“Use of annual forages in pasture rotations and as cover crops to benefit small ruminant farming systems”

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Challenge to forage production systems on small ruminant farms:

Can we alter and optimize forage systems to:

• Improve whole-farm forage utilization?
• Meet the nutritional needs of the highly productive animals?
• Lower cost of production?
• Improve soil and land carrying capacity?
• Improve animal health/welfare?
Efficient pasture-based systems strive to match animal needs and forage availability.

- Seasonal pasture growth
- Harvest Excess (Hay/Haylage and/or deferred grazing)
- Late Pregnancy & Lactation
- Feed Stored Excess
- Feed Stored
- May & June

Year
Supply side strategies to improve whole farm forage utilization:

1. Improve grazing management of perennial pastures
2. Improve harvest management of perennial excess
3. Diversify the forage base: Include annual forages in perennial rotation and/or as cover crops to improve forage availability (quality and quantity) for grazing or machine harvest, improve soil and land carrying capacity.
How can forage base diversification with annual forages improve whole-farm forage utilization?

- **Fill in deficits** in perennial pasture production
  - ✓ extend the grazing season and **reduce stored forage use**

- **Improve forage quality at times of need**
  - ✓ **Improve energy** content of forage (soluble CHO and fiber digestibility)
    - ➢ Late pregnancy and lactation of prolific ewes
    - ➢ Growing lambs

- **Provide “safe” forages, low in parasite infectivity**

- **Improve productive capacity of the land**
  - ✓ Replacement of low productivity pastures
    - ➢ Addition of soil amendments (manure, lime, etc.)
    - ➢ Replace with more productive and/or palatable species
  - ✓ Rests perennials to improve productivity and resilience
  - ✓ Annuals can out-yield perennials if strategically planted
  - ✓ Allows an increase in total forage output including stored forage
Case study of a complimentary forage rotation system:

• Perennial pasture renovation targets:
  ✓ Pastures of poor yield and/or species composition
  ✓ Pasture birth paddocks

• Year 1- Brassica, warm season (C4) or brassica/C4 mixture planted into herbicide killed sod after approx. 50-60% of seasonal biomass production has been harvested by grazing or machine harvest

• Year 2- Red clover, Italian ryegrass, chicory (biennial/short term perennial mixture) planted into brassica/C4 stubble from year 1.

• Year 3- Continued grazing of biennial/short term perennial mixture, then reestablishment of perennial pasture in late summer/early fall

• Years 4-8?- Perennial pasture
**Year 1: “double-cropping of perennial pasture with annual forage”**

- **Goal:** Provide high quality, parasite free forage that will fill in the summer slump period *and* exceed yield of perennial pasture.
- **Annual forage crop planted in late June/early July after >60% perennial pasture annual yield.**
- **Soil amendments added (compost, manure, etc.)**
  - Annual crops that germinate under limited soil moisture:
    - ✔ Sudan hybrids (C4)
    - ✔ Forage brassicas
    - ✔ Brassica and warm season grass (C4) combinations
  - ✗ No-till seeding will limit moisture loss
60 days after planting
BMR sudan grass and ‘Hunter’ (forage turnip x chinese cabbage) strips - day 25 after planting
‘Goliath’ (rape x kale) at 50 days post emergence, Sept 22, 2015
Post weaning ewe lambs grazing a monoculture of ‘Hunter’ forage (turnip x chinese cabbage)
Year 2-3: High quality, short term perennial pasture

• Goal: provide forage with outstanding quality and yield to maximize performance per unit land
• Additional soil amendments (manure, compost, lime, etc.) added and planting performed in early Spring.
• Legume, forb, grass mixture (Red clover, chicory, rye grass).
• Grazed for 2 years
Short term perennial pasture of red clover/Italian ryegrass mixture in year 2
Lamb growth performance was assessed in grazing trials on annual and short term perennial forage crops:

• 28 day grazing periods with 2-4 day grazing bouts
• Pre- and post- grazing crop mass measurements
• Crop yield and production costs calculated
<table>
<thead>
<tr>
<th>Species</th>
<th>Date planted</th>
<th>Grazing period (days)</th>
<th>DM Yield (lb/acre)</th>
<th>Intake target</th>
<th>Gain per lamb (lb/d)</th>
<th>Gain per acre (lb/acre)</th>
<th>Cost of gain ($/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Hunter’ turnip and BMR sudan mix</td>
<td>June 22</td>
<td>112</td>
<td>8154</td>
<td>45%</td>
<td>0.68</td>
<td>708</td>
<td>0.41</td>
</tr>
<tr>
<td>‘Hunter’ turnip</td>
<td>June 22</td>
<td>112</td>
<td>9793</td>
<td>45%</td>
<td>0.68</td>
<td>729</td>
<td>0.37</td>
</tr>
<tr>
<td>‘Hunter’ turnip and BMR sudan strips</td>
<td>June 22</td>
<td>112</td>
<td>9123</td>
<td>45%</td>
<td>0.61</td>
<td>751</td>
<td>0.38</td>
</tr>
<tr>
<td>BMR sudan</td>
<td>June 22</td>
<td>112</td>
<td>7850</td>
<td>45%</td>
<td>0.45</td>
<td>454</td>
<td>0.68</td>
</tr>
<tr>
<td>Red clover and Italian ryegrass</td>
<td>April 22</td>
<td>153</td>
<td>8887</td>
<td>45%</td>
<td>0.61</td>
<td>1275</td>
<td>0.20</td>
</tr>
<tr>
<td>Orchard grass, tall fescue and alfalfa</td>
<td>Perennial</td>
<td>194</td>
<td>10608</td>
<td>45%</td>
<td>0.28</td>
<td>955</td>
<td>0.23</td>
</tr>
</tbody>
</table>
Projection of lamb gain potential in 2 forage systems (pound of gain per acre)

<table>
<thead>
<tr>
<th></th>
<th>Perennial</th>
<th>Annual/Short term Perennial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>955</td>
<td>573+724=1297</td>
</tr>
<tr>
<td>Year 2</td>
<td>955</td>
<td>1275</td>
</tr>
<tr>
<td>Year 3</td>
<td>955</td>
<td>1275</td>
</tr>
<tr>
<td>Total</td>
<td>2865</td>
<td>3847</td>
</tr>
</tbody>
</table>

- Improvements in forage quality improved land productivity close to 30% with added opportunity to decrease cost of gain
Cover crop grazing for small ruminants: a huge opportunity to improve production efficiency

- Use of annual forages within a cropping system
- Gigantic potential after primary crops of small grains, vegetables and corn harvested for silage
- **Fencing and water are barriers but easily overcome**
- **Opportunity for synergy between crop and livestock programs**
  - Within a farming program
  - Partnership with neighboring farms

- Crop farmers use cover crops for nutrient scavenging, soil protection, pest and weed control.
- Cover crops provide quality feed that can be **stockpiled** and can fill a deficit in a forage program
Small ruminant cover crop grazing program 2010-2017:
• Brassica, radish (4-9 lbs/acre) and oat (30-50 lbs/acre) combinations evaluated
• Planted into wheat stubble (July 25-Aug 20)
• Addition of 50 pounds N/ acre in early September
• Sheep introduced between October 1 and 25
• Sheep removed Jan 10-March 15
• Crop and sheep farm agreement:
  ✓ Sheep farm: seed and fertilizer, manages grazing
  ✓ Crop farm: plants seed
Cover crop combinations:

• **Brassicas, radish and small grains:**
  - ✓ Provide complementary (high soluble CHO plus digestible fiber)
  - ✓ Combination lowers risks of crop failure
  - ✓ Small grains help control mud issues during wet weather grazing

• **Brassica/radish choice:**
  - ✓ **Bulb turnips**
    - ✓ Bulbs stockpile well into February, tops are lost after extended cold <15 °F
  - ✓ **Rape and Kale hybrids**
    - ✓ Tops hold quality longer than turnips, loose quality after extended cold at < 0 °F
  - ✓ **Radishes**
    - ✓ Only top part of bulb available but tops hold quality longer than turnip bulbs but less than rape
    - ✓ Perhaps a good compromise between land and livestock benefits
Candidates for cover crops: 
Rape hybrids, Turnips, Radishes

40 days post emergence, Sept. 28, 2012; planted following break in 25 year drought
Cover Crops: Oil seed radish and oats
Early winter cover crop grazing:
Oats, purple top turnips, oil seed radish and forage rape
December 10, 2014
Sheep in final grazing rotation before driven to home farm, January 10, 2011
Rape/kale

Jan 15, 2013 Eaton Rapids, MI

“Winfred” forage rape hybrid
January 20, 2013

‘Hunter’ Chinese cabbage x forage turnip
January 20, 2013
115 lb lambs fed no grain, 7 mo. old
<table>
<thead>
<tr>
<th></th>
<th>No seed</th>
<th>Turnips and Oats</th>
<th>Radishes and Oats</th>
<th>Turnips, Radishes and Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fertilizer</td>
<td>0</td>
<td>32</td>
<td>29.7</td>
<td>32.5</td>
</tr>
<tr>
<td>46 lbs N</td>
<td>102</td>
<td>37.7</td>
<td>42.8</td>
<td>35.6</td>
</tr>
</tbody>
</table>
## Nutritional value of cover crop mixes

<table>
<thead>
<tr>
<th></th>
<th>No seed</th>
<th>Turnips and Oats</th>
<th>Radishes and Oats</th>
<th>Turnips, Radishes and Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein (%)</td>
<td>21</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>ADF ¹(%)</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>NDF²(%)</td>
<td>43</td>
<td>38</td>
<td>38</td>
<td>36</td>
</tr>
<tr>
<td>TDN³(%)</td>
<td>77</td>
<td>75</td>
<td>75</td>
<td>76</td>
</tr>
<tr>
<td>48 h dry matter digestibility</td>
<td>93</td>
<td>90</td>
<td>90</td>
<td>91</td>
</tr>
</tbody>
</table>

1. ADF=acid detergent fiber  
2. NDF=neutral detergent fiber  
3. TDN=total digestible nutrients
Barriers for adoption of cover crop grazing:

- Fencing – need for security and portability
- Water – how can it be supplied during late fall and winter on crop land?
Electric netting is a secure and portable fencing option (35” plastic strut version shown)
• Plastic strut versions can “cope” with ice or snow load
• Winter grazing areas need to be fenced before frost gets >1 inch deep
~late Dec. to early Jan. in southern MI
Erecting and taking down netting is a quickly learned skill:

• 2 people can set up 8-12 acres per hour
• Fencing labor: 0.2-0.6 man hours / ton dry matter consumed as measured in cover crop grazing trials
• Fencing cost (10 year life) estimate at $2-5 per ton of forage DM consumed
Factors to consider when assessing water needs of livestock during cover crop grazing

• Most cover crops are lush and with a water content (>80%) through mid fall which declines as the crop dies and is subject to freeze/thaw conditions

• Livestock water needs decrease by ~50% between 72° and 36° F

• Water needs are dependent on stage of production: (maintenance<growth<pregnancy<lactation)

• Snow is a major water source for winter grazing
Forage water content required to meet water needs according to species and production state during cool weather (<55° F).

<table>
<thead>
<tr>
<th>Species</th>
<th>Production State</th>
<th>Forage water %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td>non-lactating, first 2/3 pregnancy</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>last 30 days of pregnancy - singles</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>last 30 days of pregnancy - twins</td>
<td>87</td>
</tr>
<tr>
<td>Cattle</td>
<td>non-lactating, first 2/3 pregnancy</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>late pregnancy</td>
<td>85</td>
</tr>
</tbody>
</table>

Adapted from “Nutrient requirements of domesticated ruminants” CSIRO 2007
Relationship between air temperature and forage water content required to meet water need of non-lactating ewes.

Forage water content (%) required to meet water needs*


* Needs of non-lactating ewes before the last 30 days of pregnancy
Forage water content needs to be meets the need of most sheep classes except prolific ewes during late pregnancy

- Consumption of soft snow can make up deficit
- May need to move ewes off winter grazing during late pregnancy
Forage water (oats plus radishes) in mid January = 76%
Brassica tubers are >90% water
Supplemental feeding may be necessary when icy/frozen snow conditions limit grazing access
Summary:

• The use of annual forages in pasture rotation systems can improve forage yield and quality providing a needed boost to modern sheep and goat programs with prolific animals.

• Cover crop grazing with small ruminants has many benefits:
  ✓ Improved parasite management
  ✓ Inexpensive yet quality forage
  ✓ Resting of perennial pastures
  ✓ Quality forage at times of need

• Portable electric netting fence allows for secure containment of sheep and goats without the need for permanent fence

• Forage water content of cover crops in winter is high enough to meet the water needs of non-lactating sheep and goats before late pregnancy.
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