COVER CROP COCKTAILS

USING MULTI-SPECIES COVER CROP MIXTURES TO IMPROVE NO-TILL SOIL QUALITY IN LOW RAINFALL AREAS OF THE NORTHERN PLAINS

Susan Tallman, CCA
MSc Candidate
The Summerfallow Challenge

- Soil moisture recharge
- Saline seeps
- N leaching
- Erosion
- Organic matter
- Soil quality

Decrease in Summerfallow Acres

1971: 42 million acres
2010: 10 million acres

MLRA 52: 84% of cropland
MLRA 53: < 40% of cropland

Tanaka et al., 2010

NASS, 2010
Cover Crops as a Solution

Example 1
Decrease N leaching on sandy soils
July – Oct.
• Millet
• Soybean
• Radish
• Sweet Clover
• Cowpea
• Turnip
• Sunflower

Example 2
Increase OM on field previously used for corn silage
May - July
• Oat
• Pea
• Radish
• Turnip
• Red Clover
• Hairy Vetch

Photos courtesy of BCSCD, Bismarck, ND
Benefits of Cover Crop Cocktails

- Decrease N leaching
- Increase OM
- Decrease herbicide use
- Cattle forage/Corn silage replacement
- Improve soil nutrient availability

Gabe Brown

- No-till since 1993
- Cover crop cocktails
- Intensive rotational grazing
- Intercropping
- Reduced herbicide: 75%
- Reduced fertilizer: 90%

Innovative No-Till: Using Multi-Species Cover Crops to Improve Soil Health

www.attra.org
www.bcscd.com
Can cover crop cocktails work in Montana?

### Annual Precipitation (in)

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<th></th>
<th>Bismarck</th>
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<tr>
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<td><strong>TOTAL</strong></td>
<td><strong>16.84</strong></td>
<td><strong>14.89</strong></td>
<td><strong>11.46</strong></td>
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NOAA, 30 year average
Research Questions

1. How might a cover crop mixture affect both soil water use and soil quality compared to both summerfallow and a single species legume cover crop?

2. How will a cover crop mixture affect the following year’s grain yield, quality, and economic return compared to both summerfallow and a single species legume cover crop?

3. What does each plant functional group in the mixture contribute to overall soil quality?
Study Design: 2 Approaches

**Plot Study**
- 4 no-till sites
- April – June growth
- Herbicide termination
- 3 year rotation
  - CCM – wheat – CCM

**Farm Study**
- 4 to 6 no-till farms
- 2 year rotation: CCM – wheat
- Farmers select species and timing
Plot Study Functional Groups & Species

**Nitrogen Fixers**
- Spring Pea
  - *Pisum sativum*
- Common Vetch
  - *Vicia sativa*

**Fibrous Root**
- Oats
  - *Avena sativa*
- Italian Ryegrass
  - *Lolium multiflorum*

**Tap Root**
- Safflower
  - *Carthamus tinctorius*
- Purple Top Turnip
  - *Brassica campestris*

**Brassica**
- Daikon radish
  - *Raphanus sativus*
- Camelina
  - *Camelina sativa*
Plot Study: Treatments

1. SF - Summerfallow
2. PEA - Spring Pea
3. CCM - Full Mixture: Pea, Vetch, Oat, Ryegrass, Turnip, Safflower, Radish, Camelina
4. NF - Nitrogen Fixers: Pea, Vetch
5. FR - Fibrous Root: Oat, Ryegrass
6. TR - Tap Root: Turnip, Safflower
7. BC - Brassica: Camelina, Radish
8. MNF - Minus NF: Oat, Ryegrass, Turnip, Safflower, Camelina, Radish
9. MFR - Minus FR: Pea, Vetch, Turnip, Safflower, Camelina, Radish
10. MTR - Minus TR: Pea, Vetch, Oat, Ryegrass, Camelina, Radish
11. MBC - Minus BC: Pea, Vetch, Oat, Ryegrass, Safflower (No turnip)
Plot Study: CCM Phase

Measurements
- Cover Crop Biomass
- Biological Indicators
  - Microbial Biomass
  - Enzyme activity
  - PMN
  - Mycorrhizal colonization and infectivity
  - Earthworm density
- Physical Indicators
  - Wet aggregate stability
  - Compaction
  - Soil Temperature
  - Soil water
- Chemical Indicators
  - Available N
  - Available P

Sampling
Year 1: SF, PEA, Full Mix
  Biomass of all treatments by species
Year 3: Repeat treatments in place
  Sample all treatments
Plot Study: Winter Wheat Phase

Measurements
- Grain yield
- Grain quality
- Economic return

Sampling
Year 2: All treatments
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<th>Year</th>
<th>Phase</th>
<th>Location</th>
<th>Site</th>
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<td>CCM</td>
<td>Gallatin valley (1)</td>
<td>Vandermolen farm</td>
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<tr>
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<td>CCM</td>
<td>MLRA 52 (1)</td>
<td>Oehlke farm</td>
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<tr>
<td>2013</td>
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Farm Study

2012 and 2013
4 to 6 on farm studies
Field scale with adjacent fallow control
No-till with herbicide termination

Sampling
• Cover crop biomass
• Plant N content
• Soil water (4 ft): fallow, CCM
• Nitrate-N (3 ft): fallow, CCM
• Grain yield and quality in following year
### Expected Results: 2012 - 2013

#### Plot Study

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<tbody>
<tr>
<td><strong>Biomass</strong></td>
<td>Full Mix &gt; Pea</td>
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<tr>
<td><strong>Microbial Biomass, PMN, Mycorrhizae</strong></td>
<td>Full Mix ≥ Pea &gt; SF</td>
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<tr>
<td><strong>Soil Water</strong></td>
<td>SF &gt; Pea ≥ Full Mix</td>
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<tr>
<td><strong>Available N (spring)</strong></td>
<td>Full Mix ≈ Pea &gt; SF</td>
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<tr>
<td><strong>Soil Temp</strong></td>
<td>SF &gt; Functl. Groups ≈ Pea ≥ Full Mix</td>
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<tr>
<td><strong>Grain Yield</strong></td>
<td>SF ≈ Pea ≈ Full Mix</td>
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<tr>
<td><strong>Grain Quality</strong></td>
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<td><strong>Available N (spring)</strong></td>
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*Burgess, unpublished*

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Do CCM’s provide soil quality benefits? If so, how can we make recommendations for their use?
Thanks and Further Resources

- USDA - WSARE
- Dr. Perry Miller, MSU
- Dr. Cathy Zabinski, MSU
- Dr. Clain Jones, MSU
- Jeff Holmes, MSU
- Herb Oehlke
- Carl Vandermolen
- Jane Holzer, MT Salinity Control Assoc
- Stacey Eneboe, MT NRCS
- Jay Fuhrer, ND NRCS
- Gabe Brown
- Burleigh County Soil Conservation District, www.bcscd.com
- Dr. Mark Liebig, USDA-ARS
- Dr. Yvonne Lawley, U Manitoba
- Dr. Lisa Rew, MSU
- Dr. Bruce Maxwell, MSU
- Pat McGunagle
- NCAT/ATTRA, www.attra.org

First Field Day:
June 14th 10 am
Vandermolen Farm
Amsterdam, MT

MSU Cover Crop Cocktails website:
landresources.montana.edu/soilfertility/covercrops.html

MT NRCS