Conservation Tillage in Vegetable Production

Sustainable Vegetable Production

Zheng Wang, PhD
University of California Cooperative Extension
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Zheng Wang

- UCCE Vegetable and Irrigation Farm Advisor since March 2018
- University of Kentucky: PhD (2011-2015)
- The Ohio State University: Postdoc (2015-2017)
- Optimizing regional and statewide vegetable production

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Today’s Class

Provides fundamental knowledge about 1) major differences between conventional and conservation tillage, and 2) how conservation tillage is implemented in vegetable production.
Why Till?

- Prepare fine seedbeds for germination
- Create good seed-soil contacts
- Destroy existing weeds
- Loosen soil for root development
- Improve soil profile aeration
- Warm soil for early maturity
Many Terms
Aggressive tillage, conventional tillage, intensive tillage, full-field tillage, standard tillage, plastic mulch, plasticulture......

- Deep tillage: > 10 inches
- < 15% crop residues left on soil surface
- 100% top soil disturbed
- Tractor-powered tools to accomplish field work
- Raised beds commonly used w/o plastics
Full-field Tillage in Vegetable Production

**Moldboard Plow**

- Inverts soil up and down.
- Leaves no surface cover.
- Includes curved plate with sharp edges.

[https://www.youtube.com/watch?v=zo_5EihK4-I](https://www.youtube.com/watch?v=zo_5EihK4-I)

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Disk and Chisel

- Turns over soil slightly.
- Leaves some residual cover.
- Breaks soil into small particles.

https://www.youtube.com/watch?v=uWM5Z3nCXdl
Full-field Tillage in Vegetable Production

Rototill

Tines spin fast to break soil into even smaller particles for vegetable planting.

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Shape raised beds covered with (left image) or without (right image) plastics.
Aggressive tillage leads to:

1) Soil erosion and compaction
2) Cost increases
3) Soil property degradation
4) Environmental issues
5) Shortened soil life
6) Less arable lands
7) Soil “addicted” to tillage
OXYGEN
PLEASE!

CHECKED ON MY TOMATOES TODAY
SO FAR SO GOOD!
Arable land is losing

According to American Farmland Trust...

➢ > 1 acre lost/minute in the U.S.

➢ 1982-2007, > 23 million acres lost = size of Indiana

➢ Deforestation to make up the land scarcity
Tillage is a source of land degradation.
Planting without plowing

Early 1970s in South and North America
- Crop residues
- Cover crop
- Fuel cost

New techs lessen the need for tillage.

Source: FAO 2000
Taken by Dr. Zheng Wang at Lexington, KY and Wooster, OH.
Credits: Univ. of KY and The OSU-OARDC.
Conservation Tillage

- $\geq \frac{1}{3}$ soil undisturbed and covered with crop residues
- Types: no-till and reduced tillage
- Modified or specialized equipment required
- Unique field preps and management

Source: Conservation Technology Information Center
What are the Benefits?

In contrast to the standard tillage, conservation tillage tends to:

- Protect soil integrity (stabilization): less disturbance
- Reduce cost: tractors, chemicals, fuels
- Alleviate environmental burdens: less nutrient loss, leaching
- Sustain more water: crop residues, good water storage
- Elongate soil arability: soil depletion slows down
No-till/Zero-tillage

- 0% soil disturbance
- Rely on crop residues (last cash crop or cover crop)
- Vegetables are planted with no-till transplanter (disk, in-row chisel, and coulters)
- More common for agronomic crops

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Form Mulches: Roller-crimper
No-till Planter

https://www.youtube.com/watch?v=lwLj_GvLQn0
Reduced Tillage: A Combination

- Till plant rows only and leave other areas undisturbed and covered.

- Strip tillage and Ridge tillage

- Combine benefits of no-till and regular tillage
Strip Tillage (Clockwise)

Plant into a narrow opened space created by a strip tiller (less than 12” wide).

Tilled area provides more favorable soil conditions for plants to grow.

The rest field is protected.
Strip Tiller

Video from Dr. Anu Rangarajan
Cornell Univ.

https://www.youtube.com/watch?v=hdnr7ymlpKs

Hiniker Series 6000 Single-row Strip tiller
https://www.hiniker.com/ag_products%20new/6000_striptill.html
Like other conservation tillage, strip tillage can...

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Details</th>
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<tbody>
<tr>
<td>Protect soil structure and quality</td>
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<tr>
<td>Reduce nutrient leaching</td>
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<td>Retain soil moisture</td>
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<td>Enhance microbial activity</td>
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<tr>
<td>Save fuel and other costs</td>
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<tr>
<td>Increase fruit quality (cleaner fruit)</td>
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</table>

**Diagram:**

- Do we overlook anything?
  - Crop Yield!
    - Consistency among crops
      - Crops suited in strip tillage

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Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

Corn (including sweet corn)

Source: Morning Ag Clips

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Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

Soybean

Source: MN Department of Agriculture
Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

Cucurbits (summer/winter squash, pumpkin, melon)

Source: Weed management strategies, eXtension
Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

<table>
<thead>
<tr>
<th><strong>Starting with drawbacks, strip tillage sometimes...</strong></th>
<th><strong>Corn</strong> has a wide range of herbicides for weed control, a deep/extensive root system, and a vigorous upright growth habit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increases weed problems</td>
<td><strong>Soybean</strong> has a wide range of herbicides for weed control and a high seeding density that canopy closes the between-row space quickly to prevent weed growth.</td>
</tr>
<tr>
<td>Causes lower soil temperature</td>
<td><strong>Cucurbit crops</strong> are deep-rooted, generally planted in late spring or early summer after soils have warmed, and also have an aggressive growth habit, which can help shade weeds.</td>
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<td>Delays crop maturity</td>
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<td>Restricts root penetration</td>
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<td>Produces lower yields</td>
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14 days after planting

28 days after planting

59 days after planting

42 days after planting

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Other vegetables, such as tomato, pepper, and brassicas, have been studied for their suitability in reduced-tillage systems. However, their yield performance and other variables were dynamic in a case-by-case situation.
Summary

• Dramatic differences between conventional and conservation tillage from many aspects.

• Conservation tillage: not simply to reduce plows.

• Currently there is not a wide-spectrum, universally accepted tool due to crop and environment specificities.
Post-Class Reading Assignments

Three journal articles have been emailed to you. Please
read and pay more attention to the “Materials and
Methods” sections to understand the differences of
field preparation for various tillage approaches.
Questions can be sent to Dr. Zavalloni or me
(zzwwang@ucdavis.edu).
Next Class: September 18, 2018

Conservation Tillage and Cover Cropping in Sustainable Vegetable Production