Genetic variability among red clover and alfalfa cultivars for nitrogen fixation and transfer to companion grasses.

• Performance of forage mixtures under a beef grazing management system
Forage Breeding In Canada

Dr. Yousef Papadopoulos
Red Clover, Birdsfoot trefoil

Dr. Annie Claessens
Alfalfa, Timothy, Orchardgrass, Smooth and Meadow Brome
Research Team at AAFC - Quebec

Scientists

Annie Claessens  Plant breeding
Annick Bertrand  Plant biochemistry
Yves Castonguay  Molecular physiology
Patrice Audy  Plant pathology

Research assistants

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François Langevin  Germplasm development
Josée Bourassa  Plant biochemistry
Jean Cloutier  Molecular genetics
Réjean Desgagnés  Molecular biology
David Gagné  Bioinformatics
Josée Michaud  Molecular physiology
Breeding Program

Dairy industry

- Improve forage nutritive value for superior animal performance

Bioproduct industry

- Improve biomass quality to meet bio-industry needs

- Bio-energy / bio-fuels
- Bio-materials
- Bio-chemicals

- Biomass

- Alfalfa
- Timothy
- Tall fescue
- Switchgrass
- Reed canarygrass
- Big bluestem

Development of genetic material adapted to the cold and humid environmental conditions of eastern Canada
Breeding Projects

**Alfalfa**

- Nutritive value
  - Concomitant selection for high stem sugar content and greater fiber digestibility
- Persistence
  - Marker-assisted introgression of cold hardiness into germplasm with low fall dormancy
  - Development of phenotypic assays and marker-assisted approaches to improve dry matter digestibility and stress tolerance (Phytophthora and Aphanomyces root rot, cold and salt tolerance)

**Timothy**

- Yield
  - Increase timothy regrowth capacity

**Switchgrass**

- Persistence
  - Increase switchgrass cold tolerance
- Bio-fuels
  - Increase switchgrass dry matter degradability
Forage Breeding In Canada

Dr. Bruce Coulman
Smooth, Meadow and Hybrid Bromes; Timothy; Crested Wheat Grass, Native Grasses

Dr. Annie Claessens
Alfalfa, Timothy, Orchardgrass, Smooth and Meadow Brome

Dr. Yousef Papadopoulos
Red Clover, Birdsfoot trefoil
Meadow bromegrass breeding at the University of Saskatchewan/AAFC

- **Recent new varieties**
  - Armada (2008)
    - Improved seed and forage yield
  - Admiral (2009)
    - Improved vigor and greenness in fall

- **Present program**
  - Expand genetic base
    - Evaluate new accessions from world genebanks
  - Further improvement in forage yield
  - Evaluation of NAAIC lines selected at four locations
Hybrid bromegrass breeding at the University of Saskatchewan/AAFC

- Meadow X smooth bromegrass hybrid populations
- Two cultivars released in early 2000s – have been widely used
- Continue selection in existing populations
- Expand adaptation to more humid regions
  - New population (S9478) from crosses using “southern” type smooth brome parents
B. riparius

Hybrid
B. riparius X B. inermis

B. inermis
Forage Breeding In Canada

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Red Clover, Birdsfoot trefoil

Dr. Annie Claessens
Alfalfa, Timothy, Orchardgrass, Smooth and Meadow Brome

Dr. Bruce Coulman
Smooth, Meadow and Hybrid Bromes; Timothy; Native Grasses

Dr. Surya Acharya
Alfalfa, Sainfoin, Cicer milkvetch, Orchardgrass, PC rye, Fenugreek, Native grasses

Salt and grazing tolerance testing
LRC Forage Program deals with seven forage crops

- Orchardgrass
- Cicer Milkvetch
- Sainfoin
- Fenugreek
- Alfalfa
- Giant Wildrye
- PC rye
LRC breeding program has produced winter hardy, high yielding and disease resistant alfalfa cultivars.

We have also produced an acid tolerant and a saline tolerant alfalfa cultivar in recent years.
Work on biotic and abiotic stress tolerance in alfalfa continues with emphasis on mixed cropping and grazing tolerance.

Alfalfa can cause pasture bloat and so is not utilized for grazing.
Pasture Bloat

Fast release of soluble proteins into rumen fluid upon eating, thickening of rumen fluid

Fermentation gases get trapped in thickened rumen fluid making it foamy

Trapped gas can not be expelled, keep accumulating causing animal to bloat, and in extreme cases death occurs

Condensed tannin containing forage legumes e.g. sainfoin do not cause ruminant bloat
Sainfoin

- Excellent quality and palatability.
- Easy to establish.
- A low proportion of sainfoin in alfalfa pasture can prevent bloat in grazing cattle.

Why is it not used for bloat prevention in alfalfa pasture?
Available sainfoin cultivars do not

✦ survive in mixed alfalfa stands
✦ regrow at the same rate as alfalfa after grazing and so cannot be used for bloat prevention all summer
✦ have tolerance for frequent cutting or grazing
✦ produce as much biomass as alfalfa although easy to establish
We have developed several new sainfoin populations with ability to survive in mixed alfalfa stands, tolerate frequent cutting and produce high biomass yield. The challenge was to prove that bloat can be prevented in mixed alfalfa pastures using these new populations.
Pasture bloat observed in alfalfa / sainfoin mixed stands at Lethbridge in 2010 and 2011.
Under direct grazing a newly developed sainfoin population prevented bloat as it survived in mixed stands with AC Blue J alfalfa in higher proportions than Nova for 3-4 years.

Bloat incidence and severity in sainfoin/alfalfa mixed pastures observed in 2010 and 2011 at Lethbridge, AB

<table>
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<tr>
<th>Experiment (Year)</th>
<th>No. of animals</th>
<th>% sainfoin</th>
<th>Bloat incidence</th>
<th>No. of multiple distension/day</th>
<th>Highest bloat score</th>
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5% Sainfoin: Nova/AC Blue J mixed stand
25% sainfoin: LRC3519/AC Blue J mixed stand
Major Conclusions

New sainfoin populations can stay in alfalfa pasture in higher proportions than Nova for 3-4 years under simulated or direct grazing.

Higher proportion of new sainfoin populations in mixed alfalfa pasture significantly reduced bloat incidence and severity under rotational grazing.
Major Conclusions

In mixed alfalfa stands new sainfoin populations produced as much ADGs as Nova without causing bloat in grazing cattle.

Some newly developed sainfoin populations produced significantly higher biomass yield than Nova, some produced similar or higher yield than high yielding alfalfa cultivars under simulated grazing.

Please stay tuned for further improvement in sainfoin populations.
Develop cultivars with improved forage yield and seedling vigor.
Two quick establishing and high yielding cicer milkvetch cultivars were released from LRC program. These cultivars yield about 20% better than old cultivar Oxley.
Orchardgrass breeding goals

Develop cultivars with improved

Forage yield, seed yield, winterhardiness, digestibility and disease resistance.
Progress to date

New synthetics with improved:
- wh & forage yield (AC Kayak)
- wh & digestibility
- wh & fy & dmd (2014??)
Perennial cereal rye breeding goals

Develop cultivars with improved

Forage yield, seed yield and winterhardiness.
Presently focusing on nutritional quality and seed yield improvement of PC rye without sacrificing forage yield.

Developed and released first North American PC rye cultivar “ACE-1”.

ACE-1 produces high biomass yield but does not produce as much seed as some fall rye cultivars.

Presently focusing on nutritional quality and seed yield improvement of PC rye without sacrificing forage yield.
Fenugreek breeding goals

Develop cultivars with improved

Forage yield, seed yield and nutraceutical properties.
Developed and released “Tristar”, the first NA forage fenugreek cultivar.

Tristar produces high yield and high quality forage in western Canada. High quality seed production in this area is not consistent due to the growth habit of Tristar.

Presently focusing on improvement in seed yield and seed quality without sacrificing forage yield.
Leymus cinereus

Basin wild rye or giant wild rye

Leymus cinereus
My thoughts

- Development of adapted forage cultivars and appropriate agronomic packages for optimizing forage and seed production for distinct eco-climatic regions need to be given high priority.

- Increased funding for forage crop research is essential for maintaining sustainability of our forage industry which, I believe, has a major impact on Canadian agriculture industry.