Strip-Tillage Option for Continuous Corn

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Challenges in Managing Continuous Corn

- Residue management
  - Residue distribution (Uniformity)
- Soil quality:
  - Soil C loss
  - Soil structure
  - Soil compaction
- Water quality and N use
Challenges in Managing Continuous Corn

- Residue & soil temperature:
  - Reduction of soil moisture evaporation
  - Wet-cold soil and low soil temperature
  - Corn germination problem
Strip-tillage Concept…

- Builds mini-ridge or “berms” speed up water evaporation.
- Strip-tillage is a “transitioning system” to No-till and used on fields relatively flat, heavy soils, and poorly drained.
- Strips are tilled typically in the fall provide better seed-bed.
Strip-tillage Concept...

- Mole knife, 18-in. covering discs, residue cleaners, row marker
- Anhydrous, P & K - liquid or dry can be applied at the same time of pulling the strips.
- Planting must be done in the tilled zone.
Complete Fall Strip-till Tool System

Anhydrous

P & K
Plant in the Strips

- 1/3 of the field was tilled
- Tilled strips dry faster and have higher soil Temp
- Planter row-spacing has to match strips
Tillage System Effect on Soil Temperature

- **Dry and Cold Day**
  - April 13, 2002 (DOY=103)

- **Dry and Hot Day**
  - April 15, 2002 (DOY=105)

- **Wet and Cold Day**
  - April 21, 2002 (DOY=117)

- **Wet and Hot Day**
  - April 16, 2002 (DOY=108)
Tillage system Effect on Seed Germination

![Graph showing the effect of different tillage systems on seed germination over time. The graph compares Chisel Plow, No Tillage, and Strip Tillage methods. The y-axis represents Emergence Rate Index, and the x-axis represents Days After Planting Corn. The graph illustrates that Chisel Plow generally results in higher emergence rates compared to No Tillage and Strip Tillage.](image)
## Corn Yield of C-C and C-s from 1997-2006, on Loam (Indiana) (Vyn et al, Purdue)

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>1997-2006</th>
<th>2001-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-s</td>
<td>C-C</td>
</tr>
<tr>
<td>Fall CP</td>
<td>193.5</td>
<td>181.9</td>
</tr>
<tr>
<td>Fall Disk</td>
<td>197.4</td>
<td>187.3</td>
</tr>
<tr>
<td>ST</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>NT</td>
<td>189.7</td>
<td>167.2</td>
</tr>
</tbody>
</table>
## Continuous corn yield as affected by tillage at Rochester, MN.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till</td>
<td>160</td>
<td>162</td>
<td>151</td>
<td>148</td>
<td>155</td>
</tr>
<tr>
<td>Rawson zone-till</td>
<td>166</td>
<td>171</td>
<td>159</td>
<td>156</td>
<td>163</td>
</tr>
<tr>
<td>Strip-till</td>
<td>152</td>
<td>172</td>
<td>164</td>
<td>158</td>
<td>162</td>
</tr>
<tr>
<td>Chisel plow +</td>
<td>161</td>
<td>170</td>
<td>171</td>
<td>163</td>
<td>166</td>
</tr>
<tr>
<td><strong>LSD (0.10):</strong></td>
<td>5</td>
<td>NS</td>
<td>6</td>
<td>8</td>
<td>3</td>
</tr>
</tbody>
</table>
Long-Term Tillage Study Description...

- Eight locations across Iowa
- Two crop rotations: S-C and S-C-C
- Each site study replicated 4 times
- N Rates: 130-135 lb/acre for s-C and 160-170 lb/acre for s-c-C
- Standard management for each sites (i.e., weed control, pesticides, etc.)
# Field Operations and Management Practices for Different Tillage Systems

<table>
<thead>
<tr>
<th>Operation</th>
<th>MP</th>
<th>CP</th>
<th>DR</th>
<th>ST</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stalk chopping</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary tillage</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Secondary tillage</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injected nutrient application</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface nutrient application</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spraying</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Row cultivation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total number of trips</strong></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Across both rotations NT and ST corn yielded 6-21% less than other tillage systems.

- No differences between crop rotations.
- No tillage effect on soybean yield.
- ST corn yield 3-10% over NT and similar to other systems with s-C rotation.
- s-C 3-10% over 2nd-yr corn with all tillage
- No tillage effect on soybean yield

**Yield Response:**

Northeastern Region, Nashua, IA

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**Corn Yield (bu/acre)**

<table>
<thead>
<tr>
<th>Rotation</th>
<th>NT</th>
<th>ST</th>
<th>DR</th>
<th>CP</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>+3%</td>
<td>+10%</td>
<td>+6%</td>
<td>+6%</td>
<td>+5%</td>
</tr>
</tbody>
</table>

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**Soybean Yield (bu/acre)**

<table>
<thead>
<tr>
<th>Region/State</th>
<th>NT</th>
<th>ST</th>
<th>DR</th>
<th>CP</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>+2%</td>
<td>+3%</td>
<td>0%</td>
<td>+1%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Yield Response:

- ST 2% over NT compared to 4-11% with other systems in both rotations.
- 2nd-yr corn 9-14% over s-C with all systems.
- No tillage effect on soybean yield.

Northwestern Region, Sutherland, IA

<table>
<thead>
<tr>
<th>Rotation Difference</th>
<th>Corn Yield (bu/acre)</th>
<th>Soybean Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>-10%</td>
<td>c-S +1%</td>
</tr>
<tr>
<td>ST</td>
<td>-10%</td>
<td>c-S +1%</td>
</tr>
<tr>
<td>DR</td>
<td>-14%</td>
<td>c-S +1%</td>
</tr>
<tr>
<td>CP</td>
<td>-9%</td>
<td>c-S +1%</td>
</tr>
<tr>
<td>MP</td>
<td>-12%</td>
<td>c-S +1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region/State Difference</th>
<th>Corn Yield (bu/acre)</th>
<th>Soybean Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>-1%</td>
<td>+1%</td>
</tr>
<tr>
<td>ST</td>
<td>0%</td>
<td>+1%</td>
</tr>
<tr>
<td>DR</td>
<td>-1%</td>
<td>+1%</td>
</tr>
<tr>
<td>CP</td>
<td>0%</td>
<td>+1%</td>
</tr>
<tr>
<td>MP</td>
<td>0%</td>
<td>+1%</td>
</tr>
</tbody>
</table>
Yield Response:
- ST and NT yielded 4-10% < systems
- ST 2nd-yr corn 10% over NT
- s-C over yielded s-C-C with all systems
- No tillage effect on soybean yield

Southern Region, Crawfordsville & Chariton, IA

<table>
<thead>
<tr>
<th>Rotation</th>
<th>NT</th>
<th>ST</th>
<th>DR</th>
<th>CP</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>+14%</td>
<td>+4%</td>
<td>+13%</td>
<td>+12%</td>
<td>+10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region/State</th>
<th>NT</th>
<th>ST</th>
<th>DR</th>
<th>CP</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>+12%</td>
<td>+14%</td>
<td>+15%</td>
<td>+15%</td>
<td>+18%</td>
</tr>
</tbody>
</table>

Corn Yield (bu/acre)

- s-C: 0%, +10%, +6%, +4%, +5%, +9%
- c-C: +10%, +6%, +7%, +6%, +4%, +6%

Soybean Yield (bu/acre)

- c-S: 0%, +1%, +3%, +2%, +5%, +1%
- State Average: +1%, +3%, +2%, +5%, +1%
Regional Tillage Differences

Corn Yield (bu/acre)

Region

WN  W  N  CN  E  S

s-C  c-C

NT  ST  DR

Regional Tillage Differences

Corn Yield (bu/acre)

NT

ST

DR

CP  MP

Region

W  NW  NC  NE  S
# Tillage and Management Cost Inputs ($/acre)

<table>
<thead>
<tr>
<th></th>
<th>Corn after Soybean</th>
<th>Corn after Corn</th>
<th>Soybean after Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-tillage</td>
<td>$288</td>
<td>$312</td>
<td>$147</td>
</tr>
<tr>
<td>Strip-tillage</td>
<td>$299</td>
<td>$322</td>
<td>$157</td>
</tr>
<tr>
<td>Deep rip</td>
<td>$314</td>
<td>$343</td>
<td>$173</td>
</tr>
<tr>
<td>Chisel plow</td>
<td>$309</td>
<td>$338</td>
<td>$168</td>
</tr>
<tr>
<td>Moldboard plow</td>
<td>$317</td>
<td>$346</td>
<td>$177</td>
</tr>
</tbody>
</table>

- Cost inputs accounts for machinery costs, labor, seed, nutrients, chemicals, and insurance. Cost inputs does not include land rental ($155 cash rent equivalent).
- Labor was figured at $9.50/hr, nutrients are based on crop removal rates, and insecticides were accounted for in corn after corn.
- Herbicide tolerant soybeans were used in cost inputs considerations.
- Cost inputs based from ISU Extension publication FM 1712 and Ag Decision Maker file A1-20.
Economic Returns:
North Central Region, Ames & Kanawha, IA

- Highest returns for corn with tillage
- NT Soybean return 12-16% higher
- ST Soybean return better than DR, CP, MP

Net returns are based on $3.00/bushel corn and $6.15/bushel soybean prices and previously mentioned cost inputs.
ST net return  18% over NT s-C and 3% with 2nd-yr corn.

Economic Returns:  
s-C net return 20-27% over 2nd-yr corn.

Northeastern Region, Nashua, IA

Soybean – Highest returns occurred in ST & NT

Net returns are based on $3.00/bushel corn and $6.15/bushel soybean prices and previously mentioned cost inputs.
- ST and NT returns 5-10% less with 2nd-yr corn. NS differences with s-C.
- 10-26% higher returns with 2nd-yr corn in all systems.

**Northwestern Region, Sutherland, IA**

- Soybean - NT had 5-17% higher returns

Net returns are based on $3.00/bushel corn and $6.15/bushel soybean prices and previously mentioned cost inputs.
- Net return for s-C is the same for all systems
- ST 2nd-yr corn was 28% over all systems
- s-C 25-74% higher net return over 2nd-yr corn
- Soybean – NT had 4-17% higher returns

Net returns are based on $3.00/bushel corn and $6.15/bushel soybean prices and previously mentioned cost inputs.
Strip-tillage Benefits

- **Phosphorus (P)**
  - held tightly to soil particles, little in solution
  - roots must explore soil volume to take up P
  - cold soil, high pH soils limit availability

- **Potassium (K)**
  - more available in soil solution
  - cold soils limit root growth and uptake

- **Strip-tillage (deep banding) provides P and K in concentrated band for early season uptake**
Strip-tillage Benefits

- **Soil Temperature**
  - Enhances soil warming and drying in the spring ahead of corn planting.
  - Elevated residue-free strip warms quickly as high as conventional tillage at planting.

- **Allows for no-till corn planting without yield loss**

- **Soil Borne Diseases**
  - Pythium thrives in 40 degree soils, kills plants, reducing stands
  - Because of warmer soil temperature in the strip, little to no seedling blights occur
Strip-tillage Disadvantage

- Pulling heavy load when applying fertilizer.
- Weight and rolling resistance of the tank and dry fertilizer.
- Needs high horsepower tractor due to the depth of tillage 20-30 hp per knife is needed.
- Special Guidance equipment on the planter.
Challenges For Strip-tillage Adoption

- Farmer
  - Time demands of harvest operations may prevent getting strips in on timely basis
  - Added expense of nitrogen stabilizer if applied after soybean harvest and soils are still warm
  - Needs high horsepower tractor
  - Needs labor source to run strip-till unit
  - Has to trust someone else to put the strips in properly (i.e. placing next year’s rows)