No-till / Rotation Economics

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No-till (NT) is a technology to consider

Potential benefits…

- Machinery cost savings
  - Reduces fuel and labor requirements
- Allows farm expansion
  - Dilutes fixed costs (spread over more acres)
- May improve timing
  - Reduces land preparation time
  - Can increase cropping intensity
- Related to water savings
  - Can increase cropping intensity
  - Increases crop yields

Is NT black and white?

- NT is not black and white
  - Moisture savings come from reducing tillage
  - May use NT on one crop and not another in a rotation
- But, years of soil change can be harmed with one year of tillage
- Adopting NT happens in stages for many
  - Later adopters can skip certain stages
- Looking at the adoption of NT provides some evidence as to its economic potential…

Slow, steady adoption (are we hitting a plateau?)…

Distribution of tillage systems in U.S. -- All crops

It's not an obvious technology...

Adoption of conservation tillage has been lagging somewhat on small grain crops (especially fall-seeded)

Possible reasons for adopting conservation tillage / no-till...

- Increase profitability
- Reduce labor requirements
- Reduce machinery cost/acre
- Increase acres farmed
- Reduce moisture stress/increase yield
- Conservation compliance/soil erosion
- Other (e.g., wildlife, carbon sequestration)
Economic analysis using Kansas Farm Management data

• Which management factors impact profitability?
• 10 years of data (1999-08)
• Total of 705 farms (244 in SE KS)
• Analysis focuses on crop producers

Factors affecting profits in SE KS...

(99-08) diff in profit (over avg farm) by being in best 1/3 of:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Yield</th>
<th>Price</th>
<th>Tech</th>
<th>Plant</th>
<th>Rent</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>$20.51*</td>
<td>$4.25*</td>
<td>$8.57*</td>
<td>$11.51*</td>
<td>$16.86*</td>
<td>$9.63*</td>
<td>$26.09*</td>
</tr>
</tbody>
</table>

* statistically different from 0 at 90% confidence

Factors affecting profits...

(99-08) change in $/acre profit with a 1 std increase in:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Yield</th>
<th>Price</th>
<th>Tech</th>
<th>Plant</th>
<th>Rent</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>$23.65*</td>
<td>$3.97*</td>
<td>$8.78*</td>
<td>$10.36*</td>
<td>$14.59*</td>
<td>$8.94*</td>
<td>$22.72*</td>
</tr>
</tbody>
</table>

* statistically different from 0 at 90% confidence

Factors affecting profits...

(99-08) change in $/acre profit with a 1 std increase in:

<table>
<thead>
<tr>
<th>Cost</th>
<th>Yield</th>
<th>Price</th>
<th>Tech</th>
<th>Plant</th>
<th>Rent%</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>$39.05*</td>
<td>4.57</td>
<td>9.09*</td>
<td>4.90</td>
<td>12.88*</td>
<td>4.99</td>
<td></td>
</tr>
</tbody>
</table>

* statistically different from 0 at 90% confidence
Factors affecting profits in SE KS...

(99-08) change in $/acre profit with a 1 std increase in:

- Cost
- Yield
- Price
- Tech
- Plant
- Rent%
- Size

*statistically different from 0 at 90% confidence

Profitability...

Revenue (yield x price)
- Cost (variable and fixed)

Profit or net returns

Tillage won't impact price, thus profitability will depend on how yields and costs are affected by reducing tillage.*

* If some type of conservation program (e.g., EQIP, CSP) exists, then revenue and costs need to reflect payments received from program participation.

Kansas Annual Precipitation, 1971-2000

Source: K-State Weather Data Library – www.oznet.ksu.edu/wdl

Effect of no-till on YIELDS
**Tillage impact on yield -- wheat/row crop/fallow rotation**

Source: SWREC, Garden City, 1991-1997

K-State research data
(19.0 in annual precipitation region)

<table>
<thead>
<tr>
<th>Crop</th>
<th>CT</th>
<th>RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milo</td>
<td>11%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>3.6%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>Sunflower</td>
<td>4.7%</td>
<td>17%</td>
<td></td>
</tr>
</tbody>
</table>

**Tillage impact on wheat and sorghum yield (W-M-F rotation)**

Source: SWREC, Tribune, 1991-2009

K-State research data
(19.0 in annual precipitation region)

<table>
<thead>
<tr>
<th>Crop</th>
<th>CT</th>
<th>RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>15%</td>
<td>31%</td>
<td></td>
</tr>
<tr>
<td>Milo</td>
<td>54%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comparison of No-Till vs. Tillage -- Yield**

Source: NW Farm Management Association

K-State research data
(19.0-24.2 in annual precipitation region)

<table>
<thead>
<tr>
<th>Crop</th>
<th>CT/RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Milo</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>-6%</td>
<td></td>
</tr>
</tbody>
</table>

**Tillage impact on yield -- milo/soybean rotation**

Source: Belleville Experiment Field, 1975-1981

K-State research data
(29.4 in annual precipitation region)

<table>
<thead>
<tr>
<th>Crop</th>
<th>CT</th>
<th>RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milo</td>
<td>3.1%</td>
<td>1.6%</td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>0.0%</td>
<td>4.2%</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of No-Till vs. Tillage -- Yield
Source: NC Farm Management Association, 1996-2008

Farm-level data
(24.2-34.6 in annual precipitation region)

Tillage and rotation impact on crop yields
Source: Ashland Bottoms, Manhattan, KS. 1975-2008

K-State research data
(29.4 to 34.6 in annual precipitation region)

Comparison of conventional and no-till planting
Source: Powhattan Experiment Field, 1975-1984

Tillage and rotation impact on wheat and milo yields
Source: Hesston Experiment Field, 1986-1995

K-State research data
(34.6 in annual precipitation region)

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Source: NC Farm Management Association, 1996-2008

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(29.4-34.6 in annual precipitation region)
Effects of Previous Crop and Tillage on Wheat and DC SB Yield

Source: SE Agricultural Research Center, 1996-2007

Effect of tillage on yields?

Research in central and eastern Kansas generally has shown little yield difference between tillage systems for wheat, milo, soybeans, and corn => NT cost driven. (rotation is often more important than tillage)

Research in western Kansas has shown that yields increase as tillage is reduced, especially for summer crops such as corn and milo => NT revenue driven. (wheat yields lower in early years, better over time)

Effect of no-till on COSTS

- General thoughts…
- Projected budgets
- Actual farm-level data

No-till equipment costs more to purchase…

Purchase Cost per Row for New Planter, 2008
Source: Lazarus (U of MN)
No-till equipment costs more to purchase...

Purchase Cost per Foot for New Grain Drill, 2008
Source: Lazarus (U of MN)

K-State projected budgets
Cost comparison of tillage and rotation

Increased cropping intensity requires additional capital
Tradeoff between machinery and herbicide costs, has it changed?

Impact of relative prices on NT adoption?

Farm level herbicide (glyphosate) and diesel prices

Comparison of No-Till vs. Tillage – Costs
Source: NW Farm Management Association

Higher yields allow adoption of this more costly technology
**NC Kansas actual farm-level data**

**No-Till cost study - NC Farm Management Association, 2004-2008**

<table>
<thead>
<tr>
<th>EXPENSE ITEM, $/acre</th>
<th>CT/RT</th>
<th>NT</th>
<th>CT/RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct input (seed, fert, chem, etc)</td>
<td>$65.36</td>
<td>$79.08</td>
<td>$66.95</td>
<td>$75.36</td>
</tr>
<tr>
<td>Machinery cost</td>
<td>$52.16</td>
<td>$45.56</td>
<td>$49.33</td>
<td>$43.47</td>
</tr>
<tr>
<td>Labor</td>
<td>$33.24</td>
<td>$28.19</td>
<td>$31.17</td>
<td>$26.90</td>
</tr>
<tr>
<td>Total asset charge</td>
<td>$50.77</td>
<td>$47.08</td>
<td>$48.64</td>
<td>$44.93</td>
</tr>
<tr>
<td>Building and conservation</td>
<td>$2.83</td>
<td>$2.40</td>
<td>$2.66</td>
<td>$2.29</td>
</tr>
<tr>
<td>Other</td>
<td>$14.56</td>
<td>$12.91</td>
<td>$13.84</td>
<td>$12.33</td>
</tr>
<tr>
<td><strong>Total expense</strong></td>
<td><strong>$218.92</strong></td>
<td><strong>$215.21</strong></td>
<td><strong>$212.59</strong></td>
<td><strong>$205.29</strong></td>
</tr>
</tbody>
</table>

Total acres: 915
Harvested acres/land acres: xxxx
NT farms are cropping more intensively and are larger

**Comparison of No-Till vs. Tillage -- Total Cost**

Source: NC Farm Management Association, 1996-2008

**NT farms have slightly lower costs on average, but in recent years costs have been similar...**

**SC Kansas actual farm-level data**

**No-Till cost study - SC Farm Management Association, 2006-2008**

<table>
<thead>
<tr>
<th>EXPENSE ITEM, $/acre</th>
<th>CT/RT</th>
<th>NT</th>
<th>CT/RT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct input (seed, fert, chem, etc)</td>
<td>$78.86</td>
<td>$97.65</td>
<td>$78.81</td>
<td>$90.16</td>
</tr>
<tr>
<td>Machinery cost</td>
<td>$62.37</td>
<td>$58.34</td>
<td>$62.39</td>
<td>$53.97</td>
</tr>
<tr>
<td>Labor</td>
<td>$35.06</td>
<td>$30.35</td>
<td>$35.07</td>
<td>$28.09</td>
</tr>
<tr>
<td>Total asset charge</td>
<td>$48.31</td>
<td>$46.47</td>
<td>$48.36</td>
<td>$43.04</td>
</tr>
<tr>
<td>Building and conservation</td>
<td>$2.42</td>
<td>$2.92</td>
<td>$2.42</td>
<td>$2.70</td>
</tr>
<tr>
<td>Other</td>
<td>$11.98</td>
<td>$10.89</td>
<td>$11.99</td>
<td>$10.09</td>
</tr>
<tr>
<td><strong>Total expense</strong></td>
<td><strong>$239.00</strong></td>
<td><strong>$246.61</strong></td>
<td><strong>$239.05</strong></td>
<td><strong>$228.06</strong></td>
</tr>
</tbody>
</table>

Total acres: 1,392
Harvested acres/land acres: xxxx
NT farms are cropping more intensively and are larger

**Effect of no-till on costs**

- Central and eastern KS data indicate slight decrease to little change in total costs if acreage is held constant. Western KS data suggest costs increase with NT compared to CT.
- Changes cost “structure” --- i.e., herbicide is substituted for tillage-related expenses (this can potentially impact crop share leases).
- Fixed costs (land, machinery, management, etc.) will depend on acreage and thus will vary between producers. Machinery costs might increase in transition period.
Rotation x tillage study  
(Hesston Experiment Field Mark Claassen)

- Wheat rotated with...
  - wheat (continuous cropping), sorghum, corn, or soybeans
- Sorghum rotated with...
  - sorghum (continuous cropping) and wheat
- Tillage
  - v-blade and no-till (all wheat planted no-till after row crop)
- 10 years of yield data, 1997-2006 (no corn yields in 2000)
- Costs based on Mathew Pachta's M.S. thesis
  (2008 custom rates and 2009 input prices)

Rotation has bigger impact on yield than tillage...

![Rotation and tillage impact on crop yields](chart)

Source: Hesston Experiment Field, 1997-2006

- V-blade vs. No-till
  - Wheat/corn: 11% vs. 9%
  - Wheat/milo: 4% vs. 2%
  - Wheat/soy: 7% vs. 6%
  - Wheat/wht: 8% vs. 7%
  - Crn/wht: 2% vs. 0%
  - Milo/wht: 2% vs. 0%
  - Soy/wht: 2% vs. 0%

Continuous cropping generates less revenue...

![Tillage and rotation impact on crop revenue](chart)

Continuous cropping generates less revenue...

![Tillage and rotation impact on crop revenue](chart)

- V-blade / chisel vs. No-till
  - Wheat: $275 vs. $250
  - Soybean: $225 vs. $250
  - Milo: $275 vs. $250
  - Corn: $225 vs. $250

Costs are slightly lower with tillage systems...

![Tillage and rotation impact on crop costs](chart)

Costs are slightly lower with tillage systems...

![Tillage and rotation impact on crop costs](chart)

- V-blade / chisel vs. No-till
  - Wheat: $225 vs. $250
  - Soybean: $175 vs. $200
  - Milo: $225 vs. $250
  - Corn: $175 vs. $200

(Source: Pachta -- 2008 custom rates and 2009 input prices)
No-till systems slightly less profitable, but rotation has bigger impact...

Relative profitability is not particularly sensitive to cost assumptions...

Baseline Scenario
- Crop prices: 2004-08 averages
- Costs: Machinery = 2008 custom rates
- Herbicide = 2009 prices

Alternative Scenario
- 2004-08 averages
- Machinery = 2008 custom rates x 125%
- Herbicide = 2009 prices x 90%

Comparison of Tillage Method for Central Kansas Farms
- Michael Langemeier, KSU Ag Econ
- KFMA farms in central Kansas with continuous data from 2004 to 2008 (i.e., 5-year averages).
- To be classified as a “no-till” farm, a farm had to utilize a no-till production system for all of their crops (in 2008).
- Number of Farms
  - 77 no-till farms
  - 234 mixed tillage farms

Whole-Farm Data: Definitions
- Value of Farm Production
  - Sum of livestock, crop, and other income computed on an accrual basis minus accrual feed purchased.
- Net Farm Income
  - Return to operator’s labor, management, and equity (net worth) computed on an accrual basis.
- Less Tillage Index
  - Computed by dividing herbicide and insecticide cost by total crop machinery cost which includes repairs, fuel, auto expense, machinery and equipment depreciation, crop machine hire, and an opportunity interest charge on crop machinery and equipment investment.
Comparison of Farm Types, Central Kansas

<table>
<thead>
<tr>
<th>Farm Characteristics</th>
<th>No-Till</th>
<th>Mixed Tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Farm Production</td>
<td>$468,629</td>
<td>$324,832</td>
</tr>
<tr>
<td></td>
<td>+44.3%</td>
<td></td>
</tr>
<tr>
<td>Net Farm Income</td>
<td>$108,467</td>
<td>$71,510</td>
</tr>
<tr>
<td>Total Acres</td>
<td>2,173</td>
<td>1,780</td>
</tr>
<tr>
<td></td>
<td>+22.1%</td>
<td></td>
</tr>
<tr>
<td>Less Tillage Index</td>
<td>0.173</td>
<td>0.115</td>
</tr>
</tbody>
</table>

Whole-Farm Data: Definitions

• **Profit Margin**
  – Computed by dividing net farm income plus cash interest paid minus opportunity charges on operator and family labor by value of farm production.

• **Asset Turnover Ratio**
  – Computed by dividing value of farm production by total farm assets.

• **Technical Efficiency Index (ranges from 0 to 1)**
  – Farms with an index of 1 are using the best available technologies and producing on the production frontier.

• **Cost Efficiency Index (ranges from 0 to 1)**
  – Farms with an index of 1 are producing at the lowest cost per unit of aggregate output.

Comparison of Farm Types, Central Kansas

<table>
<thead>
<tr>
<th>Financial Ratios and Efficiency</th>
<th>No-Till</th>
<th>Mixed Tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit Margin</td>
<td>0.1676</td>
<td>0.1233</td>
</tr>
<tr>
<td>Asset Turnover Ratio</td>
<td>0.4070</td>
<td>0.3199</td>
</tr>
<tr>
<td>Cost Efficiency</td>
<td>0.6620</td>
<td>0.6050</td>
</tr>
</tbody>
</table>

Technical Efficiency was not significantly different between the two groups of farms.

Comparison of Farm Types, Central Kansas

<table>
<thead>
<tr>
<th>Income Shares</th>
<th>No-Till</th>
<th>Mixed Tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Grains</td>
<td>0.2303</td>
<td>0.1805</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>0.1687</td>
<td>0.1059</td>
</tr>
<tr>
<td>Small Grains</td>
<td>0.2271</td>
<td>0.3071</td>
</tr>
</tbody>
</table>

There was not a significant difference between hay and forage, beef, or dairy income shares.
Comparison of Farm Types, Central Kansas

<table>
<thead>
<tr>
<th>Cost Shares (as percent of VFP)</th>
<th>No-Till</th>
<th>Mixed Tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>0.1702</td>
<td>0.2299</td>
</tr>
<tr>
<td>Seed</td>
<td>0.0663</td>
<td>0.0534</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.0797</td>
<td>0.0552</td>
</tr>
<tr>
<td>Capital</td>
<td>0.5626</td>
<td>0.6695</td>
</tr>
</tbody>
</table>

There was not a significant difference between livestock and fertilizer cost shares.

Summary

- Impact of NT on economics varies regionally
  - Western KS – higher yields and higher costs
  - Central / eastern KS – similar yields & costs

- Profitability complicating factors:
  - Cropping intensity
  - Farm size
  - Tillage x rotation interaction

- NT adoption is increasing, suggesting profitability

Questions ???

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