Climate Change and Agricultural Resilience in New England

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University of Vermont

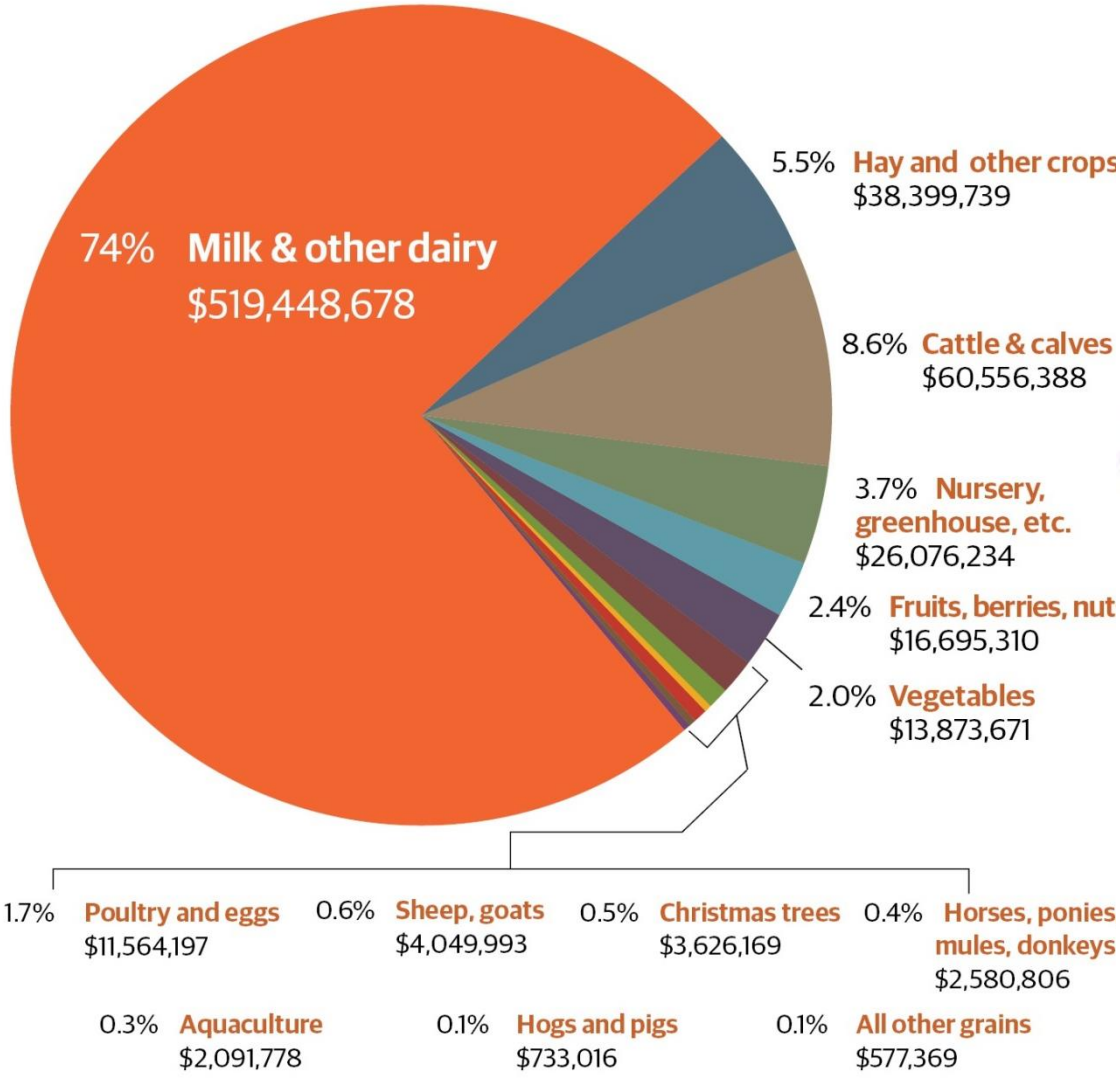
2019 Island Agrology Workshop
August 19, 2019

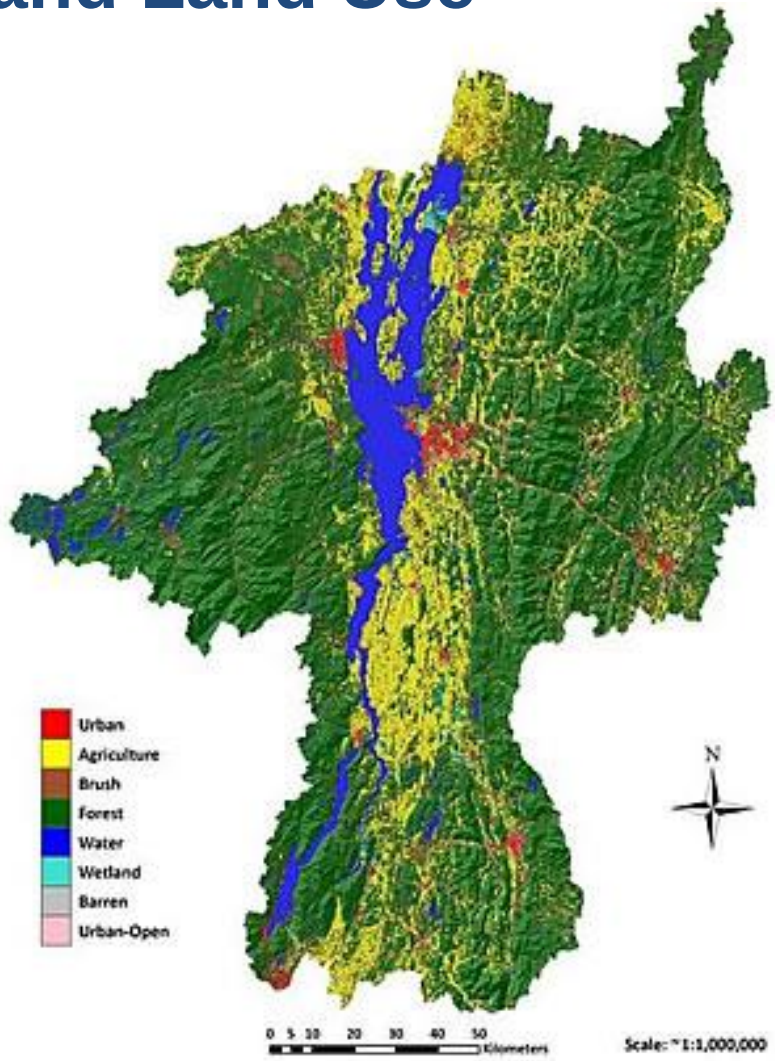
AP Photo: Toby Talbot

The University of Vermont EXTENSION

Center for Sustainable Agriculture

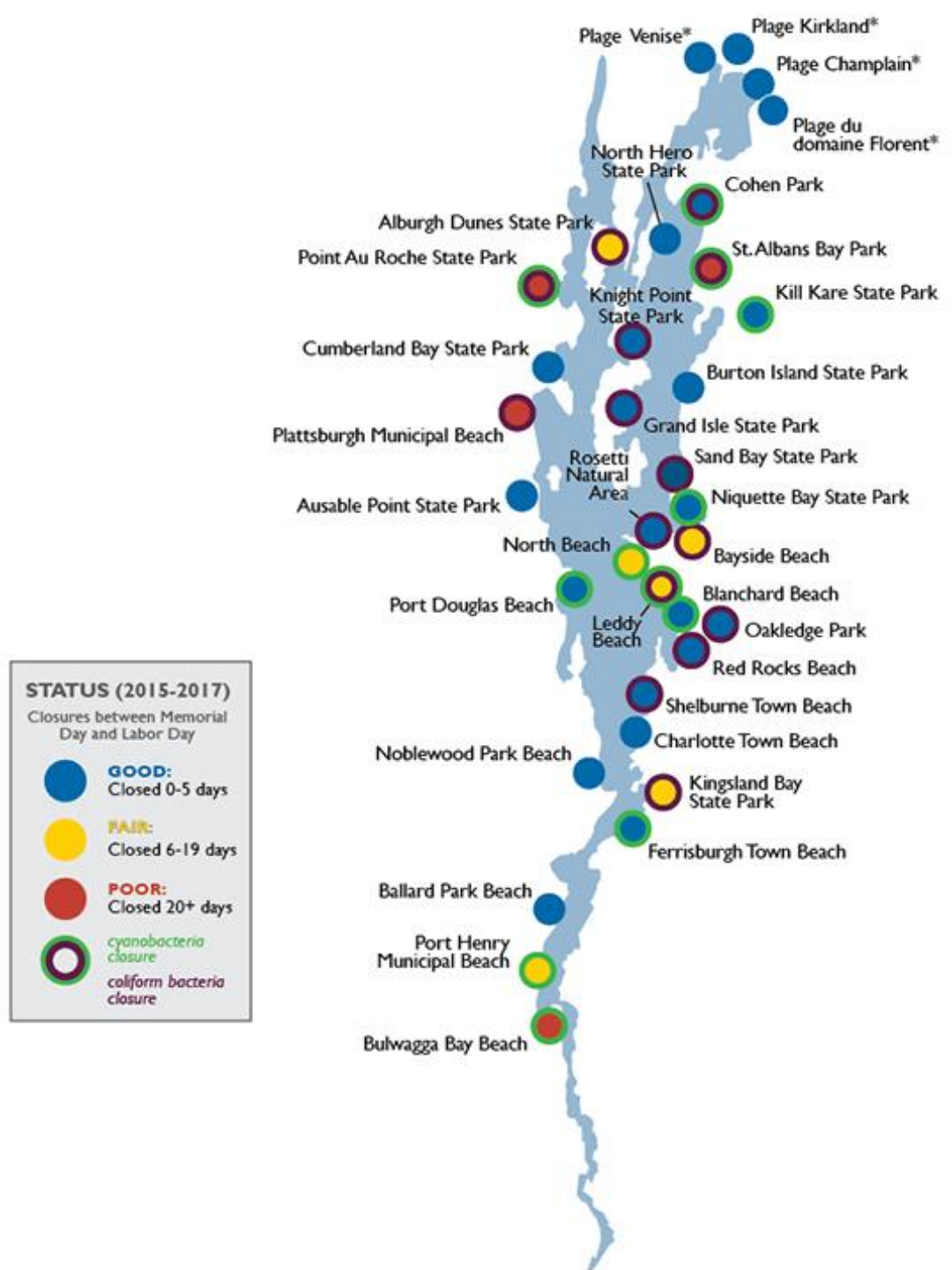
Vermont Agriculture and Land Use





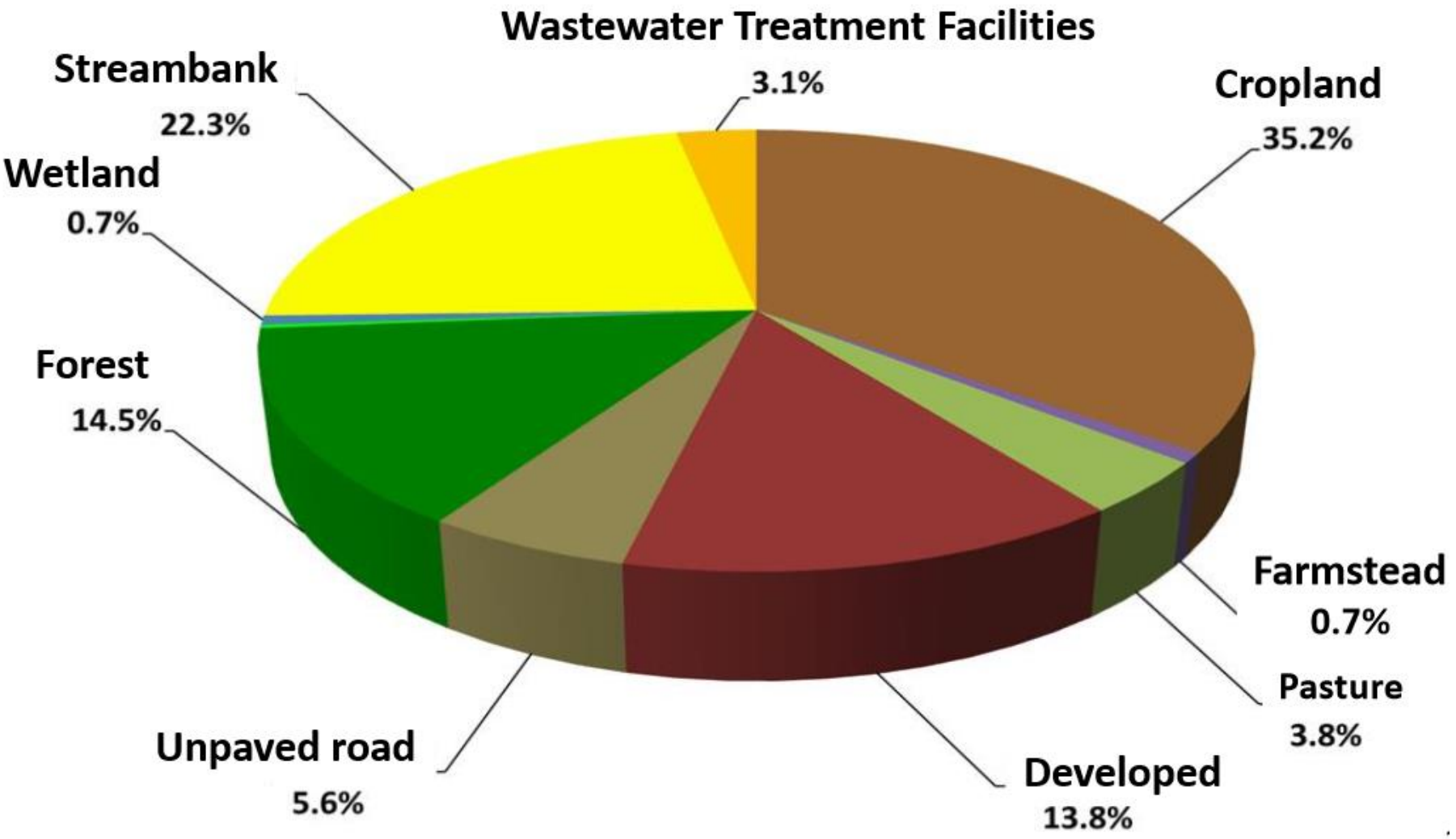
Source: USDA 2007 Census of Agriculture, Table 2, www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_002_002.pdf. Adjusted for inflation to 2010

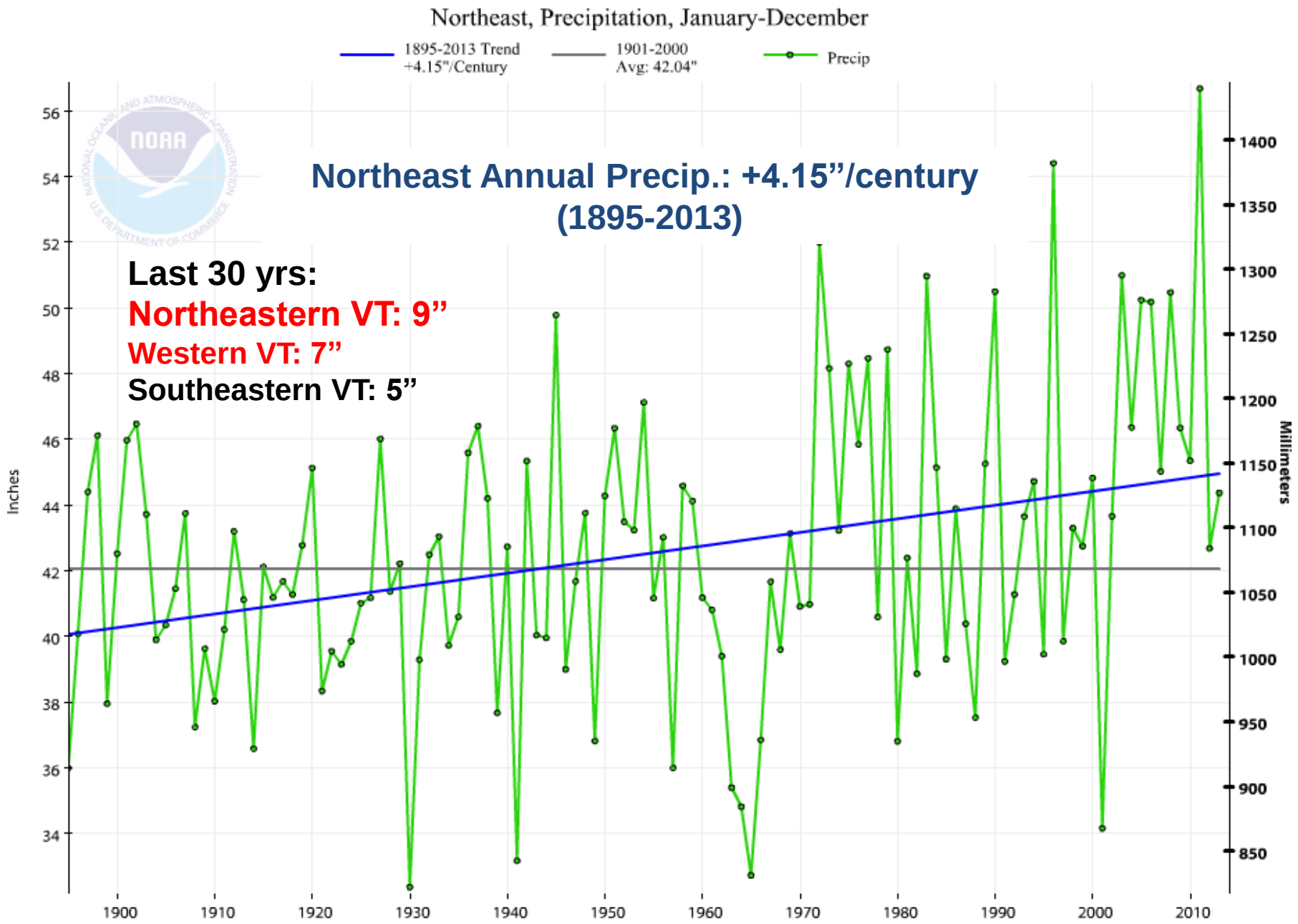
Harmful Algal Blooms…



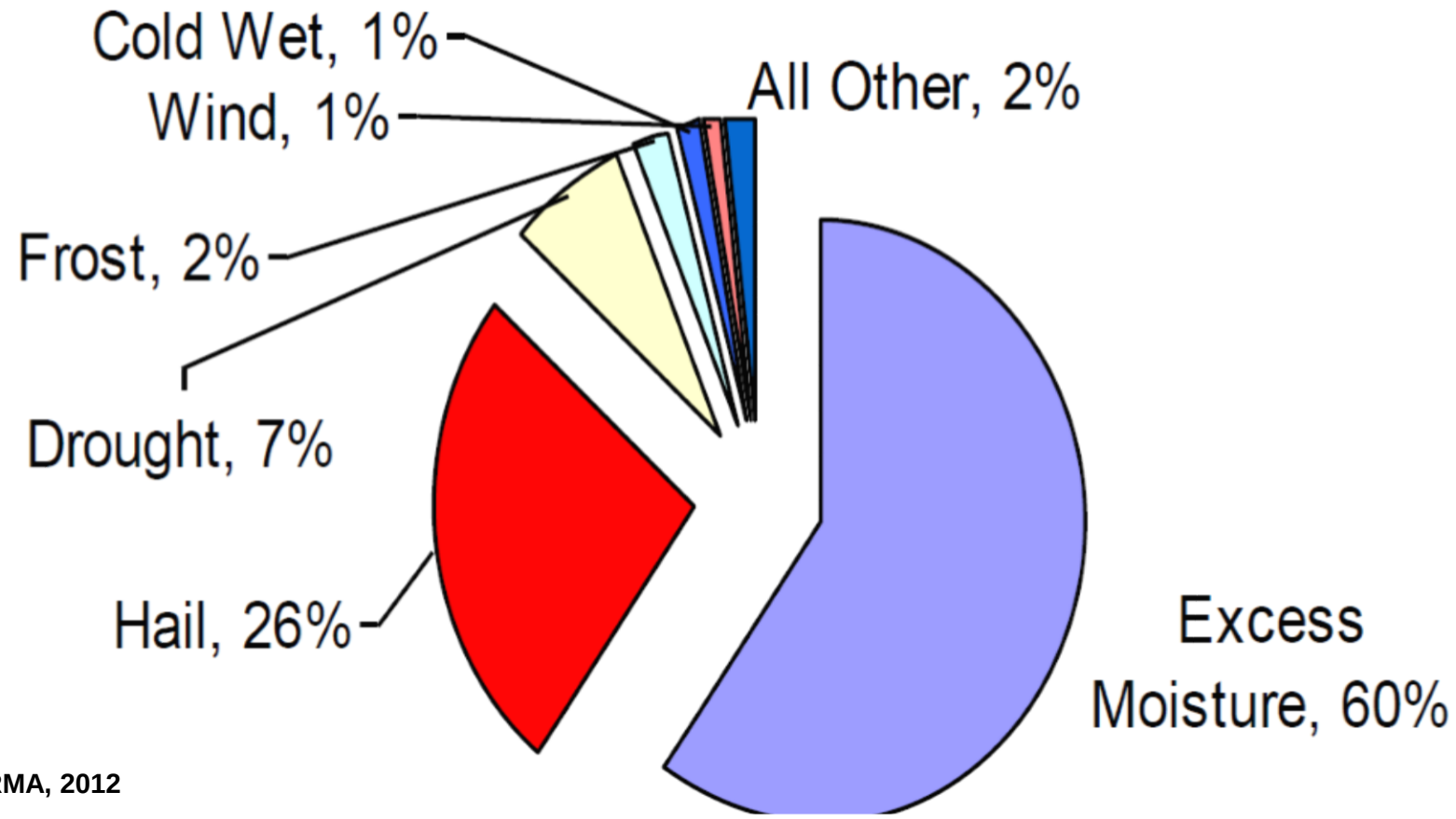
Sources of phosphorus in the Vermont portion of the Lake Champlain Basin

(from EPA – Tetra Tech, 2013)



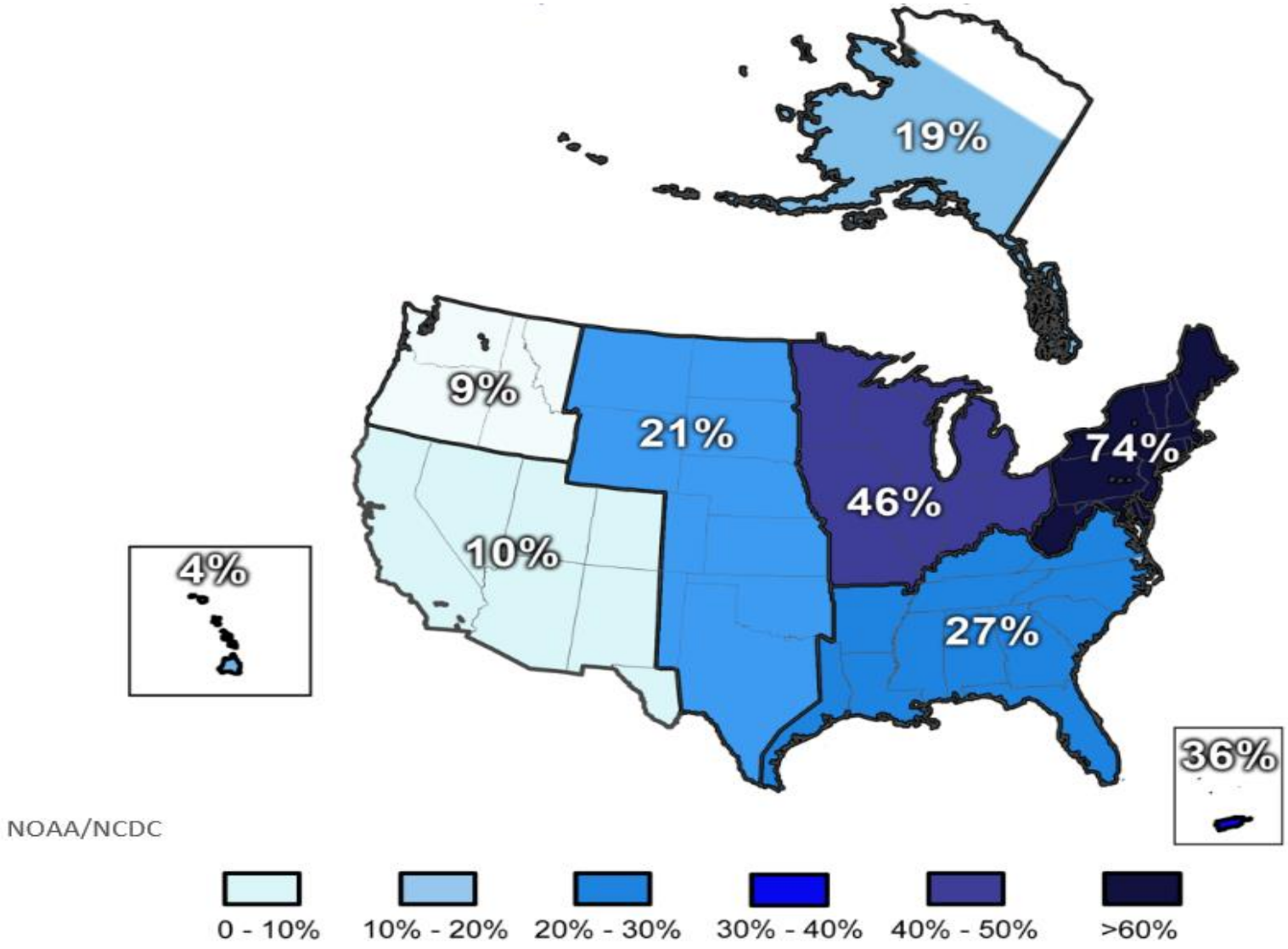

Northeast, Precipitation, January-December
1895-2013 Trend
+4.15"/Century
1901-2000
Avg: 42.04"
Precip
Northeast Annual Precip.: +4.15”/century
(1895-2013)
Last 30 yrs:
Northeastern VT: 9”
Western VT: 7”
Southeastern VT: 5”
Inches
Millimeters
56
54
52
50
48
46
44
42
40
38
36
34
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

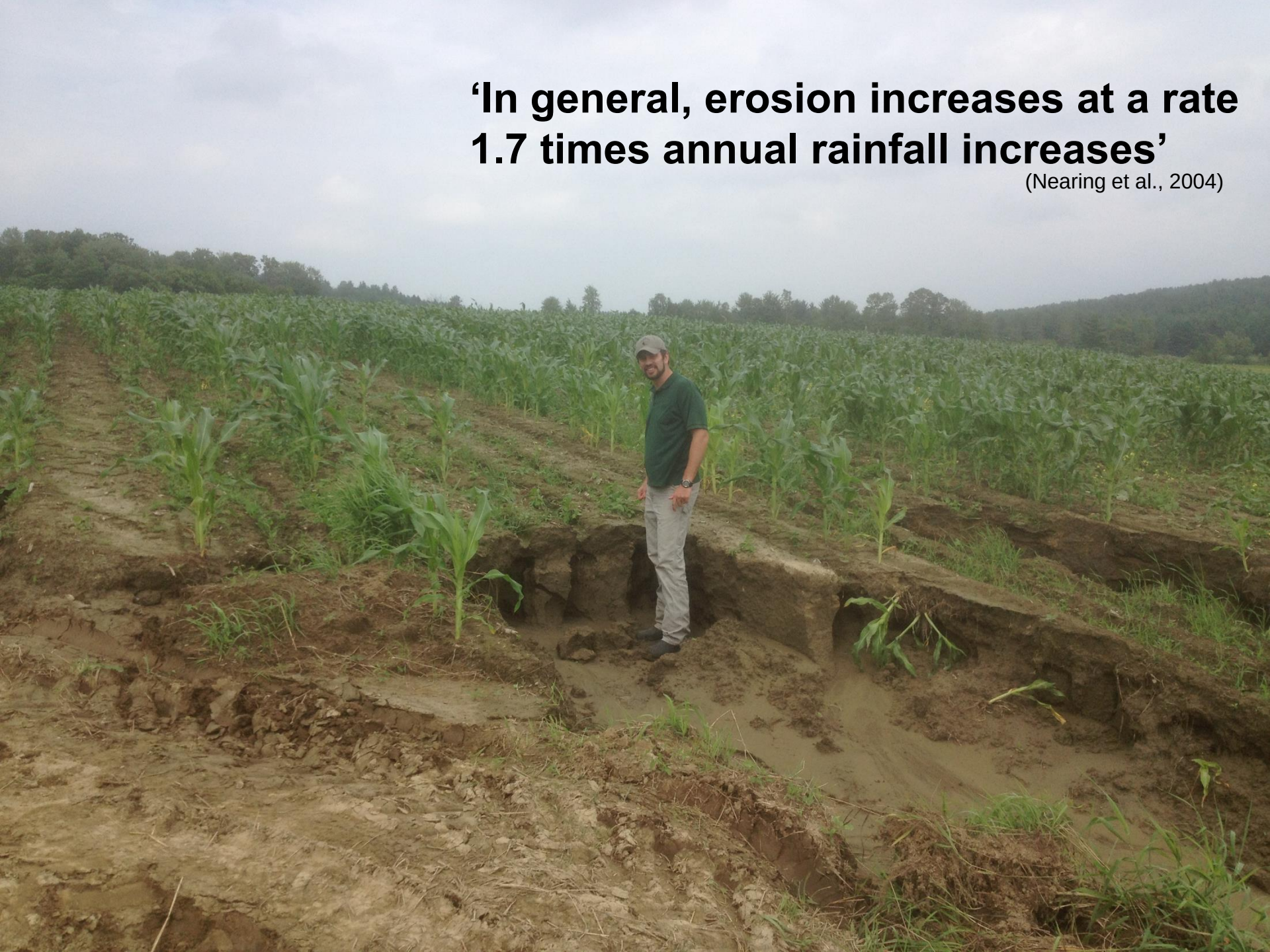
Why Vermont Crops Fail (2001-10)

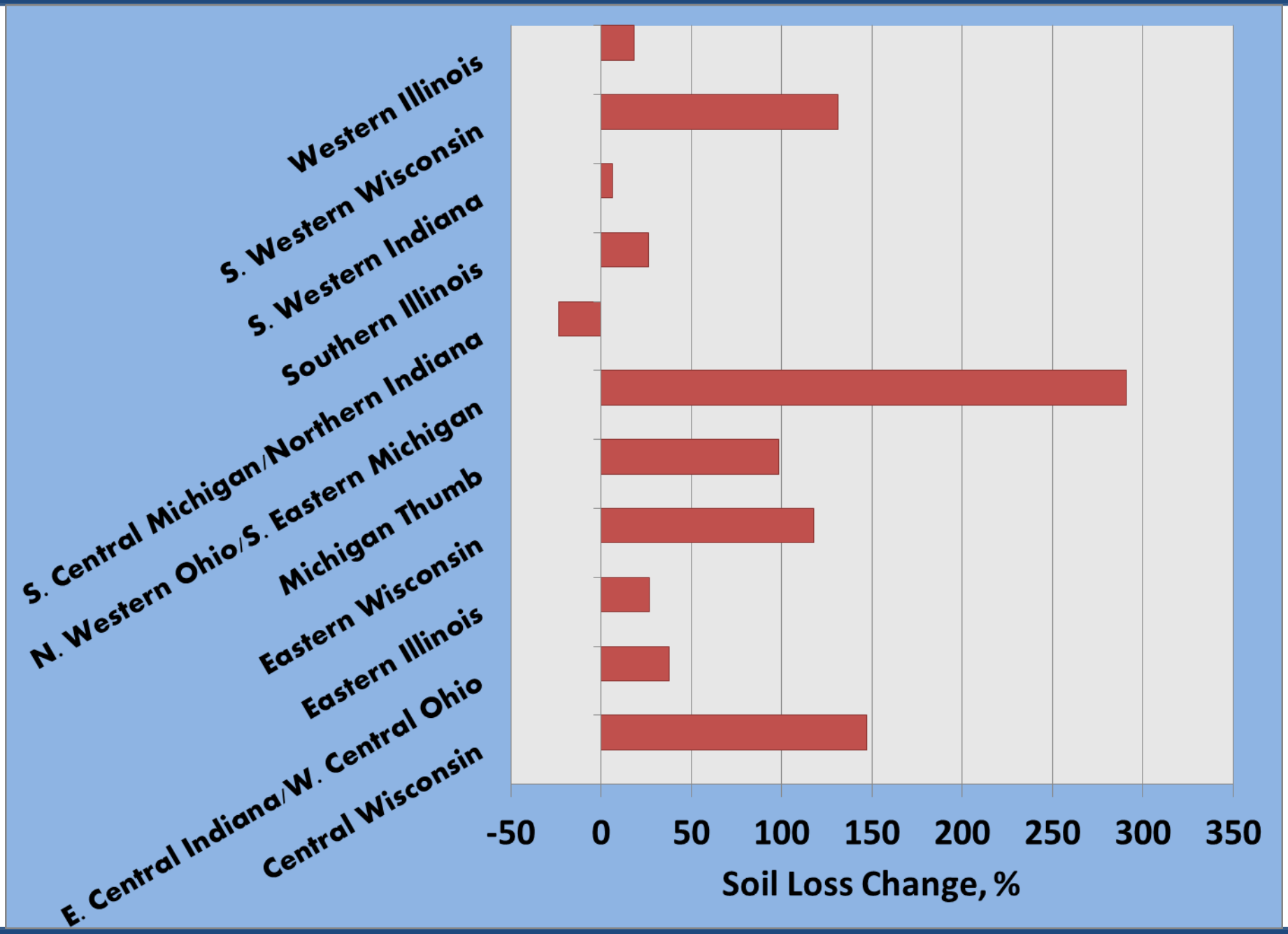


RMA, 2012

Trend in 1-day Very Heavy Precipitation
(1958-2010)

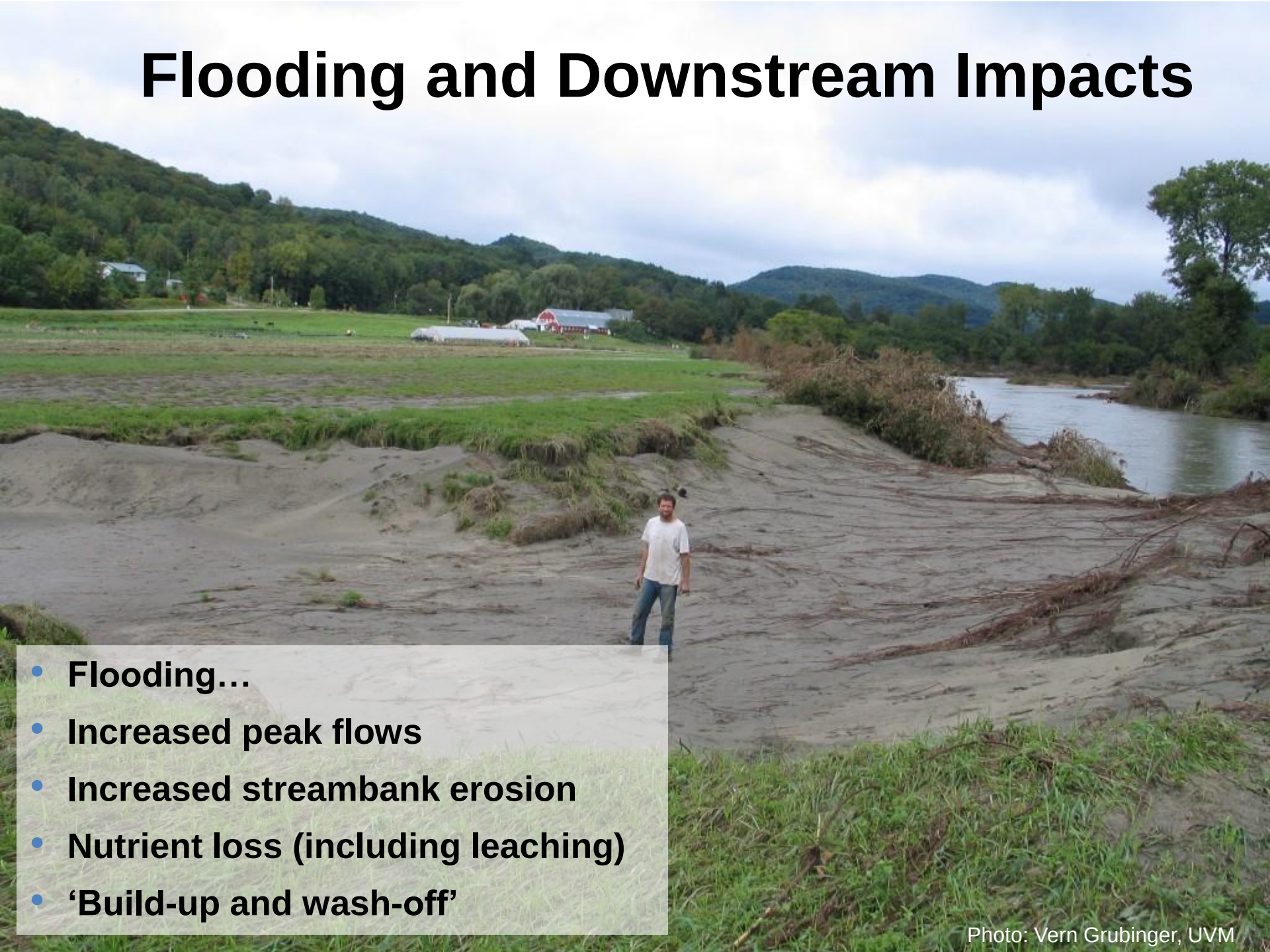



‘In general, erosion increases at a rate 1.7 times annual rainfall increases’
(Nearing et al., 2004)



(O'Neal et al., 2005)

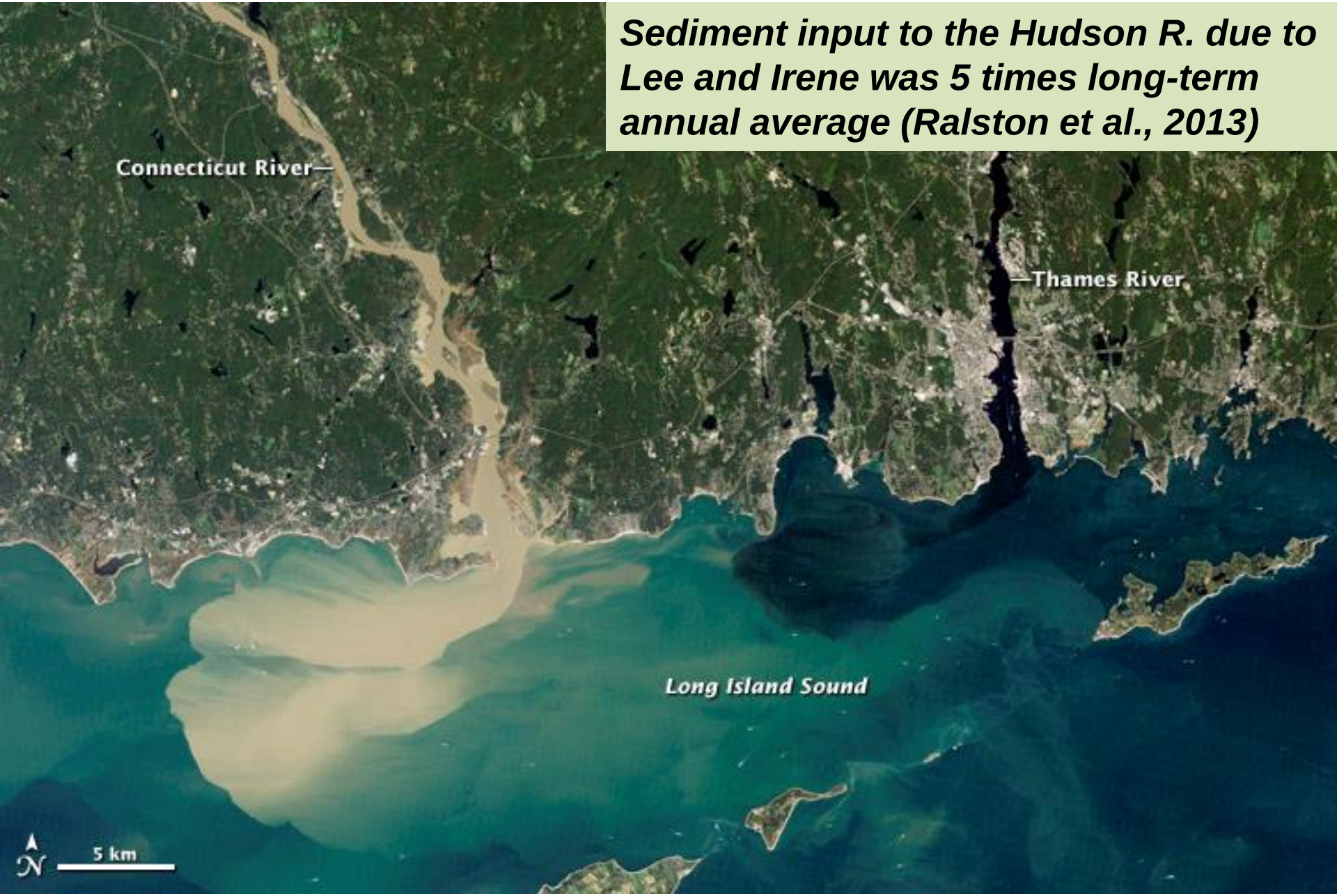
Flooding and Downstream Impacts



- Flooding…
- Increased peak flows
- Increased streambank erosion
- Nutrient loss (including leaching)
- ‘Build-up and wash-off’

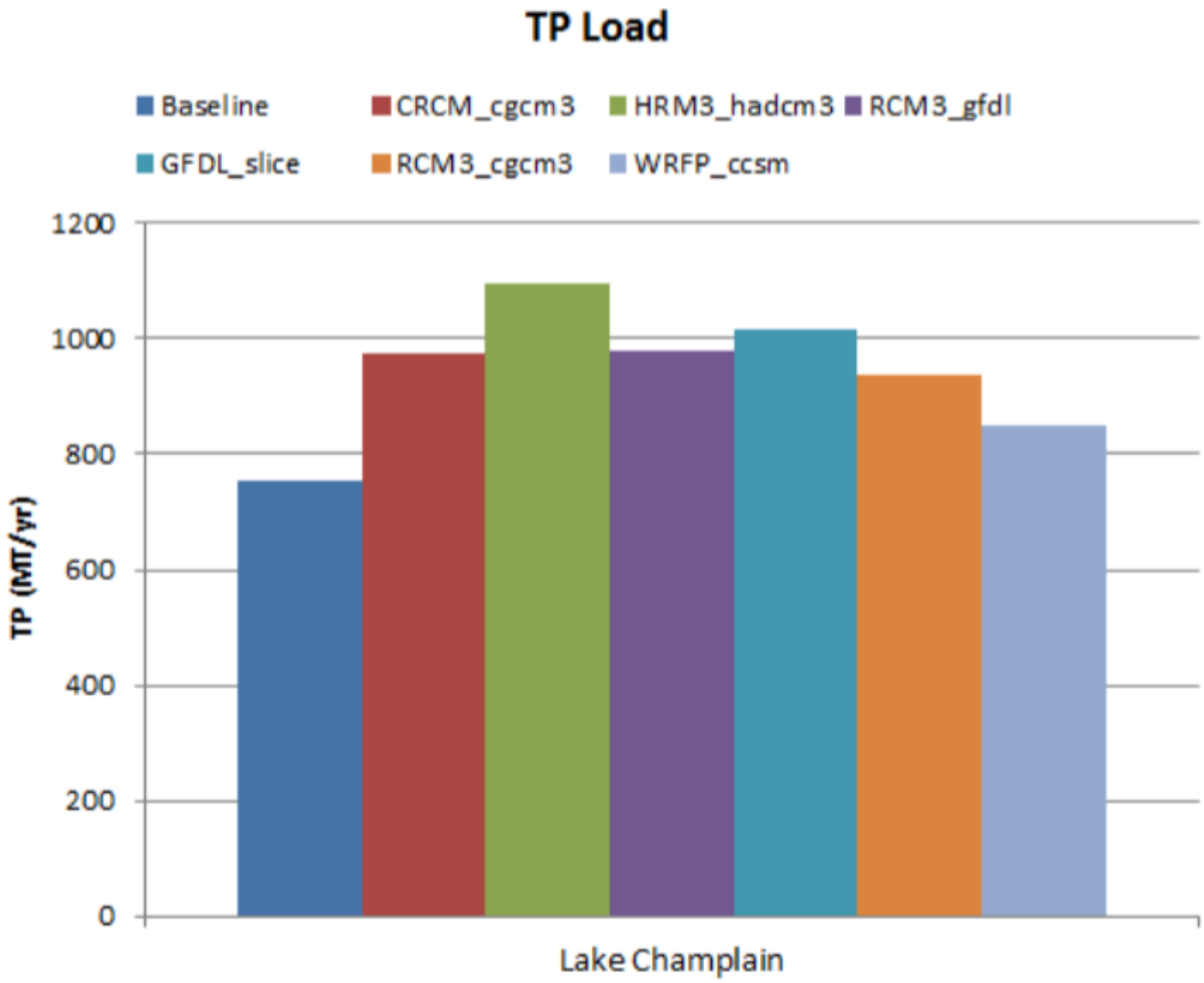
Photo: Vern Grubinger, UVM

Sediment input to the Hudson R. due to Lee and Irene was 5 times long-term annual average (Ralston et al., 2013)

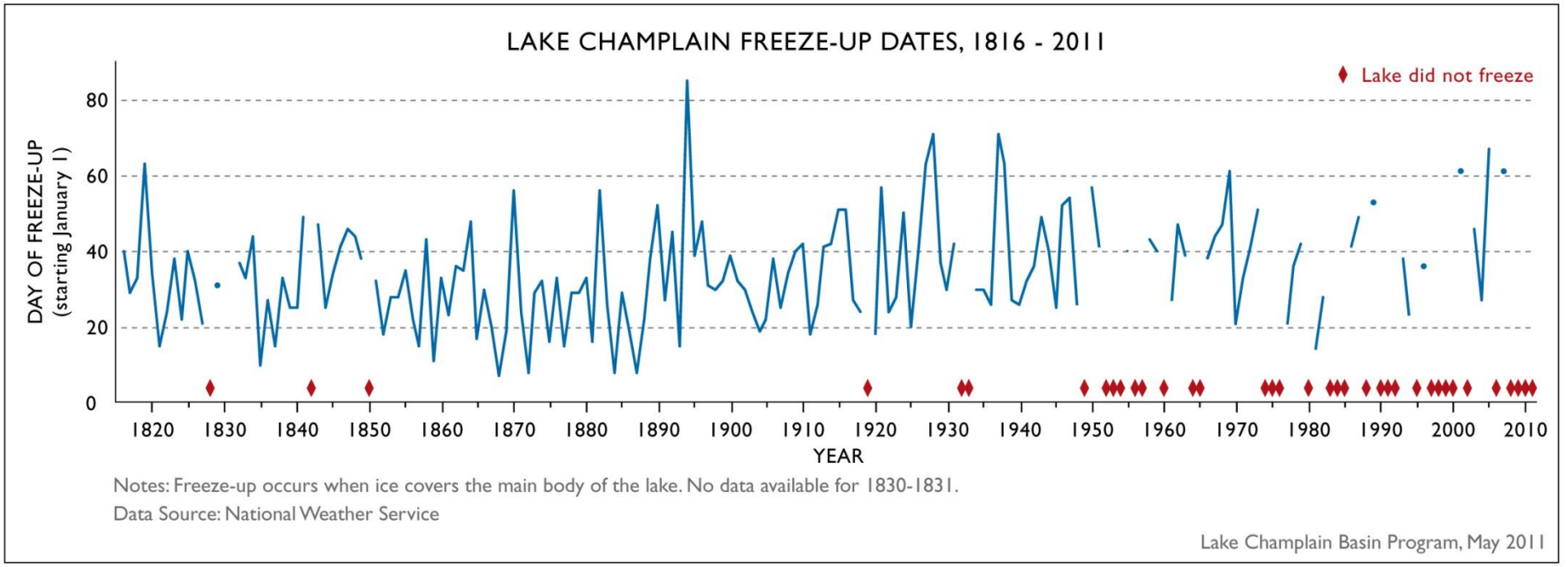


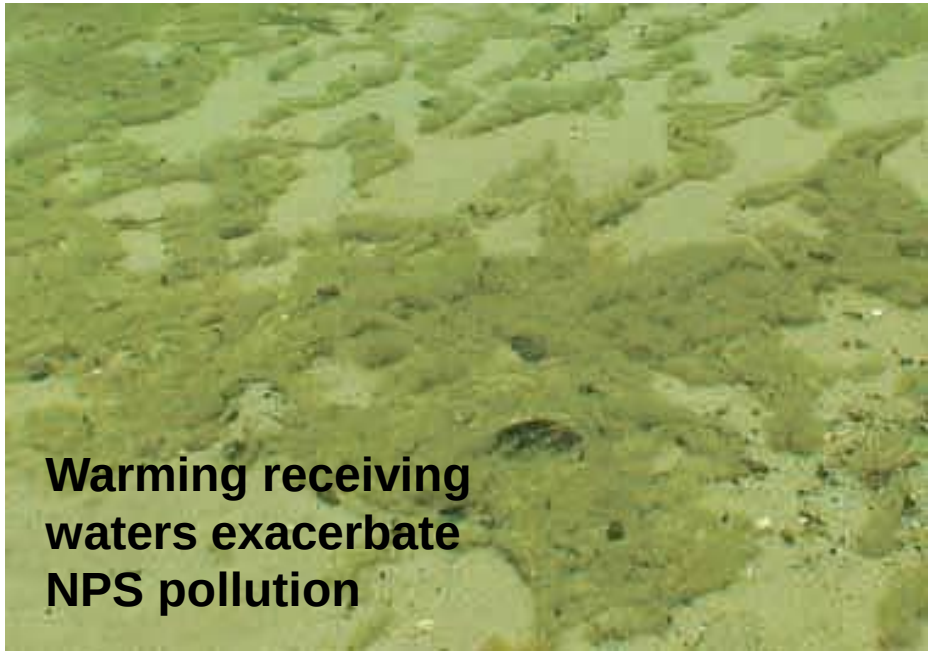
(Source: earthobservatory.nasa.gov))

Modeled Total P: Six Climate Scenarios



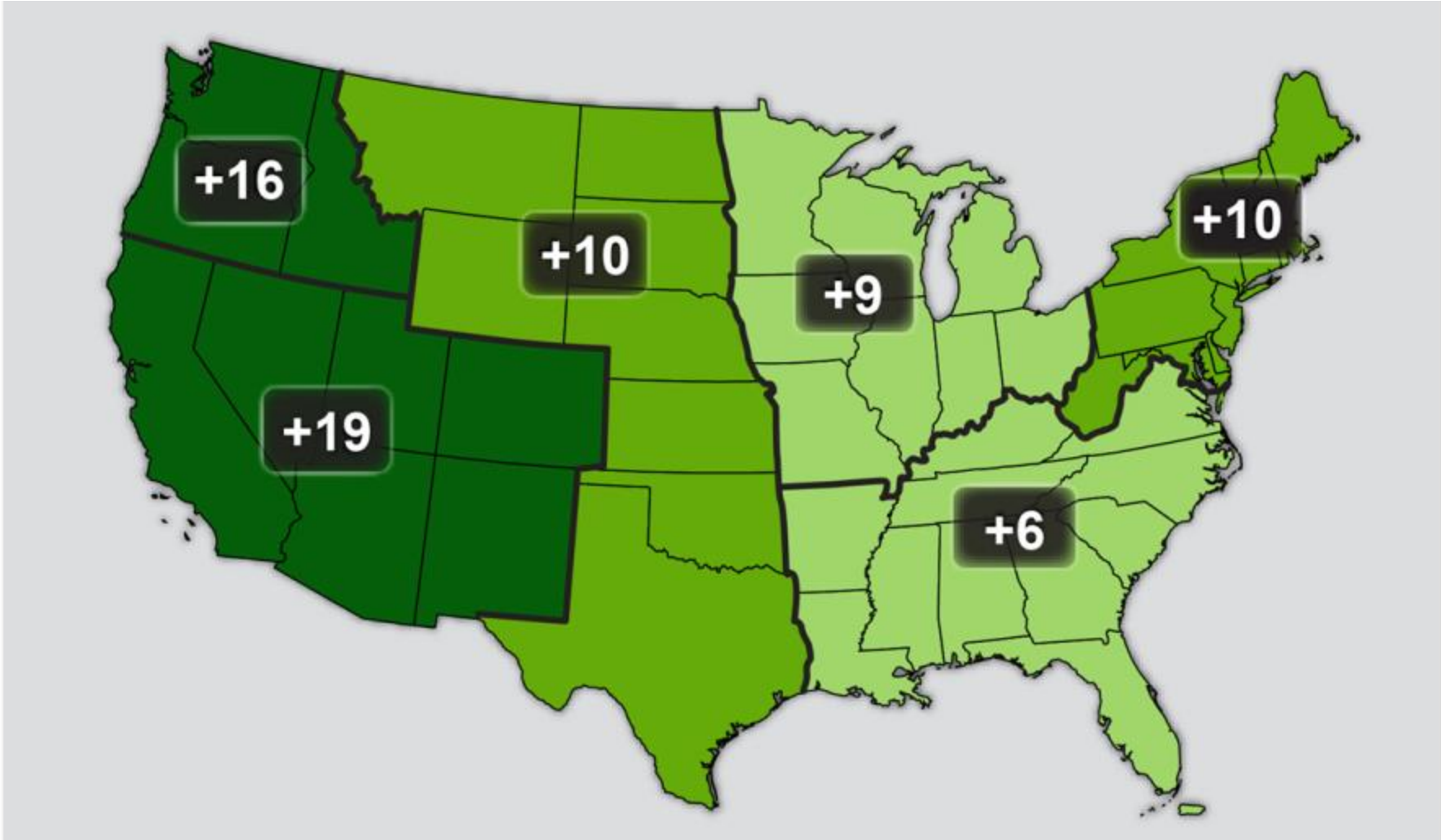
(Tetra Tech, 2013)





Warming receiving waters exacerbate NPS pollution

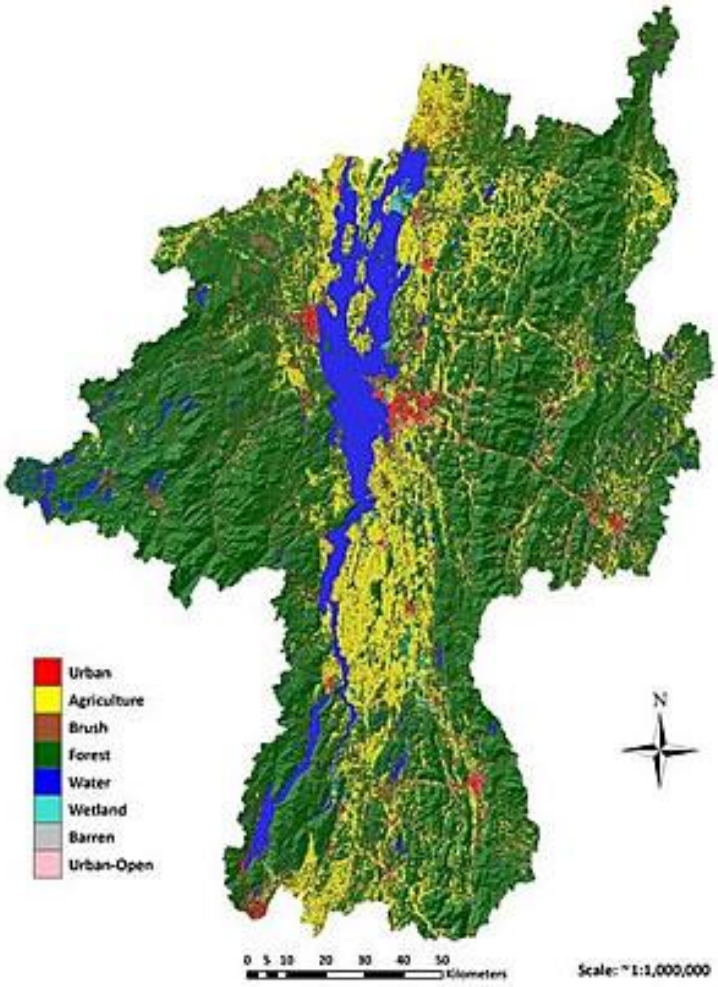
Observed Increase in Frost-Free Season Length 1991-2012 relative to 1901-1960



Source: Kenneth E. Kunkel, Cooperative Institute for Climate and Satellites – NC
Image Source: NOAA NCDC / CICS-NC

Projections in Vermont (Champlain Basin)

Factor	Base Average	2050 Projection
Freezing Days	117	85
Days above 90 degrees	6	24
Heat Index	130	475
Growing season (days)	141	169
Maple sap (days)	60	53



Guilbert et al., 2014: *Impacts of projected climate change over the Lake Champlain basin in VT*

How does climate change impact crops?

- Cool-season crops will be of lower yield or quality
  - Sweet corn
- Reduced grain yield (rapid maturation and moisture)
  - Field corn, nutrient content…
- Reduced vernalization lower some fruit yields; increased frost risk?
  - Apples
- New pests are able to over-winter, emerge early; increased pesticides
  - Flea beetle, SWD?
- Some warmer season crops will do better
  - Red wine grape, peaches, watermelon
- Water stress in crops…

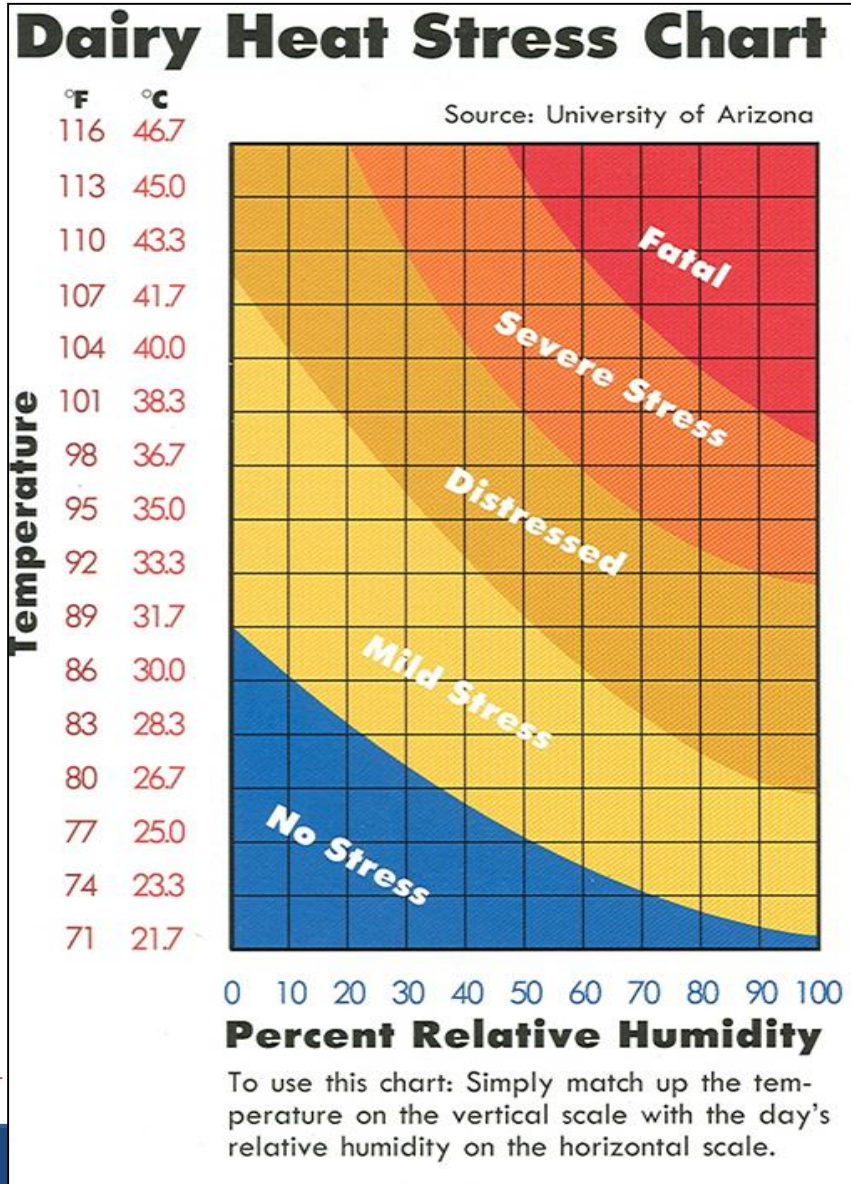
CO_2 and Round-up

Increasing CO_2 reduces herbicide efficacy

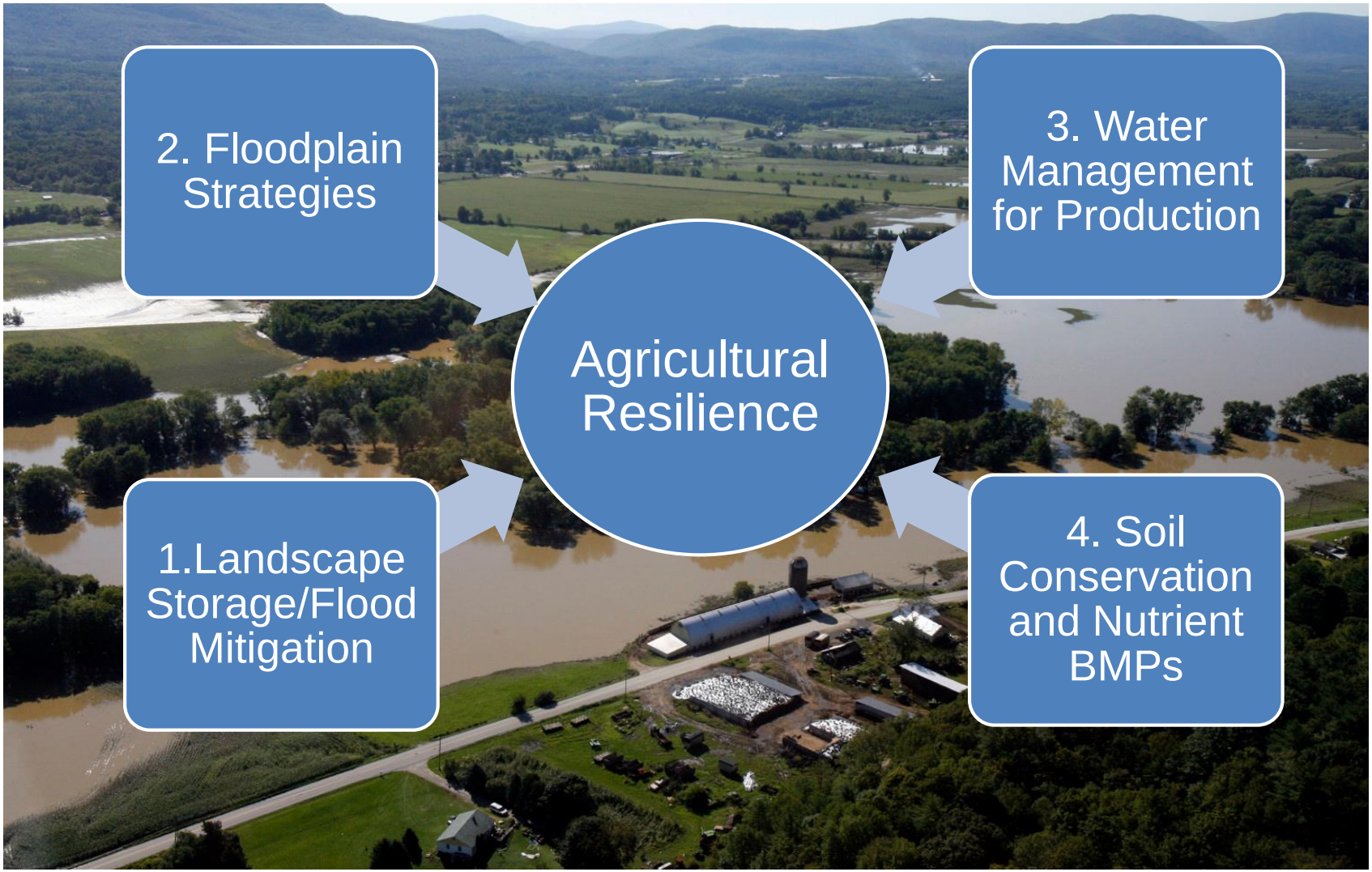
Image: www.climateandfarming.org

How does climate change impact livestock?

- Warming Temperatures
  - Livestock
    - Heat stress in dairy cattle
  - Higher body temperatures
  - Increased respiration rates
  - Less activity
  - Increased water intake
- Performance
  - Dry matter intake down by 10-20%
  - Milk production down by 10-25%
  - Reproductive processes decrease



Adaptation from a Soil and Water Perspective



Outreach

Education

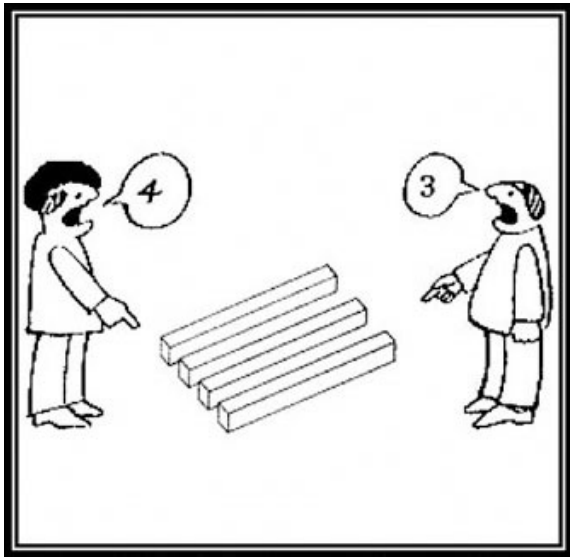
Research

Technical Assistance

AP Photo: Toby Talbot

Increasing landscape storage capacity

- Benefits:
  - Reduces runoff peak flow and volumes
  - Helps prevent erosion and nutrient loss
  - Allows for nutrient cycling to occur
  - Reduces drought risk
- Shift in perspective…
- Approaches:
  - Managerial
  - Structural



Soil Management Approaches to Landscape Storage

Three principles of healthy, resilient soils:

1. ***Constant soil cover (preferably living!)***
2. ***Building organic matter***
3. ***Reduced disturbance/soil structure***

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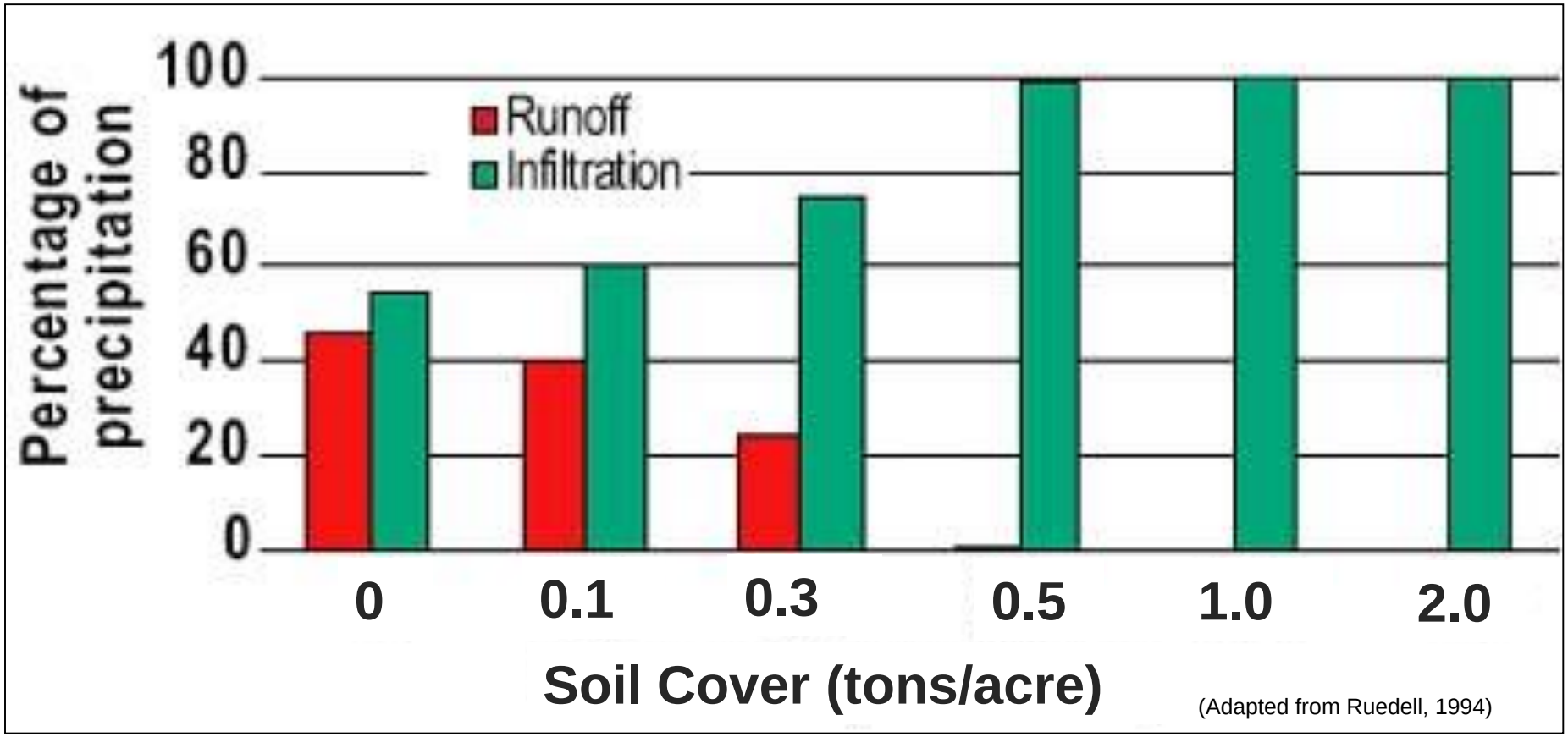
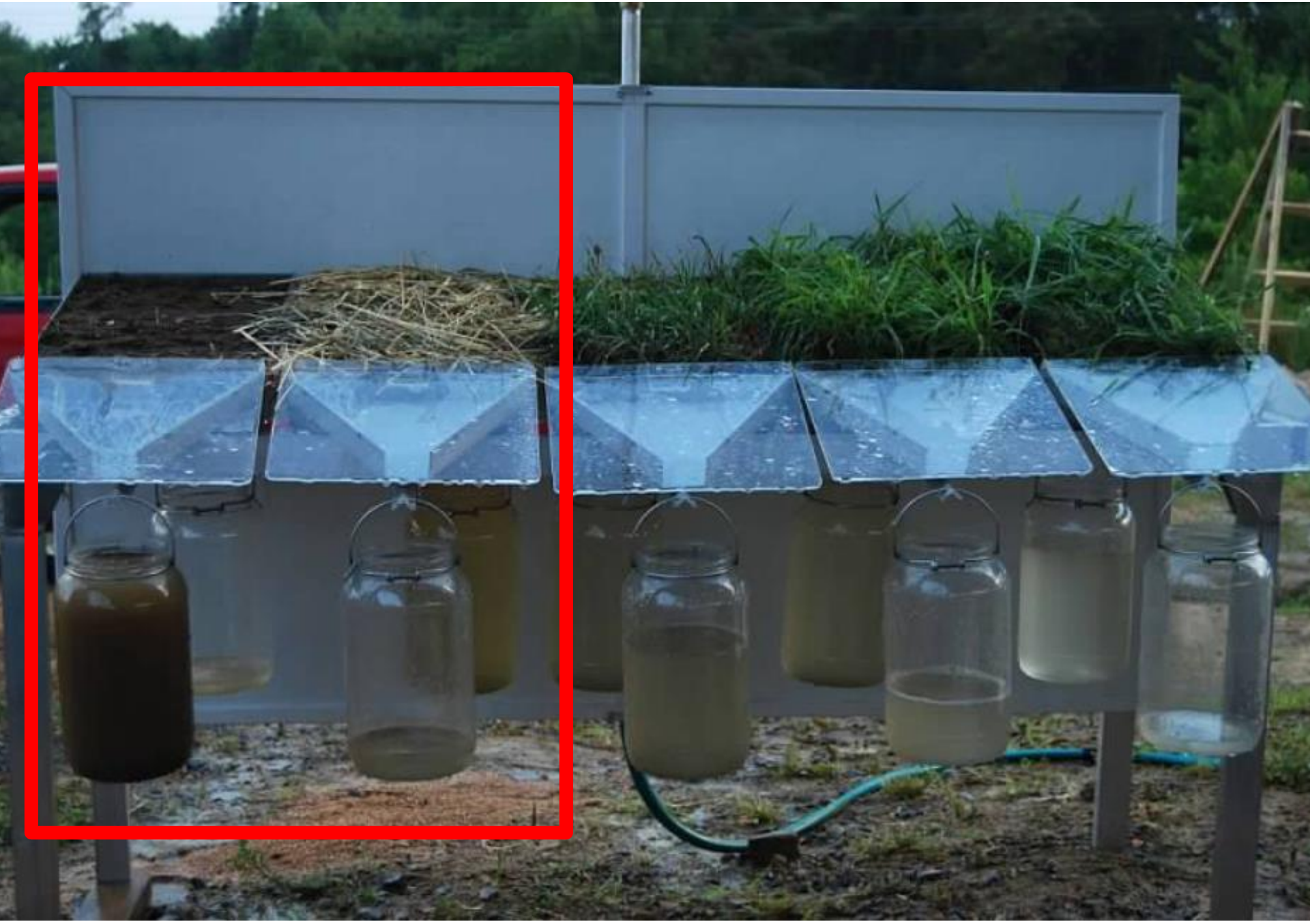
www.nrcs.usda.gov

Soil Cover: Residue, mulch, or cover crops



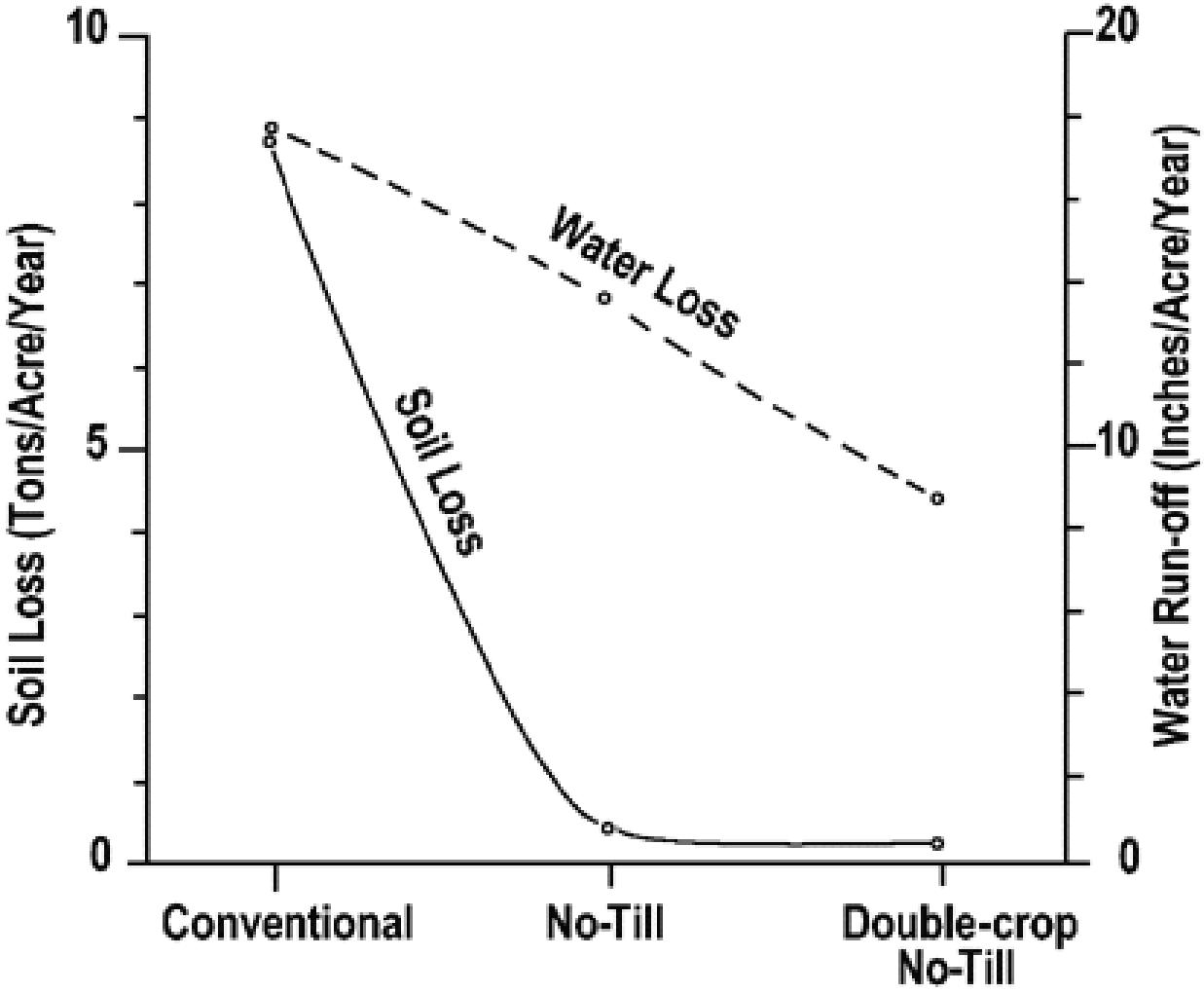
- **Physically prevents raindrop impact**
- **Slows runoff down, allowing more time to infiltrate**



Reduced Tillage and Infiltration

- No-, zone-, strip-, ridge-till, etc.
- Less macro-fauna disturbance (i.e., earthworms)

(Dan Brainard, msue.anr.msu.edu)



(Source: Herbek, AGR-101; www2.ca.uky.edu)

Organic Matter and Infiltration

Cum. Infiltration (m^3/m^2)

0.12
0.10
0.08
0.06
0.04
0.02
0.00

0 30 60 90 120 150 180 210 240 270 300

Minutes

High O.M.

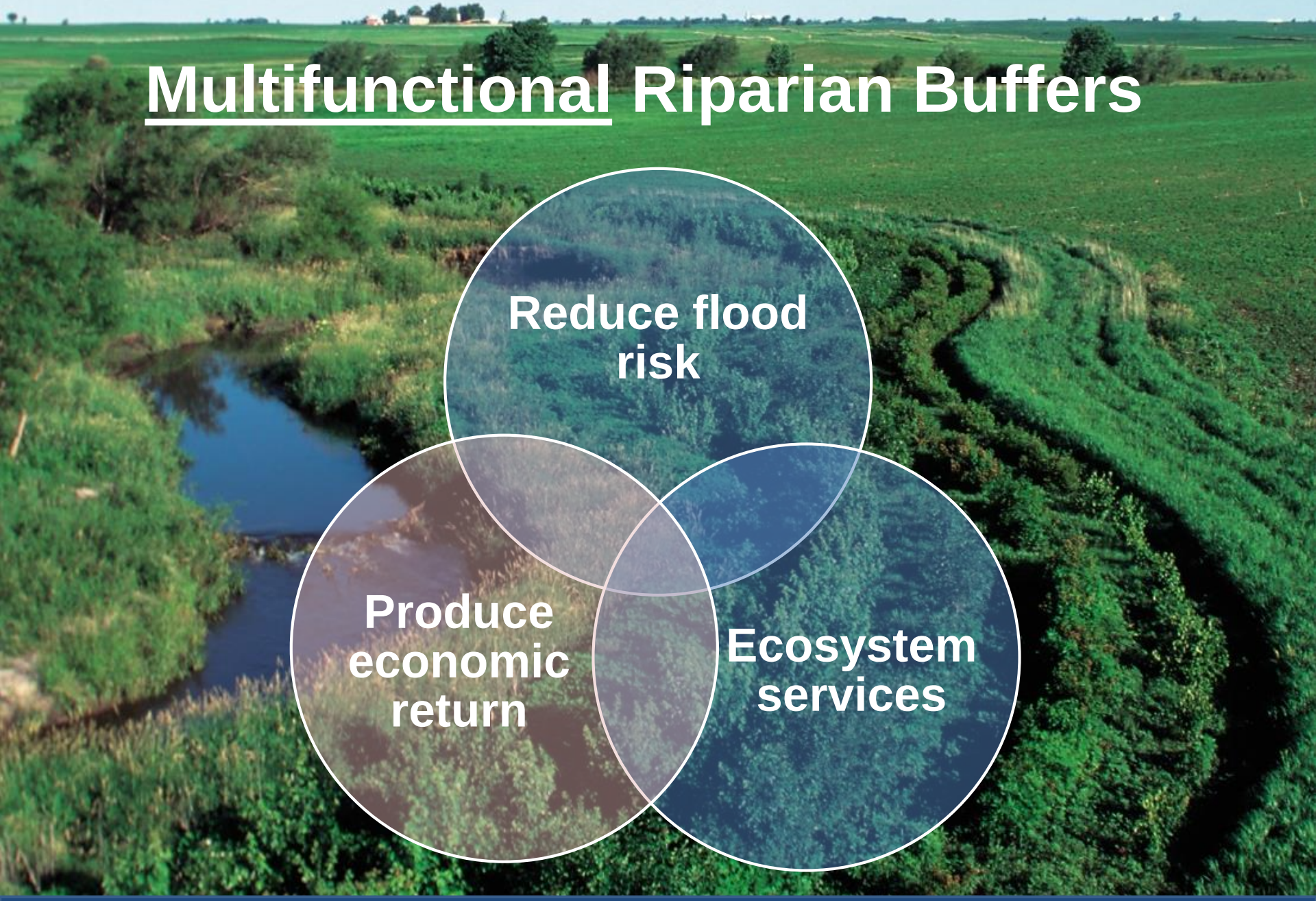
Low O.M.

(Colla et al., 2000)

2. Floodplain Strategies

AP Photo: Toby Talbot

Multifunctional Riparian Buffers



(Photo: NRCS)

3. Water Management for Production

Losses of over 30% were experienced by fruit and vegetable farmers in areas of NY due to 2016 drought
(Sweet et al., 2017)

(McDonald and Girvetz, 2013)

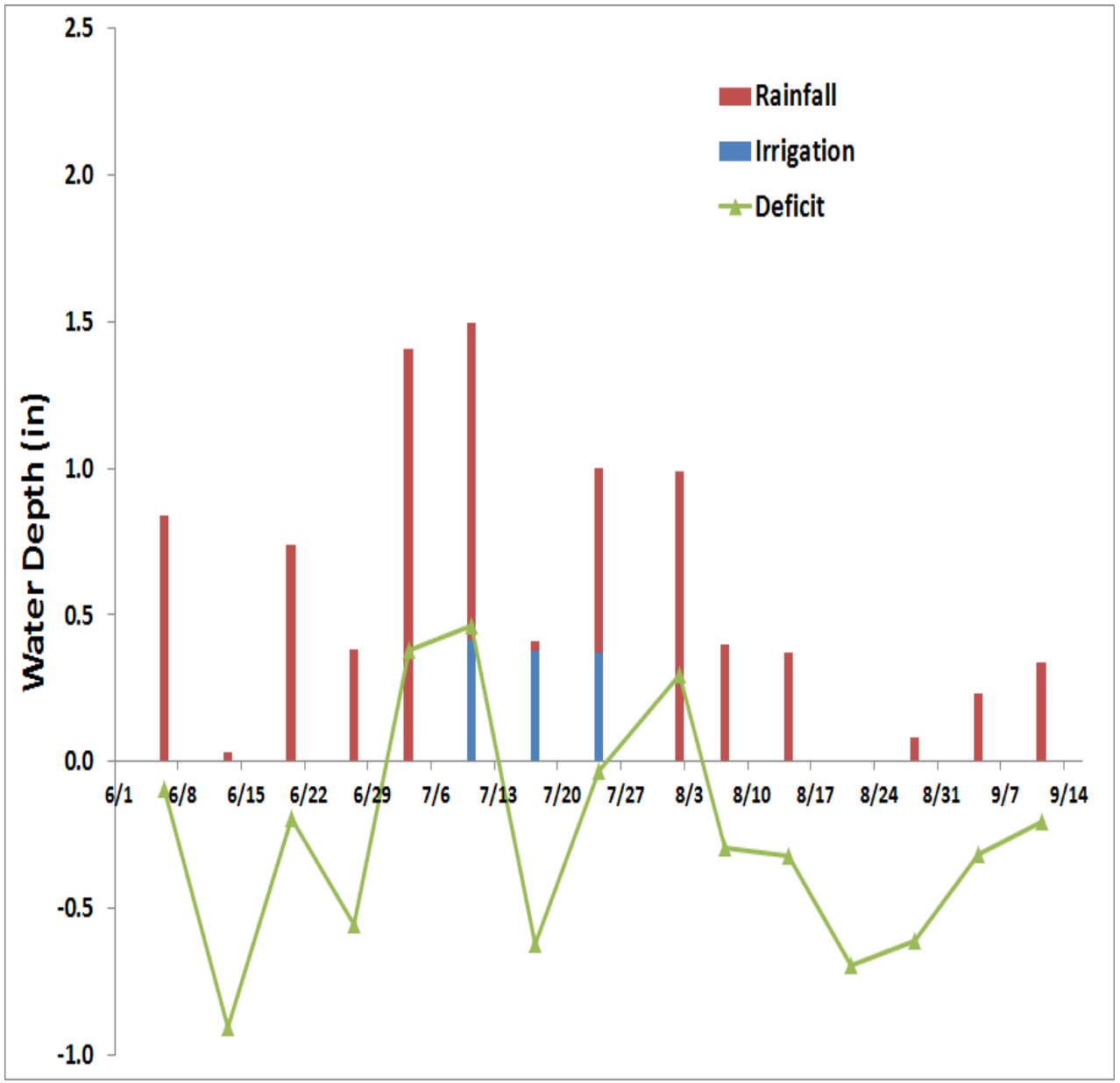
On-Farm Research 2018

Addison County Farm

30.5 acres of mixed vegetables
Fine sandy loam soils
Reliable surface water source
Overhead irrigation on 26.5 acres
Drip irrigation on 4 acres
Separate flow meters on overhead and drip systems

(Faulkner and Schattman, 2018)

Overhead Irrigation on Addison Co. Farm



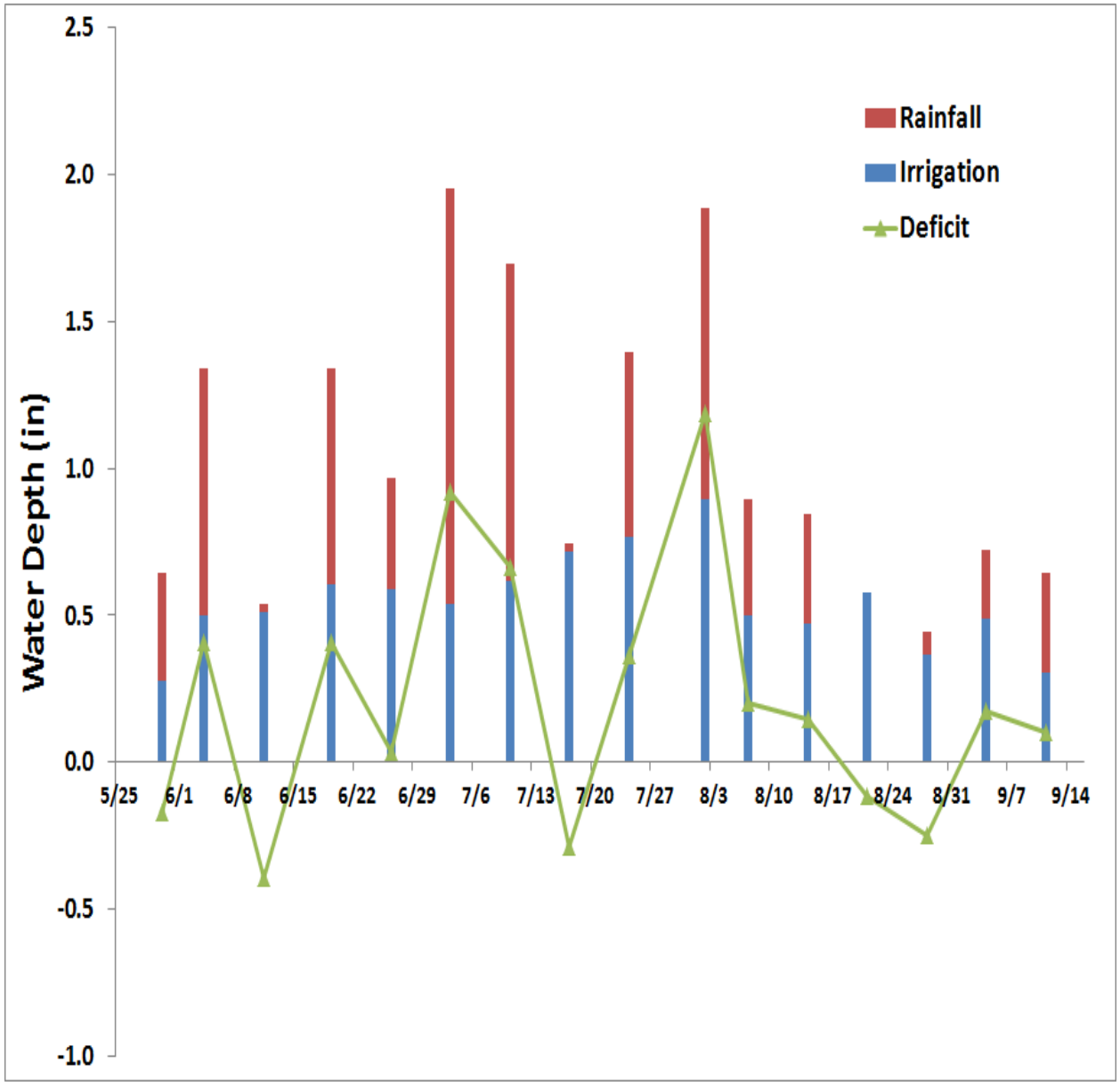
Total usage:
839,340 gal

Unit area usage:
31,673 gal/acre

Total deficit:
-2,672,000 gal

Unit area deficit:
-100,830 gal/acre

Drip Irrigation on Addison Co. Farm



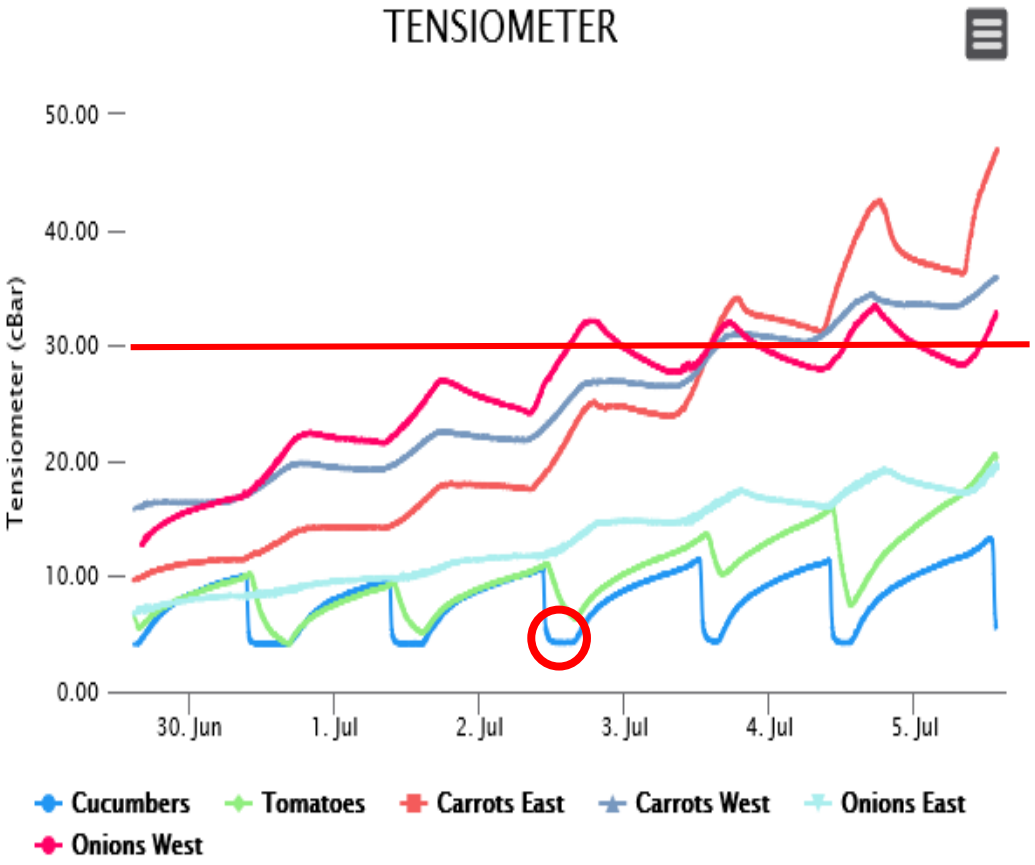
Total usage:
947,260 gal

Unit area usage:
236,816 gal/acre

Total deficit:
368,917 gal

Unit area deficit:
92,230 gal/acre

Soil moisture sensors



Subsurface Drainage: "It's complicated…"

"All those gullies I used to have are gone, now that I have drainage" – VT Farmer

Photo: Dwight Burdette.

Other Agricultural Adaptations

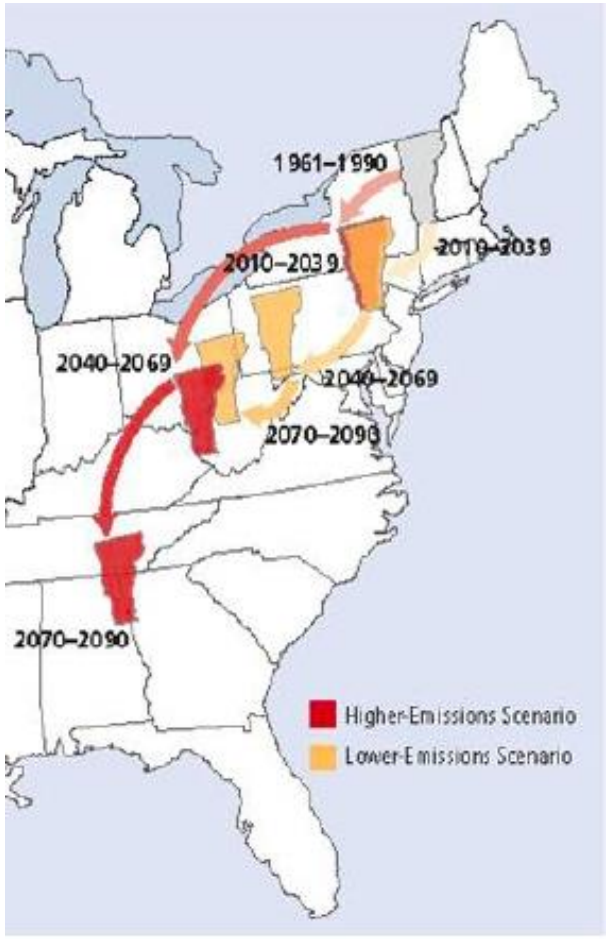
Diversification

- Crops
- Land
- Enterprises
- Markets
- Income Sources
- Social Networks

Photo: Debbie Roos, NC State Extension

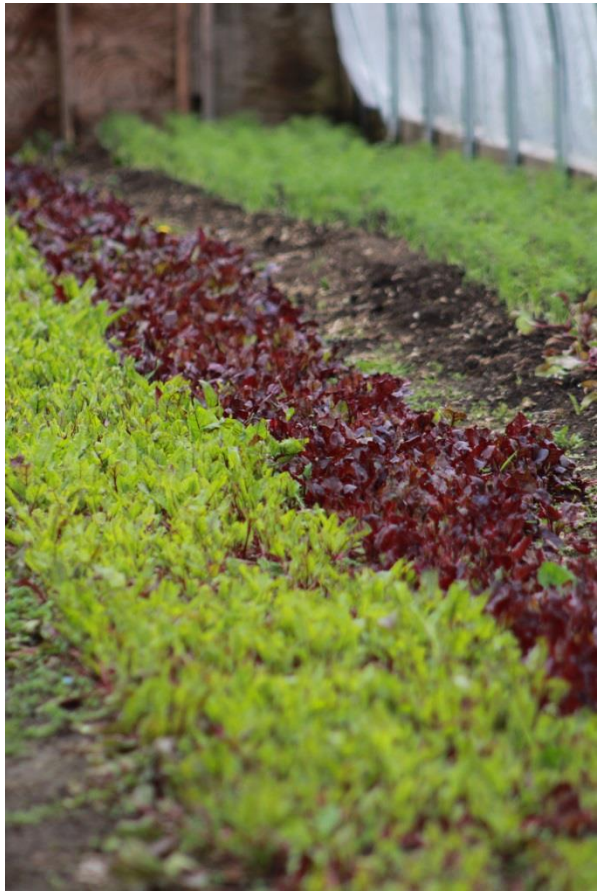
Other Agricultural Adaptations

New varieties, new crops, and new enterprises



Other Agricultural Adaptations

Quick Turnaround Crops



Low Risk/Investment Crops

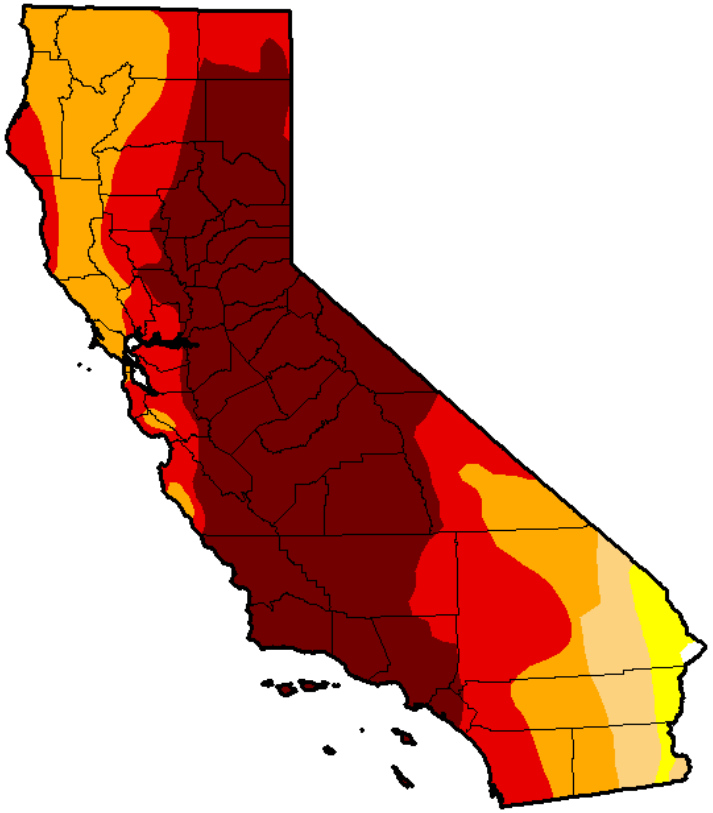
- Small grains
- Forage
- Pasture
- Soil improvement

AP Photo: Toby Talbot

Elsewhere…

U.S. Drought Monitor

California



October 6, 2015

(Released Thursday, Oct. 8, 2015)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.14	99.86	97.33	92.36	71.08	46.00
Last Week 9/29/2015	0.14	99.86	97.33	92.36	71.08	46.00
3 Months Ago 7/7/2015	0.14	99.86	98.71	94.59	71.08	46.73
Start of Calendar Year 12/30/2014	0.00	100.00	98.12	94.34	77.94	32.21
Start of Water Year 9/29/2015	0.14	99.86	97.33	92.36	71.08	46.00
One Year Ago 10/7/2014	0.00	100.00	100.00	95.04	81.92	58.41

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:

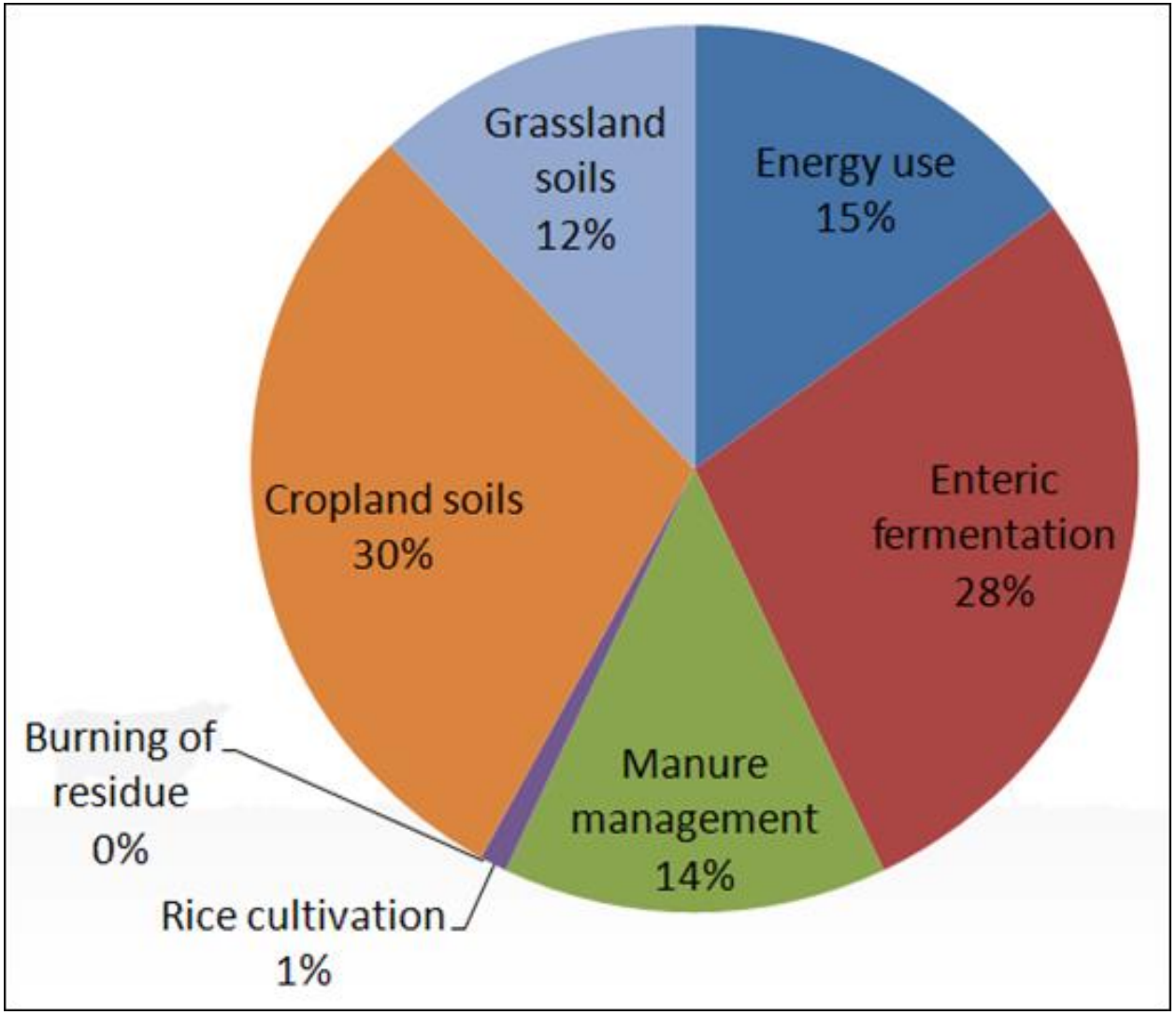
David Miskus

NOAA/NWS/NCEP/CPC

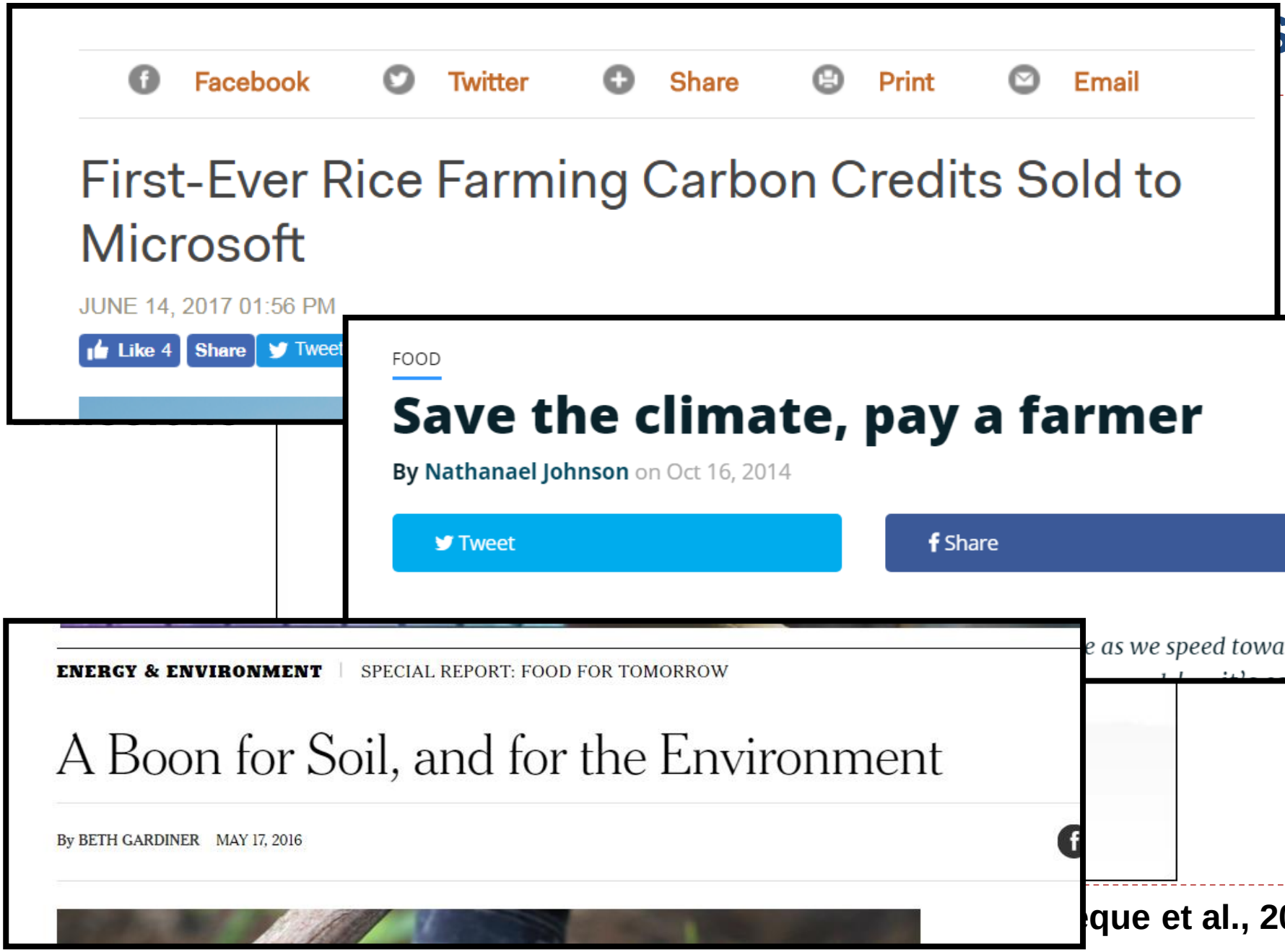
http://droughtmonitor.unl.edu/

How does agriculture impact climate change? (US)

8% of Total GHG Emissions

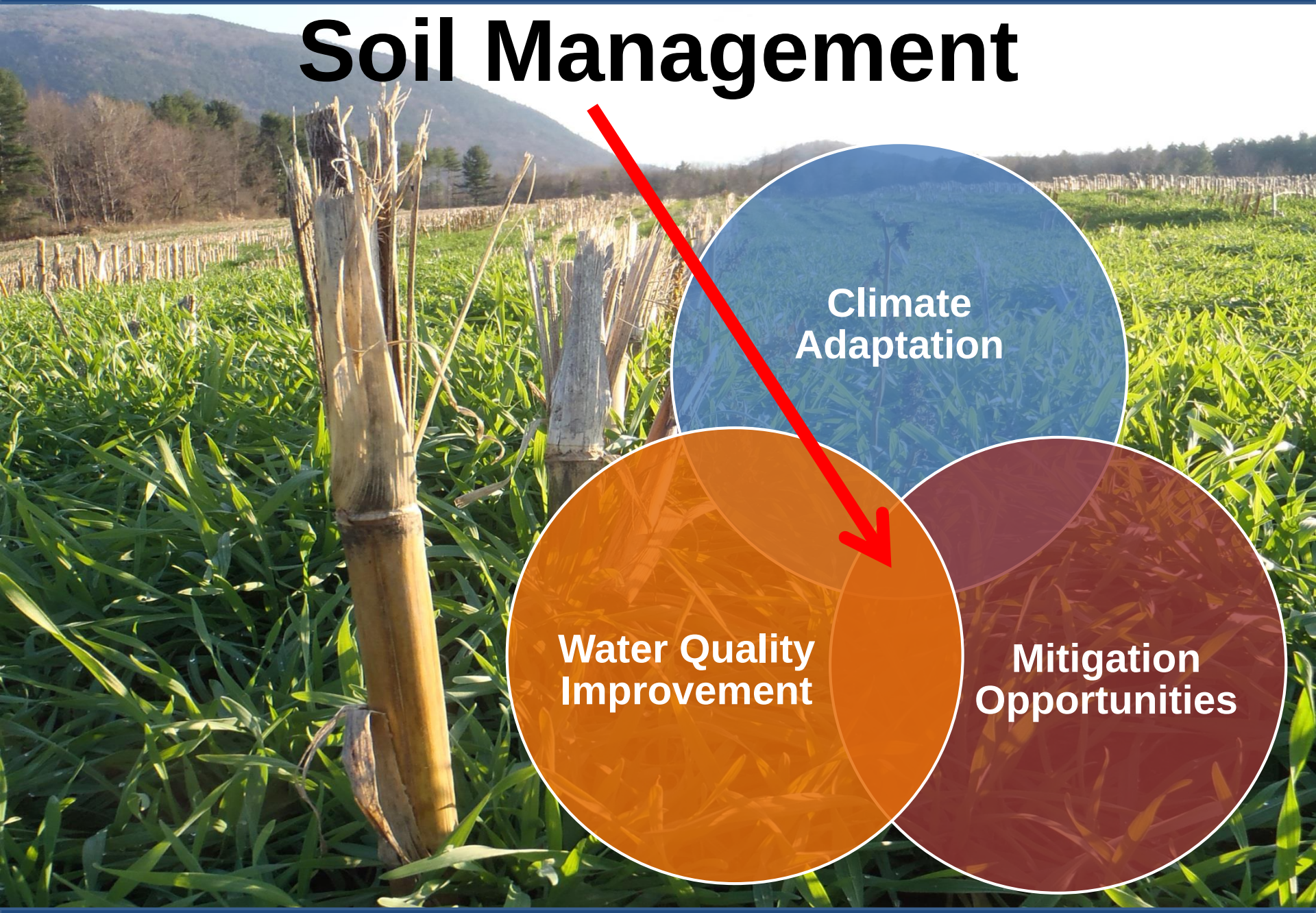


U.S. agricultural greenhouse gas sources (Adapted from Archibeque et al., 2012)



que et al., 2012)

Soil Management



(Photo: Kirsten Workman)

Summary: Adaptation Principles for NE Farms

1. Manage soil differently
2. Manage water differently
3. Variety/crop/breed/enterprise selection
4. Diversification in many ways (enterprises, crops, markets, income, networks, land base, etc.)
5. Investment in infrastructure (high tunnels, land, ventilation, equipment, structures)
6. Financial risk management tools (i.e., building financial cushion, crop insurance)

Thank You


http://flavormagazinevirginia.com/got-dairy-farmers/


http://www.greenlandbluewaters.org/covercrops.html


http://www.annmeekins.com/pages.asp?pg=northernneck_tour

The University of Vermont EXTENSION

Joshua.faulkner@uvm.edu

Additional Resources:
http://www.uvm.edu/~susagctr/

Center for Sustainable Agriculture