Conservation Tillage in Vegetable Production

Sustainable Vegetable Production

Zheng Wang, PhD
University of California Cooperative Extension
September 13, 2018

University of California
Agriculture and Natural Resources

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

University of California
Agriculture and Natural Resources

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.

University of California
Agriculture and Natural Resources

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

University of California
Agriculture and Natural Resources

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

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

https://www.youtube.com/watch?v=zo_5EihK4-I

University of California
Agriculture and Natural Resources

Full-field Tillage in Vegetable Production

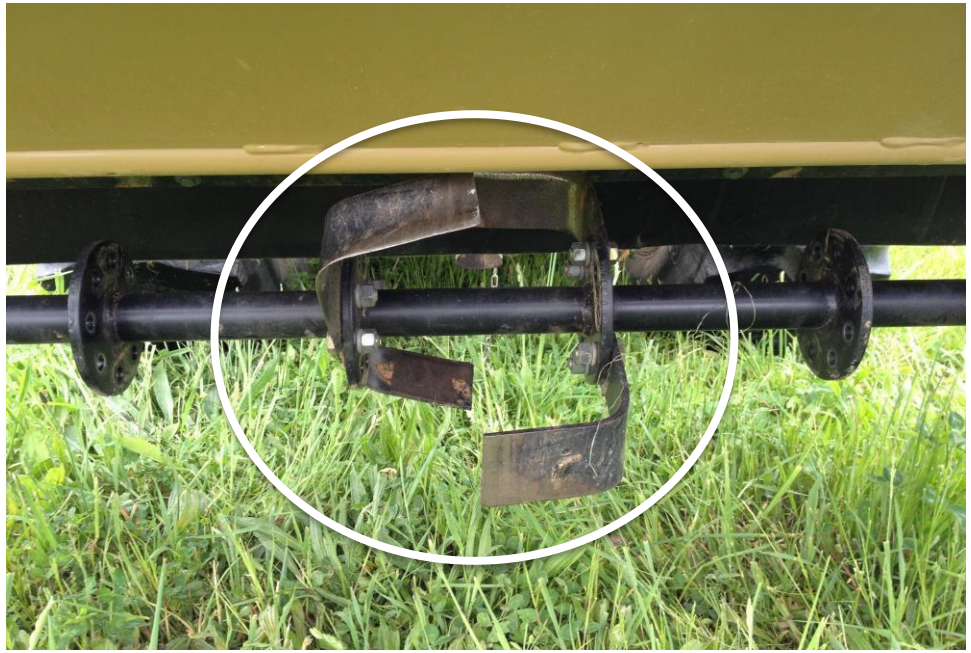
Disk and Chisel

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

https://www.youtube.com/watch?v=uWM5Z3nCXdI

University of California
Agriculture and Natural Resources

Full-field Tillage in Vegetable Production



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

University of California
Agriculture and Natural Resources

Full-field Tillage in Vegetable Production

Shape raised beds covered with (left image) or without (right image) plastics.

University of California
Agriculture and Natural Resources

Friend or Foe?

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

University of California
Agriculture and Natural Resources

OXYGEN PLEASE!

University of California
Agriculture and Natural Resources

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

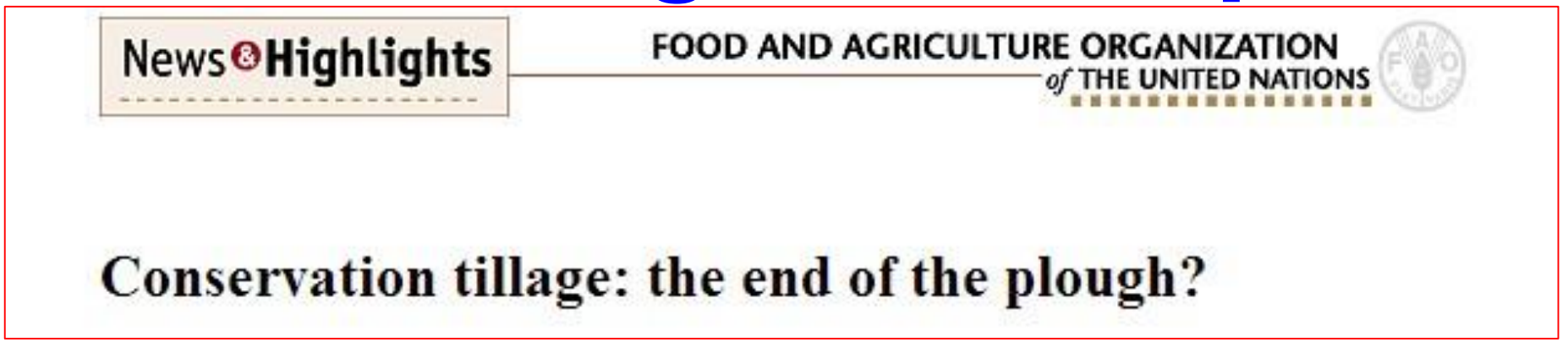
➢ Deforestation to make up the land scarcity

University of California
Agriculture and Natural Resources

Tillage is a source of land degradation.

University of California
Agriculture and Natural Resources

Planting without plowing


News & Highlights

FOOD AND AGRICULTURE ORGANIZATION of THE UNITED NATIONS

Conservation tillage: the end of the plough?

Early 1970s in South and North America

- Crop residues
- Cover crop
- Fuel cost

New techs lessen the need for tillage.

Conservation tillage

University of California
Agriculture and Natural Resources

Source: FAO 2000






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

University of California
Agriculture and Natural Resources

Conservation Tillage

- ≥ 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

University of California
Agriculture and Natural Resources

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

University of California
Agriculture and Natural Resources

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

University of California
Agriculture and Natural Resources

Form Mulches: Roller-crimper

University *of* California
Agriculture and Natural Resources

No-till Planter

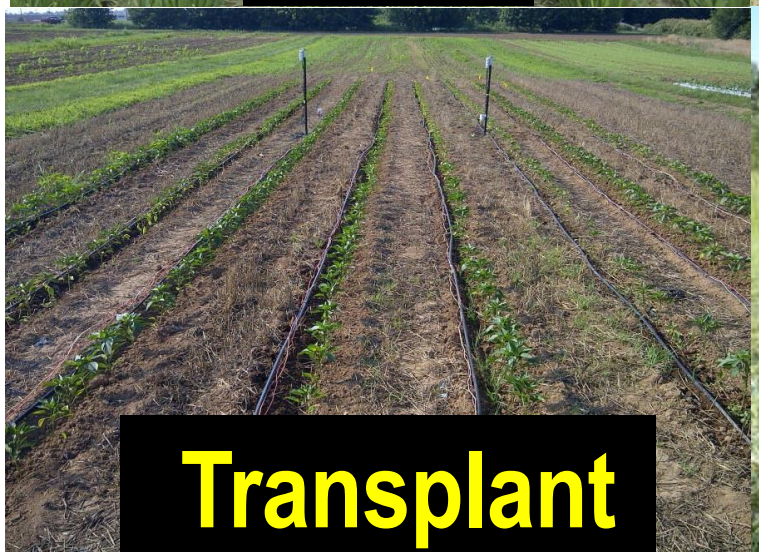
https://www.youtube.com/watch?v=IwLj_GvLQn0

University of California
Agriculture and Natural Resources

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)



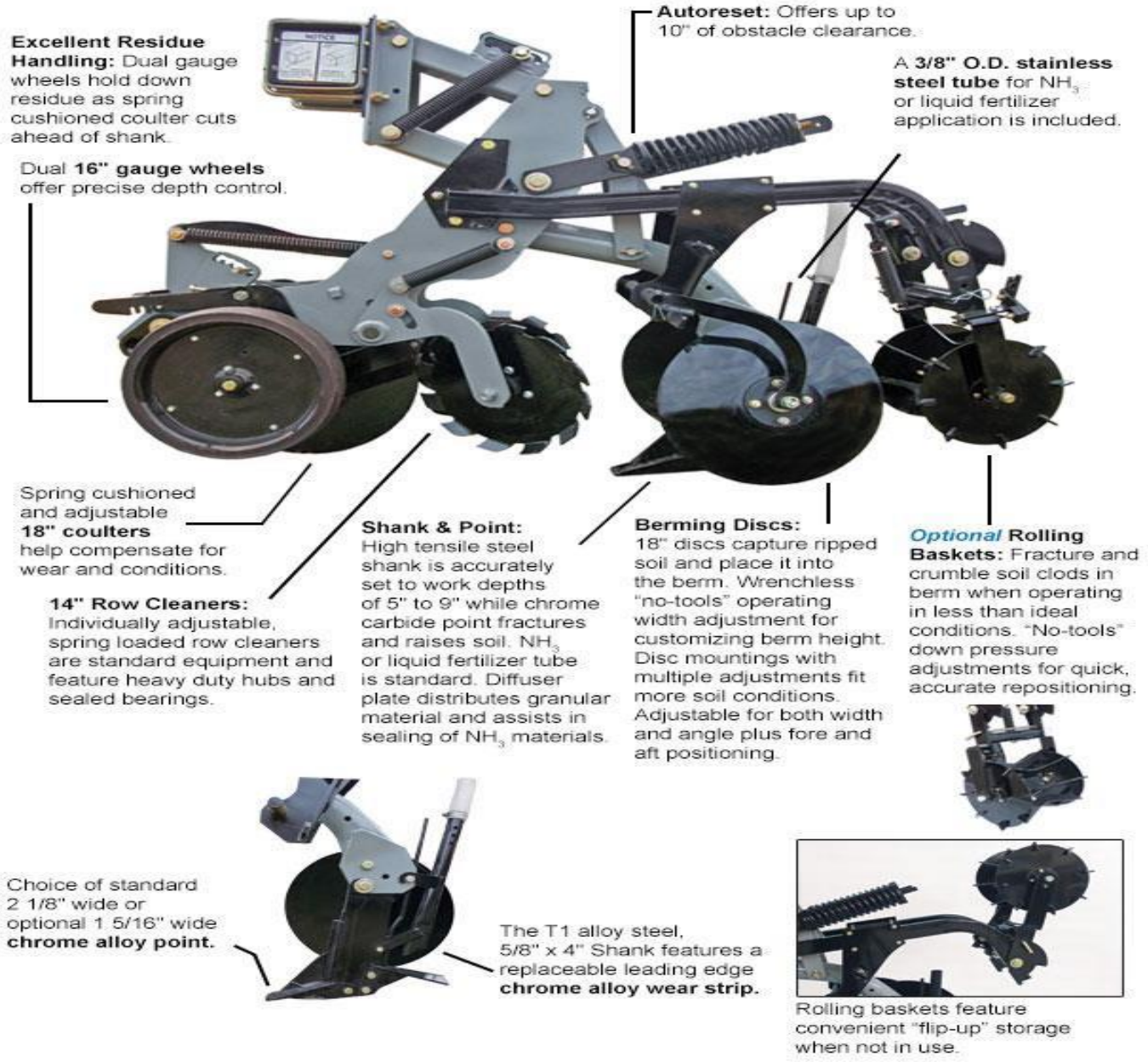
Plant into a narrow opened space created by a strip tiller (less than 12” wide).

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

The rest field is protected.

University of California
Agriculture and Natural Resources

Strip Tiller



Video from Dr. Anu Rangarajan Cornell Univ.

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

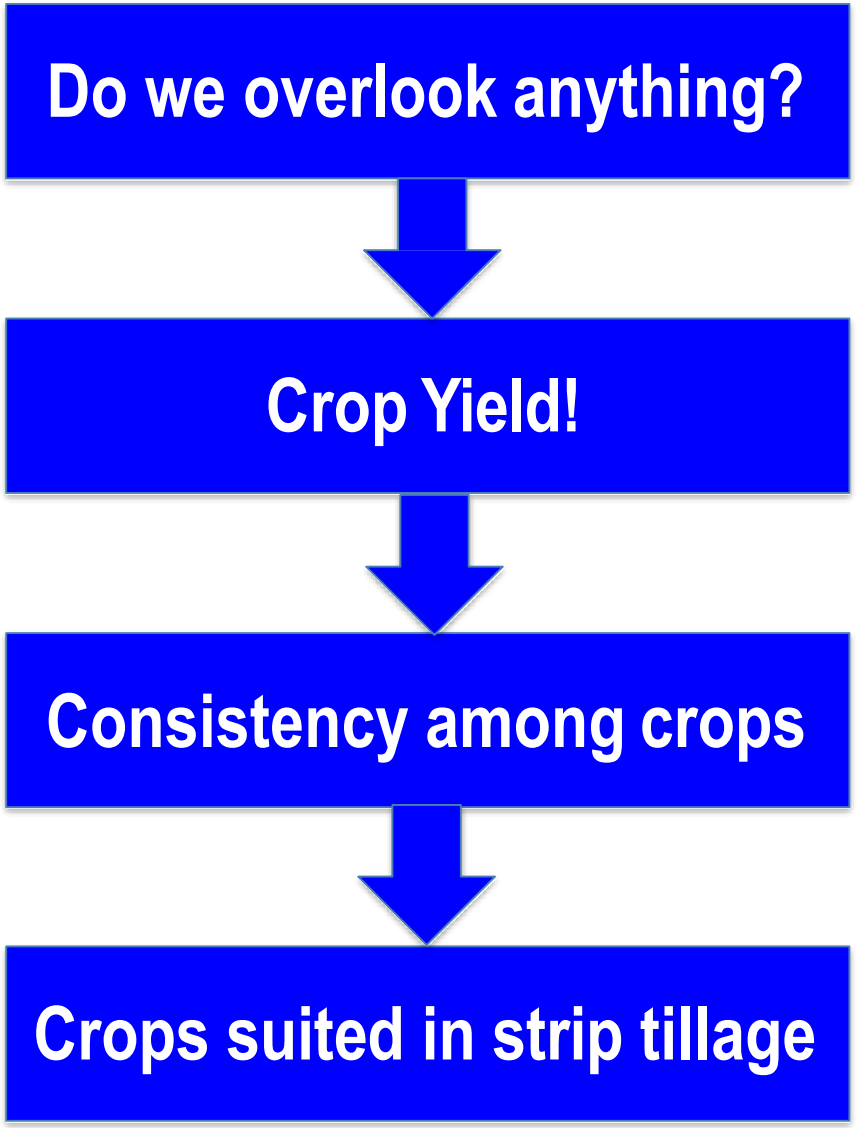
Hiniker Series 6000 Single-row Strip tiller

https://www.hiniker.com/ag_products%20new/6000_striptill.html

University of California
Agriculture and Natural Resources

Like other conservation tillage, strip tillage can…

- Protect soil structure and quality
- Reduce nutrient leaching
- Retain soil moisture
- Enhance microbial activity
- Save fuel and other costs
- Increase fruit quality (cleaner fruit)



University of California
Agriculture and Natural Resources

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

Corn (including sweet corn)

Source: Morning Ag Clips

University of California
Agriculture and Natural Resources

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

Source: MN Department of Agriculture

University of California
Agriculture and Natural Resources

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

Cucurbits (summer/winter squash, pumpkin, melon)

Source: Weed management strategies, eXtension

University of California
Agriculture and Natural Resources

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

Starting with drawbacks, strip tillage sometimes…

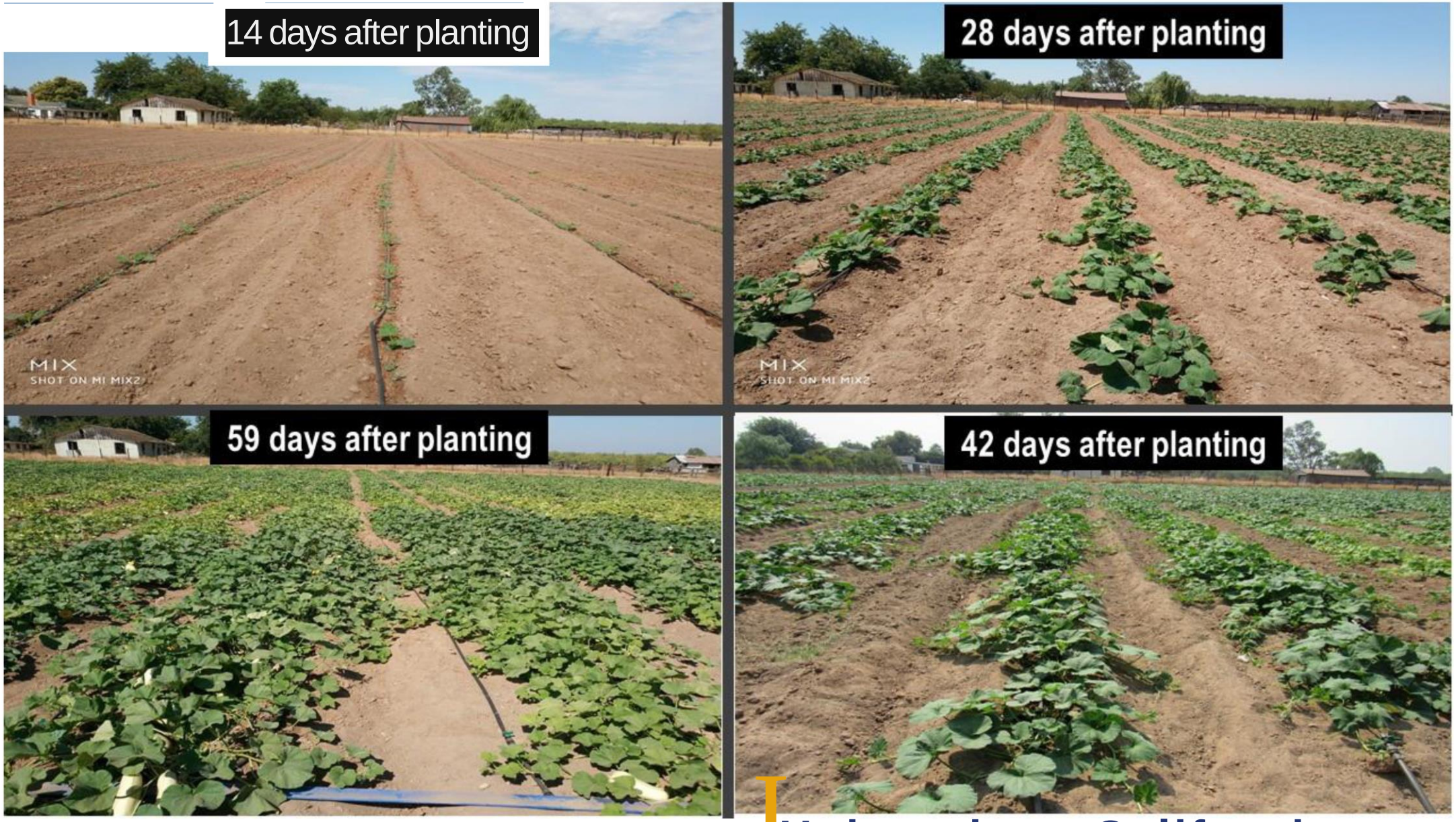
- Increases weed problems
- Causes lower soil temperature
- Delays crop maturity
- Restricts root penetration
- Produces lower yields

Corn has a wide range of herbicides for weed control, a deep/extensive root system, and a vigorous upright growth habit.

Soybean 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.

Cucurbit crops 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.

University of California
Agriculture and Natural Resources



University of California

Agriculture and Natural Resources



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.

University of California
Agriculture and Natural Resources

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).

University of California
Agriculture and Natural Resources

Next Class: September 18, 2018

Conservation Tillage and Cover Cropping in Sustainable Vegetable Production

University of California
Agriculture and Natural Resources