Fallow Replacement in Western Kansas

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Cover Crop Benefits

• Improve soil quality
  – Increase soil organic matter
  – Reduce soil erosion
  – Reduce soil compaction
  – Increase water infiltration
    • Decrease runoff
  – Supply nitrogen
• Suppress weeds
• Government programs (EQUIP & CREP)
• Conserve soil moisture?
• Reduce nitrate leaching?
• Impact yield of following crop?
Increase in Soil C

- Claassen–Hesston, KS
  - Wheat/Cover-Sorghum, 2002-2010
  - Residue: Sun hemp > Soybean

- ↑ Soil C (0-3 in)
- ↑ Water infiltration
- = Soil aggregate stability w/N
- = Soil compaction (0-3 in) w/N
- ↑ Soil ag. and comp. wo/N
- ↑ crop yield @ low N rate only

Fallow Replacement Study

- Initiated in 2006 at KSU-Garden City
- Crop rotations:
  - Wheat-Fallow, Wheat-Wheat, & Wheat-Cover Crop/Forage/Grain,
- RCB design, 4 replications, each phase of the rotation present each year
- Plots are 30’ x 135’, 224 plots total, 11 A study
- Measuring:
  - Cover crop water use
  - Forage yield and nutritive value
  - Water storage in seed zone and profile
  - Wheat yield, test weight, and protein
  - Profitability/loss of including cover crops in rotation
Fallow Treatments (Cover, Forage, Grain)

<table>
<thead>
<tr>
<th>Season</th>
<th>Cover Crop</th>
<th>Year Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2007</td>
</tr>
<tr>
<td>Winter</td>
<td>Yellow sweet clover</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Yellow sweet clover/Winter triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Hairy vetch</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Hairy vetch/Winter triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter lentil</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter lentil/Winter triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter pea (grain)</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter pea</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter pea/Winter triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Winter triticale</td>
<td>x</td>
</tr>
<tr>
<td>Spring</td>
<td>Spring lentil</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spring lentil/Spring triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spring pea</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spring pea (grain)</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spring pea/Spring triticale</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Spring triticale</td>
<td>x</td>
</tr>
</tbody>
</table>

• Fallow and cont. wheat, 16 treatments total

Cover and Forage Crop Termination

• Winter terminated ~May 15 (winter triticale heads)
• Spring terminated ~June 1 (spring triticale heads)
• Plots split: ½ hayed & ½ sprayed out and left standing
• Winter lentil: 2009-2010

2008-2010, Crop Biomass

• Winter triticale yield > spring triticale

2008-2010, Crop Biomass Average

• Legumes: spring yield > winter: winter injury
  – Spring pea > winter pea
  – Winter lentil = spring lentil
  – Hairy vetch 1 year winter kill
Residue or Forage Value?

- Microbial protein and amino acid production
- > 13% “premium” nutritive value
- Alfalfa 18-24% CP
Total Digestible Nutrients (TDN)

- Energy available
- Alfalfa 61-67% TDN

Cover and Forage Crop Impact on Winter Wheat
Western KS Moisture Results

- Fallow storage, 20-30% effective
- Growing cover crop used moisture
  - Improves storage and may improve stand establishment

2008 Yield Results

- Hail week prior to harvest
- Only visual difference was cont. wheat

![Graph showing winter wheat yield following 2007 cover crops]
2009 Yield Results

2009 Winter Wheat Yield following 2008 Cover Crops

- Only visual difference was cont. wheat
- No effect of residue management treatment

2010 Yield Results

2010 Winter Wheat Yield following 2009 Cover Crops

- Only visual difference was cont. wheat
- Cover yielded 2.9 bu/A more than hay
2011 Yield Results

- Very dry year, marginal wheat stands
- No effect of residue management treatment
- On average spring forage reduced yield 3 bu/A

2009-2011 Yield Results

- 2 good years, 1 very poor year
- No effect of residue management treatment
- Winter triticale, grain pea, and cont. ww yields less
Field Pea Yields

- Austrian winter pea (2006-2011): too much injury
- Spring pea (2010-2011): 30-35 bu/A
- Feed pea: $4.50/bu (60 lbs/bu)
  - 10 bu/A wheat yield reduction
  - ~$13/A profit, with 10 bu/A wheat reduction
  - Additional $45/A profit compared to chem-fallow

Western KS Preliminary Results

<table>
<thead>
<tr>
<th>Expenses</th>
<th>Winter</th>
<th>Spring</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill $/A</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Seed lb/A</td>
<td>28</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Seed $/lb</td>
<td>2.3</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Total seed cost $/A</td>
<td>56</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>Total drilling cost $/A</td>
<td>47</td>
<td>46</td>
<td>23</td>
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<tr>
<td>Swath $/A</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Bale &amp; Stack $/ton</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Total hay cost $/A</td>
<td>15</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Spray application $/A</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>RT3, $/A</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2,4-D, $/A</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Applications/A</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total spray cost $/A</td>
<td>33</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Total Expense (cover)</td>
<td>101</td>
<td>102</td>
<td>37</td>
</tr>
<tr>
<td>Total Expense (hay)</td>
<td>116</td>
<td>130</td>
<td>71</td>
</tr>
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</table>

Returns

<table>
<thead>
<tr>
<th>Returns</th>
<th>Winter</th>
<th>Spring</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield ton/A</td>
<td>0.3</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Price $/ton</td>
<td>91</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Yield Return $/A</td>
<td>25</td>
<td>221</td>
<td>19</td>
</tr>
<tr>
<td>N Return lb/A</td>
<td>40</td>
<td>40</td>
<td>40</td>
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<tr>
<td>N value $/lb N</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>N Return $/A</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Soil benefits $/A</td>
<td>-81</td>
<td>-90</td>
<td>-9</td>
</tr>
<tr>
<td>Net Return (cover)</td>
<td>-91</td>
<td>-60</td>
<td>-37</td>
</tr>
<tr>
<td>Net Return (hay)</td>
<td>-38</td>
<td>-38</td>
<td>-38</td>
</tr>
</tbody>
</table>

*Assumption: N contribution from legume 0 when hayed, 50 lbs of N add for winter triticale, and 25 lbs of N add for spring triticale.
COVER CROPS REDUCE SOIL LOSS IN RUNOFF

COVER CROPS REDUCE THE SOIL’S SUSCEPTIBILITY TO WIND EROSION
Western KS Cool-Season Crops

- **Legume**
  - Clover: biennial-slow growth, seed cost ($25/A)
  - Vetch: hard seed, cattle-photosensitization and muscle problems, winter injury, seed cost ($50/A)
  - Peas (W & S): winter injury, fair yield, seed cost ($25/A)
  - Lentils (W & S): hardy, low yield, seed cost ($11/A)
- **Non-legume**
  - Triticale (W & S): hardy, high yield, seed cost ($15/A)
- **Mixtures**
  - Legumes survive better, high yield, some N fixing, reduce seed cost

Future Direction

- Wheat-grain sorghum-(fallow/fallow replacement)
- Spring oats compared to triticale
- Radishes and turnips: large taproot-reduce soil compaction?
- Cocktail mixes?

<table>
<thead>
<tr>
<th>Crop</th>
<th>Hay</th>
<th>Cover</th>
<th>Grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring pea</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Spring pea/Spring Oat</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Spring pea/Spring Triticale</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Spring Oat</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Spring Triticale</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Daikon radish &amp; Shogoin turnip</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cocktail mix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(oat, triticale, pea, buckwheat, radish and turnip)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fallow</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Daikon Radish

- **Planted 8/30/10**
- **Harvested 12/2/10**
- Size of plants with competition

- **Planted 8/30/10**
- **Harvested 12/2/10**
- Size of plants without competition

<table>
<thead>
<tr>
<th>Soil depth (in)</th>
<th>Soil penetrometer (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132</td>
</tr>
<tr>
<td>2</td>
<td>244</td>
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<tr>
<td>3</td>
<td>320</td>
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<tr>
<td>4</td>
<td>386</td>
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<td>5</td>
<td>468</td>
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<td>6</td>
<td>493</td>
</tr>
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<td>7</td>
<td>473</td>
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<tr>
<td>8</td>
<td>493</td>
</tr>
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<td>9</td>
<td>453</td>
</tr>
<tr>
<td>10</td>
<td>437</td>
</tr>
<tr>
<td>11</td>
<td>442</td>
</tr>
<tr>
<td>12</td>
<td>437</td>
</tr>
</tbody>
</table>
Mixtures?

- A lot of interest in mixtures
- Some species more competitive
- Select a mixture based on need, more is not necessarily better
  - Spring forage: legume improving N content of forage and N fixation, and grass for high biomass (ex: spring pea and oat)
  - Spring cover crop: large taproot may help soil quality, legume for N fixation, and large biomass crop (ex: daikon radish, spring pea, and triticale)
  - Summer grazing: large taproot for soil quality and grazing, legume, and high biomass (ex: turnip, cowpea, sorghum sudangrass)

Eastern KS: Cover Crop Study

- Cover crop-grain sorghum rotation 3 site yrs (Manhattan & Hutchinson)
- Cover crop biomass

![Graph showing cover crop biomass](image)
Eastern KS: Cover Crop Study

- Grain sorghum yield correlated to N in cover crop
- Correlation to flag leaf N, $R^2 = 0.79$

Western KS Results

- Impact on wheat yield and profitability?
  - In wet years little to no impact on yield
  - In drought years all treatments reduced yield except some of the spring crops
    - On average spring crops reduced yield (3 bu/A)
      - 1 ton forage @ $100/ton: net $40/A more than chem-fallow vs.
        - 3 bu/A @ $8.00/bu: $24.00/A
  - Averaged across years:
    - Cont. WW reduced yield 37% (25% more total than W-F)
    - Winter triticale reduced yield 9% or 5.5 bu/A
    - Grain pea reduce yield 11% or 7 bu/A (11 bu/A less in drought)
    - No difference between cover or hay
Western KS Results

• Bale it, Graze it, or Combine it!
• High seed cost, offsets N contribution- grow own seed
  – More economical to apply N
• Select fallow replacement crop adapted to region
  – Winter hardiness
  – Many proposed cover crops will not perform
• Terminate cover crop prior to June 1 for wheat
• If moisture is available consider double-crop after wheat
• Harvesting crop as forage or grain increased profitability

Questions?
Planting Spring Crops in the Fall

- Plant a mixture of spring and winter crops for more fall grazing
- Plant a spring crop in the fall for feed in a drought
Eastern KS: Cover Crop Study

• Cover crop N accumulation

![Graph showing cover crop N accumulation](image)

Western KS Warm-Season Crops

• Legume
  – Oilseed: guar and soybean
  – Forage: cowpea, lablab, mungbean, pigeon pea, soybean
  – Cover: sunhemp (toxic to cattle)

• Brassicas
  – Soil & Cover: turnip, radish, and Ethiopian cabbage

• Grasses
  – Forage: forage sorghum, sorghum sudangrass, millet

• Drought, Weeds & Rabbits (2011)
  – Best: turnip, radish, guar, cowpea, lablab, Ethiopian cabbage, and grasses