Birdsfoot Trefoil as a Forage on Organic Dairy Farms

- BFT basics
- Past BFT dairy data
  - BFT tannins
- Utah BFT organic dairy research
  - Rationale for organic research
  - Study design
  - Establishment
    - BFT seeding rate study
  - Results
    - Forage availability and disappearance
    - Milk production
    - Cheese fatty acids
- BFT for beef production
  - Average daily gains
  - Sensory panel data

The Shoot of Birdsfoot Trefoil (BFT)

“Birdsfoot” refers to the shape of the seedhead. Clusters of 3 to 6 flowers develop into inch-long brown pods that each contain about 20 seeds.

Fairy & Smith 1999 Trefoil: the science and technology of Lotus, Ch. 9 Seed Production
The Shoot of Birdsfoot Trefoil (BFT)

“Trefoil” refers to the 3 leaflets at the tip of the leaf, but each BFT leaf actually has 5 leaflets, 3 at the tip and 2 more at the base of the leaf.

Fairy & Smith 1999 Trefoil: the science and technology of Lotus, Ch. 9 Seed Production

Birdsfoot Trefoil Adaptation

The Penn State Extension bulletin on Birdsfoot Trefoil compares its adaptation to alfalfa:

“Soils with few limitations are generally sown to alfalfa. Soils with a low pH, poor drainage, poor native fertility, or fragipans prone to heaving are not suitable for alfalfa production. Birdsfoot trefoil (Lotus corniculatus L.) is a forage legume that is more tolerant of these adverse production conditions.”

However, birdsfoot trefoil also yields well and is persistent on soils with “few limitations,” just like alfalfa!

From Agronomy Facts 20
http://extension.psu.edu/plants/crops/forages/species/birdsfoot-trefoil
Birdsfoot Trefoil Adaptation

Average season total dry matter yields of legumes plus weeds of 14 birdsfoot trefoil cultivars grown at three locations in 2006 and 2007. (Mg ha⁻¹ = 0.446 U.S. tons per acre).

Tannin Concentrations:
- Michigan: 3.1%
- Utah: 1.9%
- Wisconsin: 2.1%

The Root and Crown of Birdsfoot Trefoil

Birdsfoot trefoil is deep-rooted, but most carbohydrate storage occurs in the fall.

This makes fall management important to the persistence of birdsfoot trefoil.

The Root and Crown of Birdsfoot Trefoil

One-year old crowns and roots of BFT (left) and alfalfa (right). The line indicates the soil surface.

The Root and Crown of Birdsfoot Trefoil

Root carbohydrate storage differences with 3 cuttings. Birdsfoot trefoil stores less than red clover or alfalfa.

Birdsfoot trefoil retains its quality and can be used for stockpiling (Mike Collins Agronomy Journal 1982).
Perennial ryegrass pastures with increasing amounts of birdsfoot trefoil (Lotus): none, 15%, 29% and 45%.

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount of lotus in diet (g Lotus DM/100g DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Intake (kg DM/cow/d)</td>
<td>15.1</td>
</tr>
<tr>
<td>Milk yield (kg/cow/d)</td>
<td>14.3</td>
</tr>
<tr>
<td>Milk fat (%)</td>
<td>5.29</td>
</tr>
<tr>
<td>Milk protein (%)</td>
<td>3.60</td>
</tr>
<tr>
<td>Milk solids yield (kg/cow/d)</td>
<td>1.27</td>
</tr>
<tr>
<td>Milk N output (g N/cow/d)</td>
<td>80.7</td>
</tr>
</tbody>
</table>

There is 29% more milk production with 45% BFT.
Excreted waste nitrogen is "transferred" from the urine to the feces.

Fecal nitrogen output increased with BFT.

Urinary nitrogen output decreased with BFT.
This study compared cows fed perennial ryegrass or birdsfoot trefoil (Lotus). PEG (polyethylene glycol) was used to eliminate the effects of tannins.

Milk yield was 32% higher for cows fed BFT (Lotus vs. Ryegrass).

Methane on the basis of milk solids production was 32% lower for cows fed BFT.
Why Do BFT Tannins Increase Milk Production?

All tannins can prevent bloat and reduce internal parasites. BFT tannins precipitate excess plant proteins in the rumen, preventing bloat, but they release those proteins in the abomasum as by-pass protein (Waghorn, 2008).

How Do Tannins Prevent Bloat?

10 g of leaves of each forage (sainfoin, BFT and alfalfa) were blended in pH 5.6 buffer and allowed to stand for five minutes. Higher stable foam predicts greater bloat (Rumbaugh, 1968).

The Benefits of Tannin-Containing Forages

This is a new Extension publication by collaborators on the organic dairy project that discusses the beneficial aspects of tannins in forages.
Rationale for Organic Dairy Research

From McBride and Greene, 2009: feed costs were 25% lower for the organic dairies that used the most pasture compared with the organic dairies that used the least pasture.

Rationale for Organic Dairy Research

From McBride and Greene, 2009: milk production was 30% lower for the organic dairies that used the most pasture compared with the organic dairies that used the least pasture.

Rationale for Organic Dairy Research
Utah Organic Dairy Research

Study participants used 10 acres of existing grass pasture and planted 10 acres of BFT pasture to use in the dairy grazing study.

The red outline is around the grass and BFT pastures, with the grass pasture on the left and the BFT pasture on the right. This farm was sprinkler irrigated.

Utah Organic Dairy Research

Pastures were designed for a 6-week rotation with 84 12-hour breaks (7 days/week x 6 weeks x 2 breaks/day). Each break had about 0.12 acres for 9 cows.

Water tanks were located in laneways (O), and only laneway t-posts for fencing and gates were added.

Utah Organic Dairy Research

Birdsfoot Trefoil Pasture
Establishment of BFT:
In autumn of 2010, old stands of pasture were plowed. In spring 2011, organic oats were planted. Seedbeds were prepared for autumn 2011 planting. Seeding was done with a Brillion "Sure Stand" Seeder. ‘Norcen’ BFT was coated with OMRI-certified Apex™ Green Coating included Nitragin K rhizobium inoculum. Seed was broadcast at 25 kg PLS per ha (22 lbs. per acre). Seeding dates ranged between 26 July and 8 September. Farms ID-1 and ID-2 were sprinkler irrigated. Farms ID-3, UT-1 and UT-2 were all flood irrigated.

Establishment data taken about 3 weeks after planting, and the next spring. Farm ID-2 was shown in the previous slides. 100 plants/m² is a satisfactory stand.

Successive subdivisions of the seeding rate study site
Organic BFT Seeding Rate Study

Organic BFT seeding rate study yield data, mean of 3 years of production following the planting year (2010).

Organic BFT Seeding Rate Study

Organic BFT seeding rate study % cover data, taken in the spring of 2013, the 3rd production year.

Utah BFT Organic Dairy Research

Forage availability is reported in kg ha⁻¹, and represents the forage dry matter in a given paddock before grazing.

Grazing did not start until June 20 because this was the year following seeding.

Pasture dry matter was determined with a calibrated rising plate meter.
Intake differences were greater than yield differences because legumes are more digestible than grasses.

Units are kg/cow/day, and cows also received 10 lbs. of concentrate with minerals each day.

Milk yields are also in kg/cow/day (kg x 2.205 = lbs.). Milk production was measured morning and evening for 2 days.

Tannin concentrations changed with forage maturity.

Grass pastures were mixtures of perennial ryegrass, orchardgrass, tall fescue, quackgrass and white clover.

Tannin in grass pastures could have come from weeds or from white clover flowers.
Why Do Cows Produce More Milk on BFT?

In addition to BFT tannin effects, there is less fiber in legumes than in grasses.

<table>
<thead>
<tr>
<th></th>
<th>NDF</th>
<th>ADF</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BFT</td>
<td>54%</td>
<td>39%</td>
<td>17%</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>70%</td>
<td>42%</td>
<td>10%</td>
</tr>
</tbody>
</table>

From Wen et al., 2002

BFT Forage Nutritive Value Data

Variety trial data carried out in Utah that compared two alfalfa check cultivars with 14 BFT cultivars. Plants were sampled at harvest, in early June, mid-July and late August. Alfalfa NDF was higher, but BFT non-fibrous carbohydrates were higher.

From MacAdam and Griggs, 2013

Utah BFT Yield and Forage Nutritive Value Data
Utah BFT Organic Dairy Research - Cheese

In a comparison of cheese made from the milk of TMR-, grass- and BFT-fed cows, omega-3 fatty acid concentration was TMR<grass<BFT. CLA concentration was TMR<grass & BFT.

Utah BFT Beef Research – Liveweight Gain

Angus gains on BFT pastures gained about 2 lbs. per day from late May to mid-September (111 d), and finished low choice.

Utah BFT Beef Research – Liveweight Gain

These 10 Angus-Simmental cross steers gained 3.63 lbs. per day for 104 days on a 6.5-acre BFT pasture (953 --> 1331 lbs.); the two we slaughtered finished high select.
Utah BFT Beef Research – Sensory Panel Data

Red = grain-finished, blue = grass-finished, green = BFT-finished. Left – USU-raised; right – purchased. 6 panels x 120 consumers.

Future BFT Research – Enteric Methane

Our research in 2014 will compare the methane output of cows on BFT, grass and cicer milkvetch (non-tannin) pastures.

Future BFT Research – Plant Breeding

A grant led by Edzard van Santen from Auburn University will select BFT for the Eastern Transition Zone (upper South and Midwest). BFT tannins appear to reduce the negative effects of the alkaloids produced by endophyte-infected tall fescue.