Economics of Cover Crops

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Cost of Tillage Operations/Acre

• Chisel Plow $14/A
• Disk Tandem $13/A
• Field Cultivate $11/A
• Plow $17/A
• Soil Finishing Tools $11/A
• Subsoil $18/A

Ohio Farm Custom Rates 2010
Barry Ward, OSU Economist
<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>Seed Price/lb</th>
<th>Pound Planting</th>
<th>Planting Cost</th>
<th>Kill Cost</th>
<th>Total Cost/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpeas</td>
<td>$.80</td>
<td>40-50</td>
<td>$14</td>
<td>$0</td>
<td>$46-54</td>
</tr>
<tr>
<td>Winter peas</td>
<td>$1.00</td>
<td>30-40</td>
<td>$14</td>
<td>$0-15</td>
<td>$34-$69</td>
</tr>
<tr>
<td>Red Clover</td>
<td>$2.00</td>
<td>10-12</td>
<td>$6</td>
<td>$15</td>
<td>$41-$45</td>
</tr>
<tr>
<td>Chickling vetch</td>
<td>$1.00</td>
<td>30-70</td>
<td>$14</td>
<td>$15</td>
<td>$59-$99</td>
</tr>
<tr>
<td>Sweet Clover</td>
<td>$1.50</td>
<td>10-20</td>
<td>$6</td>
<td>$10</td>
<td>$31-$46</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>$1.25</td>
<td>15-20</td>
<td>$14</td>
<td>$15</td>
<td>$49-$54</td>
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</tbody>
</table>
## Grass Cover Crop Seed Cost

<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>Seed Price/lb</th>
<th>Pound Planting</th>
<th>Planting</th>
<th>Kill</th>
<th>Total Cost/A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal Rye</td>
<td>$.20/$12/bu</td>
<td>60 1 bu</td>
<td>$14</td>
<td>$15</td>
<td>$41</td>
</tr>
<tr>
<td>Annual Rye</td>
<td>$.80</td>
<td>15-25</td>
<td>$14</td>
<td>$15</td>
<td>$41-$49</td>
</tr>
<tr>
<td>Wheat</td>
<td>$.10/$6/bu</td>
<td>60 1 bu</td>
<td>$14</td>
<td>$15</td>
<td>$35</td>
</tr>
<tr>
<td>Oats</td>
<td>$.15/$6/Bu</td>
<td>42-63 1-1.5 bu</td>
<td>$14</td>
<td>$0</td>
<td>$20-$23</td>
</tr>
<tr>
<td>Brassicas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>$3.00</td>
<td>1-10</td>
<td>$14</td>
<td>$0</td>
<td>$17-$44</td>
</tr>
</tbody>
</table>
Basic differences among land systems

Natural Vegetation

Conventional Tillage

No-Tillage + Cover Crop

Litter + roots

Continuous porosity

Steady State

Aggregates Forming

Continuous C flux

Structure disrupted

Unstable

Active “Pool”
Slow “Pool”
Passive “Pool”

SOM Losses

Active MCB and high CO₂ flux

Cover + Crop roots

Continuous porosity

New Steady State

Re-aggregation

Aeration + mix to Crop Residue

Continuous C flux

Active “Pool”
Slow “Pool”
Passive “Pool”
Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches
1% organic matter = 20,000#

Nutrients:
Nitrogen: \(1000\# \times \$0.50/\#N = \$500\)
Phosphorous: \(100\# \times \$0.48/\#P = \$48\)
Potassium: \(100\# \times \$0.42/\#K = \$42\)
Sulfur: \(100\# \times \$0.50/\#S = \$50\)
Carbon: 10,000# or 5 ton \(\times \$2/Ton = \$10\)

Value of 1% SOM Nutrients/Acre = \$650

Conventional agriculture is related to soil, air and water quality degradation.

1.2 billion ton CO$_2$/y
i.e. 570 M ton SOM loss

A 1% loss of SOM = 1000 lbs N/ac
Soil Organic Matter Accumulation

• Takes 10 tons of Decomposed Organic Matter to equal 1% SOM
• If start with 40 tons Organic Matter and lose 75% to get 10 tons decomposed SOM
• Accumulate 4-6 tons and lose 75% equals 1-1.5 tons Decomposed SOM or .1-.15% SOM * $560/Acre or $56 to $84/Acre

You are Building Your Soil Fertility with SOM!
Crop Residue along Ditch from Bare Cropland, Chiseled Wheat Stubble
Crop Residue along Ditch
Value of Ton of Topsoil

• Most Biological activity occurs in top 3 inches.
• One million pounds or 500 ton of topsoil in top 3 inches.
• Average Value of Cropland = $5,000/Acre
• Soil Lost at T value = 4-5 ton/acre
• Soil Productivity Value: $5,000/500 = $10/Ton
• Lost value per acre = $10/ton soil loss * 4-5 tons
  Losing $40 to $50 per acre.
Productivity of SOM

• Michigan study: Every 1% SOM = 12% increase in crop yields.
• Baseline Yields: 170 bu corn, 50 bu soybeans
  Starting SOM = 3% and add 1% SOM

Soybeans 50 bu * 12% = 6 bu * $10 = $60/A.
  .1 to .15% SOM increase/year = $6-$9/yr.

Corn 170 bu * 12% = 20.4 bu * $5 = $102/A
  .1 to .15% SOM increase/year = $10.20-$15.30/yr.
Do we get more N loss from inorganic (fertilizer) N or organic N?

• Inorganic (fertilizer) N had significantly higher N losses.
• How much? 31% for fertilizer compared to 13% for crop residue (organic N).
• Crop residue has 73% more retention of N in the soil than fertilizer N (26% retention).
• Suggests slower N recycling in crop residues (or proteins) protects against N losses. (Delgado, 2010)
A Common *Myth* about inorganic fertilizers: They feed the plant directly

<table>
<thead>
<tr>
<th>Fertilizer Nitrogen applied Kg/ha (pounds/ac)</th>
<th>Corn Grain Yield Mg/ha (Bu/ac)</th>
<th>Total N in corn plant Kg/ha (pounds/ac)</th>
<th>Fertilizer derived N in Corn Kg/ha (pounds/acre)</th>
<th>Soil-derived N in corn, in Kg/ha (pounds/acre)</th>
<th>Fertilizer-derived N in corn as percent of total N in corn %</th>
<th>Fertilizer-derived N in corn as percent of N applied %</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 (45)</td>
<td>3.9 (62)</td>
<td>85 (77)</td>
<td>28 (25)</td>
<td>60 (54)</td>
<td>33</td>
<td>56</td>
</tr>
<tr>
<td>100 (90)</td>
<td>4.6 (73)</td>
<td>146 (131)</td>
<td>55 (50)</td>
<td>91 (81)</td>
<td>38</td>
<td>55</td>
</tr>
<tr>
<td>200 (180)</td>
<td>5.5 (88)</td>
<td>157 (141)</td>
<td>86 (78)</td>
<td>71 (63)</td>
<td>55</td>
<td>43</td>
</tr>
</tbody>
</table>

Source of Nitrogen in Corn in North Carolina on an Enon Sandy Loam Soil Fertilized with Three Rates Nitrogen as NH₄-NO₃ (tagged Isotope 15 N)

(Calculated from Reddy and Reddy 1993)
About 50-75% of the Available P in soil is organic. P stabilizes the OM and forms a bridge to the clay. Our current P use efficiency is 50%.
Increased Efficiency

Nitrogen Efficiency: 30-50% conventional Increase to 80-90% with No-till & Cover Crops.

Phosphorus Efficiency: 50% conventional Increase to 90% with No-till & Cover Crops.
Lime Costs/acre

• 1 to 2 tons of lime per acre * $14/Ton
• Plus spreading cost $6/Acre
• Total lime cost: $34/Acre over 3-5 years
• Cost /Acre/Year: $7-11
• No-till and Cover Crops need less lime because they keep Ca$^{2+}$ circulating
## Legume Cover Crop N Economics

<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>Total Cost/A.</th>
<th>Pound Of N</th>
<th>Value of N</th>
<th>Total N $</th>
<th>Net Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpeas</td>
<td>$46-54</td>
<td>120-150</td>
<td>$.40</td>
<td>$48-60</td>
<td>($2)-$14</td>
</tr>
<tr>
<td>Winter peas</td>
<td>$34-$69</td>
<td>120-150</td>
<td>$.40</td>
<td>$48-60</td>
<td>($9) - $26</td>
</tr>
<tr>
<td>Red Clover</td>
<td>$41-$45</td>
<td>100-120</td>
<td>$.40</td>
<td>$40-$48</td>
<td>($3)-$7</td>
</tr>
<tr>
<td>Chickling Vetch</td>
<td>$59-$99</td>
<td>50-125</td>
<td>$.40</td>
<td>$20-$50</td>
<td>($9-$49)</td>
</tr>
<tr>
<td>Sweet Clover</td>
<td>$31-$46</td>
<td>100-150</td>
<td>$.40</td>
<td>$40-$60</td>
<td>($6)-$29</td>
</tr>
<tr>
<td>Hairy Vetch</td>
<td>$49-$54</td>
<td>100-200</td>
<td>$.40</td>
<td>$40-60</td>
<td>($9)-$11</td>
</tr>
</tbody>
</table>
Drainage

- $800 to $1000/acre for subsurface drainage.
- Farmers say you pay for drainage every 20 years whether you pay for it or not. Poor drainage costs you in reduced yields.

Keep $1000 in Bank, Collect 2-3% interest
Spend Interest on Cover Crops: $20-30/A.
Still have principal at end of 20 years.
Annual Ryegrass Cover Crop
No-till Cropland No cover
Annual Ryegrass Cover Crop
Water Storage Value

- Every 1% SOM hold 1 acre-inch of water
- Value of an acre-inch of water = $12
- Value of 6% SOM vs 2% SOM = 4 acre-inches of water * $12/acre-inch = $48
- .1% SOM addition per year = .1 acre-inch * $12/acre-inch = $1.2 per year
## Indiana Corn Yields

<table>
<thead>
<tr>
<th>Planting method</th>
<th>Yield bu/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
</tr>
<tr>
<td>Conventional (mulch till)</td>
<td>55</td>
</tr>
<tr>
<td>Conventional (with soil compaction)</td>
<td>23</td>
</tr>
<tr>
<td>No-till/ryegrass Silt loam soil</td>
<td>138</td>
</tr>
<tr>
<td>No-till/vetch-ryegrass Claypan soil</td>
<td>83</td>
</tr>
<tr>
<td>No-till no cover crop Claypan soil</td>
<td>65</td>
</tr>
</tbody>
</table>
# 2005 Illinois demonstration results

<table>
<thead>
<tr>
<th>Tillage/cover crop</th>
<th>Yield bu./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional tillage</td>
<td>82</td>
</tr>
<tr>
<td>No cover crop no-till</td>
<td>124</td>
</tr>
<tr>
<td>Ryegrass 1 year no-till</td>
<td>137</td>
</tr>
<tr>
<td>Ryegrass 6 years –claypan</td>
<td>165</td>
</tr>
<tr>
<td>Ryegrass 6 years no claypan</td>
<td>215</td>
</tr>
</tbody>
</table>

Rain fall .... May- Sept.  2.3”
Cover Crop Benefits in Drought

2005 Illinois Corn Data (2.3 inches rain)
Conventional tillage 82
No-till 124-82=42 bushels * $5/Bu = $210
No-till + Annual Rye 137-82=55*$5 = $275
$275/20 years $14 per year

Negative Effects:
Cover crops may excessively dry the soil through respiration in a dry spring. Solution is to kill the cover crop early if the soil is getting too dry.
Weeds

- Farmers promote weed seed by tilling the soil.
- Ways to fight weeds
  1) Hoe or pull them out
  2) Kill with herbicides
  3) Compete for sunlight and nutrients by growing cover crops and reduce weed seed production.
- Farmers with No-till and Cover Crops reduce herbicide cost by $1/3 = $7-$12/A.
- Early weeds reduce crop yields 10% * 50 bu soybeans * $10/A. = $50
- Reduced weeds: cereal rye, oilseed radish, etc.
Insects

Positive: Soybean Cysts Nematodes (SCN)
1) 80-90% Reduction using cereal rye/annual rye
   50 bu * 30% =15 bu * $10 = $150/A

Natural Pollinators: $5 Billion/350 million = $14/A

Negative: Slugs, Cutworm, Armyworm

1) Carabidae beetles or ground beetles are natural predators of soft body insects.
2) Cover crops may be an alternative food source for slugs and may protect corn from damage.
Diseases

Diseases that thrive under excess water
- Phytophthora: 20% loss * 50 bu = 10 bu * $10 = $100/A
- Phythium: 5-10% * 50 bu = 2.5-5 bu * $10 = $25-$50/A
- Fusarium: 10% * 50 bu = 5 bu * $10 = $50
- Rhizoctonia 2-5% * 50 bu = 1-2.5 bu * $10 = $10-$25/A

Thrive with less biological activity (tillage)
- Sclerotina/White Mold (Bury seed with tillage)
  2 to 4 bushel per acre * $10 = $20-40/A
Seed Production

Cereal rye:
30-60 bushels * $12 =
$360-$720/A minus $49 seed, plant, kill it plus
$20 for harvesting = $290 - $650

Cowpeas: 30-35 bushels per acre or 1500 to
1750 pounds times $.80/lb = $1200 - $1400/A
minus seed, planting, harvesting costs
Forage Value of Cover Crops

- Oats, cereal rye, annual ryegrass
- 4 tons cereal rye at $80/ton = $320 Income
- Costs $49 (2 bu/Acre for seed) per acre for seed, plant, kill it.
- Harvest Costs: $33
- Net Income: $237
Manure Application & Retention

Manure Applied to a Cover Crop
Manure Value of Cover Crops

Swine Manure: 95% Water 5% solids
Manure Nutrient Analysis: 18-16-14/1000 gallons
Uptake: At 5,000 gallons/A = 90-80-70 $33
    At 10,000 gallons/A = 180-160-140 $44

Dairy Manure: 98% water 2% solids
Manure Nutrient Analysis: 20-15-15
Uptake: At 5,000 gallons/A = 100-75-75 $36
    At 10,000 gallons/A = 200-150-150 $64

*Absorb 70% N, maximum 20# P
SOM Buffers Soil Temperatures

• Early frost 1/20 years
• Value to replant soybeans $100/acre
• Value of frost protection over 20 years = $5/acre
Indirect Water Quality Costs

1) Water Treatment Costs: $1-2/1000 gallons * 161 gallons/day/person* $1-2/1000 * 365 days * 310 million people * 85%/350 million acres = $44/Acre

2) Army Corp Annual Dredging Costs: $1.345 Billion/350 million acres = $4/Acre
Soil Compaction costs

Conventional tillage vs No-till and Cover Crops
Corn 3% yield gain
150 bushel corn * 3% = 4.5 bu * $4 = $18/A

Soybeans 8-10% yield gain
50 bushels soybeans * 10% = 5 bu * $8 =$40/A

Cover crops improve soil structure, water infiltration, and decrease runoff.
Government Payments

CSP payments: Range from $10 to $30/Acre

Carbon Credits: Depends on Price $1-4/A or more depending on how much carbon is stored in the soil.

Nutrient Credits: Miami Conservancy paying $1 per pound for N & P credits.
Other Local or Regional Payments

Nitrogen and Phosphorus Credits: Miami Conservancy (Dayton) is paying $50 to $80/A if grow grass cover crop after corn silage (N, P, soil erosion) and apply manure, $20 to $40 after soybeans and wheat (P, soil erosion) if no manure applied.

Grand Lake St. Marys: $50-70/A for Cover Crops for manure management.
Cover crop effects

No Cover Crop
80+/- bu/ac

6 years CC (annual ryegrass)
160+/- bu/ac

Mike Plumer’s long-term no till with ryegrass cover crops on heavy clay soil.
Yield Benefits

Positive Results for Corn

1) Crimson clover + Radish
   235.3 bu – 227.8 bu = 7.5 bu * $5 = $37.50/A

2) Oats + Radish
   195.5 bu - 186.5 bu = 9 bu * $5 = $45.00/A

3) ARG + Manure on Sandy Soil
   Leman, IN
   20 bushel * $5 = $100.00/A
Corn Yield Losses

1) ARG
227.8 bu – 211.1 bu = (16.7 bu)*$5 = ($83.50/A)
Why: Dry weather may reduce corn yields.
Solution: Kill ARG earlier to reduce water loss.

2) Winter pea + Radish
227.8 bu – 223.1 bu = (4.7 bu)* $5= ($23.50)
Golden Goose

Two Farmers with 10 Golden Geese

First Farmer: Wants 10+ eggs/day. Kills one goose and gains 5 eggs. (Conventional tillage)

Second Farmer: Can sacrifice and live with 9 eggs/day. Breeds one goose and hatches 10 eggs. Takes 3-5 years before a mature bird lay eggs. (No-till+Cover crops)

Which farmer is going to be richer and better off after 5-10-20 years?
# Cost Savings and Added Income

<table>
<thead>
<tr>
<th>Practice</th>
<th>Conventional</th>
<th>NT + Cover Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>$35-$50/A</td>
<td>$30-$99/A</td>
</tr>
<tr>
<td>SOM</td>
<td>($25-$50)/A</td>
<td>$56-84/A</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>($40-$50)/A</td>
<td>$0</td>
</tr>
<tr>
<td>N Efficiency</td>
<td></td>
<td>+30-60%</td>
</tr>
<tr>
<td>P Efficiency</td>
<td></td>
<td>+40%</td>
</tr>
<tr>
<td>Lime</td>
<td>($7-11/A)</td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td>($1000/A)</td>
<td>($20-30) + Principal</td>
</tr>
</tbody>
</table>
### Cost Savings and Added Income

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<tr>
<th>Practice</th>
<th>Conventional</th>
<th>NT + Cover Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeds</td>
<td></td>
<td>Maximum $50/A</td>
</tr>
<tr>
<td>Insects (SCN)</td>
<td></td>
<td>Maximum $150/A</td>
</tr>
<tr>
<td>Diseases</td>
<td>Phytophthora</td>
<td>Maximum $100/A</td>
</tr>
<tr>
<td>Diseases</td>
<td>Phythium</td>
<td>Maximum $25-50/A</td>
</tr>
<tr>
<td>Diseases</td>
<td>Rhizoctonia</td>
<td>Maximum $10-25/A</td>
</tr>
<tr>
<td>Diseases</td>
<td>Fusarium</td>
<td>Maximum $50/A</td>
</tr>
<tr>
<td>Diseases</td>
<td>Sclerotinia</td>
<td>Maximum $20-40/A</td>
</tr>
<tr>
<td>Seed Prod.</td>
<td></td>
<td>$290-$1400/A</td>
</tr>
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</table>
## Cost Savings and Added Income

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<tr>
<th>Practice</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Forage Production</td>
<td></td>
<td>$200</td>
</tr>
<tr>
<td>Manure Value</td>
<td></td>
<td>$33-64/A</td>
</tr>
<tr>
<td>Water Treat.</td>
<td>($44/A)</td>
<td>($44/A)</td>
</tr>
<tr>
<td>Dredging</td>
<td>($4/A)</td>
<td>($4/A)</td>
</tr>
<tr>
<td>SOM Productivity</td>
<td></td>
<td>$6-15/A</td>
</tr>
<tr>
<td>Water Storage</td>
<td></td>
<td>$14/year</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td>$5/Acre</td>
</tr>
<tr>
<td>Soil Compaction</td>
<td>($18-$40/A)</td>
<td>($18-$40/A)</td>
</tr>
</tbody>
</table>
## Added Income or Losses

<table>
<thead>
<tr>
<th>Practice</th>
<th>Conventional</th>
<th>NT + Cover Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP</td>
<td></td>
<td>$10-$30/A</td>
</tr>
<tr>
<td>Carbon</td>
<td></td>
<td>$1-4/A</td>
</tr>
<tr>
<td>Local Watershed</td>
<td>For N and P or manure credits</td>
<td>$20-80/A</td>
</tr>
<tr>
<td>Yield Gain</td>
<td></td>
<td>$37.50-100/A</td>
</tr>
<tr>
<td>Yield Loss</td>
<td></td>
<td>($23.50-83.50/A)</td>
</tr>
</tbody>
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