Making Diverse Rotations Work

Small Grains in the Corn Belt: Production Data Synthesis

July 2020
Methods

- Farmers participate in cost share for small grain crop + legume cover crop ‘17-present
- Farmer data collected via survey in 2017, 2018 & 2019
- Two cohorts in this analysis:
  - 2017 cohort: 2017, 2018, 2019 (3 years of rotation – N = 10)
  - 2018 cohort: 2018, 2019 (2 years of rotation – N = 35)
- Corn-soy rotation with cover crop serves as a baseline, provided by corn and soy company supply chain project
- Data used to populate:
  - Fieldprint Calculator (FPC)
  - Cool Farm Tool (CFT)
- Management changes captured include addition of a cover crop and changes in inputs to following crop years
The Tools

- Fieldprint® Calculator (FPC) measures **emissions only** for GHG
- Cool Farm Tool (CFT) measures **emissions and sequestration** of GHG
- FPC also offers metrics on:
  - Soil Conservation
  - Soil Carbon
  - Water Quality
  - Biodiversity
Our Hypotheses

1. Diverse rotations with small grains lead to more roots in the ground year round
2. Fertilizer reduction to corn following a legume cover crop has a big impact on reducing GHG emissions
3. Extended rotation benefits of increase corn and soy yields and biological nutrient cycling that allows more drastic cutting of fertilizer cannot be capitalized fully by farmers in first 1-3 years of practicing the rotation
## 1. More Roots

### Table: Rotation and Cover Crop Usage

<table>
<thead>
<tr>
<th>Rotation</th>
<th>2017 Crop</th>
<th>Cover Crop</th>
<th>2018 Crop</th>
<th>Cover Crop?</th>
<th>2019 Crop</th>
<th>Proportion Practicing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small Grain</td>
<td>Legume Cover Crop</td>
<td>Corn</td>
<td>100% (6/6)</td>
<td>Soybeans</td>
<td>60% (6/10)</td>
</tr>
<tr>
<td>2</td>
<td>Small Grain</td>
<td>Legume Cover Crop</td>
<td>Corn</td>
<td>50% (1/2)</td>
<td>Corn</td>
<td>20% (2/10)</td>
</tr>
<tr>
<td>3</td>
<td>Small Grain</td>
<td>Clover</td>
<td>Clover</td>
<td>100% (1/1)</td>
<td>Corn</td>
<td>10% (1/10)</td>
</tr>
<tr>
<td>4</td>
<td>Small Grain</td>
<td>Alfalfa</td>
<td>Alfalfa</td>
<td>100% (1/1)</td>
<td>Alfalfa</td>
<td>10% (1/10)</td>
</tr>
</tbody>
</table>

### Note:

90% of 2017 cohort had continuous living cover for 3 years straight
(from small grain planting in fall of 2016 or spring of 2017 until crop harvest in fall of 2019)

2017 cohort, n=10
1. More Roots

2019 Practical Farmers of Iowa Nitrate-N Concentrations

PFI Average Under Small Grains = 5.75
1. More Roots

Rotation 2019 - 2018

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Average Nitrate-N Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn - Corn</td>
<td>12.6</td>
</tr>
<tr>
<td>Corn - Soybean</td>
<td>10.8</td>
</tr>
<tr>
<td>Soybean - Corn</td>
<td>11.4</td>
</tr>
<tr>
<td>Other</td>
<td>5.8</td>
</tr>
</tbody>
</table>
2. Fertilizer Reductions

• Of population that grew corn in 2019 after small grain + legume cover ...
  • 48% used less fertilizer compared to two-year rotation corn
  • 36% used the same fertilizer compared to two-year rotation corn
  • 16% did not have a comparison field

• Farmers self-reported reducing an average of 46 lbs/ac (median 50 lbs) if they indicated they applied less fertilizer

2019 corn after legume cover, N = 25
2. Fertilizer Reductions

Ex. Rotation Corn 2017-2019, N=41
Corn with Cover Crop 2017-2019, N = 529
2. Fertilizer Reductions

All Crops in Cover Crops and Extended Rotation Data Set, N = 1304
2. Fertilizer Reductions

In six years:

- Spring small grains rotation result in **10% reduction in GHG**
- Winter small grains rotation results in **3% reduction in GHG**

From emissions only (and with only half cutting fertilizer)

<table>
<thead>
<tr>
<th></th>
<th>Corn w/ CC</th>
<th>Soy w/ CC</th>
<th>Corn-SG</th>
<th>Soy-SG</th>
<th>Spring SG</th>
<th>Winter SG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean (GHG per acre (lbs CO2e / acre))</strong></td>
<td>2607.79</td>
<td>755.77</td>
<td>2675.09</td>
<td>686.01</td>
<td>1190.13</td>
<td>1544.41</td>
</tr>
<tr>
<td><strong>Project</strong></td>
<td>Corn &amp; Soy w/ CC</td>
<td>Small Grain Extended Rotation</td>
<td>Corn (grain)</td>
<td>Soybeans</td>
<td>Wheat (spring)</td>
<td>Wheat (winter)</td>
</tr>
<tr>
<td><strong>Crop</strong></td>
<td>Corn (grain)</td>
<td>Soybeans</td>
<td>Wheat (spring)</td>
<td>Wheat (winter)</td>
<td>Corn (grain)</td>
<td>Soybeans</td>
</tr>
</tbody>
</table>
2. Fertilizer Reductions

Incorporating sequestration estimates from CFT would lead to:

- Spring small grains rotation result in **21% reduction in GHG**
- Winter small grains rotation results in **14% reduction in GHG**

(again with only half cutting fertilizer)

Crops from Extended Rotation
- Data Set
  - Alfalfa: N=9
  - Corn: N=29
  - Spring Small Grain: N=28
  - Winter Small Grain: N=17
3. Delayed Gratification

• Of population that grew corn in 2019 after small grain + legume cover ...
  • **44% reported higher yields** compared to two-year rotation corn
    • Average +14.7 bushel/acre
  • **20% reported similar yields** compared to two-year rotation corn
  • **16% reported lower yields** compared to two-year rotation corn
    • Average -32.5 bushel/acre
  • 20% had no comparison for their yields

2019 corn after legume cover, N = 25
3. Delayed Gratification

Ex. Rotation Corn 2017-2019, N=41
Corn w/ Cover Crop 2017-2019, N = 529
3. Delayed Gratification

- **Instant Gratification:** Corn grown in extended rotation uses 31 lbs N/acre less synthetic fertilizer (statistically significant)

  Ex. Rotation Corn 2017-2019, N=41
  Corn 2017-2019, N = 529

- **Delayed Gratification:** Corn yields statistically the same in extended rotation (but we expect yields to climb with longer practice of rotation)

  Ex. Rotation Corn 2017-2019, N=41
  Corn 2017-2019, N = 529
QUESTIONS?
Summary/Next Steps

- Small grain + legume cover crop results in 50 lbs less fertilizer to following corn without sacrificing corn yields (instant gratification!)
- Farmers continue to see delay in increasing yields, require support in early years (delayed gratification)
- Need to tie incentive to reducing fertilizer to get the next 50% – Included in recently submitted CIG proposal
- Need more evaluation of what data is driving farmer behavior change (soil tests, neighbor experience, extension, etc.)
- None of this is scalable without a market and there are high program costs associated with the use of tools (may not be scalable)
What additional research/learning questions are important for this group to be asking and PFI/SFL to be supporting as we look ahead?
Thank You!

Questions?
Contact Carol Healy: chealy@sustainablefood.org

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