PNDSA Cover Crop Case Study

Gabe Brown
The Importance of Soil Health
Keys to Achieving a Healthy Soil

- Least Amount Of Mechanical Disturbance Possible
- Armor On The Soil Surface
- Plant Diversity
- Living Root As Long As Possible
- Integration Of Livestock On Cropland
1. If *Soil Health* is the goal, *Crop Diversity* cannot be ignored or overstated
2. Plants were created to grow in diverse ecosystems
3. *Resilience* comes from *Diversity*
4. Balanced “diet” for soil biology
5. Balance: because even good things (legumes, brassicas) when not used in moderated balance can be harmful
1. What Are The Goals/Concerns?
2. What Are The Environmentals?
3. What Is The Timeframe?
4. What Is The Budget?
What are your goals/resource concerns?

Generally speaking....

1. The more specific your goals/concerns, the less diverse your mixes will typically be.

2. The tighter your planting windows, the fewer species will work and thus the less diverse your mixes will be.
1. Rainfall or irrigation
2. Evapo-Transpiration (ET)
3. Growing season
4. Soil type and condition
5. Seeding method
6. Previous crop and next crop
7. Previous herbicides
1. **Spring** - fallow ground or prior to a spring crop (chemical/mechanical termination) (Check crop insurance implications!)
2. **Early Summer** - Right after wheat harvest (frost or chemical/mech. termination)
3. **Late Summer** – Delay after wheat harvest (frost termination)
4. **Fall** - After fall crops (frost termination or over-wintering)
Filling the Production Gaps
Forage Chart

1-Apr
21-May
10-Jul
29-Aug
18-Oct
7-Dec
26-Jan

Cool Season Native
Warm Season Native
Smooth Brome
Kentucky Bluegrass
Alfalfa
Triticale/WW/Vetch
Oat/Pea
BMR S/S
Grazing Corn
Kale/Turnips/Vetch
What is your budget?

1. **Low** (less than $20/acre)
   (Low seeding rates – very few legumes)

2. **Medium** ($20 - $30/acre)
   (Average seeding rates – some legumes)

3. **High** ($30 - $40/acre)
   (High seeding rates – high legume %)

4. **Higher** ($40 - $60/acre)
   (special use: organic N production, nematode control, perennials, etc...)
Get 4 Things Right

1. The Right Species
2. The Right Inoculants
3. The Right Seeding Rates
4. The Right Seeding Time
Cover Crop Tips

- Use species that are adaptable to your environment
- Adjust species composition to season of use
- Diversity
- Be aware of herbicide residuals
- Check with crop insurance eligibility
- Don’t use a species in the mix if you are planning to seed it in that field next year
- If grass finishing, do not allow any grains to set seed
- It can’t grow in the bin, when in doubt seed it!
Diversify!

- Hard To Improve Soil Health If There Is No Diversity of Crop Types.
- Need To Add Species Diversity.
## Crop Types

<table>
<thead>
<tr>
<th>Cool Season Grass</th>
<th>Cool Season Broadleaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Canola</td>
</tr>
<tr>
<td>Durum Wheat</td>
<td>Crambe</td>
</tr>
<tr>
<td>Oat</td>
<td>Flax</td>
</tr>
<tr>
<td>Spring Wheat</td>
<td>Lentils</td>
</tr>
<tr>
<td>Winter Rye</td>
<td>Lupin</td>
</tr>
<tr>
<td>Winter Triticale</td>
<td>Mustard</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td>Pea</td>
</tr>
<tr>
<td></td>
<td>Red Clover</td>
</tr>
<tr>
<td></td>
<td>Sweet Clover</td>
</tr>
<tr>
<td></td>
<td>Turnip</td>
</tr>
<tr>
<td></td>
<td>Pasja</td>
</tr>
<tr>
<td></td>
<td>Forage Canola</td>
</tr>
<tr>
<td></td>
<td>Oilseed Radish</td>
</tr>
<tr>
<td></td>
<td>Kale</td>
</tr>
</tbody>
</table>
Crop Types

**Warm Season**

**Broadleaf**
- Alfalfa
- Buckwheat
- Chick Pea
- Amaranth
- Cowpea
- Soybean
- Safflower
- Sunflower

**Warm Season**

**Grass**
- Corn
- Proso Millet
- Pearl Millet
- Sorghum
- Sudangrass
Brown’s Ranch Cover Crops

**Annual Ryegrass – CSG**
**Oats – CSG**
**Barley – CSG**
**Winter Triticale – CSG**
**Forage Winter Wheat - CSG**
**Rye - CSG**

**Hybrid Pearl Millet – WSG**
**German Millet – WSG**
**Sorghum/Sudangrass – WSG**
**Brown Millet – WSG**
**Egyptian Wheat – WSG**
**Teff – WSG**

**Canola – CSB**
**Radish – CSB**
**Turnip – CSB**
**Lentil – CSB**
**Sweet Clover – CSB**
**Phacelia – CSB**
**Sub Clover – CSB**
**Buckwheat – CSB**
**Kale – CSB**
**Flax – CSB**

**Crimson Clover - CSB**
**Berseem Clover - CSB**
**Persian Clover - CSB**
**Hairy Vetch - CSB**
**Winter Pea - CSB**
**Collards - CSB**

**Sugarbeet – WSB**
**Cowpea – WSB**
**Soybean – WSB**
**Sunn Hemp – WSB**
**Ethiopian Cabbage – WSB**
**Safflower – WSB**
**Fava Bean – WSB**
**Mung Bean – WSB**
Diversity Below Ground

- Fibrous Roots
- Tap Roots
- Shallow
- Intermediate
- Deep
What is your resource concern?

“And then, this morning, I suddenly noticed she didn’t look so good.”
Cover Crops
Designing for what you don’t have!

Resource Concerns

- Provide crop diversity
- Provide soil surface armor
- Build soil aggregates
- Improve the water cycle
- Integrated Pest Management
- Build soil organic matter
- Nutrient cycling
- Enhance pollinators
- Adjust carbon/nitrogen ratios
- Wildlife winter food & shelter
- Livestock integration
Do Your Homework!

- [www.greencoverseeds.com](http://www.greencoverseeds.com)
- Smartmix Calculator
- Midwest Cover Crop Council
- SARE
- Many Reputable Seed Suppliers
# How to Design Cover Crop Mixes

**SMART mix™**

**Zip:** 81425 - **PHZ:** 6b - **Frost Free:** 05/01 - 10/08 - **Avg Annual Precip:** 12.32"  
**Growing Period:** 07/15/2014 - 11/11/2014 - (121 days) - **GDD:** 1,820 - **Projected Rain:** 9.84"  
**Acres:** 100  
**Lbs/acre:** 19  
**Total lbs:** 1,900 lbs  
**Seeds/acre:** 279,500  
**Species:** 6  
**Full Rate:** 88%  
**C:N Ratio:** 31  
**Nitrogen Fix:** 2.8  
**Grazing:** 5.6  
**Drought:** 8.8  
**Frost:** 1.2  
**Winter:** 1.2  
**Diversity:** 6.0  
**Salinity:** 2.3

<table>
<thead>
<tr>
<th><strong>Legumes</strong></th>
<th><strong>Grasses</strong></th>
<th><strong>Brassicas</strong></th>
<th><strong>Broadleaves</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cowpea 85.25</strong></td>
<td><strong>Sorghum Sudan 85</strong></td>
<td><strong>Nitro Radish 69.75</strong></td>
<td><strong>Buckwheat 94</strong></td>
</tr>
<tr>
<td>Add +</td>
<td>Add +</td>
<td>Add +</td>
<td>Add +</td>
</tr>
<tr>
<td><strong>Mung Bean 85.25</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 lbs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legume Total:** 52%  
**Grass Total:** 26%  
**Brassica Total:** 5%  
**Broadleaf Total:** 16%

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th><strong>Full Rate</strong></th>
<th><strong>% Full Rate</strong></th>
<th><strong>% Wt.</strong></th>
<th><strong>% Wt.</strong></th>
<th><strong>% Seeds</strong></th>
<th><strong>% Seeds</strong></th>
<th><strong>Seeds/lb</strong></th>
<th><strong>Seeds/Acre</strong></th>
<th><strong>Cost/lb</strong></th>
<th><strong>Cost/Acre</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WS-B</strong></td>
<td>50%</td>
<td>10%</td>
<td>26%</td>
<td>7%</td>
<td>16%</td>
<td>4,100</td>
<td>20,500</td>
<td>$0.88</td>
<td>$4.40</td>
<td></td>
</tr>
<tr>
<td><strong>WS-G</strong></td>
<td>25%</td>
<td>20%</td>
<td>26%</td>
<td>32%</td>
<td>32%</td>
<td>18,000</td>
<td>90,000</td>
<td>$0.80</td>
<td>$4.00</td>
<td></td>
</tr>
<tr>
<td><strong>C5-B</strong></td>
<td>13%</td>
<td>5%</td>
<td>8%</td>
<td>6%</td>
<td>6%</td>
<td>25,000</td>
<td>25,000</td>
<td>$2.50</td>
<td>$2.50</td>
<td></td>
</tr>
<tr>
<td><strong>WS-B</strong></td>
<td>8%</td>
<td>13%</td>
<td>5%</td>
<td>12%</td>
<td>11%</td>
<td>8,000</td>
<td>8,000</td>
<td>$0.60</td>
<td>$0.60</td>
<td></td>
</tr>
</tbody>
</table>

**Total Cost:** $1,13 | $21.40 | $2139.75
Do Cover Crops Use Moisture?

- Of Course They Do!
- However If One Wants To Increase The Water Holding Capacity Of Their Soil One Must Increase OM.
- The Fastest Way To Do That Is With Covers!
Symptom: Fertility/Starving Soil Biology
Case Study 4

Provide crop diversity
Nutrient Cycling
Enhance pollinators
Livestock integration
Rolling pea to provide armor
July 16, 2009
8 way cover crop seeded into rolled pea stubble
Photo take on August 18, 2009
September 4, 2009
No Commercial Fertilizer

- Sunflower 1 lb
- Soybean 15 lbs
- Cowpea 10 lbs
- Turnip 1 lb
- Radish 2 lbs
- Proso Millet 4 lbs
- Pearl Millet 4 lbs
Planting Corn Into Last Year’s Cover Crop Residue May 20, 2010
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Test Level</th>
<th>Rating</th>
<th>Sufficient Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N</td>
<td>3.0 %</td>
<td>S</td>
<td>3.0 To 3.4</td>
</tr>
<tr>
<td>P</td>
<td>0.30%</td>
<td>S</td>
<td>0.25 To 0.50</td>
</tr>
<tr>
<td>K</td>
<td>2.1 %</td>
<td>S</td>
<td>2.0 To 2.4</td>
</tr>
<tr>
<td>S</td>
<td>0.20%</td>
<td>S</td>
<td>0.16 To 0.50</td>
</tr>
<tr>
<td>Ca</td>
<td>0.21%</td>
<td>L</td>
<td>0.30 To 0.60</td>
</tr>
<tr>
<td>Mg</td>
<td>0.23%</td>
<td>S</td>
<td>0.16 To 0.40</td>
</tr>
<tr>
<td>Na</td>
<td>0.01%</td>
<td>S</td>
<td>0.00 To 0.10</td>
</tr>
<tr>
<td>Zn</td>
<td>28 ppm</td>
<td>S</td>
<td>20 To 75</td>
</tr>
<tr>
<td>Fe</td>
<td>107 ppm</td>
<td>S</td>
<td>50 To 250</td>
</tr>
<tr>
<td>Mn</td>
<td>54 ppm</td>
<td>S</td>
<td>18 To 150</td>
</tr>
<tr>
<td>Cu</td>
<td>10 ppm</td>
<td>S</td>
<td>5 To 15</td>
</tr>
<tr>
<td>B</td>
<td>12 ppm</td>
<td>S</td>
<td>5 To 25</td>
</tr>
</tbody>
</table>

D.R.I.S. FOR CORN:

4  -5  8  -8  -31  4  3  6  4  16

Ratings for: CORN 12 in TO TASSLING

VL=Very Low, L=Low, S=Sufficient, H=High, VH=Very High
Corn harvest on November 8, 2010
West Side
No Commercial Fertilizer
No Compost
No Compost Tea
122.3 Bushels per Acre

East Side
No Commercial Fertilizer
1-2 Ton of Compost
2 Compost Tea Applications
128.8 Bushels per Acre

The Menoken Farm
Power of Crop Diversity
Both Sides were Planted into Last Year’s Cover Crop Residue

2006 – 2010 Burleigh County FSA Committee Reasonable Yield Established by Year = 100 Bushels per Acre
This soil is naked, hungry, thirsty and running a fever!

Ray Archuleta 2007
Symptom: Poor Soil Structure

Forest SOM = 4.3%

CT 17 yr - Soybean monoculture SOM = 1.6%

20 cm layer
### High Diversity Mix

#### Accelerating Biological Time

**Resource Concern:** Improve Soil Structure and Infiltration. Winter Grazing

**Seeding Date:** June 14\(^{th}\)  
**Seeding Rate:** 36#/acre  
**Cost:** $34.00/acre

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Vetch</td>
<td>3#/acre</td>
</tr>
<tr>
<td>Lentils</td>
<td>3</td>
</tr>
<tr>
<td>Non-GMO Soybeans</td>
<td>2</td>
</tr>
<tr>
<td>Arrowleaf Clover</td>
<td>1</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>1</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>3</td>
</tr>
<tr>
<td>Sunn Hemp</td>
<td>2</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>1</td>
</tr>
<tr>
<td>Trudan 8 and Sorg/Sud.</td>
<td>2</td>
</tr>
<tr>
<td>Oats</td>
<td>8</td>
</tr>
<tr>
<td>Nitro Radish</td>
<td>1</td>
</tr>
<tr>
<td>Winfred Kale</td>
<td>1</td>
</tr>
<tr>
<td>Hunter Turnip</td>
<td>1</td>
</tr>
<tr>
<td>Phacelia</td>
<td>1</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>1</td>
</tr>
<tr>
<td>Ethiopian Cabbage</td>
<td>1</td>
</tr>
<tr>
<td>Flax</td>
<td>2</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>2</td>
</tr>
</tbody>
</table>
Species to Use:

**Grasses**
- Sorghum-Sudangrass
- Annual Ryegrass
- Rye
- Oats
- Millets

**Broadleaves**
- Radish
- Wollypod Vetch
- Sunflower
- Buckwheat
- Clovers
Mycorrhizal Fungi
Increased surface area leads to nutrient uptake efficiency
Enlarged Soil Aggregates

Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND
Fungal hyphae binding soil particles together into aggregates. Arbuscular Mycorrhizal fungi produces Glomalin that glues soil particles together.
Pore spaces are essential for biology and water infiltration.
High Mycorrhizal Mix
DIVERSITY!
Mycohrrizal Friendly Species

- Oats
- Barley
- Flax
- Clovers
- Sunflowers
Symptom: Poor Infiltration/Compaction
Species to Use:

Grasses
- Sorghum-Sudangrass
- Annual Ryegrass

Broadleaves
- Radish
- Turnip
- Sweetclover
- Sunflower
Diversity Below Ground

- Fibrous Roots
- Tap Roots
- Shallow
- Intermediate
- Deep
Tillage Induced Restrictive Layers
Large Radish
Infiltration Pores
Slow Residue Decomposition
Nutrient Cycling
Carbon/Nitrogen Ratios

- Soil Microorganisms, Bacteria * \(5/1\)
- SOM, Mollisol Ap horizon * \(11/1\)
- Hairy Vetch Cover Crop \(11/1\)
- Young Alfalfa Hay * \(13/1\)
- Rotted barnyard manure * \(20/1\)
- Mature Alfalfa Hay * \(25/1\)
- Rye (Vegetative) \(37/1\)
- Protozoa ** \(30/1\)
- Corn Stover * \(57/1\)
- Wheat Straw * \(80/1\)
- Rye Straw \(82/1\)
- Newspaper * \(120/1\)
- Deciduous Wood ** \(300/1\)

Source:
Nyle C. Brady and Ray R. Weil
** Elaine R. Ingham, Soil Food Web
High N Crop for Fast Nutrient Cycling
Nitrogen Storage Tank
Cover Crop

No Cover Crop

Spring Weed Pressure
Species to Use for Weed Suppression:

Grasses
- Sorghum-Sudan grass
- Annual Ryegrass
- Rye
- Oats

Broadleaves
- Buckwheat
- Radish
- Clovers
- Hairy Vetch
- Woollypod Vetch
Living Root As Long As Possible

- Must Continue The Liquid Carbon Pathway.
- Cannot Afford To Not Have Living Roots!
Fill Every Window You Can!
Cowpea/ProsoMillet/Buckwheat
Buckwheat
Cowpea & Sudan Grass
Warm Season Mix

- Cowpea 10 lbs
- Soybean 10 lbs
- Pearl Millet 2 lbs
- Sorg./Sudan 7 lbs
- Radish 1 lbs
- Turnip 1 lb
- Sunflower 1 lbs
- Buckwheat 3 lbs
- Safflower 2 lbs
Seeded 8/15 Following Oat Harvest
Seeded 8/18 Following Spring Wheat Harvest
Phacelia and a Native Pollinator
Species to Use:

Grasses
- Annual Ryegrass
- Barley
- Oats
- Rye
- Sorghum-Sudangrass

Broadleaves
- Buckwheat
- Mustards
- Radish
- Cowpeas
- Medics
- Phacelia