

# Tillage and Residue Management for Organic Farming Systems: Western States

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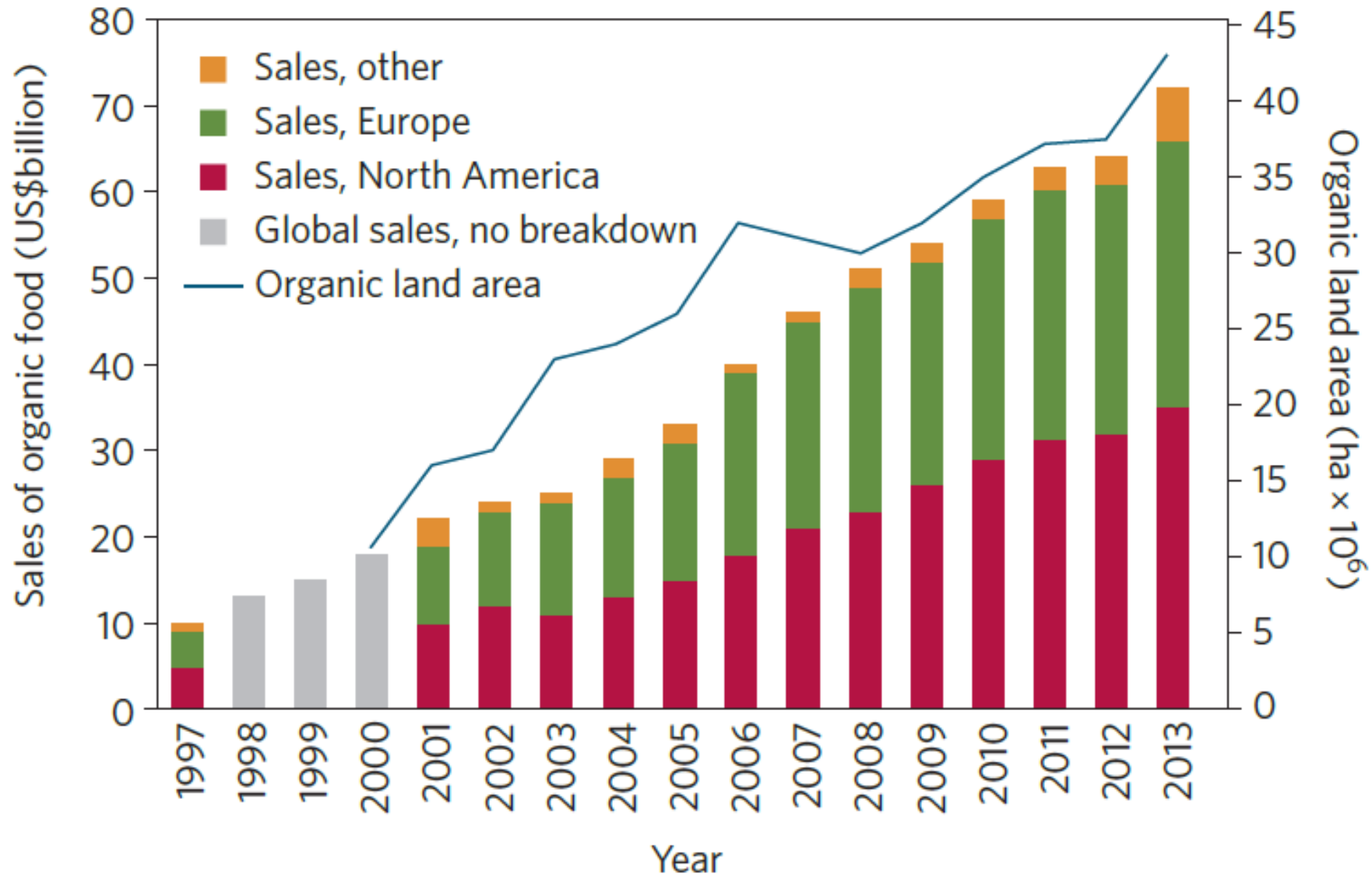
Regional Soil Health Specialist for CA, NV & Pacific Islands Area

National Soil Health Division

USDA-NRCS

Davis, CA

# Organic Agriculture



# Top 10 States in Organic Sales, 2014

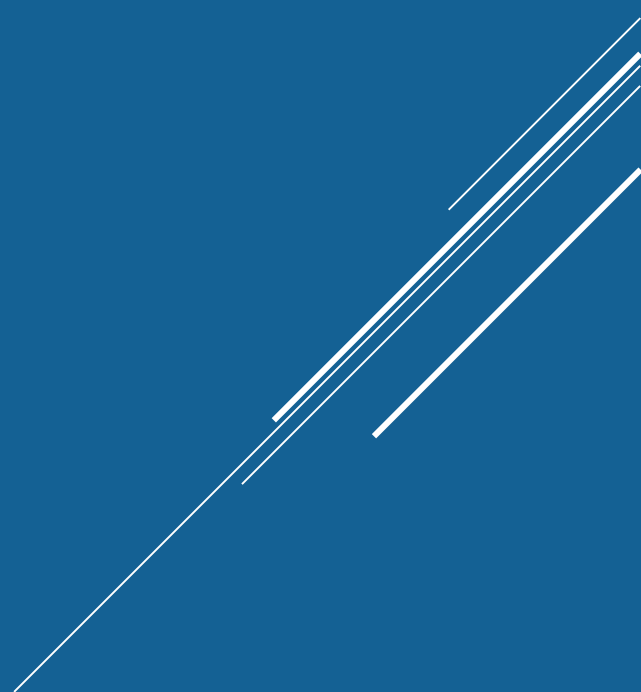
These states account for 78%  
of all sales in the U.S.



California	\$2.2 B
Washington	\$515 M
Pennsylvania	\$313 M
Oregon	\$237 M
Wisconsin	\$201 M
Texas	\$199 M
New York	\$164 M
Colorado	\$147 M
Michigan	\$125 M
Iowa	\$103 M

U.S. Total = \$5.5 B

# Organic Agriculture and Soil Health Principles



# Organic Agriculture and Soil Health Principles



# Three of the four Soil Health Principles applied



Minor Organic Farm, NM

# Russell Ranch-Agriculture Sustainability Institute (ASI) at the University of California, Davis 1993 - 2001



**Agro-chemical based** –no cover crop -  
representative of typical California  
Central Valley system



**Intermediate system** – Fertility from Winter  
Legume Cover Crop (WLCC) and some  
supplemental inorganic fertilizers; occasional  
pesticides and herbicides



**Managed according to USDA guidelines**  
– WLCC and organic fertility from  
composted chicken manure

# Russell Ranch-ASI at the University of California, Davis 2002 - 2008

## •Farming Systems



## •Tillage Practices

STANDARD TILLAGE

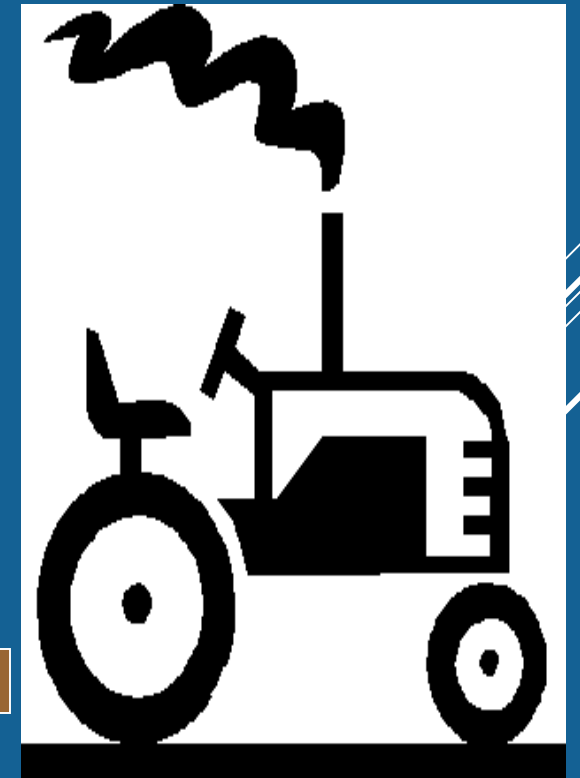
CONSERVATION TILLAGE

STANDARD TILLAGE

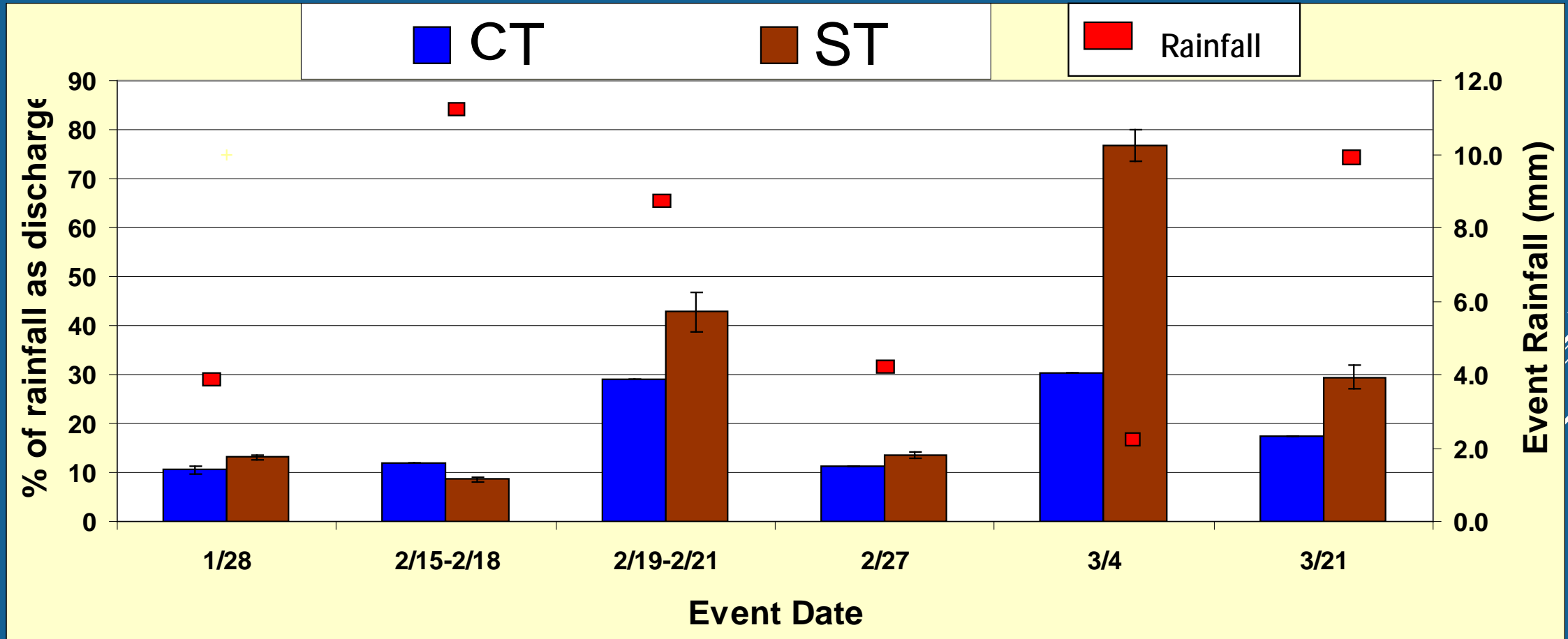
CONSERVATION TILLAGE

STANDARD TILLAGE

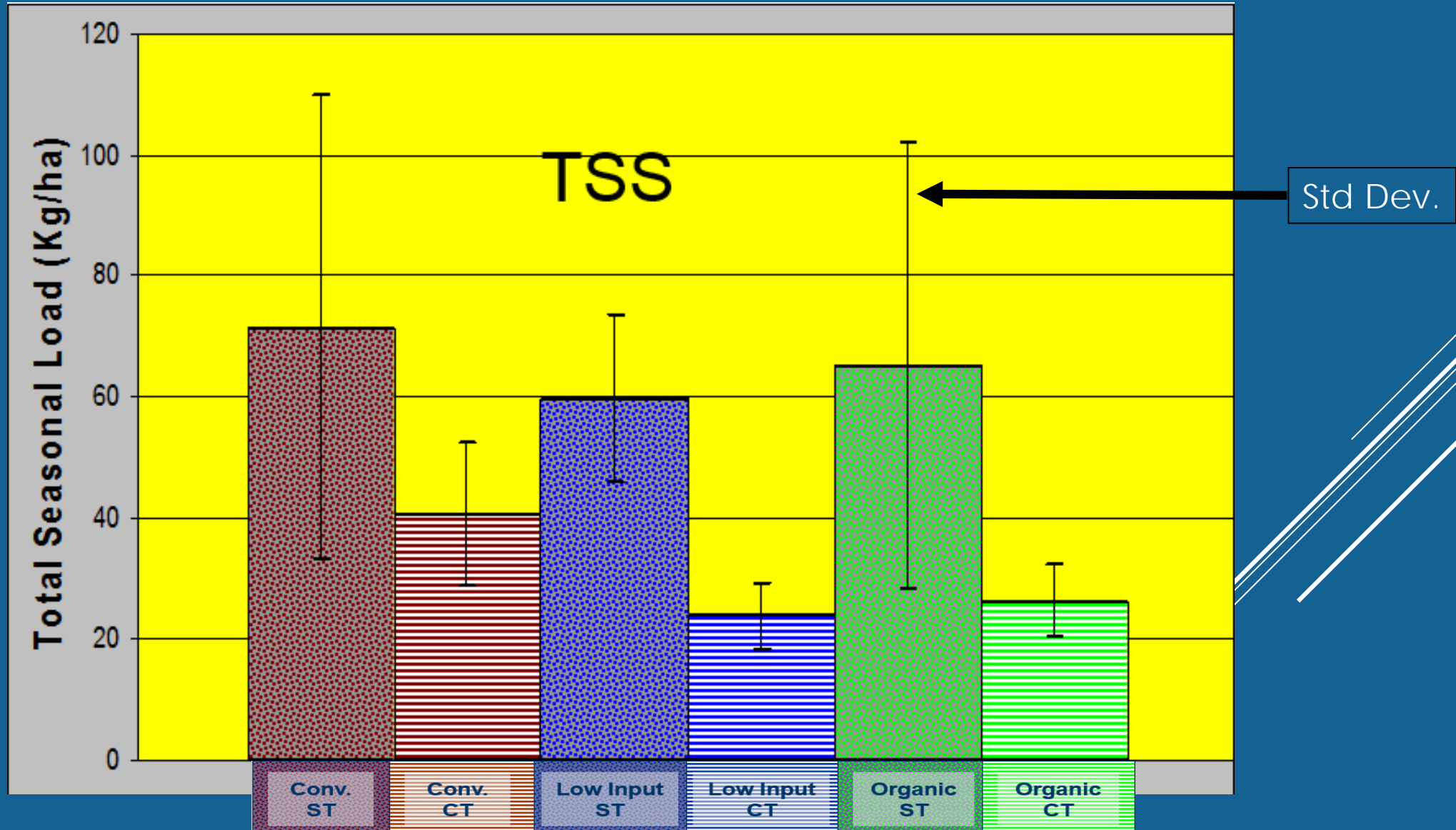
CONSERVATION TILLAGE



# Runoff as a Percentage of Rainfall in Organic System



# Seasonal Load of Total Suspended Solid (TSS) in Runoff

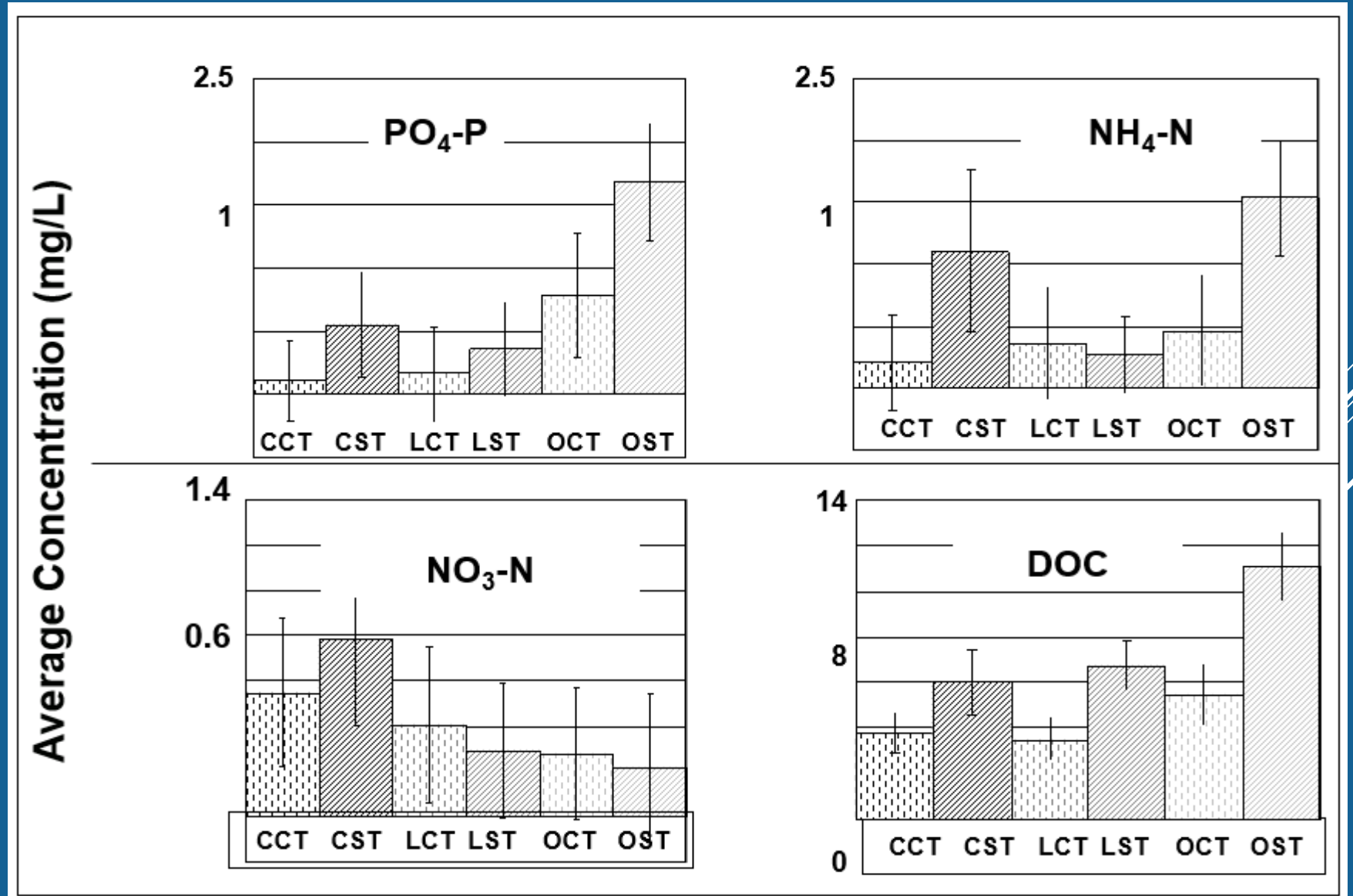


# Nutrient Concentrations in Runoff

CCT=Conventional-conservation tillage  
 CST= Conventional-Standard tillage

LCT= Low-input -Conservation Tillage  
 LST= Low-input -Standard Tillage

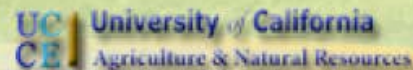
OCT= Organic-conservation tillage  
 OST= Organic-Standard tillage



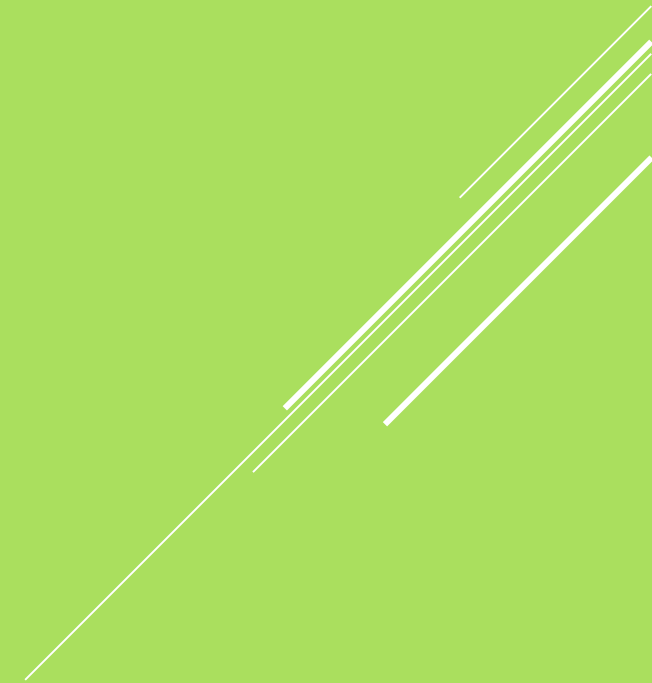
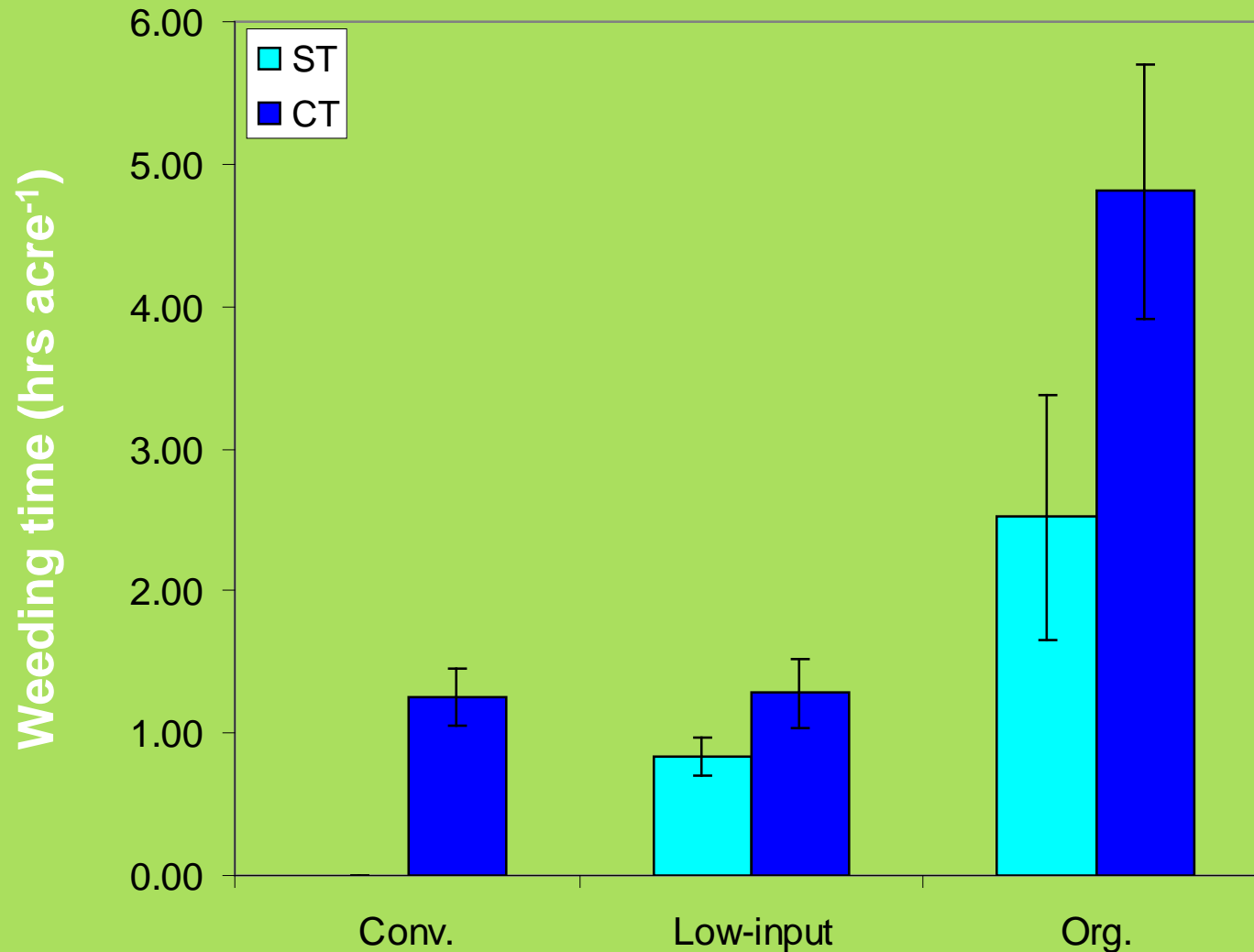
# San Joaquin Valley, California

System	Aggregate Stability (%)	Slaking * (Slaking Class)	Water Infiltration (time)	
			(First inch of water)	(Second inch of water)
STNO	28.3 ± 14.2	3.18 ± 0.56	2:02 + 0:44	10:14 ± 2:23
STCC	47.0 ± 19.1	3.65 ± 0.38	0.35 + 0:15	4:54 ± 2:08
CTNO	40.4 ± 15.7	3.76 ± 0.53	1.29 + 1:05	13:41 ± 12:13
CTCC	69.9 ± 9.5	5.28 ± 0.52	0.06 + 0.03	0.53 ± 0.43

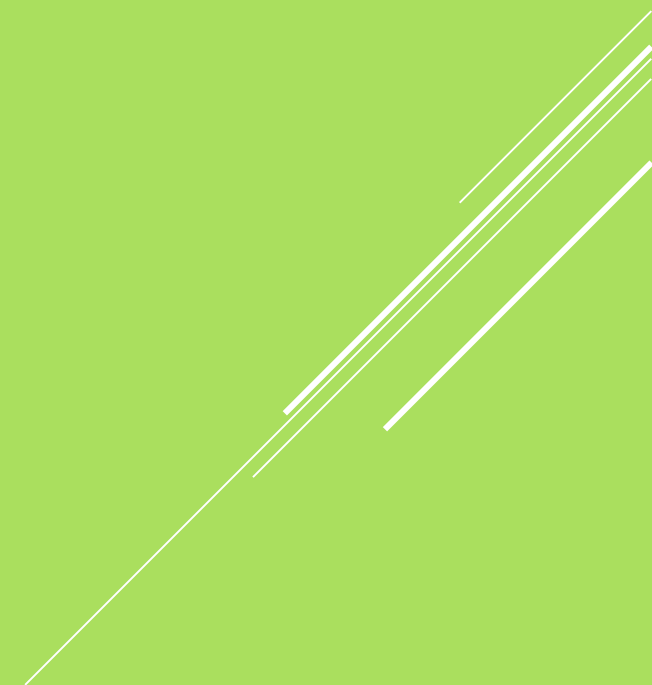
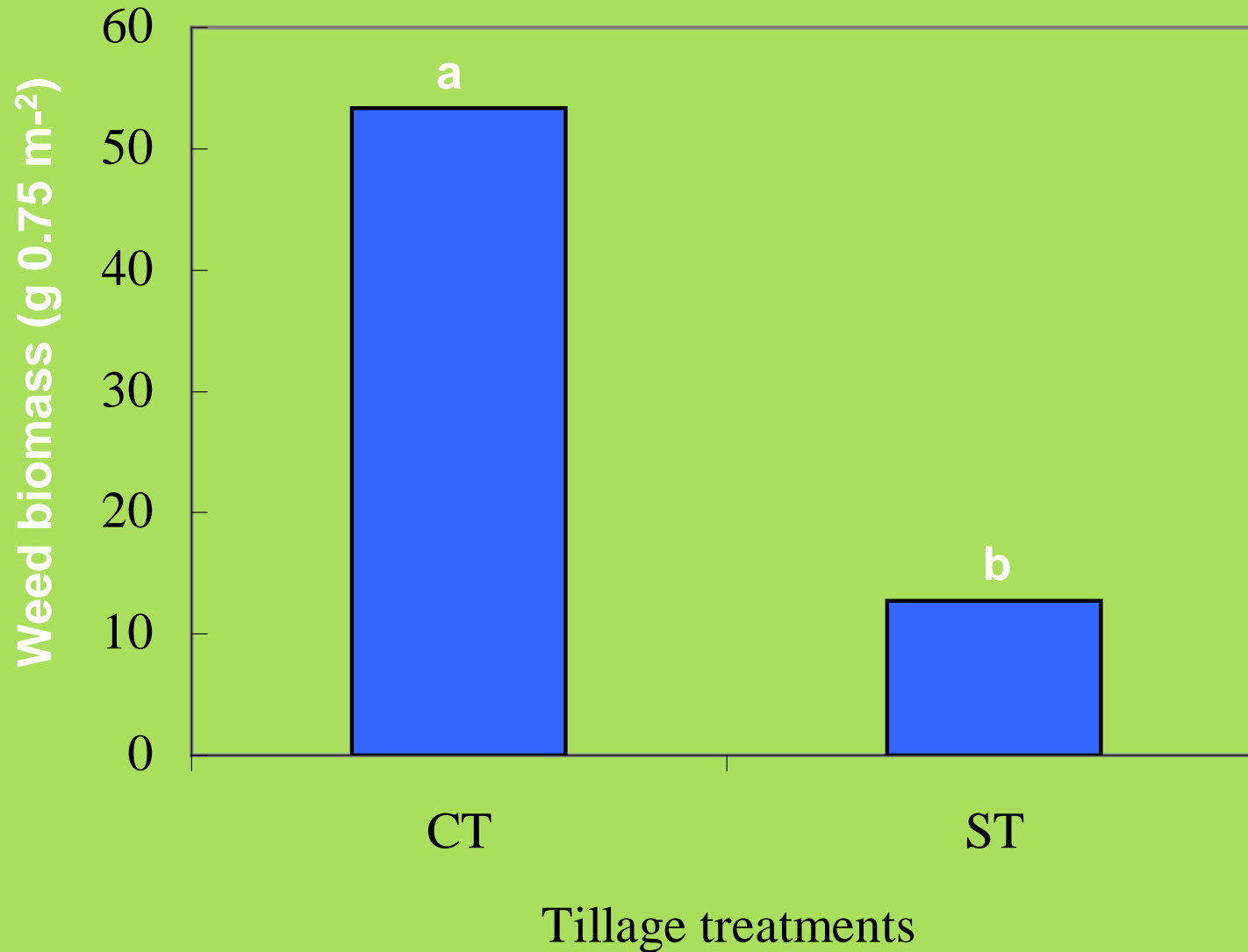
STNO = Standard tillage with no cover crop; STCC=Standard tillage with cover crop;  
 CTNO= Conservation tillage with no cover crop; CTCC=Conservation tillage with cover crop




# Weeding Time in Different Farming Systems in two tillage Practices



# Weed Biomass in Conservation (CT) and Standard Tillage (ST) in Organic System



# Strategies and Tactics to Control Weeds in Organic systems

- Prevention
  - Field selection
  - Cultural Practices
  - Physical Weed Management
  - Biological Management
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# Prevention

- Prevent weeds from going to seed
- Manage weeds in the field boundary
- Practice good 'neighborly weed management



## Prevention (After harvest)

- Tillage and mowing of a harvested field soon after harvest to kill uncontrolled weeds



# Prevention (Clean soil off Equipment)

- Sanitation



## Prevention (Composting Manure)

**In San Joaquin Valley, California: 4,170 to 21,800 weed  
Seed found per ton of dairy Manure**

Cudney et al. 1992

### **Composting manure can kill weed:**

**3 days exposure to 158°F kills most weed seed (Wiese et al. 1998),  
but higher temperatures and longer exposures are needed for bindweed seed**

# Field Selection for Organic Farming



# Cultural Practices

- Crop Rotation
- Cover crop
- Mulches
- Use of Transplants
- Soil solarization
- Irrigation
- Dust mulches
- Flaming
- Organic herbicides



# Cover Crop, Strip Till and Living Mulch



A form of strip till and sunn hemp cover crop rotation system where


A) alternated stands of cover crop is mowed, and

B) strip tilled into the soil,

C) Leaving alternating rows of sunn hemp as a living mulch

D) Zucchini is then intercropped

# Organic or Synthetic Mulches

- Act by blocking light for weed control
  - Warming the soil
  - Enhancing moisture retention
  
  - Numerous organic and synthetic materials can be used
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# Mulching from the Tree Pruning




# Strip tillage and mulching in Safflower

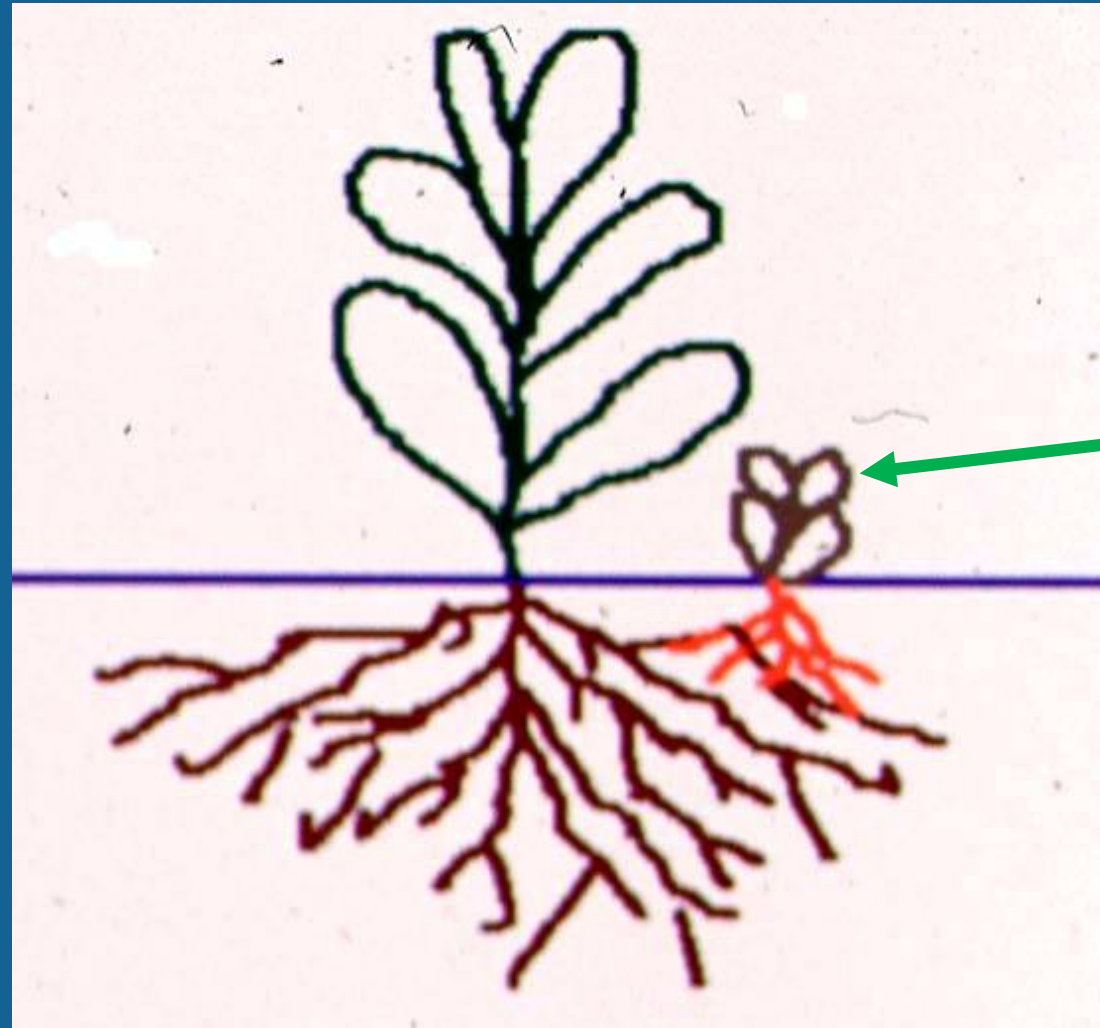


Fritz Durst Organic Farm, Esparto, CA

# Natural Organic Mulches

- ▶ **Work best in agronomic crops (Price et al 2011)**
  - ▶ **Difficult to use with seeded horticultural crops like broccoli, carrot, lettuce, onion**
  - ▶ **Work well with transplanted vegetables, orchard and vineyard**
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# The Transplant Advantage



Weed

Big crop outcompetes weed

Aug. 4, 2004

Plastic mulch in Olive Orchard



T. Lanini, UC Davis

Nov. 11, 2004





**May 17, 2005**

T. Lanini, UC Davis



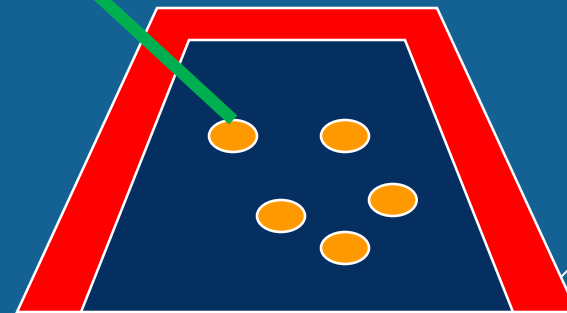
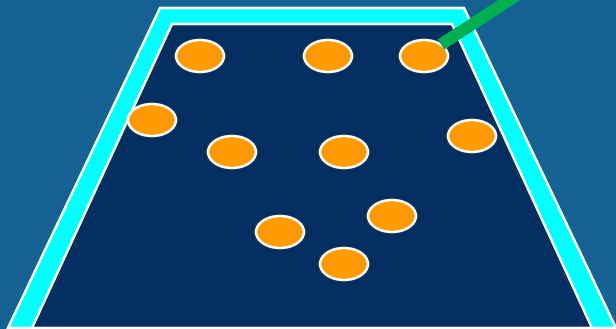


# Solarization to Control Weeds

Solarize



Weed seed



# Solarization to Control Weeds



# Steam application- in Organic Strawberry Field



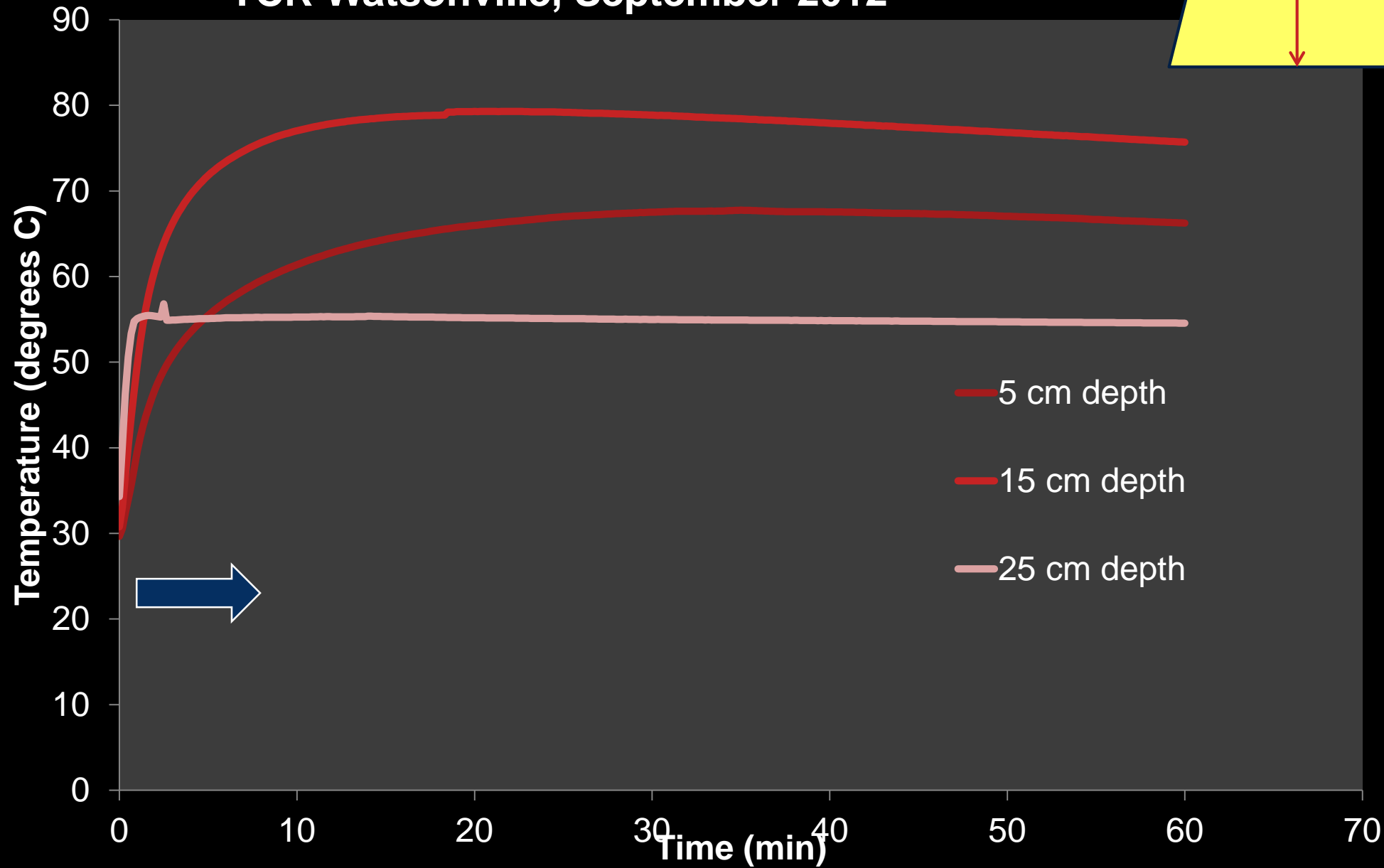
Driscoll Field, Watsonville, CA



S. Fennimore, UCCE



# TCR Watsonville, September 2012





Before Steam

After Steam

# Flaming to Control Weeds





Before  
Flaming

10 minutes  
After Flaming



# Conventional Tillage with Furrow Irrigation



# Strip Tillage



Strip tillage  
on the bed

Cleaning  
the furrow

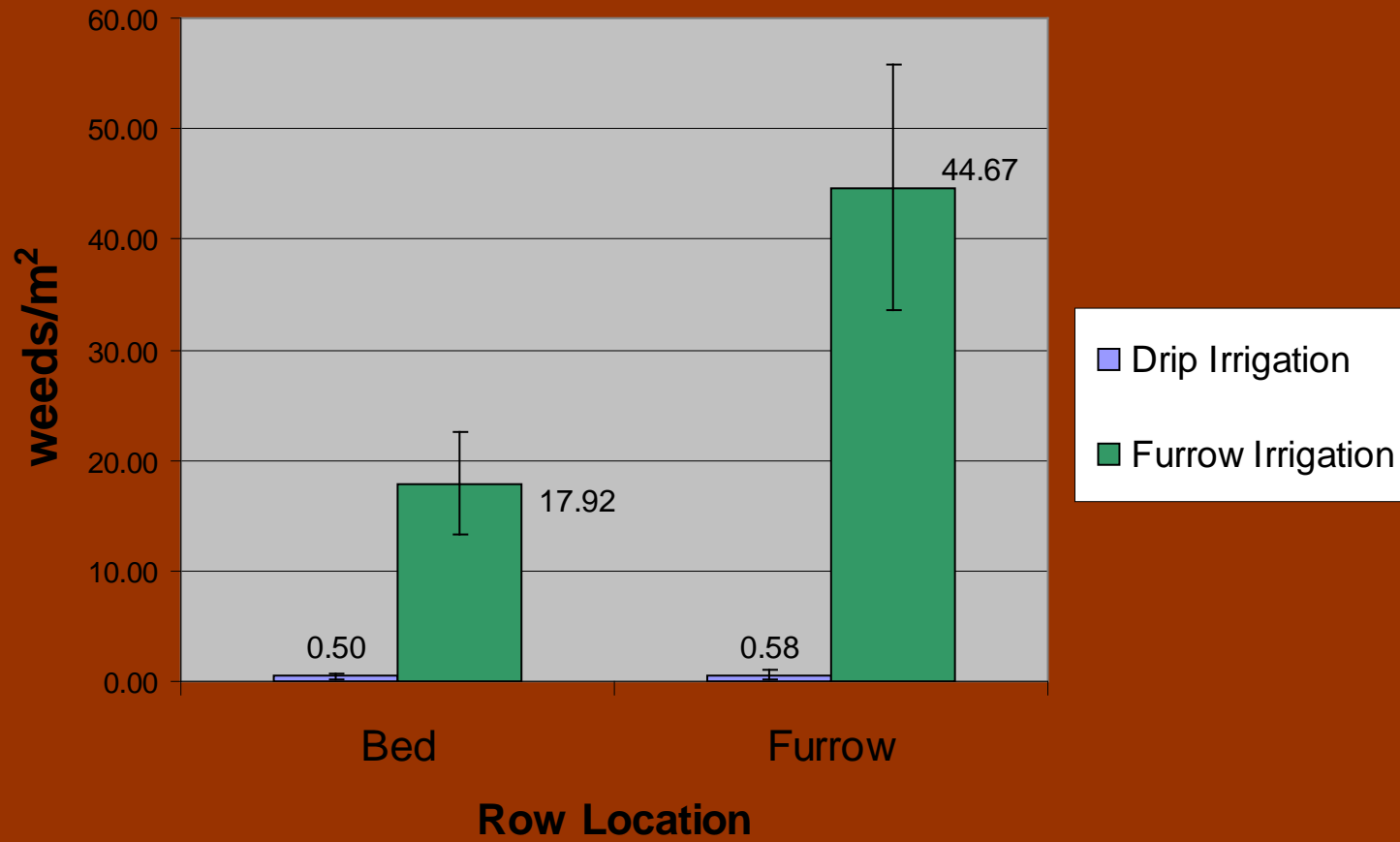
## Strip tillage with furrow irrigation



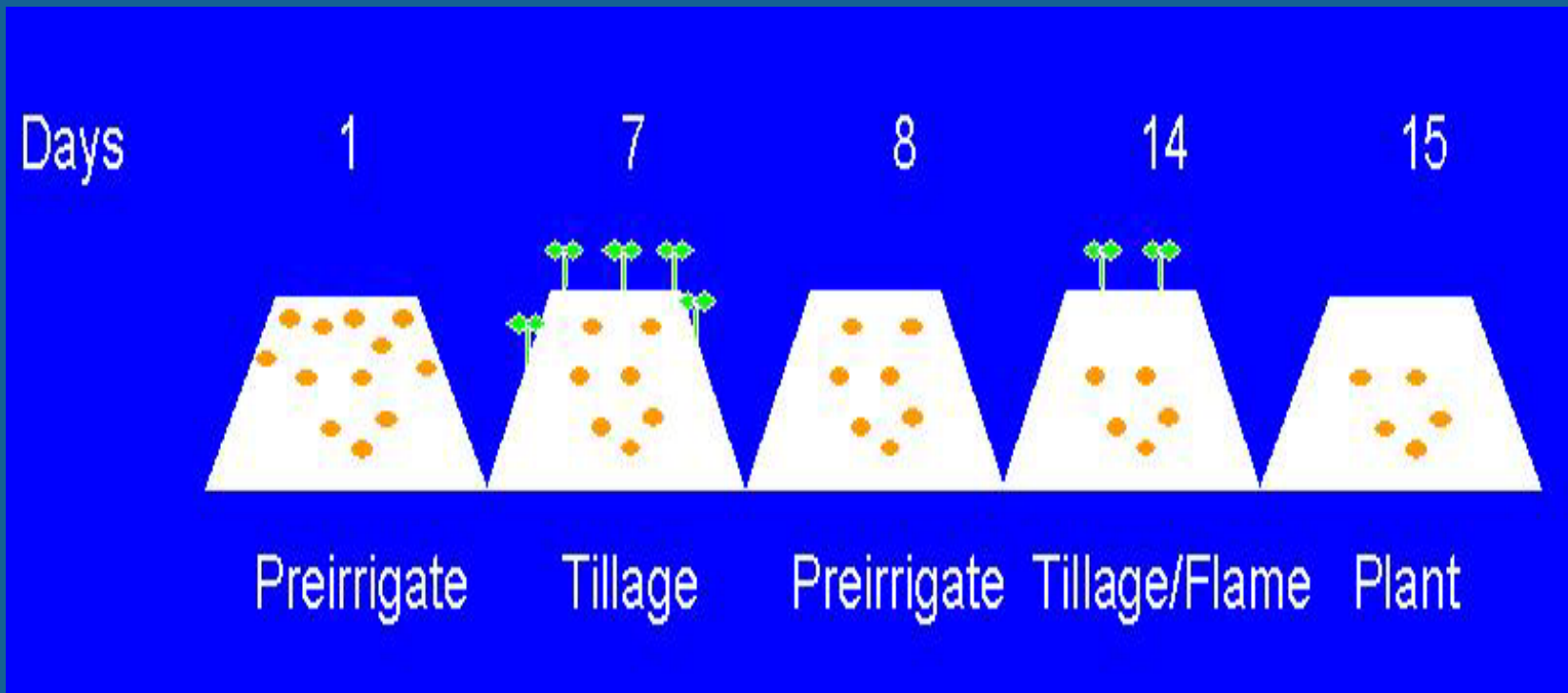
## Strip tillage with Subsurface drip irrigation



## Weed Populations Under Different Irrigation




# Pre-irrigation to control Weeds








# Physical Weed Management

- Mowing
  - Mechanical weed Cutter
  - Cultivation (Plow, Disk, chisel etc.)
  - Hand weeding
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# Mowing

- Reduces weed growth
  - Good for suppressing growth of permanent covers
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.



**Rotary Mower**

**Flail Mower**

# Flail Mowing in Row Crop



Rex Dufour, NCAT

# CAVAL Over-the-Vine Tractor



# Weed Knife



# KIMCO in-Row Vineyard and Orchard Tiller



# SLED CULTIVATOR



# Uncultivated Band With of 2 to 5 inches

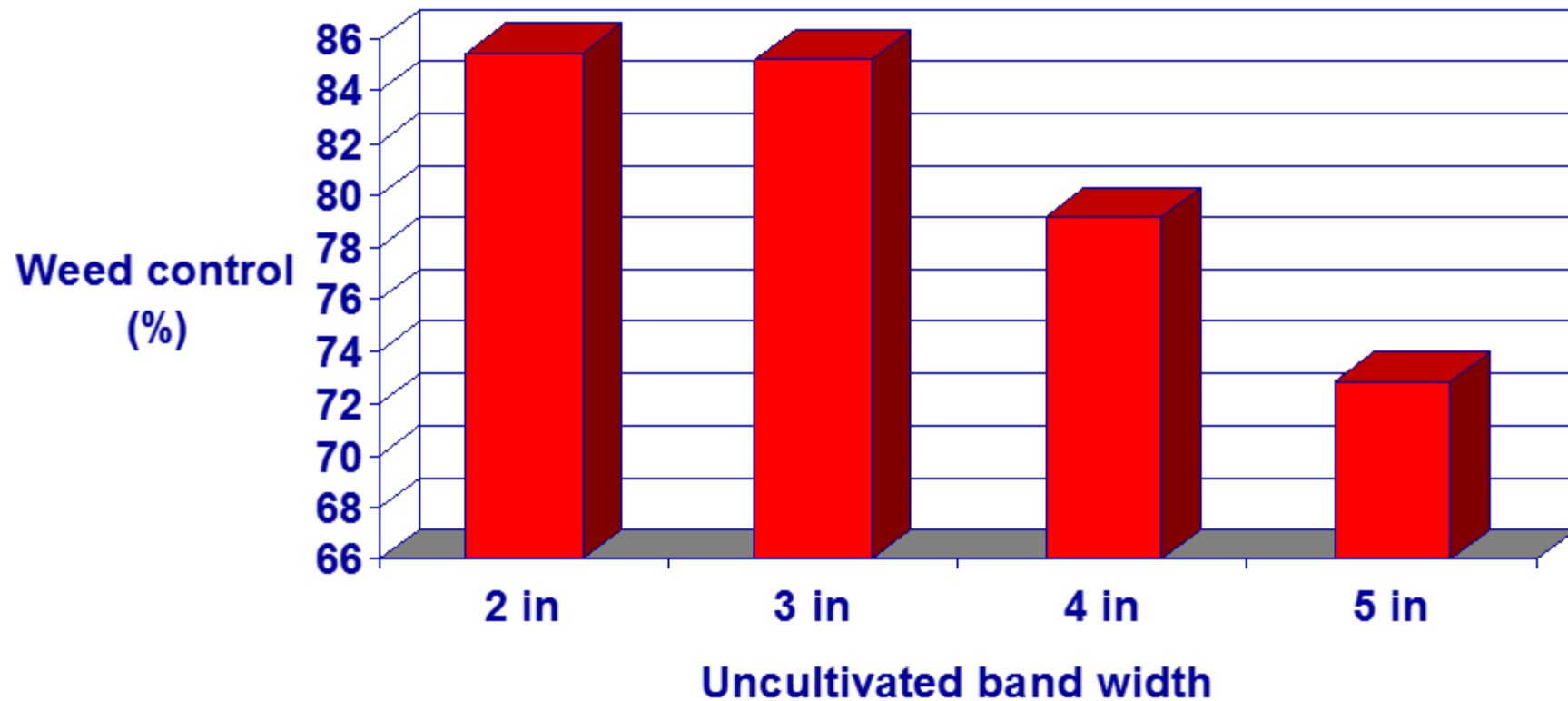


5 in



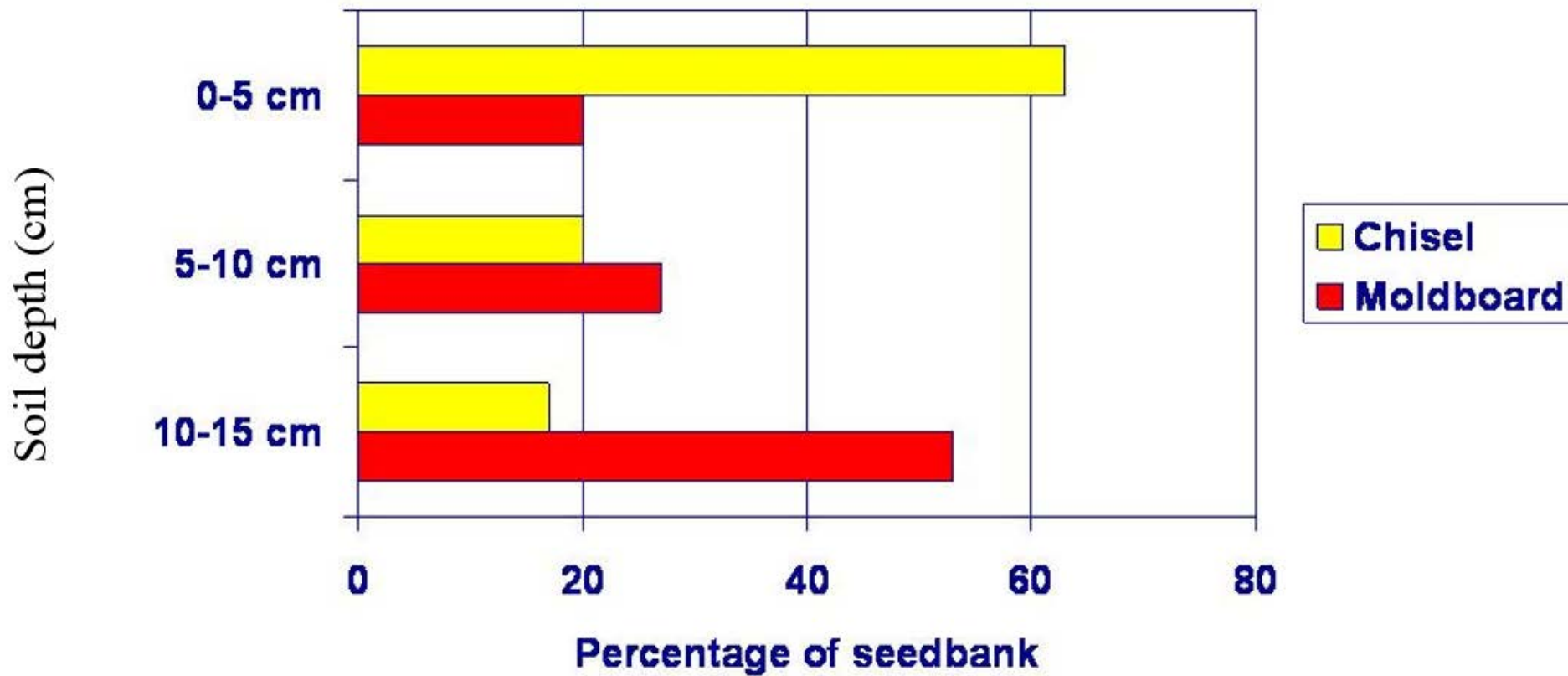
2 in

# Weed control in lettuce – 2 years results



Fennimore et al. 2010

# Effect of Tillage on Vertical Distribution of Seedbank



Ball 1992

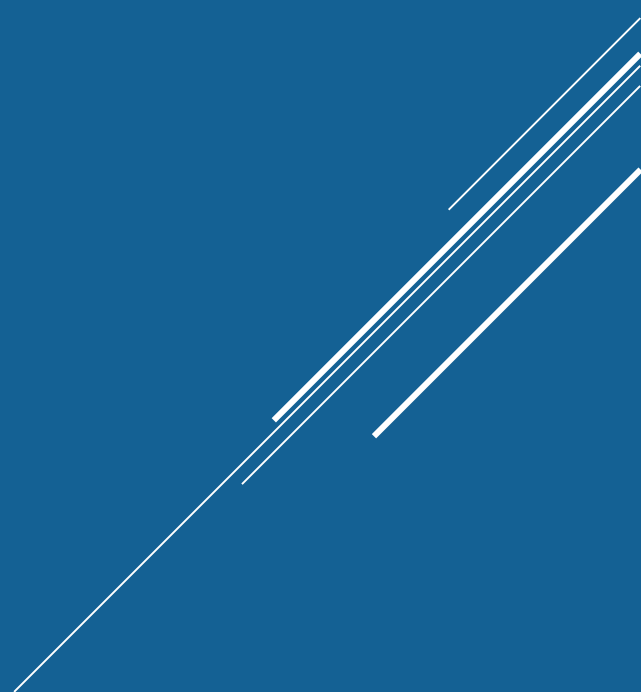
# Organic Herbicides

- Various acids
  - Vinegar, C-Cide, GreenMatch etc.
- Essential Oils
  - Matran EC, WeedZap, etc.

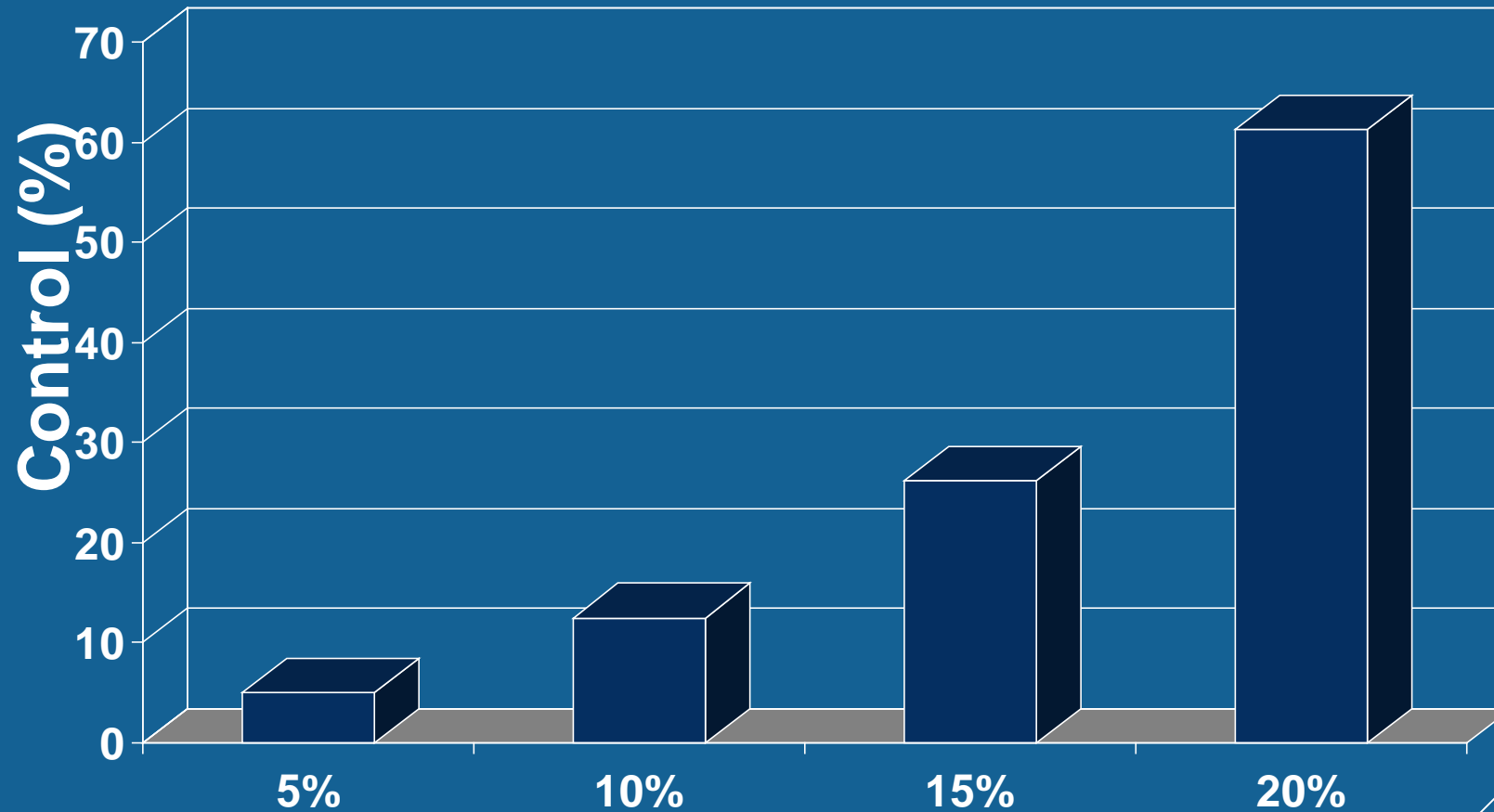
All contact organic herbicides- no residual activities



Acetic Acid  
applied  
3 times



# Mustard Control with Acetic Acid (70 gpa)



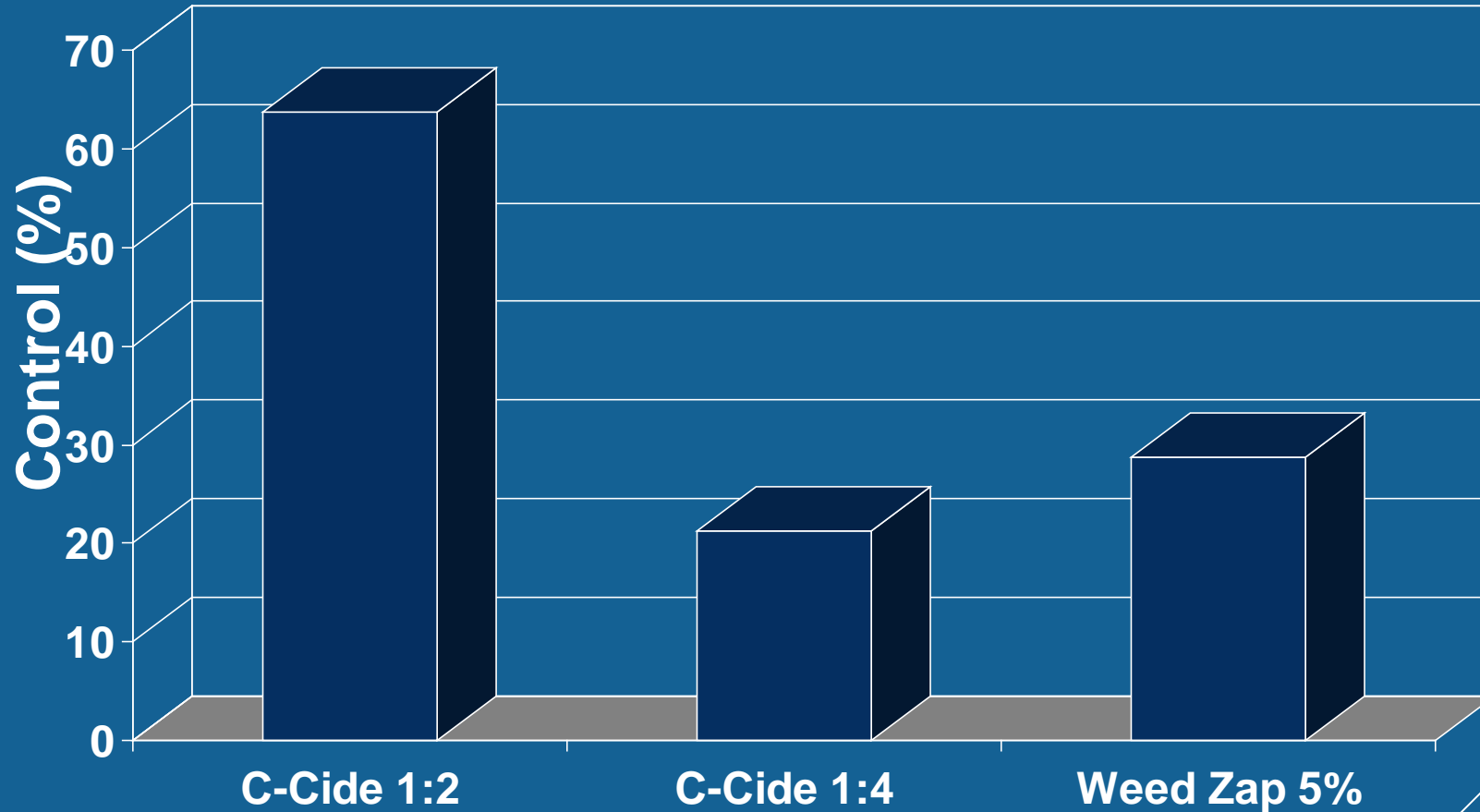
14 DAT Treated Dec 20, 2006

0.1% Yucca extract added to all trts

**Matran EC 15% - 6 DAT**




# Mustard Control with Organic Herbicides



14 DAT Treated Dec 20, 2006

2.5% Humasol added to Weed Zap

# Biological Control Agent

- Sheep, goats, and geese all will graze on the weeds
  - The animals can possibly be “hired” from a company that rents the animals for this purpose.
- 
- A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# Geeze Grazing in a Tomato Field



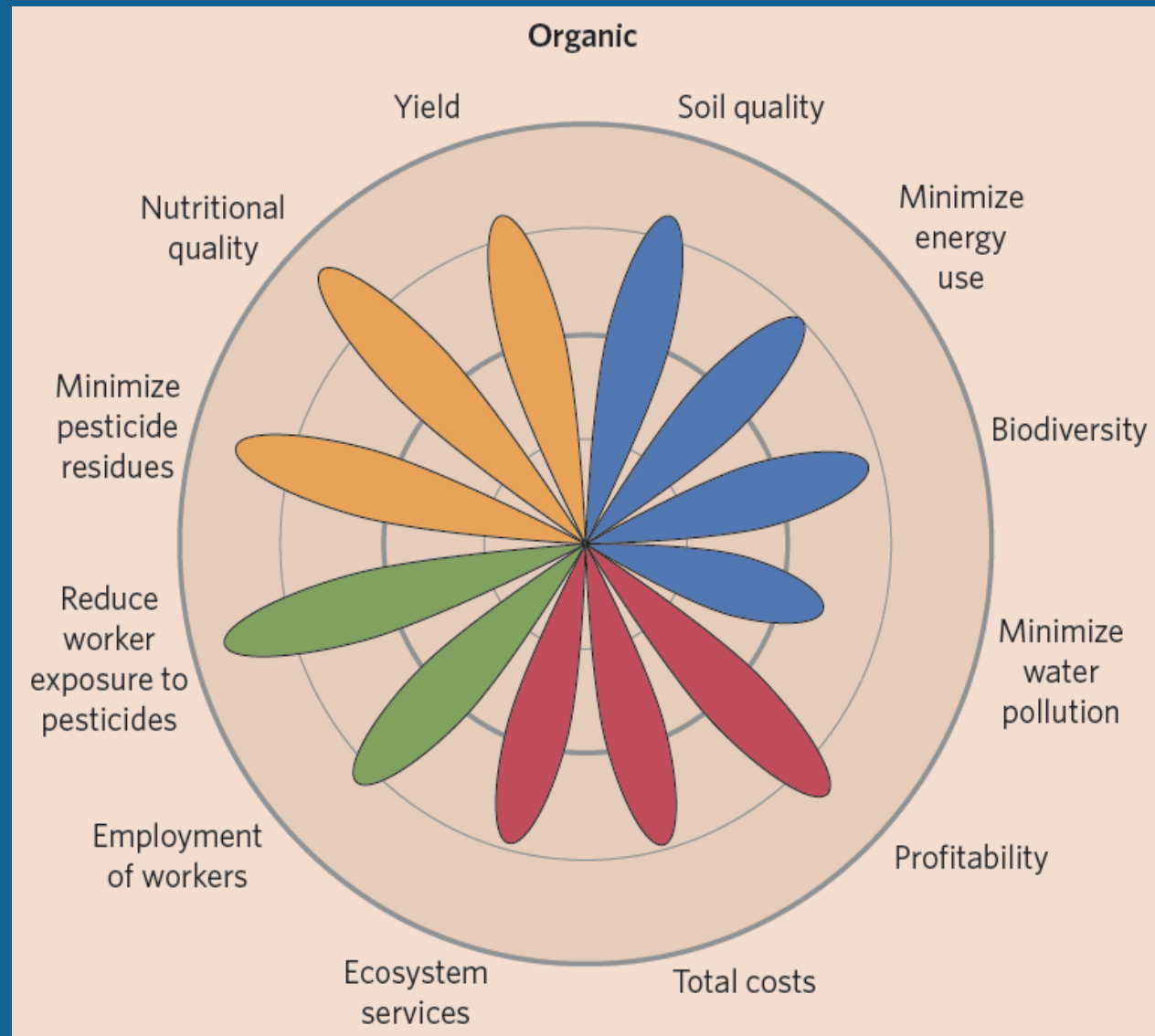
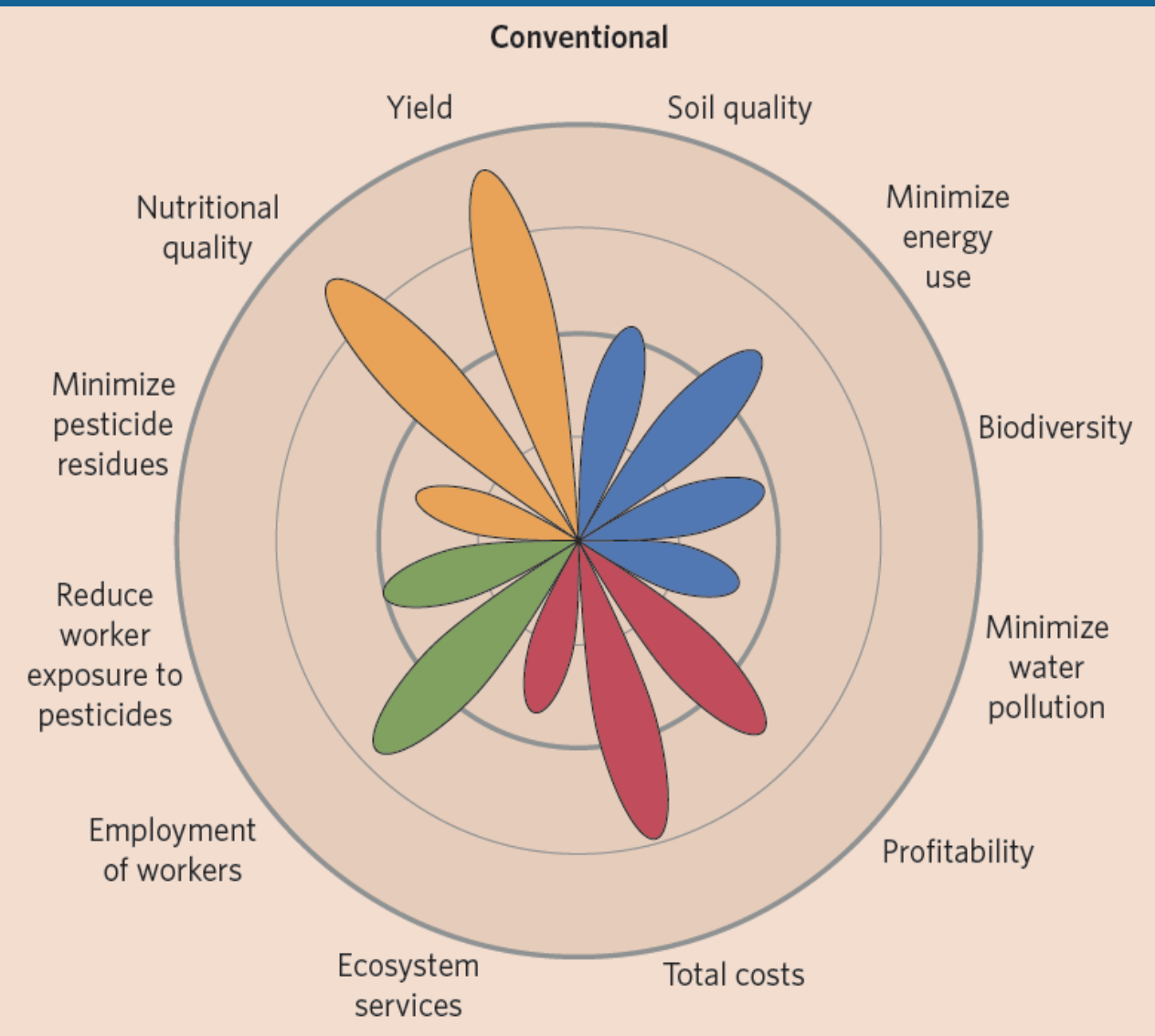
<http://www.metzerfarms.com/>

# Sheep Grazing in Vineyard




Shannon Ridge Vineyards, Lake County, CA

# Conventional vs. Organic: Areas of Sustainability



# Conclusions

- Organic weed control is a systems approach
  - Heavy reliance on tillage for weed control is not conducive to soil health
  - Use of many little hammers is necessary
  - Do not let weeds go to seeds
  - Choose appropriate technology to control weeds based on their biology
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- A decorative graphic consisting of several parallel white lines of varying thicknesses, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

# Thank You

## Acknowledgement

- ▶ Steve Hill, Natural Resource Manager, UDSA-NRCS, CA
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- ▶ Wendy Rash, District Conservationist, NRCS, Vacaville, CA