What’s the Soil Missing?
Integrated Crop Rotation and Livestock

Trent Sanderson
Clare, IL
What’s the Soil Missing?

• Diversity
  • Plant species(cash crop & cover crop)

• Animal Impact
  • Manure applied by animal, grazing, stock density, rest time

• Biology
  • Earthworms, microbes
  • *If you build it, they will come*
What we have done to improve the soil while maintaining farm sustainability?

1. ROTATE CASH CROPS
2. MINIMIZE TILLAGE
3. ADD COVER CROPS
4. INTEGRATE LIVESTOCK

IMPROVE BIOLOGY
What we have done to improve the soil while maintaining farm sustainability?

1. Rotate cash crops
2. Minimize tillage
3. Add cover crops
4. Integrate livestock

Improve biology
What we have done to improve the soil while maintaining farm sustainability?

- **ROTATE CASH CROPS**
  - corn, soybeans, small grains & *red clover*
    - Shorter season corn=earlier harvest
    - Early soybean planting, typically before corn
    - Oats, wheat, barley, cereal rye, triticale
    - Hay, straw, stalks & stubble for cattle
  - Improve yield
  - Reduced fertilizer inputs by 40%
    - Credit to placement & rotation
    - 120 units applied nitrogen=200bu. corn
  - Reduced pesticide use
Frost Seed Red Clover #12/Acre
Into Wheat
Frost Seed Red Clover #12/Acre
Into Wheat

- $20/acre seed cost

- 1 ton per acre of dry matter in September for hay harvest (~$100/A)

- 40 units of N credit for the following crop (~$20/A)
Spring Oats Seeded with #12 Red Clover

- If you choose not to harvest for hay, mow to keep from flowering until termination
What we have done to improve the soil while maintaining farm sustainability?

1. Rotate Cash Crops
2. Minimize Tillage
3. Add Cover Crops
4. Integrate Livestock
What we have done to improve the soil while maintaining farm sustainability?

• MINIMIZE TILLAGE
  • No-till all crops, strip-till corn
    • Reduced equipment
    • Reduced fuel usage
    • Reduced labor
    • Reduced fertilizer rates (placement)
    • Reduced erosion
    • Reduced weed pressure
    • Improved soil structure
    • Improved water infiltration
    • Improved water holding capacity
    • Improved fertilizer usage
    • Improved biological/microbial habitat & population
What we have done to improve the soil while maintaining farm sustainability?

1. ROTATE CASH CROPS
2. MINIMIZE TILLAGE
3. ADD COVER CROPS
4. INTEGRATE LIVESTOCK

IMPROVE BIOLOGY
What we have done to improve the soil while maintaining farm sustainability?

• COVER CROPS
  • Added diversity
    • Different species bring added benefits
    • Tillering, N fixing, C:N ratio
  • Armor
    • Protect against rain impact, soil crusting, erosion, hot days/cool nights
What we have done to improve the soil while maintaining farm sustainability?

• COVER CROPS
  • Added diversity
    • Different species bring added benefits
      • Tillering, N fixing, C:N ratio
  • Armor
    • Protect against rain impact, soil crusting, erosion, hot days/cool nights
  • Harvest FREE sunlight & soil respirated CO₂
    • carbon is deposited in the soil by plants
  • Balance the C:N ratio
    • Low C:N - microbes consume excess N by consuming aggregate glue, reducing aggregates & pores in the soil, allowing for runoff(oat & radish residue)
    • High C:N - microbes consume N in order to digest residue(rye & corn residue)
    • When in balance, residue breaks down quicker and N becomes more available
<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Lowest C:N</th>
<th>Highest C:N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Microorganisms, Bacteria</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cahaba Vetch</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Soil Organic Matter</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Austrian Winter Pea</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Purple Top Turnip</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Sunn Hemp</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Dwarf Essex Rapeseed</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>Cowpeas</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>Young Alfalfa Hay</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Yellow Sweet Clover</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Berseem Clover</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Medium Red Clover</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Dixie Crimson Clover</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Synergist Mix</td>
<td>16</td>
<td>38</td>
</tr>
<tr>
<td>Annual Ryegrass</td>
<td>17</td>
<td>38</td>
</tr>
<tr>
<td>Shield Broadleaf Mustard</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>Triticale</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>80/20 Nitro Mix</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>60/40 Nitro Mix</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Winter Mix (36AR, 60TRTCLE, 1.5Rape)</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>Kale Hybrid Rapeseed</td>
<td>18</td>
<td>32</td>
</tr>
<tr>
<td>Soil Buster Mix</td>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>3 Way Mix</td>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>Rotted Barnyard Manure</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Soybean Residue</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Millet</td>
<td>21</td>
<td>54</td>
</tr>
<tr>
<td>Oats (Vegetative)</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>Sunflower</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>Mature Alfalfa Hay</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Cereal Rye (Vegetative)</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>Sorghum Sudangrass</td>
<td>29</td>
<td>75</td>
</tr>
<tr>
<td>Piper Sudangrass</td>
<td>34</td>
<td>56</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>Oat Straw</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Wheat Straw</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Cereal Rye Straw</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Newspaper</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Deciduous Wood</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

**C:N Ratio Immobilizing N Risk**

- Under 25, little to no risk
- 25-56, low to moderate immobilization
- Above 56, high immobilization
What we have done to improve the soil while maintaining farm sustainability?

• **COVER CROPS**
  • Added diversity
    • Different species bring added benefits
      • Tillering, N fixing, C:N ratio
  • Armor
    • Protect against rain impact, soil crusting, erosion, hot days/cool nights
  • Harvest FREE sunlight & soil respirated CO₂
    • carbon is deposited in the soil by plants
  • Balance the C:N ratio
    • Low C:N - microbes consume excess N by consuming aggregate glue, reducing aggregates & pores in the soil, allowing for runoff (oat & radish residue)
    • High C:N - microbes consume N in order to digest residue (rye & corn residue)
    • When in balance, residue breaks down quicker and N becomes more available
  • Feeding biology
    • Microbes (bacteria & fungi) need a constant food source (plant residue) to survive
      • Protozoa and nematodes consume microbes, turning them into plant available N
  • Keep something living on the soil at all times!
INTERSEEDING

80% success rate in S. Ontario

INTERCROPPING

2 CAUTIONS
1.) Shade intolerance
2.) Herbicide residuals

Crop grows until canopy closes, then goes dormant.

Pic is from Sanderson Ag, DeKalb County, Clare, IL

V6-V7 broadcast June 27
16 lbs. Bounty RG + 4 lbs. Crimson Clover
11”- 12” June rainfall ◆◆ Pic taken Aug. 15

Contact Trent Sanderson 815-751-2304 or sandersontrent@gmail.com with Sanderson Ag, Clare, IL
Failed Wheat Crop; Strip-Tilled to Corn
Organic Field
- 2 bu. Cereal Rye
- Soybeans planted June 1
- Drilled 280,000
- Rye roller-cramped after

-Cut worms came in high numbers, black birds grazed like cattle
-Aphids invaded in high numbers, lady bugs had a feast
- Weed pressure minimal

-Yielded 37 bu/A, Net $105/A over conventional
What we have done to improve the soil while maintaining farm sustainability?

1. ROTATE CASH CROPS
2. MINIMIZE TILLAGE
3. ADD COVER CROPS
4. INTEGRATE LIVESTOCK

IMPROVE BIOLOGY
What we have done to improve the soil while maintaining farm sustainability?

• INTEGRATE LIVESTOCK
  • Graze after grain harvest
    • Hoof traffic, manure spread, consume combine grain losses
    • Daily moves with polywire
    • Graze cover crops
  • Bale graze over winter months
    • Added organic matter from bale “waste”
  • Gives rest to perennial pastures
  • Graze annual species planted after small grains
    • Either before a killing frost, or 3+weeks after
What we have done to improve the soil while maintaining farm sustainability?

1. ROTATE CASH CROPS
2. MINIMIZE TILLAGE
3. ADD COVER CROPS
4. INTEGRATE LIVESTOCK

 IMPROVE BIOLOGY
• IMPROVING BIOLOGY
  • Balanced bacterial-fungal balance
    • Higher fungal ratios improve plant available nutrients, especially in early plant growth
  • Increased earthworm population
    • Improve water infiltration, soil aeration, hardpan penetration, reduce soil compaction, incorporate surface residue into the soil, release crop growth stimulants, minerals brought up from subsoil, castings neutralize soil pH, carry microbes in their bodies, improve soil tilth from sugars and enzymes, consume harmful nematodes and create conditions that discourage increased nematode numbers, increased micronutrient chelation
  • Increased microbial numbers = more CO₂ = lower C:N ratio = more available N = faster residue breakdown!!
    • Corn greens up after a rain from CO₂ burst, not N
  • Carbon-based glues create soil aggregate, reducing runoff and adding air space in the soil profile
The results are in….

- Stopped loss of OM, per soil sample data and observation
- Rebuilt soil structure
- Increased earthworm populations
- Reduced dependency on commercial fertilizers & chemicals
What’s Next For Our Farm?

• 100% No-Till
• Additional livestock grazing
• Less commercial fertilizer & chemicals
• Bioreactor compost