Soil Health and Utilizing Cover Crops In Semi-Arid Regions

NAICC
St. Louis, MO
January 19, 2017
Jim Johnson
Soils and Crops Consultant
jpjohnson@noble.org
Noble Foundation

Lloyd Noble (1896 – 1950)

Founded The Samuel Roberts Noble Foundation on September 19th, 1945.

His primary concern was “the conservation and improvement of soil – our nation’s basic resource”.

Soil Health

The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

USDA, NRCS
Soil Attributes

- Soil
- Plants
- Animals
- Human

Biological
Physical
Chemical
“There can be no life without soil and no soil without life; they have evolved together.”

Charles E. Kellogg
(1902-1980)
soil scientist
What is a Cover Crop

• A cover crop is a crop planted primarily to manage soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agroecosystem (Lu et al. 2000), an ecological system managed and largely shaped by humans across a range of intensities to produce food, feed, or fiber. Wikipedia http://en.wikipedia.org/wiki/Cover_crop


• For insurance purposes, a cover crop is a crop generally recognized by agricultural experts as agronomically sound for the area for erosion control or other purposes related to conservation or soil improvement. USDA RMA http://www.rma.usda.gov/pubs/rme/covercrops.pdf

• Cover crops are grasses, legumes, and other forbs that are planted for erosion control, improving soil structure, moisture, and nutrient content, increasing beneficial soil biota, suppressing weeds, providing habitat for beneficial predatory insects, facilitating crop pollinators, providing wildlife habitat, and as forage for farm animals. Furthermore, cover crops can provide energy savings both by adding nitrogen to the soil and making more soil nutrients available, thereby reducing the need to apply fertilizer. USDA NRCS http://plants.usda.gov/about_cover_crops.html
Cover Crop

Something intentionally grown between crops for the benefit and improvement of the soil ecosystem and subsequent crops. A cover crop may or may not be multi-species and may or may not be grazed.

Jim Johnson
Ecosystem

An ecosystem includes all of the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environments (weather, earth, sun, soil, climate, atmosphere).

eschooltoday
Ecosystem
Wholes
Soil
MOS
Plants
Animals
Air
Water
Soil Health = Ecosystem Health
Principles of Soil Health

Mimic Nature

- Keep the soil surface covered
- Minimize soil disturbance
- Increase plant diversity
- Maximize days of root growth
- Increase livestock diversity
Cover

• Cover improves soil water relations
  – prevents crust
  – holds moisture until it can soak in
  – reduces evaporation

• Cover moderates soil temperature

• Cover suppresses weeds

• Cover provides food and shelter for MOS
Minimize Soil Disturbance

• Protects surface residue
• Protects MOS
• Preserves MOS food and habitat
• Conserves water
• Maintains or improves soil structure
• Reduces many weeds
Increase Plant Diversity

- Roots of different plants leak different substances
- Different plants provide habitat for beneficial micro and macro-organisms
- Some plants may be sinks for pests
- Different plants have different root structure
Living Roots

- Roots leak sugars which build soil carbon and feed MOS
- Roots provide habitat for MOS
- Roots improve soil structure
- Roots aerate soil
- Roots grow plants
Diverse Livestock

• Takes advantage of “weeds”
• Helps control some pests
• Increases food for MOS
Soil Health

- Have proper soil fertility
- Don’t till
- Manage traffic and surface disturbance
- Grow vigorous, well adapted plants
- Rotate crops
- Don’t kill all the weeds
- Add diverse cover crops
Why Cover Crops

Mimic Nature

● Keep the soil surface covered
● Minimize soil disturbance
● Increase plant diversity
● Maximize days of root growth
● Increase livestock diversity
Mimic (Don’t Fight) Nature

• Think about your environment
• Covered soil surface
  – plants and litter
• Diverse plants
  – cool and warm
  – grass and broadleaf
• Diverse animals
  – large and small
  – ruminant and non
Why Cover Crops

• Smother or suppress weeds
• Erosion control
• Moderate soil temperature
• Break compaction
• Nutrient scavenging and recycling
• Food and shelter for beneficial organisms
• Improve water infiltration
Why Not

- Herbicide carryover
- Lack of resources
  - $, Knowledge, Equipment, Time
- Weeds
- Decreased subsequent crop yield
- Seed cost and availability
- Government and insurance programs
- Weather
- Teammates
Management Considerations

• Goals
• Soils
• Existing vegetation and “seedbed” prep
• Planting equipment and calibration
• Pest control
• Planting date and seed rate
• Weather
• Seed availability and price
Soil Considerations

- Texture
- Depth
- Moisture
- Tillage
- Fertility
  - N fixation, nutrient scavenging, P, K, pH
- Problems
  - salt, compaction
Cover Crop Fertilization

• Depends on
  – soil test values
  – goal of the cover crop
  – previous crop and fertilizer applied
  – subsequent crop
  – species in the cover crop
Seedbed Prep

- In standing crop or stalks
- Baled or grazed residue
- Tilled, rolled or processed
- Herbicide, frost, senescence or fire
Equipment

Planting single or multi-species cover crops
- Box drill
- Air drill
- Planter
- Broadcast

Planting next crop into cover crop
Pests

- Pesticide
- Rotation
- Manage soil residue and disturbance
- Cover crop management
  - soil fertility
  - seed rate and date
  - species selection
  - germination date
ALWAYS READ AND FOLLOW LABEL DIRECTIONS
Windows of Opportunity

- Fall-spring between summer crops
- Summer between winter crops
- Transition from winter to summer crop or vice versa
- During rotation out of alfalfa
- As another crop in the rotation
What Plants to Use

- Warm season v Cool season
- Grass v Broadleaf
- Fibrous root v Tap root
- Tall v Short
- High C:N v Low C:N
- Legume v Broadleaf v Brassica
- Single species v Multi-species
NOT ONE SIZE FITS ALL!
Small Grains

• Oats - heavy soil
• Triticale - “hybrid” vigor
• Rye - grows at lower temp, sandy soil, controls marestail
• Wheat - many cultivars
• Barley - salty and high pH soil
Grasses

- Ryegrass - wet soil, low pH, ploidy
- Sorghums - PPS, various maturities and heights, nutrient scavenger
Millets

- Pearl - sandy soil
- Foxtail - responds to good environment
- Browntop - one of my favorites, seems broadly adapted, short season
- Proso - very short season
- Japanese - wet soil, barnyardgrass
Legumes

• Spring and Winter Peas - vigorous seedling growth
• Vetch - sandy soil, productive
• Cowpeas - heat and drought
• Mungbeans - short season, drought
• Guar - salt tolerant
• Sunnhemp - tough residue
Clovers

Crimson, Red, Sweet, Berseem, Persian, Rose, Sub, Alsike, Arrowleaf, White, Balansa
Broadleaves

- Buckwheat - short season
- Okra - loves heat, great roots
- Flax - mycorrhizal fungi
- Sunflower - fast growing
- Sugar beets - drought and heat once established
- Squash - drought tolerant
Brassicas

• Radish - nutrient scavenger
• Collards
• Turnips - cold tolerant
• Mustards - very short to very long season

Easy to get too many brassicas
### Summary

<table>
<thead>
<tr>
<th>Component</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds/Acre</td>
<td></td>
<td>39.07</td>
</tr>
<tr>
<td>Seeds/Acre</td>
<td></td>
<td>2,112,833.50</td>
</tr>
<tr>
<td>Species</td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td>Total Pounds</td>
<td></td>
<td>78,804.19</td>
</tr>
</tbody>
</table>

### Growing Period

- **Start:** 12/19/2016
- **End:** 01/13/2017
- **Duration:** 25 days
- **GDD:** 33 GDD (base 50) / 147 GDD (base 40)

### Region

- **Zip Code:** 73401
- **PHZ:** 7b
- **Frost Free:** 03/22 - 11/14
- **Projected Precip:** 1.82"
- **Avg. Annual Precip:** 37.67"

---

### Nutrient Management

#### Legumes

<table>
<thead>
<tr>
<th>Type</th>
<th>Full Rate</th>
<th>% Wt</th>
<th>% Seeds</th>
<th>Seeds/lb</th>
<th>Cost/lb</th>
<th>Cost/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-O</td>
<td>31%</td>
<td>8%</td>
<td>20%</td>
<td>174,200.00</td>
<td>$1.95</td>
<td>$6.10</td>
</tr>
</tbody>
</table>

#### Grasses

<table>
<thead>
<tr>
<th>Type</th>
<th>Full Rate</th>
<th>% Wt</th>
<th>% Seeds</th>
<th>Seeds/lb</th>
<th>Cost/lb</th>
<th>Cost/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-G</td>
<td>31%</td>
<td>8%</td>
<td>20%</td>
<td>22,150.00</td>
<td>$0.22</td>
<td>$6.80</td>
</tr>
</tbody>
</table>

#### Brassicas

<table>
<thead>
<tr>
<th>Type</th>
<th>Full Rate</th>
<th>% Wt</th>
<th>% Seeds</th>
<th>Seeds/lb</th>
<th>Cost/lb</th>
<th>Cost/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-O</td>
<td>31%</td>
<td>8%</td>
<td>20%</td>
<td>180,000.00</td>
<td>$2.75</td>
<td>$8.61</td>
</tr>
</tbody>
</table>

#### Broadleaves

<table>
<thead>
<tr>
<th>Type</th>
<th>Full Rate</th>
<th>% Wt</th>
<th>% Seeds</th>
<th>Seeds/lb</th>
<th>Cost/lb</th>
<th>Cost/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-O</td>
<td>31%</td>
<td>4%</td>
<td>15%</td>
<td>200,000.00</td>
<td>$4.50</td>
<td>$7.03</td>
</tr>
</tbody>
</table>

---

### Additional Information

- **Nutrient Content:**
  - Nitrogen Fixation: 0.7
  - C/N Ratio: 12:1
  - Drought: 8.2
  - Frost: 9.8
  - Winter: 9.1
  - Diversity: 4.3
  - Salt: 10

---

### SmartMix Auto Adjust

- **Seed Cost:** $0.73
- **Inoculant Cost:** $0.025
- **Mixing Cost:** $0.00
- **Bagging Cost:** $0.00

- **Total Cost:** $7,998.30

- **Planting Date:** October
- **Acres:**
  - 2017
  - Total Pounds: 78,804.19

---

### Notes

- Supplemental Fertilization
- Mycorrhizal Fungi Growth
- Sensor-Soil Organic Matter
## Seed Cost

<table>
<thead>
<tr>
<th>Seed Type</th>
<th>Weight</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Browntop Millet</td>
<td>16#</td>
<td>$11.20</td>
</tr>
<tr>
<td>Flax</td>
<td>32#</td>
<td>$17.60</td>
</tr>
<tr>
<td>Brown Mustard</td>
<td>8#</td>
<td>$18.00</td>
</tr>
<tr>
<td>Oat</td>
<td>75#</td>
<td>$19.50</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>16#</td>
<td>$24.00</td>
</tr>
<tr>
<td>Radish</td>
<td>9#</td>
<td>$24.75</td>
</tr>
<tr>
<td>Cowpea</td>
<td>54#</td>
<td>$45.90</td>
</tr>
<tr>
<td>Chicory</td>
<td>13#</td>
<td>$58.50</td>
</tr>
</tbody>
</table>
How Do Cover Crops Make $$

• Fertilizer savings
• Reduced pesticide in subsequent crop
• Yield bump in subsequent crop
• Saves topsoil from leaving
• Labor savings
• NRCS program payments
• Grazing
• Bees
Questions

jpjohnson@noble.org
“No civilization has outlived the usefulness of its soils. When the soil is destroyed, the nation is gone.”

Lloyd Noble
(1896-1950)
oilman, philanthropist
Healthier Soil

- Improved water relations
- Temperature moderation
- ↑ OM
- ↑ Nutrient Cycling
- ↓ Erosion
- ↓ Compaction
Cycles

Soil → Plants

Carbon, Nitrogen, Water

Atmosphere and Oceans → Animals

Humans

THE SAMUEL ROBERTS NOBLE FOUNDATION