Don’t overlook the benefits of perennial forages for soils, crops, and water quality

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Michael Russelle, USDA-ARS-PSRU, St. Paul, MN
Alfalfa is widely adapted in the USA

2002 Agricultural Census

United States: Alfalfa Hay

Yellow numbers indicate the percent each state contributed to the total national production. States not numbered contributed less than 1% to the national total.

Note: Counties shaded in gray contain data that are not published by NASS, and hence were not used in delineating the major and minor agricultural areas. Additional information on these agricultural data can be found at: http://www.nass.usda.gov/census/

- Major areas combined account for 75% of the total national production.
- Major and minor areas combined account for 99% of the total national production.
- Major and minor areas and state production percentages are derived from NASS 2002 Census of Agriculture data.

USDA World Agricultural Outlook Board
Joint Agricultural Weather Facility
Declining alfalfa acreage

Consolidation of livestock industry
Changing feed practices
(increased corn silage & soybean meal)

In the past 50 years alfalfa declined by 136,000 acres annually
Shift to more corn silage and less alfalfa for lactating cows

- DM and energy per acre
- Alfalfa winter-kill
- High degradability of alfalfa protein
- Improved corn silage hybrids
- More consistent forage quality
- Faster silo filling
- Manure nutrient management

But... Other considerations

R. Shaver, UW-Dairy Science
Perennial forages in rotations conserve resources

- Fertilizer N credit
- Corn yield increase
- Less pesticide use
- Spread labor needs

- Improves soil quality
- Erosion control
- Improves water quality
- Wildlife habitat
Fertilizer N replacement value

Lower fertilizer N costs (2 yr)
No insecticide required (1 yr)

DeWitt, 2002
Fertilizer N replacement value and other rotation effects

DeWitt, 2002

Other rotation effects

- Lower fertilizer N costs (2 yr)
- No insecticide required (1 yr)

Corn yield benefit

Fertilizer N replacement value
## Fertilizer N Credits

<table>
<thead>
<tr>
<th>Crop</th>
<th>Typical</th>
<th>Range</th>
<th>$ @ .40</th>
<th>$ @ .80</th>
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</thead>
<tbody>
<tr>
<td><strong>Alfalfa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>130</td>
<td>110-150</td>
<td>52</td>
<td>104</td>
</tr>
<tr>
<td>Fair</td>
<td>100</td>
<td>70-120</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Poor</td>
<td>70</td>
<td>40-90</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td><strong>Red Clover/Trefoil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>90</td>
<td>80-120</td>
<td>36</td>
<td>72</td>
</tr>
<tr>
<td>Fair</td>
<td>70</td>
<td>60-90</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>Poor</td>
<td>50</td>
<td>40-70</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td><strong>Grass</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>70</td>
<td>---</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>Fair-Poor</td>
<td>40</td>
<td>---</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td><strong>2nd Year</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>0-75</td>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>

*Ext Recommendations: WI, MN, PA, VT; costs are per lb of fertilizer N*
Regrowth makes a difference in N Credit

<table>
<thead>
<tr>
<th>Alfalfa Stand</th>
<th>Regrowth</th>
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<tbody>
<tr>
<td></td>
<td>&gt; 8 inches</td>
</tr>
<tr>
<td></td>
<td>lb N/acre</td>
</tr>
<tr>
<td>Good</td>
<td>190</td>
</tr>
<tr>
<td>Fair</td>
<td>160</td>
</tr>
<tr>
<td>Poor</td>
<td>130</td>
</tr>
</tbody>
</table>

Regrowth of > 8 inches = extra 40 lb N/A

Should you harvest or plow down year-end regrowth?
- Do you need the extra N credit?
- Compare to net value of extra forage.

Medium/fine textured soils; Univ Wisc Ext (Laboski et al, 2006)
Perennial Forages and Soil and Water Quality

- Erosion control
- Soil quality
- Water quality
  - Runoff
  - Leaching
Alfalfa in Rotation Reduces Erosion (RUSLE2)

Miami silt loam, 200 ft 5% slope; Dodge Co, WI; alfalfa-spring seeding w oats
RUSLE2 Calculations by Brian Hillers, NRCS-WI
Alfalfa Improves NRCS Soil Conditioning Index (SCI)

- Soil OM Increase
- Soil OM Decrease

Miami silt loam, 200 ft 5% slope; Dodge Co, WI; alfalfa-spring seeding w oats
SCI Calculations by Brian Hillers, NRCS-WI
Alfalfa builds soil C and N

Quebec, Canada
Angers, 1992

3 yr perennial - 3 yr annual

40-yr study. Alejandro La Manna, INIA, Uruguay

Annual cropping
Perennial forages in rotation improve soil quality (SQI)

SQI = SMAF Soil Quality Index

Karlen et al., 2006

30-yr, Lancaster, WI
C=corn, Sb=soybean,
M=alfalfa/red clover
Forage cover crops improve soil quality (SQI) in no-till silage corn

SQI = SMAF Soil Quality Index

Jokela et al., 2009
Perennial Forages and Water Quality -- Surface Runoff

- In row crop systems most P is lost with eroded sediment
- Reduced erosion with forage = lower P loss
- But...
  - Erosion in establishment year
  - Dissolved runoff P from frozen forage vegetation

\[ y = 0.0012x + 0.0186 \]
\[ R^2 = 0.82 \]

Silage corn, convention tillage, Marshfield, WI. (2 events excluded). Jokela et al
Alfalfa improves surface water quality – Leaching to subsurface tile

- Alfalfa and CRP vs Corn/Corn-SB
  - Less tile discharge
  - Much lower nitrate-N concentration
  - Much reduced nitrate loss

Lamberton, MN  Randall et al., 1997
How about alfalfa “waterways”?

Alfalfa “waterways” work well with tiles at normal depths (3-4 feet)
What about manure on perennial forages?

**Benefits**
- Supply nutrients: P, K, micros (N on grass)
- In-season applications
- Large nutrient removal
- Limits nitrate leaching

**Concerns**
- Plant damage
- Soil compaction
- Pathogen and disease risk?
- Nutrient runoff
- Excessive N at stand termination if big N credit
Alternative Application Methods

- Improved N utilization
- Less contamination of forage
- Decreased nutrient runoff
- More uniform application
Benefits of perennial forages in dairy cropping systems

- Provide N credits and lower fertilizer costs
- Increase corn yields in rotation
- Reduce erosion
- Improve water quality - surface runoff and nitrate leaching
- Improve soil quality
- Additional window for manure application
- Wildlife habitat