New and Alternative Forages for Modern Dairy Rations in the Northeast

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Some Challenges for Our Dairy Forage Systems

Can Perennial Forages Meet Dairy Quality Needs?

Depends on consistent forage:
- Quality (NDF level)
- Digestibility (NDFD)
- Particle size
- Rate of passage
- Palatability
- Inventory (how much is available)

Larry Chase, 2012

Using NDF for targeting when to harvest your haycrop?

- Legume 40%
- Grass 50%
- Mixture varies
  - MML 42 - 44%
  - MMG 46 - 48%
Are We Meeting Our Target NDF?

2012 Vermont Data
Source of data: Dairy One, Ithaca, NY

Mixed Mainly Grass Silage
Achieved Target NDF of 45 to 50

13%

New York Ave. 56.0
Std. Dev. 6.8

 Achieved Target NDF of 40 to 45

24%

New York Ave. 47.1
Std. Dev. 5.8

Are We Meeting Our Target NDF?

Mixed Mainly Legume Silage

Forage quality data from New York Farms analyzed at the Dairy One Lab (Dec-Feb)

<table>
<thead>
<tr>
<th>Type</th>
<th>Year</th>
<th>Item</th>
<th>n</th>
<th>Average</th>
<th>Normal Range*</th>
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<td>61.4</td>
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<td>62.7</td>
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</table>

*Within one standard deviation

Controlling Forage Quality Consistently?

Storage Management
Feeding Management
Harvest Management
Growing Management
Species, Cultivar and Mixture Selection
Soil Fertility
Soil Quality
Some Challenges for Our Dairy Forage Systems

What’s Happening With Our Weather?

- Prolonged rainy periods
- Too many “100 year” floods
- Extended dry periods
- Increasing temperatures

Why Vermont Crops Fail (2001-10)
Since 1980, Crop Ins. provided
$213 Bil. of Protection and Paid $15 Million
in Loss Payments to VT Farmers

Northeast Annual Precip.: +4.15”/century
(1895-2013)

Northeast Extremes in 1-Day Precipitation (Step 4*)
Annual (January-December) 1910-2013

Trend in 1-day Very Heavy Precipitation
(1958-2010)
Weather Extremes and Forages
Prolonged rainy periods

- Delayed harvest
- Plant stress
- Reduced protein
  - Soil N losses
  - Poor N fixation
- Reduced energy
  - Low sugar content

Temperature and Forage Quality

Elevated Temperature and Forage Quality

- Earlier reproductive development
- Plant stress
- Lignification
  - Lower NDFD
- Reduced energy
  - Low sugar content

Change In New York Summer Temperature

What’s the impact on forage quality?

*NOAA National Climatic Data Center
What Can Farmers Do To Control in Their Forage Program?

- Species/variety selection
- Soil management
- Fertility and liming
- Pest and weed management
- Cutting/grazing practices
- Storage
- Feeding

Species And Cultivar Selection

- Yield
- Quality
  - Crude protein
  - Digestibility
  - Tolerance of frequent harvests
  - Leaf texture*
- Maturity (early to late)
- Disease resistance
- Winter hardiness
- Persistence (short term vs. long term rotation)
- Endophyte enhanced

Selecting Grasses for Yield

- Grass species vary in yield but varietal differences can be larger than species

Selecting Grasses for Quality

- Want grasses that tolerate intensive cutting
  - Tall or Meadow Fescue
  - Ryegrass Group
  - Orchardgrass
  - Reed Canarygrass
What About Timothy?

- Tolerates wet sites
- Winter hardy
- Easy to establish

But…
- Does not tolerate early, frequent cuts
- Low summer yield
- Lower in CP than other CSGs

Proportion of Reproductive Tillers

<table>
<thead>
<tr>
<th>Timothy</th>
<th>Orchardgrass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost 100%</td>
<td>Varies but less than 100%</td>
</tr>
</tbody>
</table>

Change in NDF Over Time

- Optimum NDF for grasses
- Colored arrows indicate date of boot/early head

Staging Grasses

- Vegetative
- Elongating
- Boot
- Heading

# 17

# 19

# 20
Tiller Stages of Grass Treatments

How does this affect forage quality of these grasses?

Tall Fescue as part of a haylage mixture for NY and VT

Source: Cherney, Cornell

Fescue Adaptation

Tall fescue is more tolerant to heat than other cool season grasses, yet quite winter hardy. Better summer yields compared to other cool season grasses.
What about quality and palatability issues with tall fescue?

- Endophyte levels

Endophyte Infected Tall Fescue

Fungal hyphae grow between plant cells, with the highest concentrations in the stem and seedheads.

How much older tall fescue is around?

Endophyte levels

- Infected Tall Fescue

Pollen contains no endophyte.

Endophyte mycelium in seed.

Endophyte in leaf stem tissue.
Tall Fescue Alkaloids

Ergovaline
One of the Ergot Alkaloids

Loline

Testing for endophyte
- ELISA test
- Randomly collect 60 to 100 fresh tillers
- Cut out and save the lower portion (crown and lower three inches of the tiller)
- Keep cool and fresh

Stem cross sections are placed in ELISA cells for detection

Northeast study conducted by USDA-ARS

Abundance in the Northeast: Tall fescue was found on 89% of the farms sampled and 84% of the pastures. Its average cover was 17.3% where present (range 0.1 - 89.9%).

Small Plot Site, Randolph, VT
18 Commercial Mixtures
5 Festulolium cultivars with white clover
4 Orchardgrass cultivars with white clover
1 Alaska bromegrass with white clover

Three replications
What about quality and palatability issues with tall fescue?

- Endophyte levels
- Leaf coarseness

**Tall Fescue Leaves Can Be Very Coarse**

**Softer-Leaved Tall Fescue**
“Harsh” variety

Red circles indicate leaf spine presence

“Soft” variety

Red circles indicate leaf spine presence

Hartley et al., 2015. Frontiers in Plant Science: Vol. 6, Art. 35 (Un. of York, UK)

“The spines present on the harsh variety were bigger in size and the point of the spines were spear-like in appearance; these spines also appeared to protrude more from the surface compared with the soft variety, where the spines were smaller in size and the points of the spines lay closer to the surface of the leaf.”

Hartley et al., 2015. Frontiers in Plant Science: Vol. 6, Art. 35 (Un. of York, UK)

Harsh Verses Soft-Leaved Tall Fescue

The spines were rich in Si and there were other Si deposits on the leaf surface in the form of silica short cells.

Generally, the harsh variety (A) had a greater over surface deposition of Si compared with the soft one.

The soft variety (B) deposited Si as silica short cells on the leaf surface within fewer, smaller leaf spines containing less Si than in the harsh variety.

Scanning electron microscope (SEM) represented by grey images. Electron density X-ray spectroscopy (EDX) represented by black and green images; green intensity indicates Si concentration. Red circles indicate trichomes with Si deposition. Red arrows indicate silica short cells.

Hartley et al., 2015. Frontiers in Plant Science: Vol. 6, Art. 35 (Un. of York, UK)

What about quality and palatability issues with tall fescue?

• Endophyte levels
• Variety differences in leaf coarseness
• Variation in Si uptake due to varied soil drainage classes
Meadow Fescue

- A cold climate grass originally from northern Europe
- Introduced in the U.S. and Canada in the early 1800’s
- Lost out in popularity in the mid 1900’s – more or less forgotten
- Rediscovered in 1990’s by Wisconsin dairy grazing farmer in the Driftless region of southwestern Wisconsin

Conclusions

1. Leaf softness did not affect grazing preference.
2. Endophyte infection might affect grazing preference when biotic/abiotic stress causes plant death.
3. Overall, there is very little variation in tall fescue for grazing preference.
4. Therefore, tall fescue breeding programs should focus on forage yield and nutritional quality.
### Fescue Adaptation

Meadow fescue is a cold climate grass.

Tall fescue is more tolerant to heat than other cool season grasses, yet, quite winter hardy.

### Meadow Fescue Quality

NDF digestibility at each cut of five cultivars (means of two residual sward heights, two locations and two years)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Cutting</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Azov Meadow Fescue</td>
<td></td>
<td>65.3</td>
<td>66.2</td>
<td>65.9</td>
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<tr>
<td>Bartura Meadow Fescue</td>
<td></td>
<td>65.7</td>
<td>66.0</td>
<td>68.6</td>
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<tr>
<td>Hidden Valley Meadow Fescue</td>
<td></td>
<td>68.4</td>
<td>67.7</td>
<td>70.0</td>
</tr>
<tr>
<td>Barolex Tall Fescue</td>
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<td>61.4</td>
<td>59.0</td>
<td>64.2</td>
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<tr>
<td>Bronc Orchardgrass</td>
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<td>59.8</td>
<td>60.4</td>
<td>61.3</td>
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<tr>
<td>LSD (0.05)</td>
<td></td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
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</table>

Source: Brink, Casler and Martin. 2010. Agronomy J. 102: 687-874

### Orchardgrass, Tall Fescue and Meadow Fescue Quality

Source: Bosworth and Darby, Un. of Vermont

Source: Bosworth and Darby, Un. of Vermont
Meadow Fescue yield is lower than tall fescue but could still contribute to alfalfa or red clover mixtures.

Selecting Grasses

- Match reproductive maturity (heading) to needs

<table>
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<tr>
<th>Variety</th>
<th>Yield Index</th>
<th>Heading Date</th>
<th>Distributor</th>
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<tbody>
<tr>
<td>Early (%) of Orca</td>
<td>100</td>
<td>100</td>
<td>May 16</td>
</tr>
<tr>
<td>Orca</td>
<td>102</td>
<td>95</td>
<td>May 20</td>
</tr>
<tr>
<td>Rapido</td>
<td>105</td>
<td>97</td>
<td>May 26</td>
</tr>
<tr>
<td>Haymate</td>
<td>98</td>
<td>98</td>
<td>May 30</td>
</tr>
<tr>
<td>DIVIDEND VL</td>
<td>84</td>
<td>101</td>
<td>June 11</td>
</tr>
<tr>
<td>OKAY</td>
<td>100</td>
<td>100</td>
<td>June 1</td>
</tr>
</tbody>
</table>

1 Average yield of Orca in trials - southern Ontario 9.0 t/ha, northern Ontario 7.9 t/ha.
2 Average yield of OKAY in trials - southern Ontario 8.3 t/ha, northern Ontario 7.5 t/ha.

http://www.omafra.gov.on.ca/english/crops/field/forages/rethinking.htm
Change in Quality of Five Cultivars of Orchardgrass
South Burlington Vermont

Early Cultivar Head*
Extend 21-May
Profit 24-May
Niva 25-May
Intensive 28-May
Athos 30-May
*Collected in 2015

Source: Bosworth and Darby Un. of Vermont

Temperature and Grass Development

Grass Heading Date Study - South Burlington

<table>
<thead>
<tr>
<th>Variety</th>
<th>1997</th>
<th>1998</th>
<th>Difference</th>
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<tr>
<td>Orchardgrass</td>
<td>30</td>
<td>4-Jun</td>
<td>23-May</td>
</tr>
<tr>
<td>Timothy</td>
<td>44</td>
<td>15-Jun</td>
<td>11-Jun</td>
</tr>
</tbody>
</table>

Spring Conditions
Cool
Warm

Orchardgrass development is very responsive to temperature, whereas Timothy development is more responsive to day length.

Time of Grass Seedhead Development As Influenced By Temperature and Day Length

Frequency distributions for date of heading for the same set of orchardgrass varieties (n = 30) and timothy varieties (n=44) in 1997 and 1998, South Burlington, VT

Temperature and Grass Quality

Accumulative Growing Degree Days (Base 40°F)

# 30

# 31

# 32
Change in NDF content of orchardgrass and timothy

Pizza Orchardgrass  Sunrise Timothy

Selecting Grasses
- Rust resistant varieties (and other leaf diseases)

Grass Disease Ratings

Selecting Grasses
- Rust resistant varieties (and other leaf diseases)
Perennial Ryegrass Winter Injury
South Burlington
5/15/2013

But ... 10 cm (4 inches) of snow cover has been reported to be enough to maintain soil surface temperatures near 0 C.

<table>
<thead>
<tr>
<th>Site</th>
<th>T min</th>
<th>Snow Cover</th>
<th>T min</th>
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<tr>
<td></td>
<td>Degree C</td>
<td>cm</td>
<td>Degree C</td>
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<tr>
<td>Maine</td>
<td>-28.9</td>
<td>60</td>
<td>-20.6</td>
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<tr>
<td>New Hampshire</td>
<td>-22.8</td>
<td>23-30</td>
<td>-15.6</td>
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<tr>
<td>Pennsylvania</td>
<td>-24.3</td>
<td>18</td>
<td>-22.8</td>
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<tr>
<td>Vermont</td>
<td>-26.1</td>
<td>18</td>
<td>-18.8</td>
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Festulolium Winter Injury
Randolph Center, VT
**Italian Ryegrass**

- Most rapidly establishing species
- Very high yields (if you treat it ‘right’)
- Disease resistance varies among varieties
- Plant EARLY
- LOVES NITROGEN
- Short cutting schedule
- High fiber digestibility
- Sugars/starches

Source: Dan Hudson, UVM Extension

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**2015 Italian Ryegrass Forage Quality, Jericho, VT**

<table>
<thead>
<tr>
<th>Date</th>
<th>CP</th>
<th>ADF</th>
<th>NDF</th>
<th>NFC</th>
<th>NDFd-30</th>
<th>TTNDFD</th>
<th>RFV</th>
<th>RFQ</th>
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<td>12-Jun</td>
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<td>25.3</td>
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<td>67.3</td>
<td>78.6</td>
<td>63.1</td>
<td>177</td>
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<td>12-Jun</td>
<td>16.6</td>
<td>24.9</td>
<td>34.4</td>
<td>37.7</td>
<td>69.9</td>
<td>80.4</td>
<td>66.6</td>
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<td>3-Jul</td>
<td>22.9</td>
<td>27.5</td>
<td>38.9</td>
<td>25.6</td>
<td>66.2</td>
<td>82.7</td>
<td>73.9</td>
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<td>20-Aug</td>
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<td>27.3</td>
<td>67.8</td>
<td>74.9</td>
<td>58.6</td>
<td>134</td>
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</tbody>
</table>

Source: Kirsten Workman and Dan Hudson, UVM Extension

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**Low Lignin Alfalfa**

Does it fit in NY and VT?

- 7 to 10 percent less lignin than conventional alfalfa varieties
- 10 to 15 percent less lignin than conventional alfalfa varieties

Source: Dan Undersander, Un. Wisconsin

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**Source:**

Dan Hudson, UVM Extension

Kirsten Workman and Dan Hudson, UVM Extension

Dan Undersander, Un. Wisconsin
What grasses would fit with low lignin alfalfas?

Red Clover Persistence

- Newer red clover more persistent
  - 100% red clover ground cover at 9 or more plants per sq. ft
  - Not all new red clover varieties are equally persistent

Red Clover

- Perennial forage legume
  - Forage (hay, pasture, silage)
  - Nitrogen fertility source

- Advantages
  - Easy to establish
  - Shade tolerant
  - Does well in low pH soil
  - High yielding
  - Grows well with grasses
  - Lower degradable protein

- Disadvantages
  - Less persistent (3-4 years)

Forage Quality is the Key!

Storage Management
Feeding Management
Grazing Management

Harvest Management

Pests and Disease

Growing Conditions

Species, Cultivar and Mixture Selection

Soil Fertility

Source: Cherney 2015

“Overall, only 16 percent of the alfalfa acreage was seeded as pure alfalfa; the rest was seeded with perennial grass.”

Source: Heathcliff Riday, USDA Dairy Forage Research Center

Red Clover Persistence

Source: Heathcliff Riday, USDA Dairy Forage Research Center
"Imagine the Earth without grasses. There would be no lawns or meadows. No prairies. No savannahs or steppes. No wheat fields or rice paddies. No sugar cane. No sheep, elephants or horses. No people."
- Olivia Judson