Organic Pepper Production

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U.S. Organic Production

- Total organic acreage in 1992: 935,450
- 4.3 million acres in 2008
- 48,227 acres of organic vegetables: 1997
- 156,615 acres in 2008

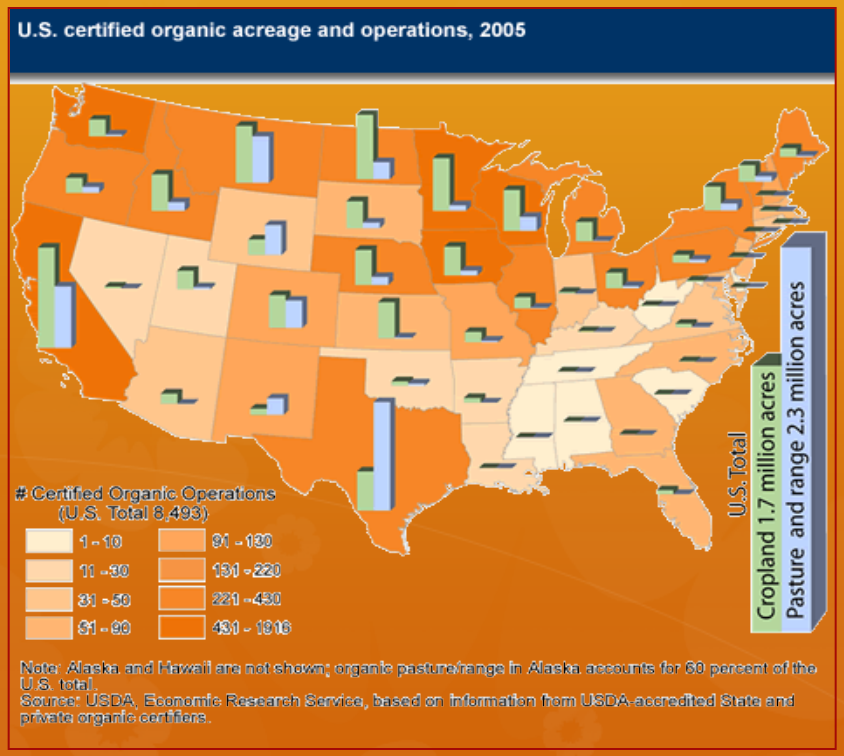
• $31 billion total

U.S. industry sales in 2011

-Annual growth rate

9% in 2011

-Iowa: 5th largest number of organic farmers

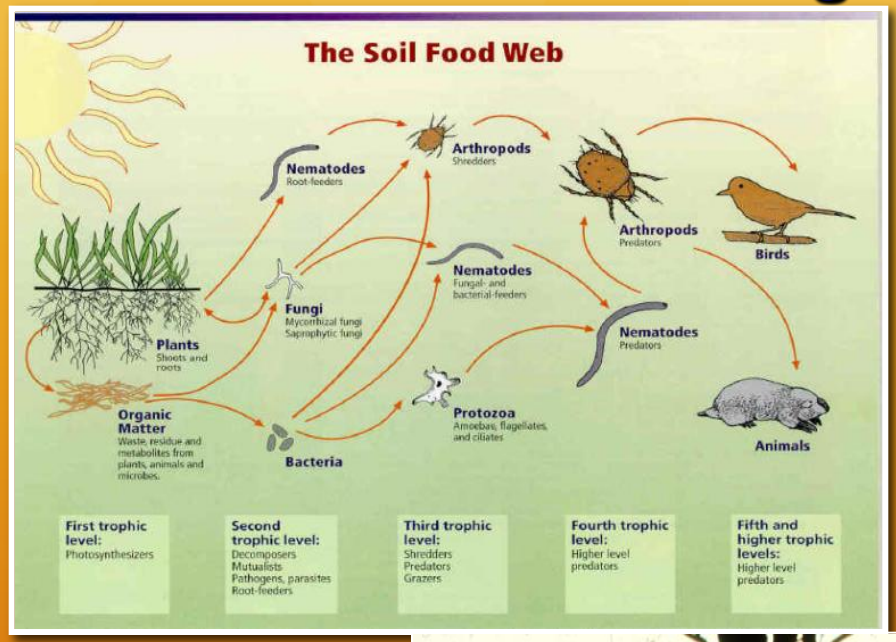


USDA-ERS website

Organic uses biologically-based Approaches

- The farm is a *system* with multiple plant-pest-natural enemy interactions
- Prevention: resistant varieties; sanitation; row covers
- Inherent biological control should be sufficient – "give Nature a chance"
- When controls are warranted, least toxic approaches should be taken
- For organic–all materials must be NOP-complaint/OMRI approved

Maintenance/Enhancement of Soil Quality: Heart of Organic Regulations



Enhance soil and water quality, decrease erosion, feed beneficial organisms throug cover crops, compost and crop rotations

Environmental concerns drive interest in organic

- Less pesticide exposure to farmers and farm workers, wildlife, environment
- Lower pesticide and nitrogen into groundwater and water ways
- More bio-diversity on farms: more crop rotations, Greater soil microbial populations, Larger populations of beneficial insects

Organic Fruit Comparison

- Univ. of California - Davis study
- Organic & sustainable produce had higher phenolics than conventional produce
- Phenolics = plants' natural defense chemicals, act as cancer-fighting compounds in humans
- Tested corn, strawberries, and marionberry

-March 3, 2003. Organically grown foods higher in cancer-fighting chemicals than conventionally grown foods. American Chemical Society.

Peppers grown all over the world in a diversified

system

Organic paprika, Serbia

Pepper Varieties

- Bell type: Lantern, Orion, Red Knight, Olympus (Johnnys)
- Chilis: Sugar Chile, Giant Jalapeno (Johnnys)
- Single lobes: Vidi, Red Start (Stokes)
  - Apple, Hungarian Wax (Johnnys)
  - Horizon, Valencia (gold when ripe)

Check your market for preferred types

Proper Varieties

- Resistance or tolerance to diseases
- Perform well under local conditions
- Depending on market: may need ripe stage (e.g., red or chocolate)-select varieties that ripen quickly/show tolerance to longer ripening period
- Harvest on timely basis (escape pathogens)

Start CLEAN
Disinfesting Greenhouses

- Pressure clean with soapy water/rinse all surfaces, tools
- Destroy all seedling trays if contaminated
- Use approved clorox solution or pericetic acid sprays on all surfaces
- Never plant seeds from an unknown source

Virus on pepper

Florida Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org

Growing transplants

- Transplants-10X seed cost, but reliable
- Greenhouse or hoophouse needed
- Transplant mix: Peat, perlite, compost, soil (sterilized): organic mixes
- Healthy seed

Growing Transplants

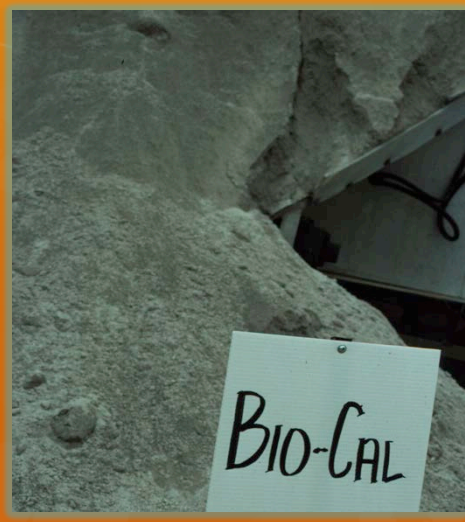
- Healthy seed
- Good drainage in media
- Ample irrigation but not continually saturated soil (water in sunny part of morning)
- Immediately remove/destroy diseased plants

Damping-off complex

Lila Steinhoff, Gardener

Fertilization

- Compost (swine, beef or poultry-based)-100 lb N/acre
  - Based on analysis, may apply 5 tons to 10 t/acre
- Biological fertilizers (feathermeal, greensand, alfalfa meal, calcium sources: check with certifier)
  - Conduct small acreage test (or pot test) first
- Cover crops
  - Hairy vetch, purple vetch, clovers (red/white/sweet), alfalfa: best with grass underseeding
  - Required for certified organic production (at least one year out of 3-5 years best)



Fertilization

- **Nitrogen from compost, fish emulsion/kelp/seaweed**
- **Phosphorus from rock phosphate; bone meal; rock dust**

- Potassium from naturally mined (Great Salt Lake): sulfate of potash

SOIL TEST FIRST & CHECK WITH CERTIFIER BEFORE USING ANY AMENDMENTS

Organic Materials Review Institute

http://www.omri.org

USDA-AMS-NOP
National List of Allowed and Prohibited Substances

Planting Strategies

- Crop rotations: separate from other solanaceous crops (eggplants, tomatoes) and use green manure crop every 3 to 5 years)
- Spacing: 18” to 30” rows (depends on equipment)
- Twelve to 18“

  between plants

Weed Management

- Cover crops/rotation
- Allelopathic rye cover crop
- Backpack flamer/cultivator
- Cultivation: hand-hoe, rototilling
- Light exclusion: mulches
- Predators

Weeder geese in organic coffee orchard

Mulches: The Workhorses for Weed Management

- Wheat or oat straw, wool, flax, plastic (landfill problems) wood chips, paper (perennials)

Weed Management

Treatment	Broadleaf weeds/m^2		
	June 22, 2004	July 19, 2004	July 30, 2004
Rye Cover Crop	0.54	1.75	1.00a
Control	0.38	1.69	11.75b
$LSD_{0.05}$	NS	NS	3.84

At season's end, there were 11 times as many weeds in the plots where there was no rye cover

Insect Pest Management

- Monitor regularly: know Economic Threshold (when controls are necessary)
- Know the life cycle of both pest and natural enemy
- Corn borer: 5% damage; may want to consider applying *Bacillus thuriengiensis*
- Aphids: 200/5 plants; may want to apply soap mixture (homemade or commercial)
- Monitor for natural enemies (parasitic wasps, lacewings, ladybeetles)

Essentials for Success in Disease Management

- Know the disease in your area
- Know accurate diagnosis of the disease
- Know pathogen biology and disease development
- Use integrated strategies for disease management

Managing Vegetable Diseases in Organic Farms - Tactics

- Resistant Varieties/Cultivars
- Site Selection (avoid flooding)
- Exclusion (keep pathogens
- Cultural Practices
- Use of Composts
- Field Scouting
- Disease Diagnosis
- Applying Control Materials

Managing Vegetable Diseases in Organic Farms - Cultural Practices

- Crop Rotation
- Timing of planting and harvest
- Good Drainage and Raised Beds
- Irrigation
- Slow-release fertilizers (e.g., compost)
- Soil pH (6.5 – 7.0)
- Field Sanitation
- Control of Weeds and Insects
- Soil Solarization

Pepper Phytophtora Blight (Disease Management)

- Pathogen: *Phytophtora capsici*
- Disease cycles: multi-cycled disease
- Plant infection: plants are infected at all growing stages
- Major Symptoms:
  - ✓ Seedling Death
  - ✓ Crown Rot
  - ✓ Vine Blight
  - ✓ Fruit Rot

Cornell Univ.

Pepper Phytophtora Blight (Resistant/Tolerant Cultivars)

- ✓Paladin
- ✓Aristotle
- ✓Emerald Isle
- ✓Enza
- ✓Reinger
- ✓Revolution

- ✓Seigers
- ✓Paladin
- ✓Revolution
- ✓Aristotle
- ✓Snapper
- ✓Alliance

Bacterial Leaf Spot

- Start with BLS-resistant or tolerant cultivars (e.g., ‘Olympus’)
- Always use disease-free seed and transplants
- Clean up Infested crop debris and infected weeds (solanaceous)
- Seed can be treated with hot water or Clorox® bleach
- Hot water: 122ºF for 25 minutes

UMD: http://extension.umd.edu/growit/bacterial-leaf-spot-pepper-vegetables

Copper Compounds (Copper Sulfate)

- **Basic Copper 53 (Albaugh, Inc.) - R**
- **Copper Sulfate Crystals (Chem One Ltd.) - R**
- **Copper Sulfate Crystals (fertilizer) (Chem One, Ltd.) - R**
- **Cuprofix (Copper sulfate) (United Phosphorus, Inc.) - R**

Copper is allowed but RESTRICTED; certifier must approve based on proof of need

Insect Pest Management

- Cultural controls
- Mechanical controls
- Biological controls
- Chemical (including natural chemical controls)
- Fortunately, with peppers, insect pests not abundant
- Protect when plants are small; grasshoppers, cutworms, aphids

Crop Production Practices-Cultural Controls

"A healthy plant tolerates more damage"

- Proper fertility
  - Amendments may be necessary
- Correct variety/cultivar
  - Insect- and disease-resistant or tolerant varieties
- Proper drainage and irrigation
- Management of weeds and diseases
  - Crop rotations
  - Windbreaks

Organic Pest Management

- Bio-diversity on farm
- Conservation of beneficial insects
- Preventative (row covers)
- Least toxic, NOP-compliant pesticides

Crop Rotations

- Improve soil structure and fertility
  - Add organic matter with cover crops/N-fixers
- Interrupt insect, weed and disease cycles
  - Pests unable to find hosts when hosts are switched
  - A minimum of a three-year rotation is recommended for certified organic production

Types of Natural Enemies

Parasitoids. This wasp is laying its egg inside an aphid where its young will develop. Parasitoid immatures develop on or inside a host, killing it as they mature. They emerge as adults and continue the cycle.

Predators. Lady beetles are well-known examples of predatory insects. A predator consumes many prey during its lifetime. Predators can feed on insects and mites.

Pathogens. This nematode is just one example of a pathogen which may kill its host. Other pathogens include bacteria, viruses, fungi and protozoa. This section also includes antagonists which control plant diseases.

Weed Feeders. Weeds can be attacked by arthropods, vertebrates, and pathogens (fungi, viruses, bacteria, and nematodes). This weevil feeds only on one particular type of weed called purple loosestrife.

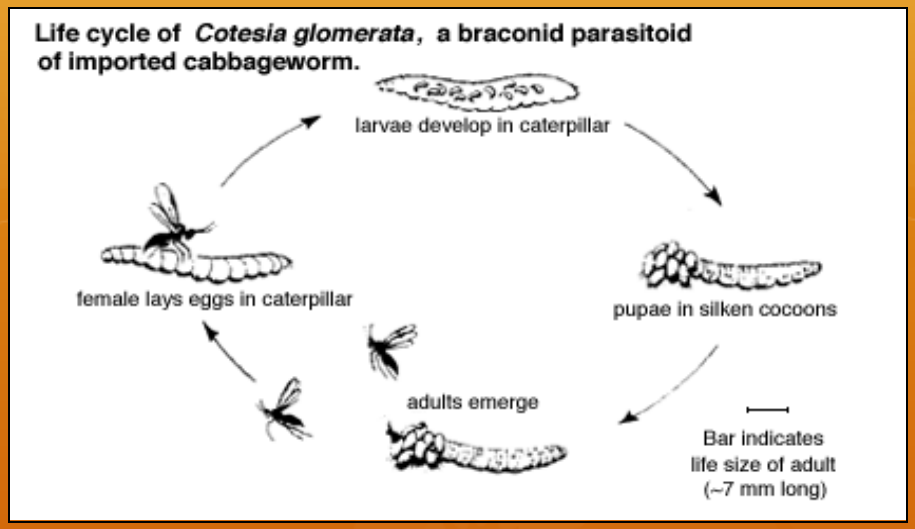
http://www.nysaes.cornell.edu/ent/biocontrol/

Parasitoid Example

Cotesia (=Apanteles) glomerata (Hymenoptera: Braconidae)

Larvae–pupae (cocoons)

Adult parasitic wasp



BIOLOGICAL CONTROL: A Guide to Natural Enemies in North America

CORNELL UNIVERSITY

Weeden, Shelton, Li, and Hoffmann, Editors

Predator Example

Predatory Wasps

Vespula spp.

Polistes

Predatory wasps are vespids, scoliids, and other families.
All feed their young with various insects (caterpillars, flies, grasshoppers)

Predator Example

Minute Pirate Bug

Adult insidious flower bug feeding on spider mite. **J.Ogrodnick**

- Both immature stages (nymphs) and adults feed on a variety of small prey including thrips, spider mites, insect eggs, aphids, and small caterpillars.
- *O. insidiosus* in the field, while in greenhouses, *Orius* spp. are used as generalist predators, especially on cucumber and bell pepper crops.
- Feeds on pollen and plant juices when prey are not available
- Found in soybean, alfalfa, corn, pea, and strawberry, on pasture land, & in orchards

Western flower thrips

Cultural Controls-Sanitation

- Harvest early and destroy all infested fruits/vegetables/crops
- Clean up after harvest (destroy/compost infected material)

Compost must reach 140° F for 3 days to kill organisms

Black Cutworm

Scout weedy fields


IOWA STATE UNIVERSITY
University Extension

Mechanical

Remove grass staging areas for European Corn Borer moths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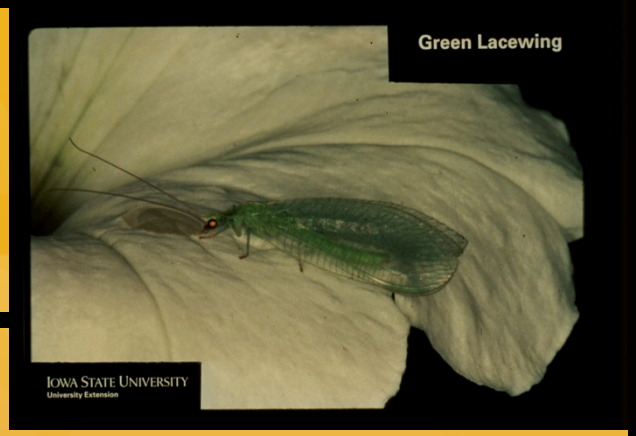
Physical Controls

- Row covers
- Screens
- Netting

Physically exclude insect pests; cut down on diseases transmitted by insects.

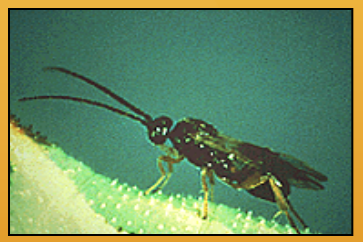
Biological Control

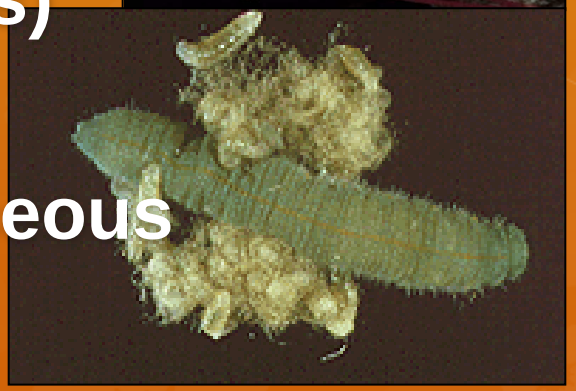


- The basis of sound organic farming
- Natural enemies (predators, parasites and pathogens) exist for nearly every pest
- Effectiveness of natural enemies depends on weather (entomopathogens), prey levels, population recruitment
- Stable, diverse ecosystems provide best environment
- Conservation of beneficials is key
- Augmentation (purchased beneficials) can work in certain cases (e.g., greenhouses) but generally, conservation is more effective

Biological Control

- Maintain adequate supply of food (prey, pollen, nectar) through plant diversity
- Insectary plants: buckwheat, clovers, herbs-dill, mint, yarrow, etc.
- Trees add nesting sites for many natural enemies (e.g., lacewings)
- Crop residues important for nesting/resting sites for predaceous beetles





Approved Treatments

- Must be naturally-based
- Check with Certification Agency before using any treatment
- Use as last resort-may affect beneficials
- *Bacillus thuringiensis* (Bt): spray at E.T.
- Botanical insecticides: pyrethrum, sabadilla, derris, neem
- Other natural treatments: D.E., vegetable oils and soaps

Harvest/Postharvest

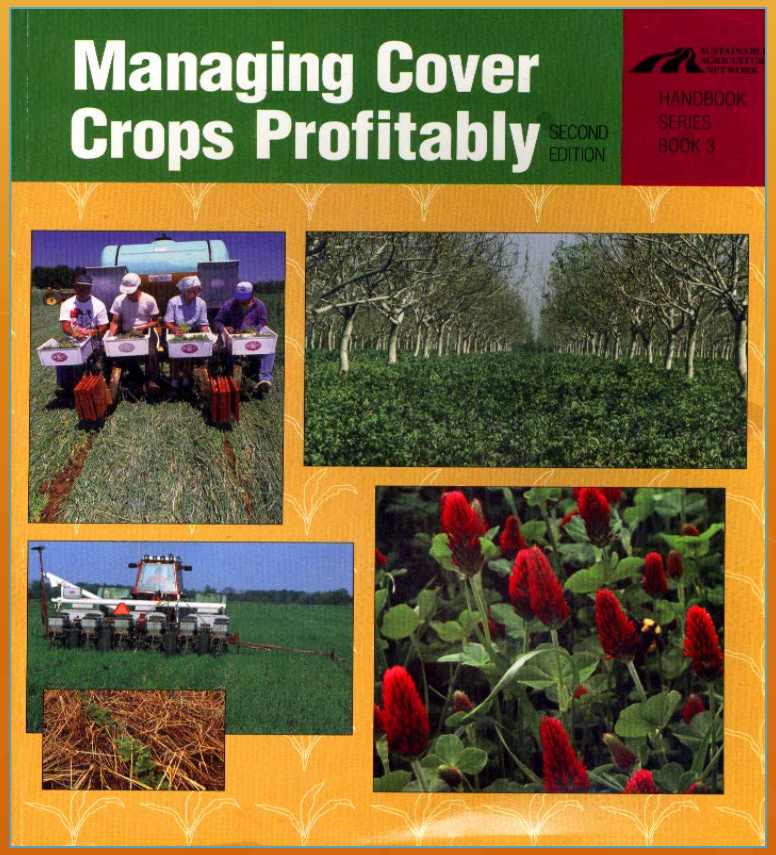
- Harvest on timely basis
- Use care in picking/packing in lugs
- Dropping can cause cracks or soft spots where pathogens can colonize
- Cool down as soon as possible
- Store at 50 degrees F
- Storage in open lugs at 90% RH
- Storage potential: Average-13 days (this year: up to 8 weeks)

Using Cover Crops

- Provide nitrogen
- Add carbon (biomass)
- Protect soil from erosion
- Weed management
- Provide habitat for wildlife and beneficial insects
- Reduce inputs/create new source of income

For high N crops, cover crops + compost best

- Crops take up 30-60% of N produced by cover crop
- Usually additional N is required: compost or organic fertilizer
- Fish emulsion as complement



Killing cover crops

- **Incorporation: Derive most N benefit**
- **Leaving residue on surface: Weed suppression, moisture retention, soil conservation**
- **Strip-tilling: Leave as dead mulch or live mulch between plant rows**
- **Mechanical killing: rotary mowing, flailing, sub-soil shearing with undercutter; chopping/flattening with rolling stalk chopper; mowing and tilling under;** rolling/crimping

Choppers and rollers

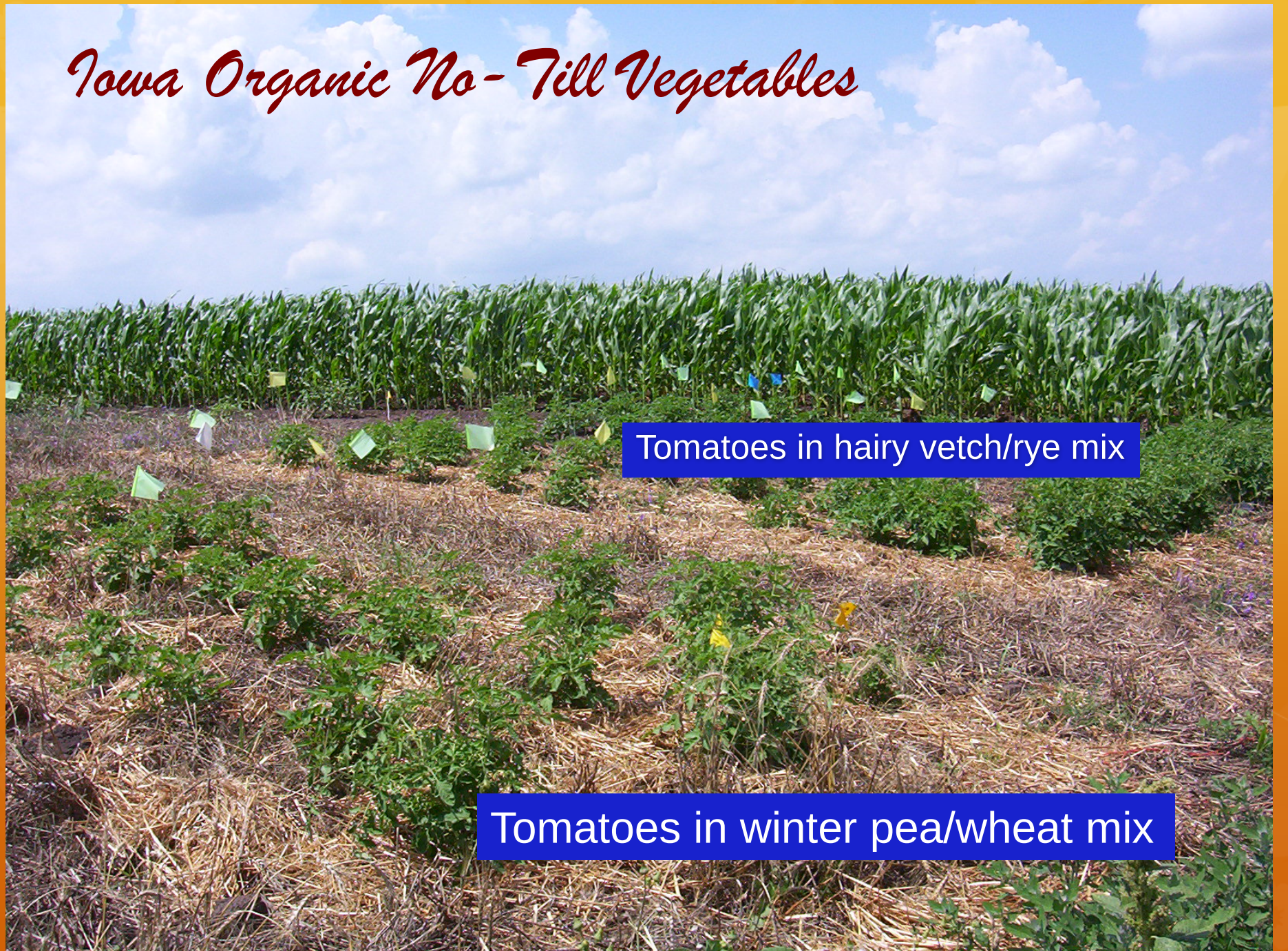
Stalk chopper

Front-mounted roller

Cover Crops Research- Iowa

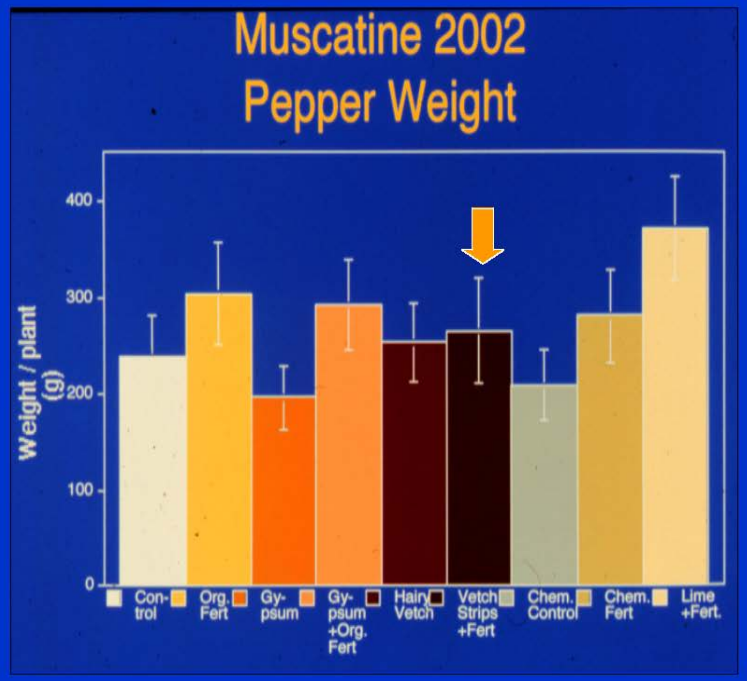
- Hairy vetch + winter rye @ 25-40 lb/A and 70 lb/acre – drilled
- Irrigation is helpful
- Vetch strips: mowed to kill; 15” strip cut in mulch for pepper transplants
- Incorporated vetch: mowed and tilled mid-May-planted June 1

Iowa Organic No-Till Vegetables



Certified Soil Amendments & Cover Crops for Organic Vegetables

Compost plus Strip-Tilled Cover Crop: Best Combination



Transplanting organic vegetables into tilled under cover crops or strip-tilled cover crops.

Delate, K. H. Friedrich and V. Lawson. 2003. Organic pepper production systems using compost and cover crops. Biol. Ag. and Horticulture 21 (1): 131–150.

USDA-NIFA-ORG experiment examines straw mulch vs. no-till vs. tilled vegetables

•Mechanically transplanting in rolled organic no-till cover crops

-Coulters with weed whippers on planter used ahead of transplanting to make rows

Ron Morse's No-Till Vegetable Transplanter

Experimental design

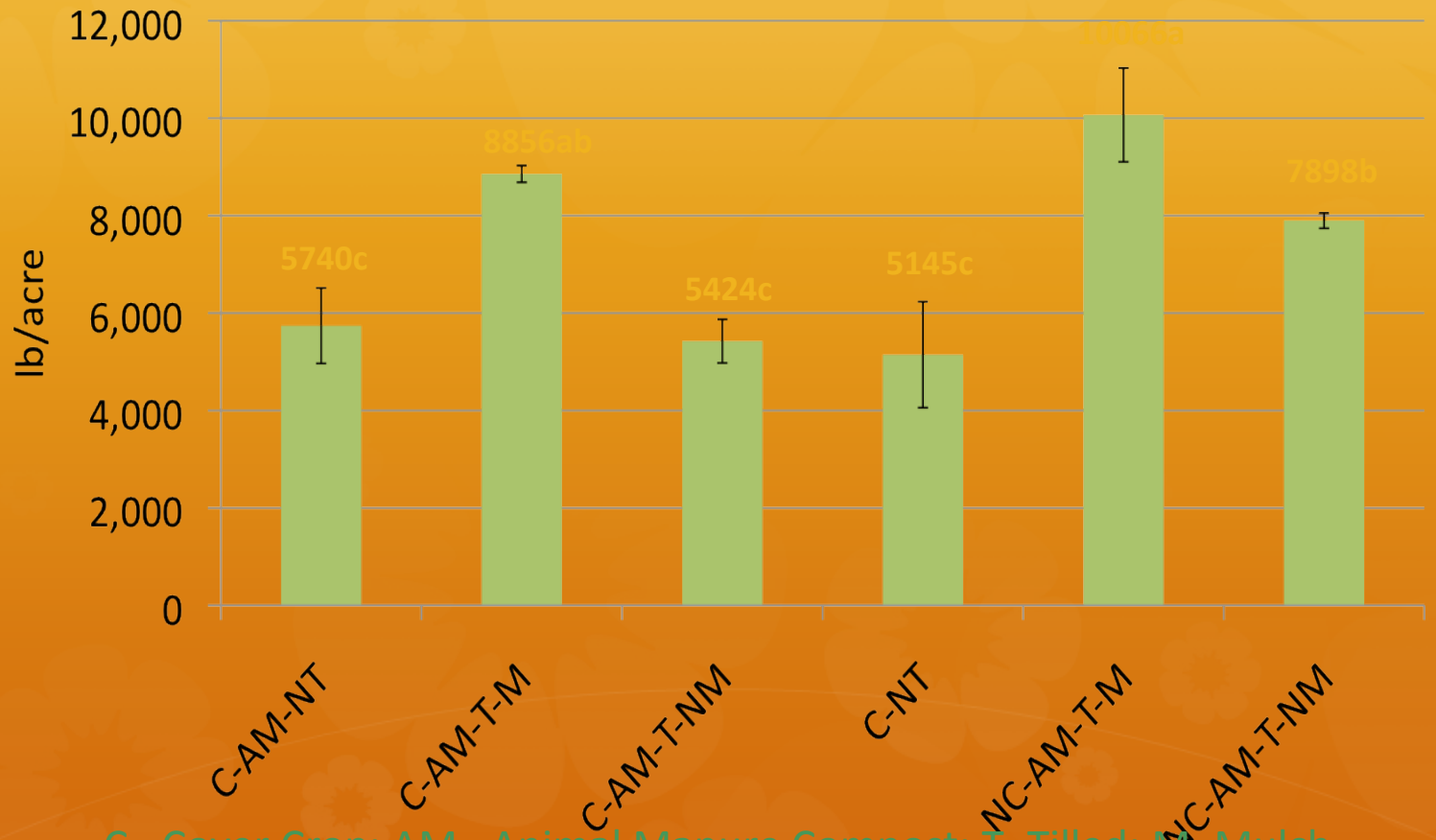
- Six cropping system treatments with different management practices
- Four treatments have cover crops (HV/rye) and two with no cover crops
- Of the four CC treatments, two are treated as organic no-till (cover crop rolled/crimped) and two are tilled prior to vegetable planting/transplanting
- Compost (100 lb N/acre) and mulch (straw at 6-inch depth) are applied to a sub-set of these treatments

Peppers/sweet corn-2012

Excellent emergence and transplant survival in no-till crushed cover crop

2012: Worst drought in 24 years

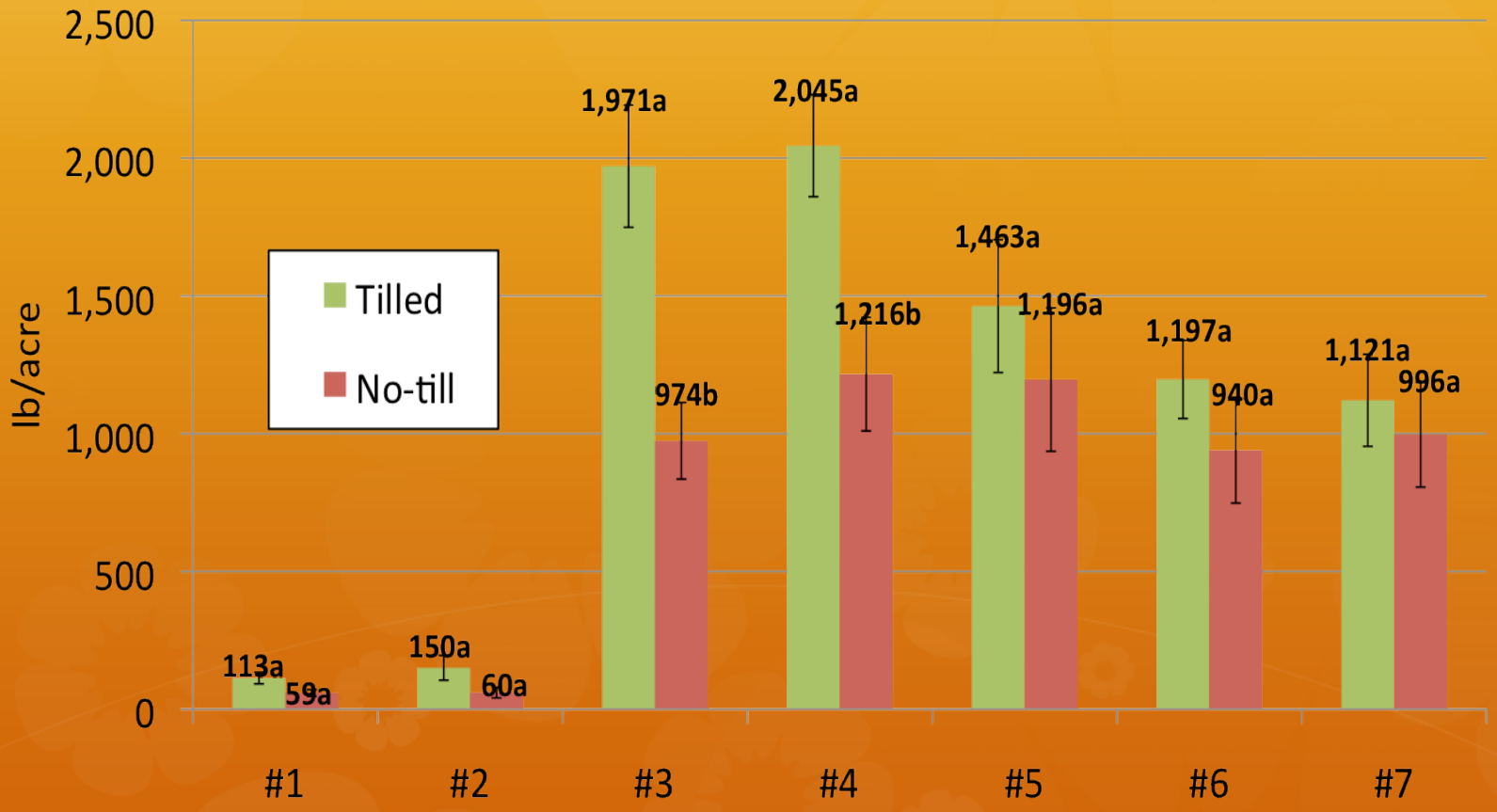
Organic pepper yield: 2012



C= Cover Crop; AM= Animal Manure Compost; T=Tilled; M=Mulch

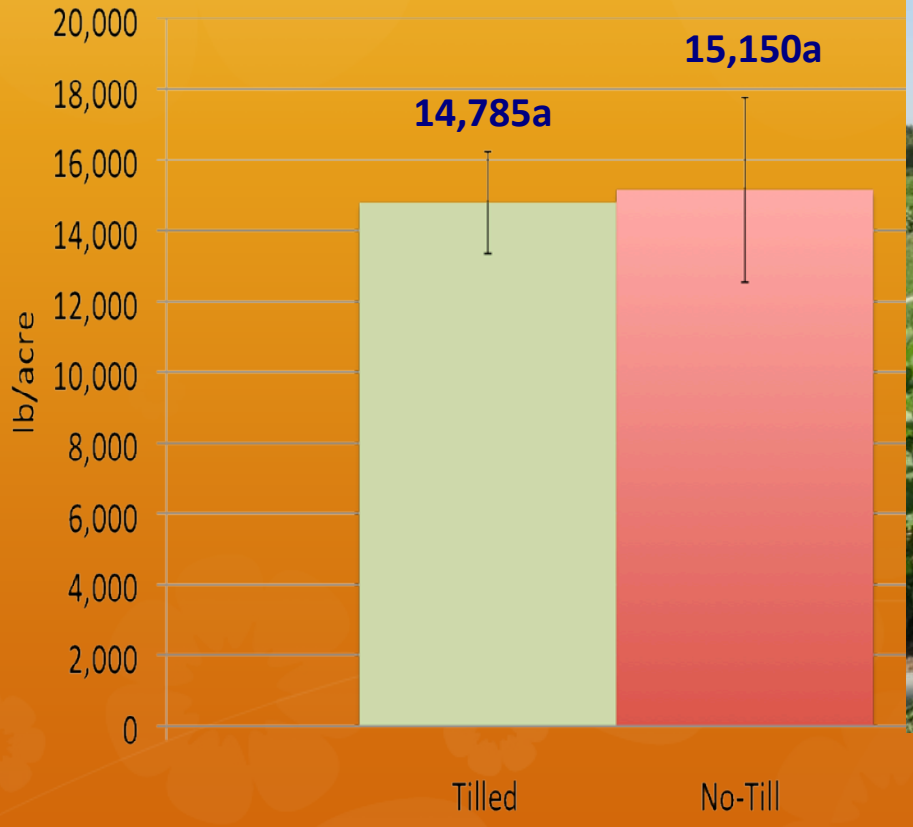
In severe drought, composted Manure and Mulch beat cover crops; Tilled beats no-till

Organic pepper yield: 2012 Tilled vs. No-till



Organic no-till: lower yields than tilled, but later harvests and higher soil quality

Organic squash yield Tilled v. No-Till: 2012



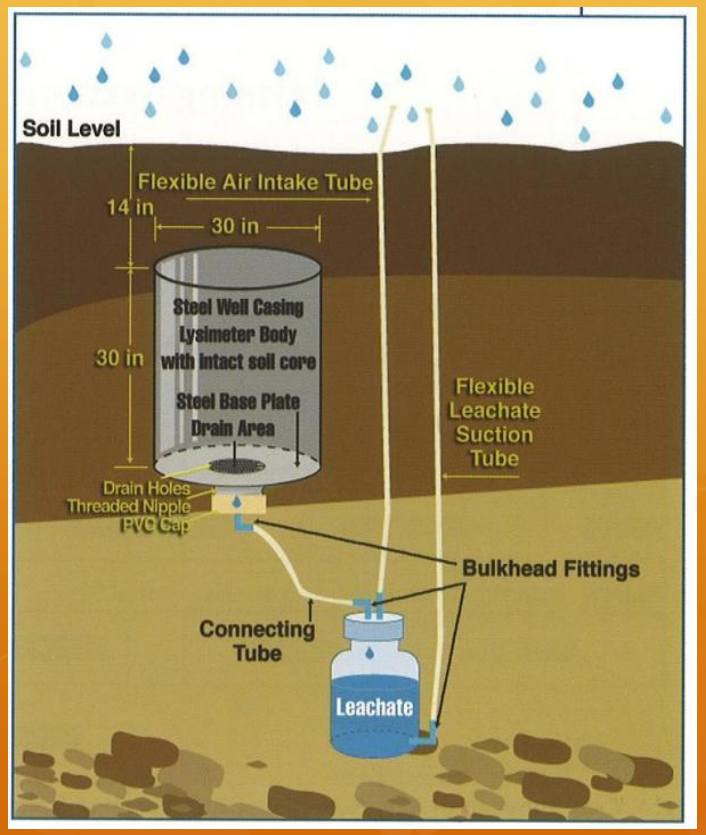
Larger-leafed transplants (squash and broccoli) seem to do better in organic no-till

No. of diseased squash plants

Credit: On the Green Farm

Less disease (bacterial wilt) in organic squash versus conventional squash: cucumber beetles avoid mulch?

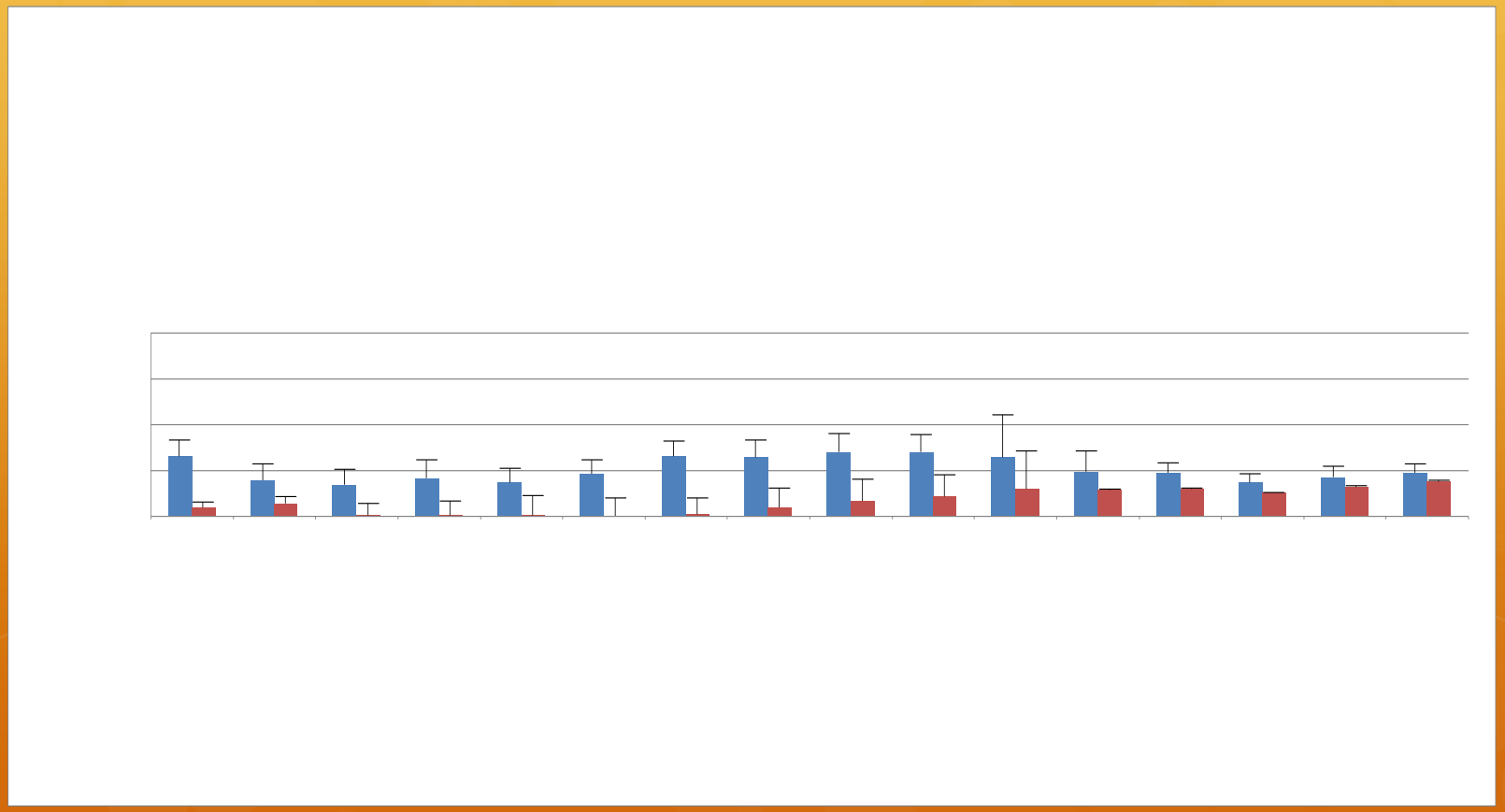
Lysimeters measure nitrate leaching



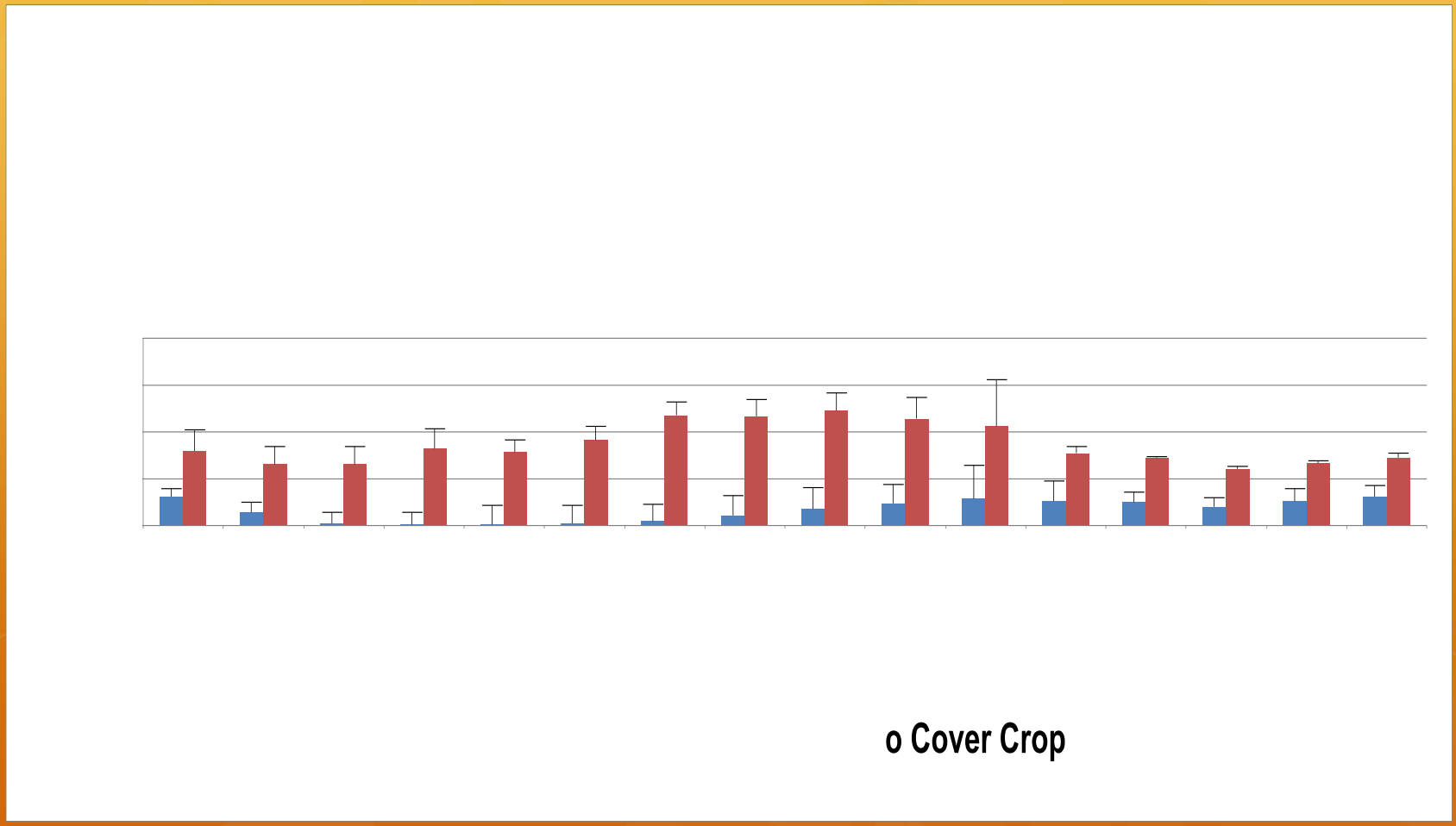
-Rodale Institute lysimeter

Lysimeter data are showing that the average root zone nitrate N concentrations over the course of the season do not exceed the drinking water standard of 10 ppm

No-till reduces nitrate leaching



Cover crops decrease nitrate leaching



Organic crops = lower nitrates in H_2O

Crop/Rotation	Nitrate-N Load (kg/ha)
Conventional corn/soybean	10.1
Organic C-S-O/A-A	7.9
Organic oats	4.9
Organic pasture/forage	7.0

-C. Cambardella, 2012, Ames, IA

Mulched plots had higher quality fruit

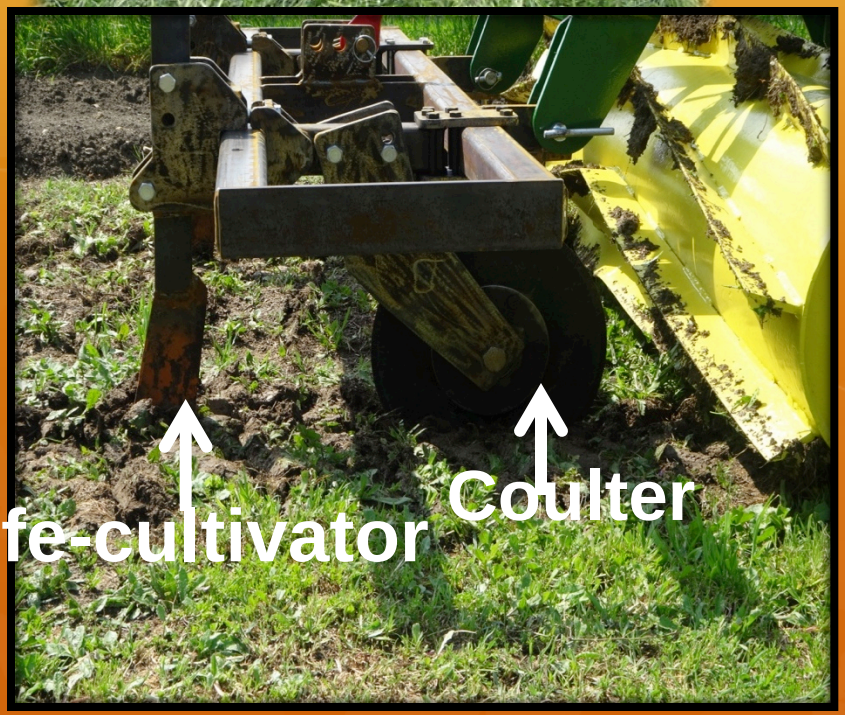
Tilled tomatoes–picked after a rain

Tomatoes from no-till and mulched plots

Future directions

On-Farm trial at Henry Wallace Home, Orient, IA

Italy: Modification of roller/crimper includes coulter followed by knife-cultivator to cut through cover crop



Survey results: 10% have tried organic no-till;
100% interest in conservation programs