Comparing Two Soil Management Approaches

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Cornell Organic Cropping Systems Project
The Cornell Organic Cropping Systems Project (OCS)

- Two experiments, 1 vegetable crops, 1 grain crops
- Vegetable experiment compares 4 different approaches, all certified organic
OCS Vegetable Experiment

- Started out in 2004 with excellent well-drained gravel loam soil
- pH 6.9
- OM 4%
- P high
- K high
OCS Vegetable Experiment

- **V1**—Intensive; high compost, no legume cover crops, 6 cash crops every 4 years
- **V2**—Intermediate; low compost, heavy legume cover crops, 4 cash crops in 4 years
- **V3**—Extensive; Nordell model, low compost applied every 2 years, heavy legume cover crops, 2 cash crops in 4 years
- **V4**—Ridge tillage version of V3
OCS Vegetable Experiment

- Cow manure compost levels based on our estimates of supplying *nitrogen* needs
- Typically 0.6-0.34-0.6 analysis, low P
OCS Vegetable Experiment

- **Basic Rotation**
  - Delicata winter squash (or sweet corn)
  - Farao fall cabbage
  - Red Fire and Ermosa lettuce
  - Yukon Gold potatoes

- Next year we will substitute onions for lettuce
System V1 crops
System V2 crops
We will look in depth at V1 and V2

- “Intensive” vs “Intermediate”
- Tillage and cultivation tools—similar
- Pest management—identical
- Weed management approach—reduce weeds that compete with the crop. In V2, some extra practices to reduce soil weed seedbank are added.
Dry Matter Contributions

<table>
<thead>
<tr>
<th>Crop</th>
<th>V1 (Compost DM)</th>
<th>V1 (legume green manures DM)</th>
<th>V2 (Compost DM)</th>
<th>V2 (legume green manures DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet corn</td>
<td>5790</td>
<td>2437</td>
<td>2910</td>
<td>2546</td>
</tr>
<tr>
<td>Cabbage</td>
<td>3750</td>
<td>1346</td>
<td>0</td>
<td>7577</td>
</tr>
<tr>
<td>Lettuce</td>
<td>2700</td>
<td>0</td>
<td>900</td>
<td>1307</td>
</tr>
<tr>
<td>Potatoes</td>
<td>6380</td>
<td>0</td>
<td>3110</td>
<td>1450</td>
</tr>
<tr>
<td>Winter squash</td>
<td>3639</td>
<td>0</td>
<td>730</td>
<td>5235</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>4452</strong></td>
<td><strong>757</strong></td>
<td><strong>1530</strong></td>
<td><strong>3623</strong></td>
</tr>
</tbody>
</table>
Estimated Average yearly N “input”

- From compost
  - V1—90 lb/acre
  - V2—28 lb/acre

- From legume green manures (not all of this is newly fixed; some is recycled from the soil)
  - V1—30 lb/acre
  - V2—120 lb/acre
How much N was removed in the crops each year?

- V1—46 lb/acre
- V2—38 lb/acre

If we assume that only half of the legume N was newly fixed, then this much was added each year:

- V1—105 lb/acre
- V2—88 lb/acre
How much N was lost each year?

- By subtraction,
  - V1—69 lb/acre
  - V2—50 lb/acre

- Where did it go?
In early spring, low levels of nitrate in soil samples, 0-4 PPM
This is a well-drained soil—has nitrogen leached down over winter?
Is it held in soil organic matter?—Has C/N ratio of SOM decreased?
V1 Cumulative Nutrient balance over 6 years

-200
-100
0
100
200
300
400

After: Sweet corn Cabbage Lettuce Potato Winter squash

lbs/acre
N
P
K

year

After: Sweet corn Cabbage Lettuce Potato Winter squash Cabbage

lbs/acre
V2 Cumulative Nutrient balance over 6 years

-400
-300
-200
-100
0
100
200
300
400

After: Sweet corn Cabbage Lettuce Potato Winter squash

lbs/acre

year

N
P
K

After: Sweet corn Cabbage Lettuce Potato Winter squash Cabbage
What did soil tests show?

**OCS Soil Test Phosphorous Levels Over Time**

- Baseline
- Sweet Corn
- Cabbage
- Lettuce
- Potato

**OCS Soil Test Organic Matter Levels Over Time**

- Baseline
- Sweet Corn
- Cabbage
- Lettuce
- Potato

**OCS Soil Test Calcium Levels Over Time**

- Baseline
- Sweet Corn
- Cabbage
- Lettuce
- Potato

**OCS Soil Test Potassium Levels Over Time**

- Baseline
- Sweet Corn
- Cabbage
- Lettuce
- Potato
Can/should We Apply Less N?

- Negative impact on yields if we do?
Nitrogen Tie-up

- **V1:**

- After low legume growth in V2:
Bumper wheat + hairy vetch crop in 2009 (5/18)
2009 wheat + hairy vetch

- V2: 1280 dry lb vetch; 5100 dry lb wheat—lowest squash yield
- V4: 3100 dry lb vetch (winterkilled oats)—highest squash yield

- Would a lower seeding rate of wheat been better?
Looking deeper

<table>
<thead>
<tr>
<th>Dry Matter Composition (%)</th>
<th>V2 Wheat</th>
<th>V2 Vetch</th>
<th>V4 Vetch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>.25</td>
<td>1.51 a</td>
<td>1.18 b</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>.26</td>
<td>0.26 b</td>
<td>0.35 a</td>
</tr>
<tr>
<td>Potassium</td>
<td>2.08</td>
<td>2.90 b</td>
<td>3.55 a</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1.4</td>
<td>3.7 b</td>
<td>4.2 a</td>
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</table>
Looking deeper

<table>
<thead>
<tr>
<th>Cover Crop Nutrients (lb/acre)</th>
<th>V2 Wheat</th>
<th>V2 Vetch</th>
<th>V2 Total</th>
<th>V4 Total (=Vetch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>13</td>
<td>19</td>
<td>32</td>
<td>37</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Potassium</td>
<td>106</td>
<td>37</td>
<td>143</td>
<td>110</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>71</td>
<td>47</td>
<td>118</td>
<td>130</td>
</tr>
<tr>
<td>Carbon @ 50%</td>
<td>2550</td>
<td>630</td>
<td>3180</td>
<td>1550</td>
</tr>
<tr>
<td>C/N</td>
<td>36</td>
<td>13</td>
<td>27</td>
<td>12</td>
</tr>
</tbody>
</table>
C:N ratios

- < 20, net N release
- 20-30, neutral
- > 30, N tie up, then release later
Rather than tilling in a large cover crop, what about harvesting it for mulch?

- N retained over winter
- Weed control
- Extra labor, equipment
Soil Health

- New Cornell Soil Health test
- Tests many parameters
- Our choices for most useful—
  - Soil OM
  - Aggregate stability
  - Active carbon
- In addition to sound nutrient management
Active Carbon

<table>
<thead>
<tr>
<th>PPM</th>
<th>after cabbage</th>
<th>after lettuce</th>
<th>after potatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>650</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>550</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rotation Point

1

2
Yields

- Have been generally good, though we have sometimes grown high-value cultivars which don’t yield well—
  - Yukon Gold potato
  - Delicata winter squash
Overall System Yields

System
NYS Average = 100
Weeds, dry Lb/A at harvest
Economics

- Have not done all crops in all years yet
- **Tentative** general trends—V1 has best net return because of extra crops
- V3 has lower net return because of costs of managing twice the land per crop
Economics

- V4 usually has low yields, resulting in lower net return; however, it had best squash yield in 2009. It seems like N release is slow in this system.
- V2 intermediate
- Will we see changes over time?