MAKING CONSERVATION TILLAGE WORK IN FRESH MARKET TOMATOES:
New Production and Business Models

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University of California

Ron Harben
California Association of Resource Conservation Districts

Fresh Market Tomato and Pepper Production Meeting
Stockton, CA
March 2, 2010
Outline of Presentation

• What could be the benefits of CT?
• Research findings from Five Points, CA
• History of the development of CT tomato systems in the SJV
• State-of-the-art commercial production operations - How’s it being done?
What might be the benefits?

• Cutting costs with sustained productivity
• Reducing emissions
• Increasing soil carbon, tilth and quality
• Ability to create new business models
Rainfed winter cover crop being seeded into cotton and tomato residue. Five Points, CA 2007.
Winter, rainfed triticale, rye and pea cover crop no-till seeded into cotton and tomato residues
Five Points, CA 2008
Cover crop biomass in STCC and CTCC systems, 2000 – 2008

<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>South</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STCC</td>
<td>8036 ± 205</td>
<td>3604 ± 169</td>
<td>1226 ± 213</td>
<td>2281 ± 188</td>
<td>1732 ± 246</td>
<td>6661 ± 401</td>
<td>1461 ± 239</td>
<td>28 ± 14</td>
<td>2894 ± 295</td>
</tr>
<tr>
<td>CTCC</td>
<td>8344 ± 345</td>
<td>2798 ± 141</td>
<td>1895 ± 213</td>
<td>5063 ± 327</td>
<td>1744 ± 206</td>
<td>8327 ± 152</td>
<td>1282 ± 143</td>
<td>66 ± 18</td>
<td>2637 ± 756</td>
</tr>
<tr>
<td><strong>North</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STCC</td>
<td>7850 ± 656</td>
<td>4058 ± 96</td>
<td>3121 ± 407</td>
<td>2031 ± 286</td>
<td>2449 ± 100</td>
<td>5223 ± 228</td>
<td>3320 ± 196</td>
<td>10 ± 0</td>
<td>5112 ± 180</td>
</tr>
<tr>
<td>CTCC</td>
<td>7889 ± 1326</td>
<td>3966 ± 55</td>
<td>4236 ± 223</td>
<td>3919 ± 638</td>
<td>3192 ± 124</td>
<td>5677 ± 228</td>
<td>3169 ± 185</td>
<td>58 ± 3</td>
<td>5328 ± 403</td>
</tr>
</tbody>
</table>
### 2009 NRI Tomato Yields

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (Bushels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard tillage no cover crop</td>
<td>49.1 ± 1.2</td>
</tr>
<tr>
<td>Standard tillage with cover crop</td>
<td>51.2 ± 1.9</td>
</tr>
<tr>
<td>Conservation tillage no cover crop</td>
<td>53.5 ± 1.3</td>
</tr>
<tr>
<td>Conservation tillage with cover crop</td>
<td>49.8 ± 0.8</td>
</tr>
</tbody>
</table>
Tillage and cover crop system erosion estimates, soil condition index sub-factors, soil tillage intensity rating and estimates of diesel fuel use.

<table>
<thead>
<tr>
<th>Cropping System*</th>
<th>Erosion Estimates RUSLE2 (Mg ha⁻¹)</th>
<th>Soil Conditioning index</th>
<th>STIR Average Annual</th>
<th>Diesel fuel use</th>
<th>Fuel cost for entire simulation ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STNO</td>
<td>0.2</td>
<td>-0.71</td>
<td>261</td>
<td>32</td>
<td>128.6</td>
</tr>
<tr>
<td>STCC</td>
<td>0.07</td>
<td>-0.96</td>
<td>390</td>
<td>40</td>
<td>160.6</td>
</tr>
<tr>
<td>CTNO</td>
<td>0.04</td>
<td>0.43</td>
<td>30.6</td>
<td>9.3</td>
<td>36.8</td>
</tr>
<tr>
<td>CTCC</td>
<td>0.03</td>
<td>0.52</td>
<td>37.1</td>
<td>11</td>
<td>43.27</td>
</tr>
</tbody>
</table>

* STNO = Standard tillage no cover crop, STCC = Standard tillage with cover crop, CTNO = Conservation tillage no cover crop CTCC = Conservation tillage with cover crop.
### Dust Production by Treatment and Operation ($\mu g/L$)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>STNO</th>
<th>STCC</th>
<th>CTNO</th>
<th>CTCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size Fraction</strong></td>
<td>Total</td>
<td>Resp.</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>Land Preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disc</td>
<td>98</td>
<td>14</td>
<td>81</td>
<td>10</td>
</tr>
<tr>
<td>Chisel</td>
<td>20</td>
<td>1</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>List Beds</td>
<td>12</td>
<td>3</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Ringroll Beds</td>
<td>44</td>
<td>7</td>
<td>39</td>
<td>24</td>
</tr>
<tr>
<td>Power Incorporate</td>
<td>127</td>
<td>20</td>
<td>93</td>
<td>7</td>
</tr>
<tr>
<td>Plant Cover Crop</td>
<td>4</td>
<td>trace *</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Mow/Chop Cvr Crop</td>
<td>22</td>
<td>9</td>
<td>61</td>
<td>6</td>
</tr>
<tr>
<td>Compact Furrow</td>
<td>9</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>300</td>
<td>44</td>
<td>270</td>
<td>58</td>
</tr>
<tr>
<td>In Season Operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray</td>
<td>12</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Lilliston</td>
<td>92</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivate Tomato</td>
<td>34</td>
<td>2</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Cultivate Cotton</td>
<td>316</td>
<td>8</td>
<td>222</td>
<td>10</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>455</td>
<td>17</td>
<td>250</td>
<td>12</td>
</tr>
</tbody>
</table>

*There were detectable dust measurements for these operations, but they rounded to 0 with this number of significant figures.*
## Dust Production by Treatment and Operation (µg/L)

(continued)

<table>
<thead>
<tr>
<th>Planting / Harvest</th>
<th>STNO</th>
<th>STCC</th>
<th>CTNO</th>
<th>CTCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Cotton</td>
<td>1</td>
<td>trace*</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Transplant Tomato</td>
<td>2</td>
<td>trace*</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Clean Furrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shred-Bed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mow</td>
<td>38</td>
<td>6</td>
<td>51</td>
<td>6</td>
</tr>
<tr>
<td>Undercut</td>
<td>29</td>
<td>3</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>Harvest Cotton</td>
<td>11</td>
<td>2</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>81</strong></td>
<td><strong>11</strong></td>
<td><strong>103</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cumulative Dust Production</th>
<th>837</th>
<th>72</th>
<th>623</th>
<th>82</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120</td>
<td>14</td>
<td>262</td>
<td>36</td>
</tr>
</tbody>
</table>

*There were detectable dust measurements for these operations, but they rounded to 0 with this number of significant figures.*
Cultural costs for standard tillage (ST) versus conservation tillage (CT) for processing tomato, Westside Field Station, 2003 (operations expensed at 2007 input prices)

<table>
<thead>
<tr>
<th>Cultural costs</th>
<th>ST</th>
<th>CT</th>
<th>Difference (ST-CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>79</td>
<td>79</td>
<td>0</td>
</tr>
<tr>
<td>Seed</td>
<td>176</td>
<td>176</td>
<td>0</td>
</tr>
<tr>
<td>Herbicide</td>
<td>76</td>
<td>70</td>
<td>6</td>
</tr>
<tr>
<td>Insecticide</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Water</td>
<td>163</td>
<td>163</td>
<td>0</td>
</tr>
<tr>
<td>Labor (machine)</td>
<td>36</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Labor (irrigation)</td>
<td>110</td>
<td>110</td>
<td>0</td>
</tr>
<tr>
<td>Labor (hand weed)</td>
<td>84</td>
<td>84</td>
<td>0</td>
</tr>
<tr>
<td>Fuel</td>
<td>58</td>
<td>21</td>
<td>37</td>
</tr>
<tr>
<td>Lube and repair</td>
<td>34</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Interest</td>
<td>36</td>
<td>31</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total cultural</strong></td>
<td><strong>853</strong></td>
<td><strong>770</strong></td>
<td><strong>83</strong></td>
</tr>
</tbody>
</table>
### Soil Carbon weights (t/ha)

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Standard Till No Cvr Crop</th>
<th>Winter Cvr Crop</th>
<th>Conservation Tillage No Cvr Crop</th>
<th>Winter Cvr Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>10.74 (0.28)</td>
<td>13.68 (0.43)</td>
<td>14.51 (0.61)</td>
<td>15.95 (3.43)</td>
</tr>
<tr>
<td>15-30</td>
<td>11.59 (0.43)</td>
<td>13.69 (0.73)</td>
<td>11.69 (0.45)</td>
<td>12.89 (0.54)</td>
</tr>
<tr>
<td>Total</td>
<td>22.33 C</td>
<td>27.37 B</td>
<td>26.20 B</td>
<td>28.84 A</td>
</tr>
</tbody>
</table>

Values in parentheses are standard error of the means (n=8; north and south field mean averages were not significantly different therefore treatments combined for analysis). Letters represent significant differences among treatments using a one-way ANOVA analysis with Tukey HSD means comparison.

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**No-till cotton production following tomato**

Five Points, CA • 2000 - 2010

Presented in Franzluebbers AJ. Surface soil organic matter as an indicator of soil quality, Winter Issue No. 58, 2010 Prairie Steward – Farming for Your Future Environment, the Newsletter of the Saskatchewan Soil Conservation Association Inc.
Conceptual diagram for the calculation of stratification ratio of soil organic matter.

Presented in Franzluebbers AJ. Surface soil organic matter as an indicator of soil quality, Winter Issue No. 58, 2010 Prairie Steward – Farming for Your Future Environment, the Newsletter of the Saskatchewan Soil Conservation Association Inc.
Stratification Ratio of Soil Organic Carbon (0-5 cm / 12.5-20 cm)

Conservation tillage

Initial level = 1.4
Plateau level = 2.8
r² = 0.52

Years of Management with Conservation Tillage

Changes in stratification ratio of soil organic carbon with time under conservation-tillage management in a survey of 89 farms in the southeastern USA.

Presented in Franzluebbers AJ. Surface soil organic matter as an indicator of soil quality, Winter Issue No. 58, 2010 Prairie Steward – Farming for Your Future Environment, the Newsletter of the Saskatchewan Soil Conservation Association Inc.
Stock of soil organic carbon to a depth of 20 cm in relation to the stratification ratio of soil organic carbon from a survey of 89 farms throughout the southeastern USA.


Presented in Franzluebbers AJ. Surface soil organic matter as an indicator of soil quality, Winter Issue No. 58, 2010 Prairie Steward – Farming for Your Future Environment, the Newsletter of the Saskatchewan Soil Conservation Association Inc.
Stability of Aggregates
(0-3-cm depth) [wet / dry]

Water Infiltration (cm · hr⁻¹)

Stratification Ratio of Soil Organic Carbon
(0-3 cm / 6-12 cm)

$r^2 = 0.86$

$r^2 = 0.63$

Relationship of water-stable aggregation and water infiltration to the stratification ratio of soil organic carbon in soils from Georgia.


Presented in Franzluebbers AJ. Surface soil organic matter as an indicator of soil quality, Winter Issue No. 58, 2010 Prairie Steward – Farming for Your Future Environment, the Newsletter of the Saskatchewan Soil Conservation Association Inc.
Patos de Minas, Brazil 2007
Silage wheat chopping ahead of tomato transplanting
Turkey
2009
Tomato transplanting following silage wheat chopping
Turkey
2009
New technology practiced on Tracy man’s farm

Jonathan Partridge
The Tracy Press

Close to 30 people from all over Northern California gathered at Hal Robertson’s Tracy farm on Friday morning to discuss ways to use less tilling for tomato fields.

The University of California sponsored “Reduced Tillage Field Day,” which informed farmers about experiments UC researchers are doing to reduce the amount of tractor work done on fields — and reduce erosion in the process.

One of the largest UC experiments is being conducted on Robertson’s farm, and spectators could look at the results on Robertson’s tomato field firsthand on Friday.

“The (UC cooperative) extension office gets excited about this stuff, so it got me excited,” Robertson said.

The Tracy farmer experimented on the experiments in his field. He attributes the Midwest’s greater experience with these growing methods to erosion requirements that those states impose on their farmers, which California doesn’t.

Ralph Ceseña, who sells equipment using this technology in California and Mexico, said many Californians are actually opposed to using reduced-tillage methods, and he was surprised at the amount of people who attended Friday’s meeting.

“I was shocked when I first came (to California),” Ceseña said. “I thought people would be more attuned to it, since they have so much information.”

But Benny Fouché, farm adviser for the University of California Cooperative Extension in San Joaquin County, said many farmers in the county are interested in new technology.

“Our growers may seem like your run-of-the-mill conservative dirt farmers, but they’re actually very innovative,” he said. “They continue to impress me.”

George Johannsen of Danville, a former horticulturist for the California Tomato Research Institute, said the Robertson family is particularly innovative.

“We’ve got one of the finest growers here in the county with the Robertson’s,” he said. “And Hal is one of the finest leaders here in agriculture.”
Rototiller Strip-tiller
Hal Robertson
Tracy, CA
2001
Fresh Market Tomatoes
Live Oak Farms
Le Grand, CA
2002
Strip-tilling into rye cover crop prior to tomato transplanting
Firebaugh, CA 2005
No-till transplanting tomatoes
Firebaugh, CA
2004
2009 Conservation Tillage Farmer Innovators
Alan Sano
and
Jesse Sanchez
Sano Farm
Firebaugh, CA
Performer® minimum tillage implement working tomato beds following harvest Sano Farm Firebaugh, CA

After Performer 2
“Second pass” minimum tillage bed reworking following tomato harvest
Sano Farm
Firebaugh, CA
October 2007

After heavy duty performer
The 25-ft Great Plains drill used for seeding winter small grain cover crops at Sano Farm. This modified drill seeds across the bed top, but does not put seed in the furrow.
Triticale cover crop at time of herbicide burn down showing size and growth stage when terminated and prior to strip-tilling

Sano Farm
Firebaugh, CA
March 8, 2009
Burned down triticale cover crop planted on bed tops
Firebaugh, CA 2005
Burned down triticale cover crop prior to strip-tilling and transplanting
April 2009
Sano Farm
Firebaugh, CA
Five-row strip-tiller preparing bed centers for processing tomato transplanting
Firebaugh, CA 2005
5-Row strip-till toolbar with Orthman 1-tRIPr row units
Sano Farm
Firebaugh, CA
March 8, 2009
“Scaling up” conservation tillage techniques at commercial processing tomato farm

Firebaugh, CA
2008
Strip-till planted processing tomatoes
Firebaugh, CA 2006
Transplanting processing tomatoes into Strip-tilled cover crop
Sano Farm
Firebaugh, CA
April 2008
PROCESSING TOMATOES STRIP-TILL PLANTED INTO TRITICALE COVER CROP FIREBAUGH, CA 2005
“This is the first worm I’ve seen in these fields in 30 years.”

Alan Sano
Sano Farms
Firebaugh, CA
May 4, 2006
An opportunity for 6 – 8 tomato growers

- To gain and develop experience with production systems that reduce costs, conserve resources, and have other benefits to long-term farm business models
CDFA Specialty Crop Block Grant

Technology transfer campaign to increase conservation cropping systems (CCS) and winter cover crops in California specialty crops

USDA NRCS Conservation Innovation Grant

BMP Challenge Across the Cornbelt and Rapid Adoption of Conservation Tillage in California Through Improved Technical Assistance and Managing Risk
What are these practices?

- Use of conservation tillage, and
- Use of cover crops
What these projects could provide

- Technical support to get started
- Equipment
- Help monitoring system performance
- Risk management
Our CT and Cropping Systems Workgroup currently has two major project initiatives in place that should help tomato producers gain experience with alternative, perhaps more ecologically-based production systems.
These sorts of systems should, in theory, afford cheaper tomato production, better resource management, and also perhaps, opportunities for producers to demonstrate and gain additional benefits from consumers and the public.
Take the CHALLENGE. How much can you save?

Dear Central Valley Farmers:

Wouldn’t it be great to have a guarantee for conservation practices that can also save you money? Farmers in the Mid-West States have been taking advantage of just such a guarantee. Now we are bringing this opportunity to farmers in California.

Seeing is believing! The BMP CHALLENGE protects your income so you can see how reduced tillage or nutrient management practices perform, in your own fields, without risk.

Thanks to a grant from the USDA Natural Resources Conservation Service, the BMP CHALLENGE is available for corn silage in California for the 2009 spring planting.

The BMP CHALLENGE process is easy from start to finish. Working with a crop advisor or the Conservation Tillage Workgroup, you select a field to enroll. You apply your usual nutrient application rate or tillage practice on a check strip in the same test field while the rest receives the BMP nutrient rates or reduced tillage. At harvest, you and your advisor compare yields and net returns.

We compensate you any net income loss. It's a great risk-free educational experience for farmers and advisors.

"IN MY OPINION, THE BMP CHALLENGE PROGRAM IS A NO-BRAINER. THERE IS NO WAY A FARMER CAN LOSE."
- Corn producer and BMP CHALLENGE participant

This program has been used successfully in conjunction with grant-funded projects including EPA 319. To date, participating producers have saved more than 150,000 lbs. of nitrogen and an estimated 2,000 tons of sediment loss in the Mid-West.

The BMP CHALLENGE is a collaborative project of Agflex, the IPM Institute of North America, American Farmland Trust, California Conservation Tillage Workgroup, and Sustainable Conservation.

For more information you can contact the BMP CHALLENGE contact:

California Conservation tillage workgroup – Dr. Jeff Mitchell (559) 303-9689  
Sustainable Conservation – Ladi Aegill – (209) 876-7729

BMP CHALLENGE  
201 Needham Street  Modesto, CA 95354  
(209) 504-6554  Fax (209) 567-7957  Email info@bmpchallenge.org  
www.bmpchallenge.org
AFT's Environmental Solutions

AFT's BMP Challenge for Reduced Tillage

Conventional tillage methods can have a negative impact on air quality and cause soil erosion. Using reduced tillage practices, farmers burn less fossil fuels and help lessen the release of greenhouse gases by allowing the land to store more carbon dioxide in the soil and lessen soil runoff into lakes, rivers and streams.

AFT’s innovative solution, the BMP (Best Management Practices) Challenge, makes it easier for farmers to reduce tillage while being protected from potential loss of income. Participating farmers can test BMPs that have been developed to save money and maintain optimal yields while protecting our water and soil.

How Does the BMP Challenge for Reduced Tillage Work?

BMPs are designed to save farmers money. Recommendations are made based on field history and soil test results to cut fertilizer costs while maintaining yield.

1. Farmers enroll one or more fields—before applying commercial fertilizer—up to 120 acres per farm.
2. Crop advisor prepares recommendation.
3. Farmer applies traditional practice to check strip. On the balance of the field, the new practices are applied.
4. Farmer manages the entire field the same way. At harvest, farmer and crop advisor assess yield vs. check strip.
5. Farmer is paid if there is a loss in yield minus fertilizer savings.

Farmers will earn at least as much as using typical tillage practices, and in most years, will make a profit. Participants help us expand the BMP Challenge to more farmers by reinvesting a portion of their savings up to $6/acre back into the program.
Thank you very much.
Ag’s place at the carbon table

By DAN CRUMMETT

AFTER 40 years of no-till and conservation farming, Bill Richards says he’s concerned certain-to-come carbon legislation will leave agriculture, and no-tillers like himself, out in the cold.

Richards, a Circleville, Ohio, farmer, is co-chairman of the 25 x 25 program, a renewable energy initiative with nearly 800 partners dedicated to seeing America’s farms, forests and ranches help provide 25% of the nation’s total energy from renewable resources by the year 2025. In addition, the group is involved in exploring agriculture and forestry’s place in helping sequester carbon and greenhouse gas emissions, and securing financial consideration will be paying more to do business. Still, he says, there is a potential revenue stream agriculture needs to consider, and as an industry. It needs to be at the table when such things are agreed upon.

“I'm just afraid many in agriculture are not paying attention as this debate begins to heat up in Congress,” the longtime farmer explains. “I think too many farmers and ranchers are just wishing the whole debate

Key Points

- No-tiller worried farm groups take carbon legislation lightly.
- Agriculture could sequester up to five times its own emissions.
- Farmers, ranchers and foresters need to help craft carbon laws.

Get paid for carbon credits

By ROD SWOBODA

INCREASING concern over global warming is opening up a new source of revenue for farmers through the sale of carbon credits. Here’s how it works.

A carbon credit is 1 metric ton of carbon isolated from the atmosphere. Farmers, ranchers and other owners of cropland and forestland can capture carbon credits by using such practices as no-till for crops, improved rangeland management or new plantings of grass and trees.

The growing plants — corn or trees or whatever — capture carbon from the air and store it as organic matter in the soil to earn the credits. Companies whose factories are emitting greenhouse gases such as carbon dioxide into the atmosphere buy the credits on the Chicago Climate Exchange, or CCX. Thus, firms can comply with clean-air regulations by hiring others, such as farmers, to sequester the carbon.

AgraGate Climate Credits Corp., a subsidiary of Iowa Farm Bureau, is one company that aggregates carbon credits. For a fee, it contracts with landowners, collects the credits and sells them on the CCX, returning the proceeds to the farmers or landowners.