Farm-level economic impact of no-till farming in Western Oklahoma

by

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Introduction

- Tillage practices can impact water quality
- Conservation tillage reduces sediment loss
- Reduced and conservation tillage can increase soluble nutrient concentrations
- Overall, conservation tillage, particularly no-till helps improve water quality
Introduction (Contd.)

- Farm profits also depend on tillage method used
- Conservation tillage – increased yield variability
- Conservation tillage yields:
  - Usually higher in dryer years
  - Often lower in wetter years
- Yield impacts of no-till are inconclusive
  - Some studies show that no-till yields increase over time relative to other tillage practices
Introduction (Contd.)

- Conservation tillage – lower crop operating costs:
  - Fewer field operations
  - Lower fuel/energy costs
  - Lower machinery ownership & maintenance costs

- Conservation tillage – generally higher pesticide costs
  - Greater need to control herbicides with chemicals
Introduction (Contd.)

- Overall, conservation tillage competitive with conventional tillage
- Relative profit on a specific farm depends primarily on yields
- Profit depends also on fuel prices
- Recent technology advances help no-till:
  - Better equipment for conservation tillage
  - Pesticide-ready seed varieties
Introduction (contd.)

- Water quality impacts of no-till quite certain
- However, economic impacts inconclusive
  - Partly due to lack of sufficient data/analysis
    - E.g. impact of no-till on grain and forage yields
    - Can hinder producer decisions
- Purpose of this study is to use Farm-level Economic Model (FEM) to determine no-till profits relative to conventional tillage or mix of current tillage practices in Western Oklahoma.
  - Based on data collected in Fort Cobb Reservoir watershed.
  - Applicable to other areas in Western Oklahoma
What we will talk about today

- Tillage systems overview:
  - Types
  - Trends
- What computer model or software we used
- How we ensured that the model estimates are reliable
- What kinds of data we used and where we got them from
- How we performed the analysis
- Results
- Recommendations
- Conclusions
Types of tillage systems

- Conventional tillage:
  Leaves less than 15% residue cover
    - With moldboard plow
    - Without moldboard plow

- Reduced tillage:
  Leaves 15-30% residue cover
Types of tillage systems (Contd.)

- Conservation tillage:
  - Leaves at least 30% residue cover
    - Mulch till
    - Ridge-till
    - No-till
Trends in tillage system use in the U.S.

[Graph showing trends in tillage systems from 1989 to 2003 for corn. The graph compares No-till, Ridge-till, Mulch-till, Reduced-till, and Conventional-till.]

No-till Oklahoma

USDA

TiAER
Trends in tillage system use in the U.S. (Contd.)

Soybeans

- No-till
- Ridge-till
- Mulch-till
- Reduced-till
- Conventional-till

Year:
- 1989
- 1991
- 1993
- 1995
- 1997
- 1999
- 2001
- 2003

Percent:
- 0
- 5
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45
- 50

No-till Oklahoma

[Graph showing trends in tillage system use for Soybeans]
Trends in tillage system use in the U.S. (Contd.)

Spring seeded small grain

<table>
<thead>
<tr>
<th>Year</th>
<th>No-till</th>
<th>Ridge-till</th>
<th>Mulch-till</th>
<th>Reduced-till</th>
<th>Conventional-till</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>50</td>
<td>20</td>
<td>10</td>
<td>10</td>
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</tr>
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<td>1995</td>
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</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>85</td>
<td>80</td>
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<tr>
<td>2004</td>
<td>0</td>
<td>90</td>
<td>85</td>
<td>85</td>
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</tbody>
</table>
Trends in tillage system use in the U.S. (Contd.)

![Graph showing trends in tillage system use in the U.S.](image-url)
Trends in tillage system use in the U.S. (Contd.)

Cotton

Year

Percent

No-till
Ridge-till
Mulch-till
Reduced-till
Conventional-till
Trends in tillage system use in the U.S. (Contd.)

Grain sorghum

- No-till
- Ridge-till
- Mulch-till
- Reduced-till
- Conventional-till

Year

Percent

1989 1991 1993 1995 1997 1999 2001 2003
Trends in tillage system use in the U.S. (Contd.)

All Cropland

<table>
<thead>
<tr>
<th>Year</th>
<th>No-till</th>
<th>Ridge-till</th>
<th>Mulch-till</th>
<th>Reduced-till</th>
<th>Conventional-till</th>
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</thead>
<tbody>
<tr>
<td>1989</td>
<td></td>
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<td>1991</td>
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<td>2003</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>
Computer model used – FEM

Brief overview

- A whole-farm annual economic model
- Simulates economic impacts of a wide range of scenarios on farms
- For each application, model is calibrated with extensive data on farm practices, budgets and other watershed information
- Includes a number of simulation and optimization routines
Major components of FEM

- Cropping Systems
- Livestock systems/husbandry
- Manure handling/management
- Land areas and uses
- Machinery and Equipment
- Structures and facilities
- Exogenous factors
How we made sure FEM works well for Western Oklahoma

- We calibrated the model
  - We adjusted model parameters and input data to reflect study area
  - For this study we compared FEM estimates to enterprise budgets and custom rate surveys

- Machinery coefficients adjusted include:
  - Prices
  - Hours of effective use
  - Field efficiency
  - Width
  - Speed
Comparison of field operation costs: calibrated FEM estimates versus Oklahoma custom rate survey data

<table>
<thead>
<tr>
<th>Field Operation</th>
<th>FEM Model Estimate</th>
<th>Current Custom Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Fixed</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>15.10</td>
<td>5.66</td>
</tr>
<tr>
<td>Chisel plow</td>
<td>9.96</td>
<td>5.00</td>
</tr>
<tr>
<td>Spring-tooth harrow</td>
<td>5.38</td>
<td>2.04</td>
</tr>
<tr>
<td>Tandem disk</td>
<td>8.50</td>
<td>5.01</td>
</tr>
<tr>
<td>No-till drill</td>
<td>12.96</td>
<td>6.47</td>
</tr>
<tr>
<td>Drill, regular</td>
<td>10.19</td>
<td>6.71</td>
</tr>
<tr>
<td>Cultivator</td>
<td>8.55</td>
<td>4.75</td>
</tr>
<tr>
<td>Packer, pulverize</td>
<td>12.53</td>
<td>4.09</td>
</tr>
<tr>
<td>Spray herbicide/pesticide</td>
<td>3.99</td>
<td>2.41</td>
</tr>
<tr>
<td>Fertilizer spreading: bulk</td>
<td>4.74</td>
<td>2.36</td>
</tr>
</tbody>
</table>

*NA: Not available in Oklahoma customs rate survey.
Data used and data sources

Prices
- Input prices – USDA-NASS, feed & chemical dealers, etc.
- Output prices – USDA-NASS

Crop yields
- Grain yields – Fort Cobb reservoir watershed, USDA-NASS
- Forage yields – Fort Cobb reservoir watershed

Cultural practices/field operations
- Current practices – Farm survey sites – Ft. Cobb reservoir watershed
- No-till/conventional tillage practices – Farm survey sites – Ft. Cobb reservoir watershed
Location of the Ft. Cobb reservoir watershed in Southwestern Oklahoma
After 9” rain – field that was conventional tilled

Photo credit: Larry Wright, USDA NRCS
After 9” rain – adjacent field that was no-tilled

Photo credit: Larry Wright, USDA NRCS
# Summary of tillage practices
from farm survey sites in Ft. Cobb reservoir watershed

<table>
<thead>
<tr>
<th>Crop</th>
<th>Conventional</th>
<th>No-till</th>
<th>Minimum till</th>
<th>Row-till</th>
<th>Row-till/No-till</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Cotton</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Peanuts</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Rye</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Wheat</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>Totals</td>
<td>26</td>
<td>18</td>
<td>24</td>
<td>2</td>
<td>2</td>
<td>72</td>
</tr>
</tbody>
</table>
Simulation Procedure

Scenario input file created for 189 iterations for each of the 40 farms:

- Diesel prices changed from $1.00 to $7.00/gallon in seven steps (7 iterations)
- No-till yield changed from -20% to +20% relative to conventional tillage yields, in 5% increments (9 iterations)
- Simulated baseline, conventional tillage and no-till for each farm (3 iterations) using FEM
Results

- Results shown here for 30-year time horizon
- Following charts show difference between farm profits for:
  - No-till versus conventional tillage
  - No-till versus baseline
    - Baseline is current mix of tillage practices
  - Conventional tillage versus baseline
- Results are annual averages across all 30 years and across:
  - All farms
  - All farms that grow only winter wheat
Results (contd.)

Impact of wheat yields when diesel is $4/gallon – all farms

<table>
<thead>
<tr>
<th>Difference in net farm returns ($/acre)</th>
<th>Ratio of no-till to conventional wheat grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>1.20</td>
</tr>
</tbody>
</table>

- No-till vs. conv.
- No-till vs. baseline
- Conv. vs. baseline
Results (contd.)

Impact of wheat yields when diesel is $4/gallon – wheat-only farms

![Graph showing the difference in net farm returns ($/acre) for no-till vs. conventional and no-till vs. baseline, as well as conventional vs. baseline, with the ratio of no-till to conventional wheat grain yield on the x-axis and the difference in net farm returns on the y-axis. The graph includes data points and trend lines for each comparison.]
Results (contd.)

Impact of diesel price when wheat yields are the same – all farms

![Graph showing the impact of diesel price on net farm returns. The x-axis represents diesel price in dollars per gallon, and the y-axis represents the difference in net farm returns in dollars per acre. The graph compares no-till vs. conventional practices and no-till vs. baseline.](image-url)
Results (contd.)

Impact of diesel price when wheat yields are the same
– wheat-only farms

![Graph showing the impact of diesel price on net farm returns.](image)

- No-till vs. conv.
- No-till vs. baseline
- Conv. vs baseline

<table>
<thead>
<tr>
<th>Diesel price ($/gallon)</th>
<th>Difference in net farm returns ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-10</td>
</tr>
<tr>
<td>2</td>
<td>-5</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>

No-till Oklahoma
Results (Contd.)

- Next set of results show cross-tabulations
- Can be used to estimate no-till impact for a wide range of fuel and yield effects:
  - Diesel price from $1 to $7/gallon
  - Relative no-till yield -20% to +20%
- Simply interpolate between prices and yields closest to what you are looking for
- Examples:
  - For $3.50 and -5% look between $3 and $4 in the -5% column
  - For $2.50 and +2% look between numbers corresponding to $2 and 0%, and $3 and 5%
Results (contd.)

Cross-tabulations of profit impacts:
No-till versus conventional tillage – all farms

<table>
<thead>
<tr>
<th>Diesel price ($/gallon)</th>
<th>Percentage difference between no-till and conventional wheat grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20%</td>
</tr>
<tr>
<td>$1.00</td>
<td>-16.26</td>
</tr>
<tr>
<td>$2.00</td>
<td>-15.10</td>
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<td>$3.00</td>
<td>-13.95</td>
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<td>-12.79</td>
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<td>$5.00</td>
<td>-11.64</td>
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<tr>
<td>$6.00</td>
<td>-10.48</td>
</tr>
<tr>
<td>$7.00</td>
<td>-9.33</td>
</tr>
</tbody>
</table>

Examples:
$3.50 and -5%: Answer is $4.05
$2.50 and +2%: Answer is $11.02
## Results (contd.)

Cross-tabulations of profit impacts:

No-till versus baseline – all farms

<table>
<thead>
<tr>
<th>Diesel price ($/gallon)</th>
<th>Percentage difference between no-till and conventional wheat grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20%</td>
</tr>
<tr>
<td>$1.00</td>
<td>-11.40</td>
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<tr>
<td>$2.00</td>
<td>-10.92</td>
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<tr>
<td>$3.00</td>
<td>-10.44</td>
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<td>$4.00</td>
<td>-9.97</td>
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<td>$5.00</td>
<td>-9.49</td>
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<tr>
<td>$6.00</td>
<td>-9.01</td>
</tr>
<tr>
<td>$7.00</td>
<td>-8.53</td>
</tr>
</tbody>
</table>

**Examples:**

$3.50 and -5%: Answer is $2.07

$2.50 and +2%: Answer is $7.32
Results (contd.)

Cross-tabulations of profit impacts:
No-till versus conventional tillage – wheat-only farms

<table>
<thead>
<tr>
<th>Diesel price ($/gallon)</th>
<th>Percentage difference between no-till and conventional wheat grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20%</td>
</tr>
<tr>
<td>$1.00</td>
<td>-47.25</td>
</tr>
<tr>
<td>$2.00</td>
<td>-45.62</td>
</tr>
<tr>
<td>$3.00</td>
<td>-43.99</td>
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<td>$4.00</td>
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<td>$6.00</td>
<td>-39.09</td>
</tr>
<tr>
<td>$7.00</td>
<td>-37.46</td>
</tr>
</tbody>
</table>

Examples:
$3.50 and -5%: Answer is $2.40
$2.50 and +2%: Answer is $22.04
Results (contd.)

Cross-tabulations of profit impacts:

No-till versus baseline – wheat-only farms

<table>
<thead>
<tr>
<th>Diesel price ($/gallon)</th>
<th>Percentage difference between no-till and conventional wheat grain yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20%</td>
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<tr>
<td>$1.00</td>
<td>-38.57</td>
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<td>$2.00</td>
<td>-37.56</td>
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<tr>
<td>$6.00</td>
<td>-33.51</td>
</tr>
<tr>
<td>$7.00</td>
<td>-32.49</td>
</tr>
</tbody>
</table>

Examples:

$3.50 and -5%: Answer is $1.14
$2.50 and +2%: Answer is $17.48
Recommendations

- Farmers need to watch no-till yields
  - Careful management may result in no yield loss and possible increase in yields with no-till
  - That leads most definitely to increased profits and improved soil and water quality

- Are all those herbicide passes needed?
  - If farmers can limit herbicide passes, no-till profits are even better

- Some financial assistance may help with initial years after converting to no-till
  - Farm profits under no-till should improve after the first few years
Conclusions

- Economic impact of tillage depends on a number of factors
- Yield is more important than fuel prices
- If yields are equal, no-till is more profitable
- Even if no-till yields are slightly lower, no-till is still better financially
- If no-till yields are much less, then no-till is not as competitive
- Higher fuel prices also help no-till
Conclusions (contd.)

- No-till yields may start low but should improve over time.
- So patience needed to realize full financial benefits of no-till.
- No-till profits would be better if farmers used fewer herbicide applications.