Alfalfa: Crop of the Future

Presentation by Neal Martin

A. Introduction

1. Alfalfa helps protect and improve our environment
2. Alfalfa grows where water needs protection
3. Alfalfa production
   a. Alfalfa hay acreage and production

Fig 1. Leading alfalfa hay harvest states, 1,000 acres, 2005

- Top ten harvest states represent 64% of U.S. acreage and 59% of production
- U.S. harvest, 22.4 million acres

Fig 2. Leading alfalfa hay production states, 1,000 tons, 2005

- Top ten states represent 60% of U.S. production and 63% of acreage, $3.9 billion
- U.S. production, 75.8 million tons
b. Alfalfa forage acreage and production which includes haylage and green chop

Fig 3. Leading alfalfa forage acreage, 1,000 acres, 2005

-Top ten states represent 64% of acreage and 60% of U.S. production
- U.S. acreage, 24.4 million

Fig. 4. Leading alfalfa forage production states, 1,000 tons, 2005

-Top ten states represent 61% of production and 61% of acreage
- U.S. production, 86.1 million tons
- Since the cropping year of 2000 National Agricultural Statistics Service has collected acreage and production data for haylage and green chop of alfalfa from 8 states (Vermont, New York, Wisconsin, Pennsylvania, Minnesota, Michigan, West Virginia, and Washington). In 2005, eleven more were added (California, Idaho, Illinois, Iowa, Kansas, Missouri, Nebraska, New Mexico, Ohio, South Dakota, and Texas) and West Virginia was dropped. Alfalfa was harvested as haylage and green chop from 3.3 million acres in 2005 from these 18 states.

B. Use of alfalfa by livestock industries

1. Dairy industry

Table 1. Changes in U. S. dairy industry since 1935

<table>
<thead>
<tr>
<th>Year</th>
<th>Dairy farms</th>
<th>Milk cows</th>
<th>Total milk</th>
<th>Cows/farm</th>
<th>Milk/cow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thousands</td>
<td>1,000 hd</td>
<td>billion lbs</td>
<td>cows</td>
<td>lbs/hd/yr</td>
</tr>
<tr>
<td>1935</td>
<td>&gt;4,100</td>
<td>24,187</td>
<td>100</td>
<td>6</td>
<td>4,184</td>
</tr>
<tr>
<td>1965</td>
<td>1,108</td>
<td>14,953</td>
<td>124</td>
<td>13</td>
<td>8,305</td>
</tr>
<tr>
<td>2005</td>
<td>78</td>
<td>9,044</td>
<td>177</td>
<td>116</td>
<td>19,570</td>
</tr>
</tbody>
</table>

Fig. 5. U. S. annual milk production of top ten states in 2005, million pounds.

-Top ten states produce 72% of U. S. milk with 70% of cows and 58% of operations
-177 billion lb
-9 million head
a. Less alfalfa being fed in dairy rations
   - Lower yield of alfalfa than other crops
   - Increased use of corn silage
   - Minimized forage in ration
   - Increase availability of by-product feeds

   - High potassium content causing milk fever in freshening cows

b. Barriers to increasing alfalfa on dairy farms
   - Expense to produce, harvest and store
   - Excessive Non-protein nitrogen in dairy diets
     Post harvest proteolysis – impact on dairy production

Red clover vs Alfalfa Silage
Strategies for decreasing post-harvest proteolysis in silage

- Low extent of fiber digestion

c. Overcoming barriers to cell wall digestibility
   - Ferulic acids play a role in limiting digestibility
   - Breeding efforts underway to increase NDF digestion of stems
   - Altered lignin content/composition in alfalfa
     Low lignin transgenic alfalfa produced based on “knockout” of enzymes involved in lignin biosynthesis

d. Strategies to reduce post-harvest proteolysis in alfalfa silage
   - transgenic alfalfa produced that contains
     o Enzyme Polyphenol Oxidase (PPO) – gene isolated from red clover
     o Tannins – alter expression of genes for alfalfa tannin biosynthesis

e. Strategies to reduce incidence of bloat

2. Beef industry

a. More total beef than dairy cattle

b. Alfalfa the single most important forage in beef cattle rations
3. Horse industry

   a. Horse numbers within U. S. are increasing

   b. Use of alfalfa for horses

C. Potential new uses for alfalfa

1. Electric generation

   a. Potential to generate electricity from baled alfalfa hay
      - Produce electricity from gasification of stems and make new livestock feed from leaf meal

   - Generate 75 MW combined cycle power plant
      50 MW generated by gasification of alfalfa stems
      25 MW power from steam generated by gas turbines

   - Requires Alfalfa Producers Cooperative
      Grow 750,000 tons alfalfa/year
      Produce 75 MW of electricity
      Sell alfalfa leaf meal

b. High phytase Transgenic Alfalfa

   - enzyme in alfalfa juice reduced P levels of manure from monogastric animals (pigs and chicks) by 50 %
   - Chicks fed alfalfa juice with Phytase increased in growth rate
   - Phytase in transgenic is heat stable
c. Protein production from liquid fractionation
   - Extract is 55% protein
   - Good balance of trace minerals
   - High in xanthophylls

d. Ethanol production

![Biomass Conversion to Ethanol Diagram](image)

- Enzymatic Breakdown of Polysaccharides
- Electricity & Processing Heat
- Residual Solids
- Fermentation
- Ethanol Recovery

- Grind
- Pretreatment to Remove Inhibitors
- Sugars


e. Produce bioadhesives from fermentation of alfalfa stems

f. Produce pharmaceuticals

D. Alfalfa in crop rotations
   1. Adds nitrogen via biological fixation
   2. Improves water infiltration and soil quality
   3. Reduces soil erosion from wind and water
   4. Improves yield of subsequent crop
   5. Reduces N fertilizer demands of subsequent crops
a. Protects surface and ground water

b. New non-fixing alfalfa developed to increase N intake from soil

c. New alfalfa developed for rapid root development to quickly - Capture nutrients

Table 2. Potential Use of Alfalfa by Livestock

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Number Million</th>
<th>lb/hd/day</th>
<th>Tons/year million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>8.9</td>
<td>24</td>
<td>218</td>
</tr>
<tr>
<td>Beef cow (&gt;1/3 pregnancy)</td>
<td>33.8</td>
<td>6</td>
<td>203</td>
</tr>
<tr>
<td>Steer &gt; 500 lb</td>
<td>14.5</td>
<td>11</td>
<td>160</td>
</tr>
<tr>
<td>Replacement &lt; 500 lb</td>
<td>4.6</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>Market lamb</td>
<td>1.7</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Horse (adult pleasure)</td>
<td>11.0</td>
<td>10</td>
<td>110</td>
</tr>
</tbody>
</table>

Total 74.5 740