What research tells us about forage mixtures for pasture?  
Part 1
Presentation Plan

- Introduction
  - Why using mixtures for grazing?
  - Why complex mixtures?

- Mixtures
  - Methodology approach
  - Binary mixtures
    - Species, dry matter yield, and nutritive value
  - Complex mixtures
    - Species, dry matter yield, and nutritive value,
    - Grazing results (Nappan site)
    - Production system to extend grazing to early fall
    - Carbon sequestration
Forage Mixtures for Grazing

One specie

Mistakes

↑ Dry matter yield
(Papadopoulos and al., 2012)

↑ Yield stability
(Deak and al., 2009)

↓ Weeds
(Finn and al., 2013)

↑ Nutritive value
(Peyraud and al., 2009)

↓ N fertilizer
(Nyfeler and al., 2011)

Easier to manage

More difficult to manage
Two different approaches

Ecological approach
- Based mainly on biodiversity
- Number of species

Agronomic approach
- Consider biodiversity but also productivity, regrowth during season, and persistance
Complex Mixtures: Trial with White Clover

- Mixtures: White clover with 2, 3 or 4 grasses

- Grasses: Timothy, Kentucky bluegrass, Reed canarygrass, Meadow fescue.

- Rotational grazing from mid-May to mid-October with dairy heifers from 2005 to 2009.

Papadopoulos and al. 2012
Dry Matter Yield
2007-2009
Contribution to DMY

Grasses
White clover
Other

Contribution to DMY (%)

Species

2 Species
3 Species
4 Species

Papadopoulos et al. 2012
Main Results from that Trial

- Best productivity with 4 grass species which was the highest number of species tested in that trial
- Complex mixtures: an answer to the climatic variability
Main Objective: Trial 1 and 2

- Identify the best performing forage mixtures under grazing:
  - Binary mixtures (1 legume + 1 grass)
  - Complex mixtures (1 legume + many grasses)
Methodology to Study Forage Mixtures

- Two major methodologies have been used
  - Plots grazing by animals (mob grazing technique)
  - Simulated grazing (mechanically harvested)
Methodology: Mob Grazing Technic

Sward height for grazing: 25 cm
Grazing within 12 hours to 24 hours
Methodology: Mob Grazing Technic

Pros:
Plants are trampled by animals.
Prefered species can be identified.

Cons:
Not long enough to determine ADG.
Methodology: Simulated Grazing

Pros:
Evaluate many different mixtures.

Cons:
No interaction between plant and animal.
Persistance of species may be different from grazing with animals.

Harvest mechanically: each time sward reached 25 cm
Forage Mixtures Under Grazing

- Three trials at different sites since 2010:
  - Nappan (NS)
  - Lévis (QC)
  - Normandin (QC)
  - New Liskeard (ON)
## Climatic Normals (1980-2010)

<table>
<thead>
<tr>
<th></th>
<th>Nappan (NS)</th>
<th>Lévis (QC)</th>
<th>Normandin (QC)</th>
<th>New Liskeard (ON)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual precipitation, mm</strong></td>
<td>1155</td>
<td>1179</td>
<td>709</td>
<td>786</td>
</tr>
<tr>
<td><strong>Annual temperature, °C</strong></td>
<td>6.0</td>
<td>4.6</td>
<td>0.8</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>GDD (5 °C basis)</strong></td>
<td>1762</td>
<td>1768</td>
<td>1329</td>
<td>1581</td>
</tr>
<tr>
<td><strong>Latitude</strong></td>
<td>45° 46’ N</td>
<td>46° 48’ N</td>
<td>48° 51’ N</td>
<td>47° 51’ N</td>
</tr>
<tr>
<td><strong>Longitude</strong></td>
<td>64° 15’ W</td>
<td>71° 23’ W</td>
<td>72° 32’ W</td>
<td>79° 67’ W</td>
</tr>
</tbody>
</table>

[http://climate.weather.gc.ca/climate_normals/index_e.html](http://climate.weather.gc.ca/climate_normals/index_e.html)
Research Team: Binary and Complex Mixtures – Trials 1 and 2

- Yousef Papadopoulos, Project Leader, (AAFC)
- John Duynisveld (AAFC)
- Gilles Bélanger (AAFC)
- Gaëtan Tremblay (AAFC)
- Julie Lajeunesse (AAFC)
- Carole Lafrenière (UQAT)
- Sherry Fillmore (AAFC)
# Species in Binary Mixtures: Trial 1

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa = Af</td>
<td>Timothy = Ti</td>
</tr>
<tr>
<td>Birdsfoot trefoil = Bt</td>
<td>Meadow fescue = Mf</td>
</tr>
<tr>
<td>White clover = Wc</td>
<td>Tall fescue = Tf</td>
</tr>
<tr>
<td></td>
<td>Orchardgrass = Og or Or</td>
</tr>
<tr>
<td></td>
<td>Meadow brome = Mb</td>
</tr>
<tr>
<td></td>
<td>Kentucky bluegrass = Kb</td>
</tr>
</tbody>
</table>
## Species and Cultivar in Binary Mixtures: Trial 1

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa – CRS1001</td>
<td>Timothy - Express</td>
</tr>
<tr>
<td>Birdsfoot trefoil – AC</td>
<td>Meadow fescue - Pradel</td>
</tr>
<tr>
<td>Langille</td>
<td>Tall fescue - Courtnay</td>
</tr>
<tr>
<td>White clover - Milkanova</td>
<td>Orchardgrass - Killarney</td>
</tr>
<tr>
<td></td>
<td>Meadow brome - Fleet</td>
</tr>
<tr>
<td></td>
<td>Kentucky bluegrass - Troy</td>
</tr>
</tbody>
</table>
Seeding Rate in Binary Mixtures: Trial 1

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa 8 kg/ha</td>
<td>Timothy 8 kg/ha</td>
</tr>
<tr>
<td>Birdsfoot trefoil 8 kg/ha</td>
<td>Meadow fescue 15 kg/ha</td>
</tr>
<tr>
<td>White clover 8 kg/ha</td>
<td>Tall fescue 15 kg/ha</td>
</tr>
<tr>
<td></td>
<td>Orchardgrass 12 kg/ha</td>
</tr>
<tr>
<td></td>
<td>Meadow brome 15 kg/ha</td>
</tr>
<tr>
<td></td>
<td>Kentucky bluegrass 22 kg/ha</td>
</tr>
</tbody>
</table>
Trial 1: Binary Mixtures for Grazing

- 18 binary mixtures (1 legume + 1 grass)
- 3 sites
  - Nappan – Mob grazing with steers (25 cm)
  - Lévis – Simulated grazing (25 cm)
  - Normandin – Simulated grazing (25 cm)
- Seeded in 2010
- Data recorded in the next five years (2011-2015)
What was Measured?

- Dry matter yield (DMY)
- Contribution of seeded species to DMY (June and August)
- Nutritive value
  - TDN (Energy)
Total Digestible Nutrients (TDN)

- Crude Proteins
- Crude Fat
- Non-structural carbohydrates
- Crude fiber

Total digestible energy in forages
How to Understand Next Three Slides

- Higher DMY: All forage mixtures (blue bar) above the orange line

- Higher DMY and higher TDN: All forages mixtures (blue bar) above the orange line and

- Higher TDN but lower DMY: All forages mixtures (blue bar) below the orange line and
Binary Mixtures: Nappan DMY and TDN: 5 Years Average

Dry Matter Yield (Tonnes/ha)

- White clover
- Birdsfoot trefoil
- Alfalfa
Binary Mixtures: Lévis
DMY and TDN: 5 Years Average

White clover
Birdsfoot trefoil
Alfalfa
Binary Mixtures: Normandin
DMY and TDN: 5 Years Average

Dry Matter Yield (Tonnes / ha)

White clover
Birdsfoot trefoil
Alfalfa
Binary Mixtures: Contribution of Legume to DMY

Nappan

Lévis

Normandin
Binary Mixtures: Nappan
Contribution of Grasses to DMY

![Graph showing contribution of grasses to DMY](image)
Binary Mixtures: Lévis Contribution of Grasses to DMY
Binary Mixtures: Normandin
Contribution of Grasses to DMY

- Timothy
- Kentucky bluegrass
- Tall fescue
- Orchardgrass
- Meadow fescue
- Meadow bromegrass

Graph showing the contribution of different grasses to dry matter yield (DMY) across GY 3, GY 4, and GY 5.
Take-home Message: Trial 1

- Under grazing (Nappan), productivity of binary mixtures are not very much different.

- Overall, tall fescue and meadow fescue are species that contributed to DMY at high level.

- Legume disappeared rapidly within 2-3 years when grazed with animals
Complex Mixtures: Trial 2

- 8 complex mixtures
- 3 sites
  - Nappan – Grazing with steers (25 cm)
  - Lévis – Simulated grazing (25 cm)
  - Normandin– Simulated grazing (25 cm)
- Seeded in 2010
- Data recorded in the next five years (2011-2015)
### Species and Cultivar: Trial 2

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa – CRS1001</td>
<td>Timothy - Express</td>
</tr>
<tr>
<td>Birdsfoot trefoil – AC Langille</td>
<td>Meadow fescue - Pradel</td>
</tr>
<tr>
<td></td>
<td>Tall fescue - Courtnay</td>
</tr>
<tr>
<td></td>
<td>Orchardgrass - Killarney</td>
</tr>
<tr>
<td></td>
<td>Meadow brome - Fleet</td>
</tr>
<tr>
<td></td>
<td>Kentucky bluegrass – Troy</td>
</tr>
<tr>
<td></td>
<td>Reed canarygrass - Venture</td>
</tr>
</tbody>
</table>
Grass Mixtures and Seeding Rate:
Trial 2

- **Mix 1**: Timothy (4 kg/ha), Meadow fescue (7 kg/ha), Reed Canarygrass (2 kg/ha) Kentucky bluegrass (3 kg/ha)

- **Mix 2**: Tall fescue (6 kg/ha), Meadow brome (7 kg/ha), Orchardgrass (4 kg/ha), Kentucky bluegrass (3 kg/ha)

- **Mix 3**: Timothy (5 kg/ha), Meadow fescue (7 kg/ha), Kentucky bluegrass (3 kg/ha)

- **Mix 4**: Tall fescue (6 kg/ha), Meadow brome (5 kg/ha), Reed canarygrass (2 kg/ha), Kentucky bluegrass (3 kg/ha)
Mixtures and Seeding Rate of Legume species: Trial 2

- **Mix 1**: with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TmMfRcBg Bt + TmMfRcBg

- **Mix 2**: with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TfMbOrKb Bt + TfMbOrKg

- **Mix 3**: with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TmMfKb Bt + TmMfKb

- **Mix 4**: with alfalfa (6 kg/ha) or birdsfoot trefoil (6 kg/ha) Af + TfMbRcKb Bt + TfMbRcKb
Nappan Site: What was Measured?

- Dry matter yield (DMY)
- Nutritive value
  - TDN (Energy)
  - Crude Protein
  - Average daily gain
Nappan: Seasonal Dry Matter Yield, 5 Years Average

![Bar chart showing seasonal dry matter yield for different crop species and varieties.](chart.png)
Nappan: Crude Protein Content
5 Years Average
Nappan: TDN Content
5 Years Average

![Bar Chart]

- **Total Digestible Nutrients (% DM)**
- **Trefoil**
- **Alfalfa**

- **TiMfRcKb**
- **TfMbOrKb**
- **TiMfKb**
- **TfMbRcKb**
Nappan: Steer Daily Weight Gain
5 Years Average

Kg/day

TiMfRcKb  TfMbOrKb  TiMfKb  TfMbRcKb

trefoil  alfalfa
Nappan: Gain per Unit of Land Area
5 Years Average

Kg gain/ha

<table>
<thead>
<tr>
<th></th>
<th>trefoil</th>
<th>alfalfa</th>
</tr>
</thead>
<tbody>
<tr>
<td>TiMfRcKb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TfMbOrKb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TiMfKb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TfMbRcKb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Take-home Message: Trial 2

- Mixtures with birdsfoot trefoil had lower DMY than alfalfa but produced more gain per day and per hectare.
Research Team: N- Fertilisation of Complex Mixtures – Trial 3

- Yousef Papadopoulos, Project Leader (AAFC)
- John Duynisveld (AAFC)
- Gilles Bélanger (AAFC)
- Gaëtan Tremblay (AAFC)
- Julie Lajeunesse (AAFC)
- Carole Lafrenière (UQAT)
- Sherry Fillmore (AAFC)
- Ira Mandell (UofGuelph)
N - Fertilisation of Complex Mixtures: Trial 3

- 4 complex mixtures
- 3 sites
  - Nappan – Grazing animals (25 cm)
  - Normandin – Grazing animals (25 cm)
  - New Liskeard – Grazing animals (25 cm)
- Seeded in 2013
- Data recorded in the next three years (2014-2016)
Methodology

Complex Mixtures - Nitrogen Fertilisation

Nitrogen application:
1/2 after first grazing
1/2 after second grazing
Nitrogen Trial: Seasonal DMY

New Liskeard Site

Seasonal production tonnes/ha

<table>
<thead>
<tr>
<th></th>
<th>GY1</th>
<th>GY2</th>
<th>GY3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8,4</td>
<td>9,4</td>
<td>6,8</td>
</tr>
<tr>
<td>60</td>
<td>8,5</td>
<td>10,5</td>
<td>7,5</td>
</tr>
<tr>
<td>120</td>
<td>8,5</td>
<td>10,3</td>
<td>8,6</td>
</tr>
</tbody>
</table>
Contribution of Legume Species to DMY
New Liskeard Site

[Bar chart showing the contribution of different legume species to DMY across different combinations and years.]
DMY for Each Grazing Cycle 2014: New Liskeard site
DMY for Each Grazing Cycle 2015: New Liskeard Site
DMY for Each Grazing Cycle 2016: New Liskeard Site
Timothy/Meadow Fescue vs Tall Fescue/Meadow brome
Year 2016: Early August vs End-September
Take-home Message:

- Tall fescue can secure forage availability during dry season.
- Maturity of tall fescue is important for grazing.
- Animals must be used to tall fescue.
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Acknowledgments:

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