Challenges and Opportunities for NE Crop Production in a Changing Climate

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CSF Apple Stage / Freeze Damage Probability

Charts observed/forecasted daily minimum temperatures vs. apple hardiness thresholds in order to assess potential risk for freeze damage.

Climate Change and NE Ag

Challenges

- Increased frequency of temperatures exceeding thresholds for damage
- Increased risk of both drought and flooding, and difficult to predict
- Climate change is more complicated than just “warming”. Water challenges can offset longer frost-free period
- Increased and changing pest, disease, weed pressure

Opportunities

- New heat stress challenges less severe than some competing regions
- Relative to other regions- we have water!
- Longer frost-free period allows exploring higher yielding crop varieties; double-cropping

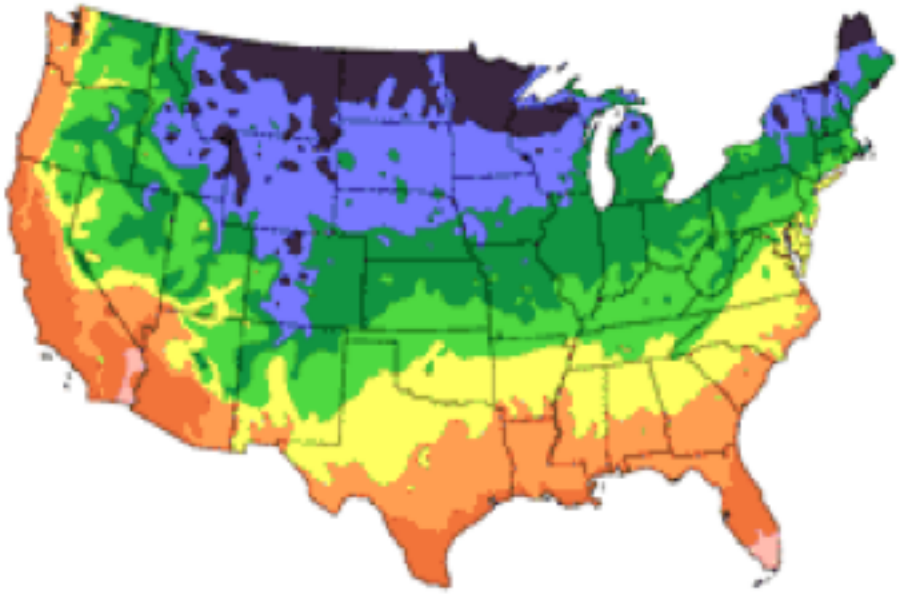
The New "Plant Hardiness Zone Map": an ecological perspective on recent change

Climate envelopes affecting biosphere are shifting (maps based on minimum winter temperatures; prior 15 years of NOAA records)

Source: www.arborday.org

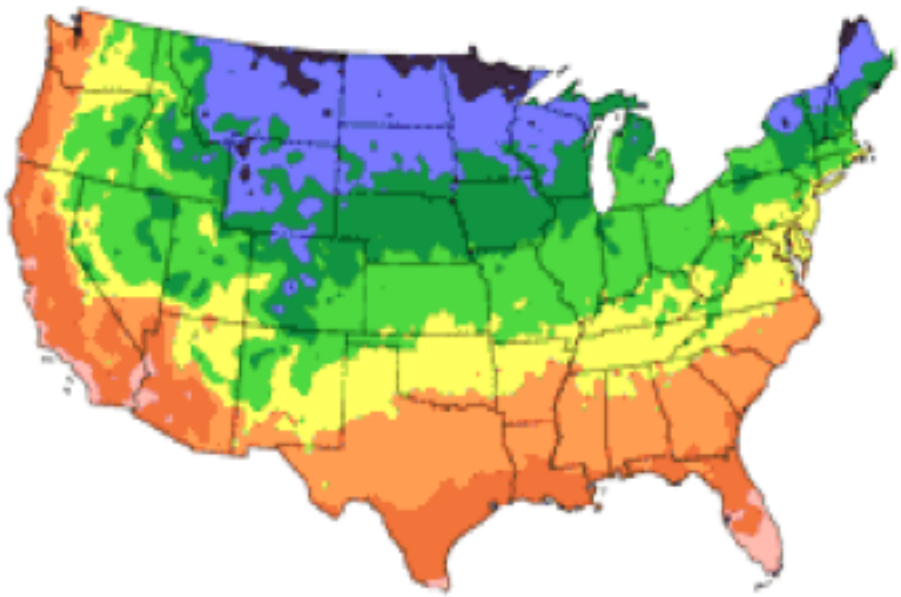
Zone	Avg. Annual Low
2	-40° through -50°
3	-30° through -40°
4	-20° through -30°
5	-10° through -20°
6	0° through -10°
7	10° through 0°
8	20° through 10°
9	30° through 20°
10	40° through 30°

1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990.

2006 Map

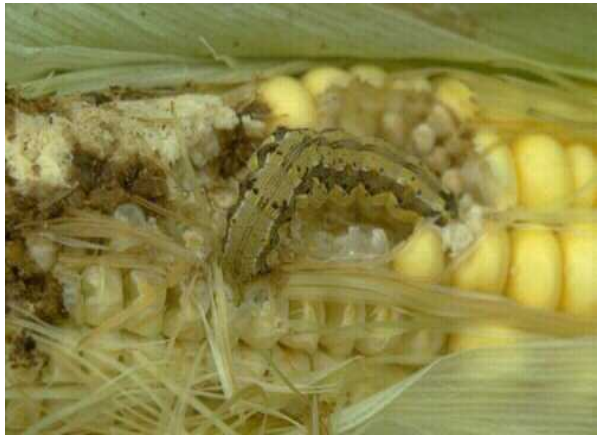


National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Longer frost-free period, warmer winters: Shifts in range and more intense pest pressure

Better insect overwinter survival in temperate regions; more generations per season; northward range expansion

Flea beetle



Corn earworm

Many invasive weeds benefit

Kudzu

Climate change trends are complex:

A longer frost-free period
does not mean a longer growing season
if rains restrict field access when you need to:

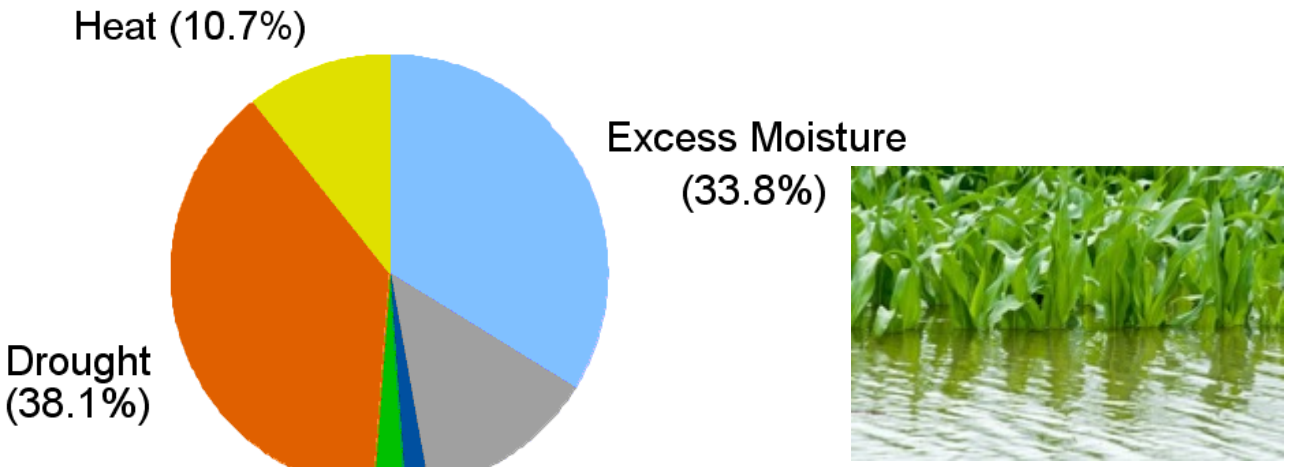
Plant

Side-dress

Harvest

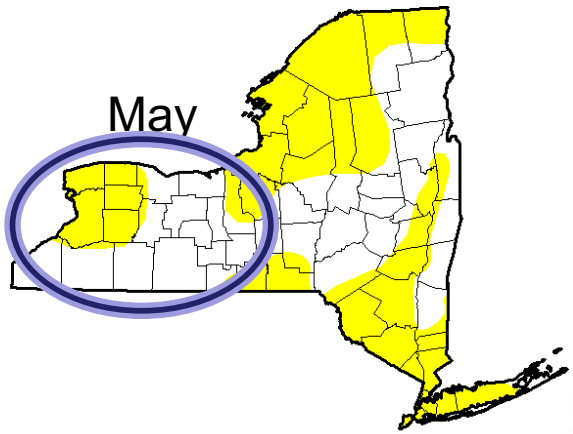
Recent causes of weather-related crop losses in the Northeast

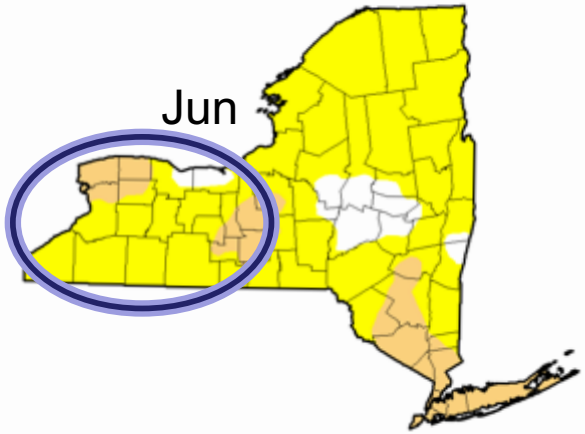
Causes of Loss, FSA Noninsured Crop Disaster Assistance Program Acres (Northeast U.S., 2013-2016)

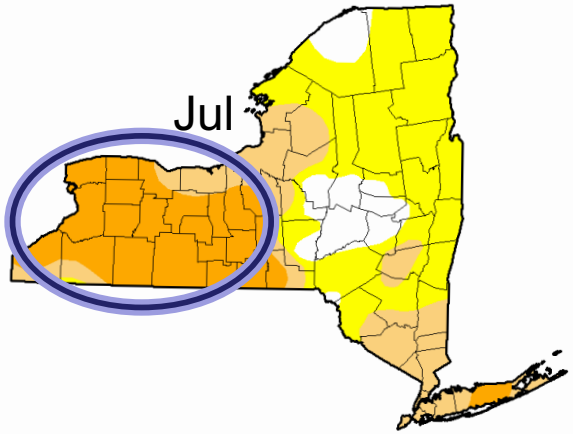


Wolfe et al. 2018 Climatic Change. 146: 231-245

Lessons From the 2016 Northeast Drought: NY farmer survey and analysis (n=275)



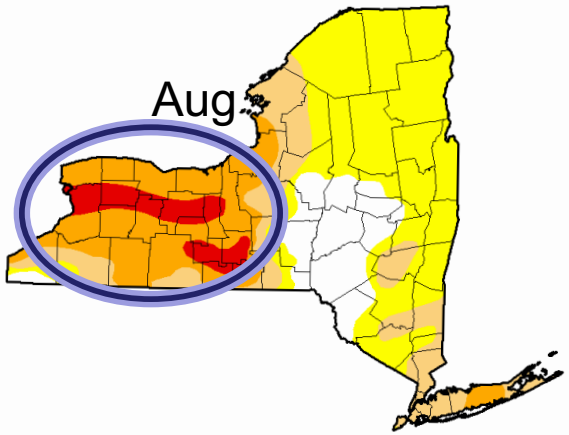


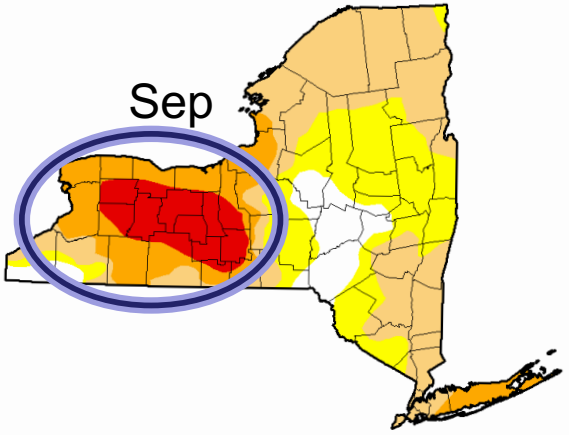


Drought Severity

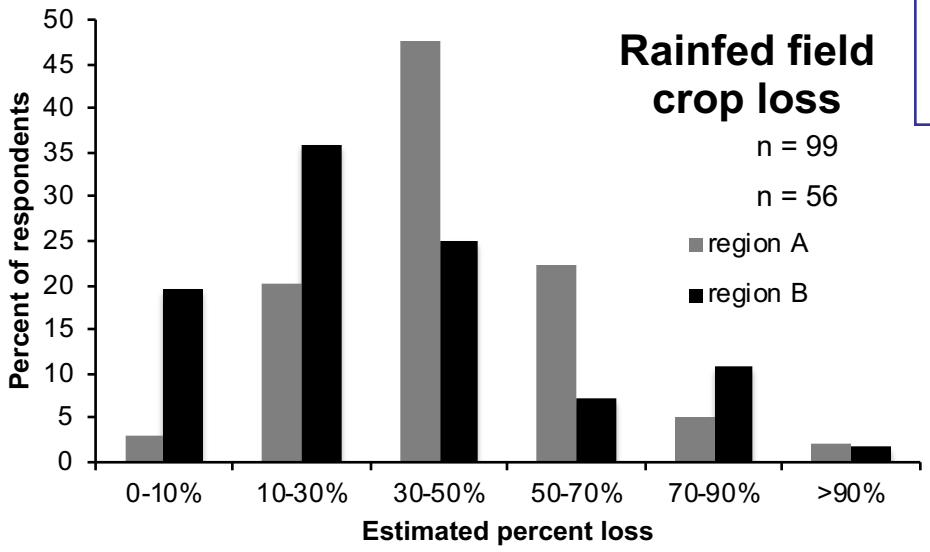
- No drought
- Abnormally dry
- Moderate drought
- Severe drought
- Extreme drought

www.droughtmonitor.unl.edu

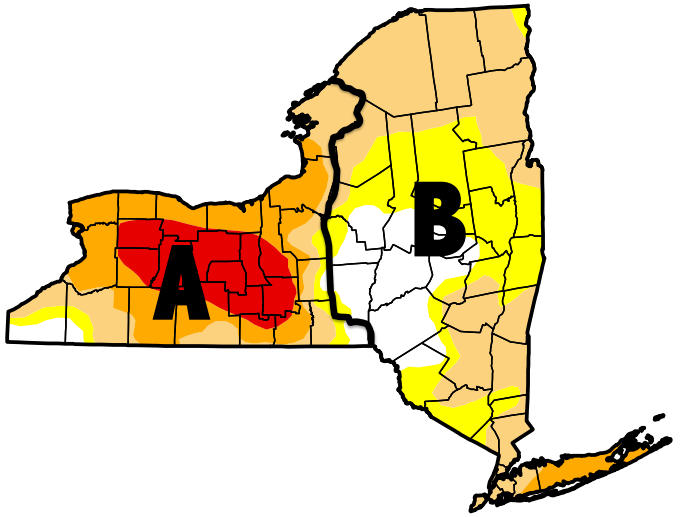


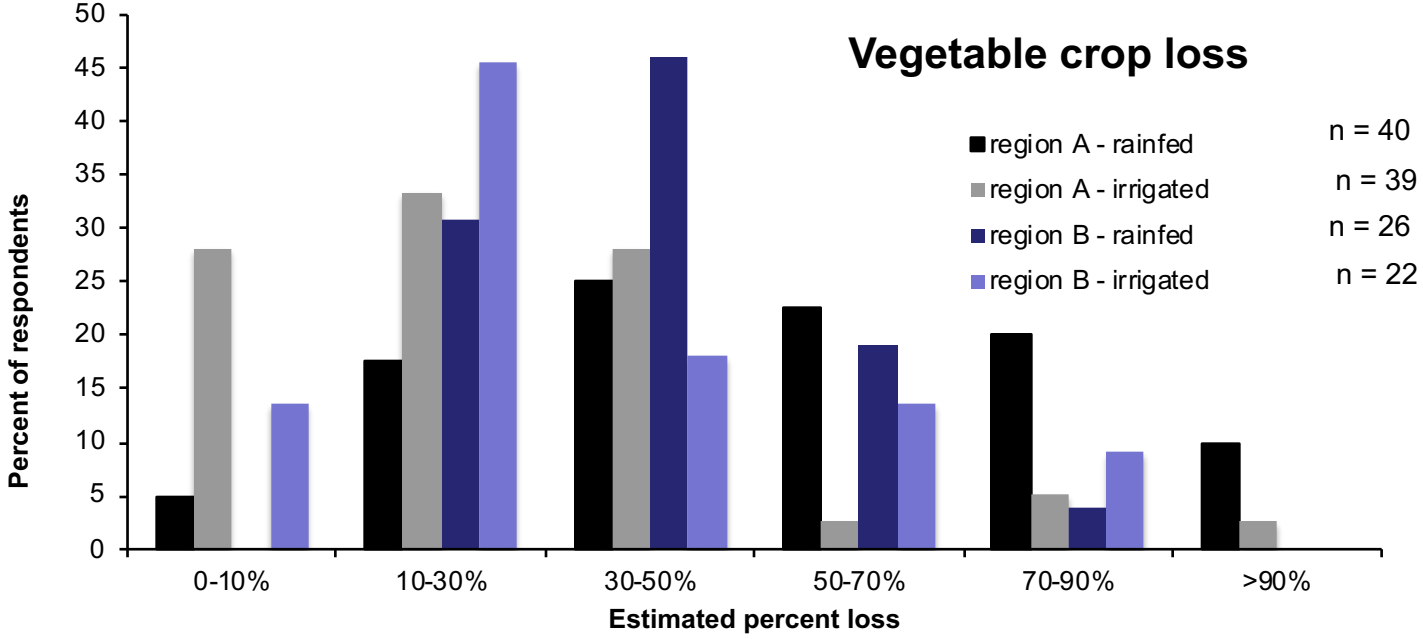


Sweet et al. 2018. *Agric Forest Meteor* 247: 571-581.
Sweet et al. March 2017. *CICSS Res & Policy Brief*. Iss. 3, pp. 1-4 (www.climateinstitute.cals.cornell.edu)



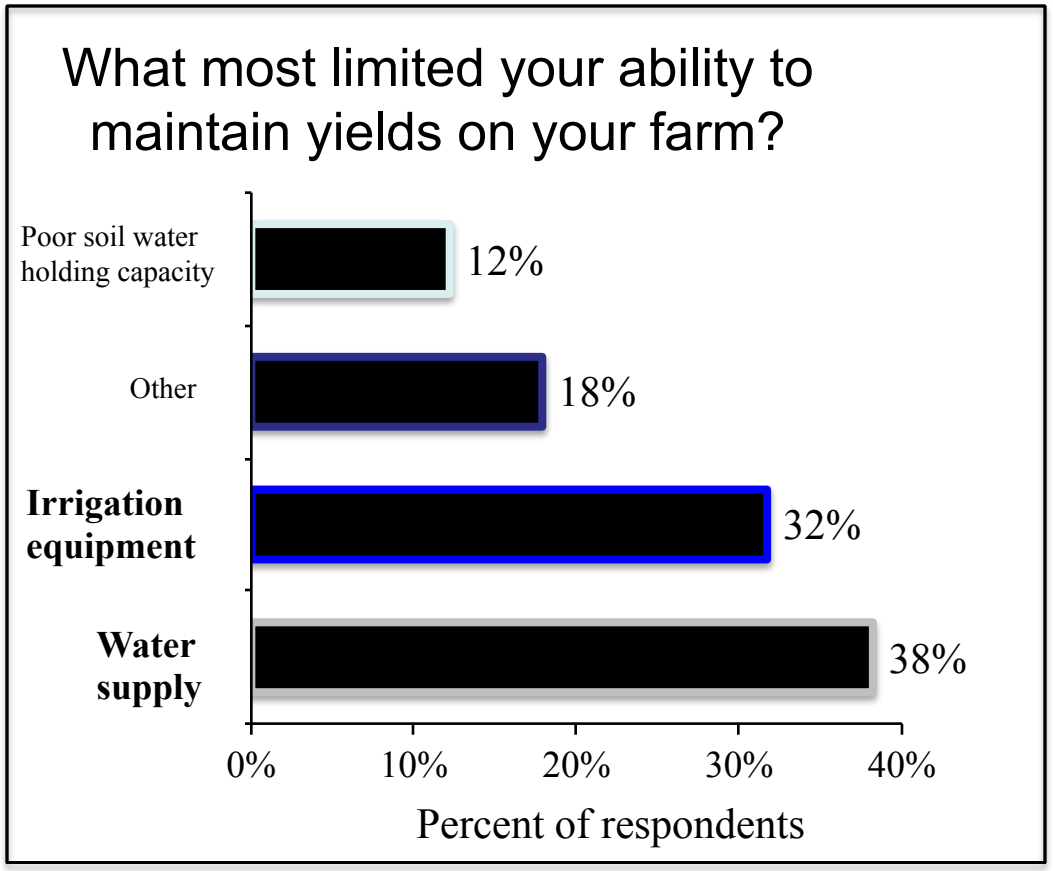
More than half of rainfed NY acreage had >30% loss





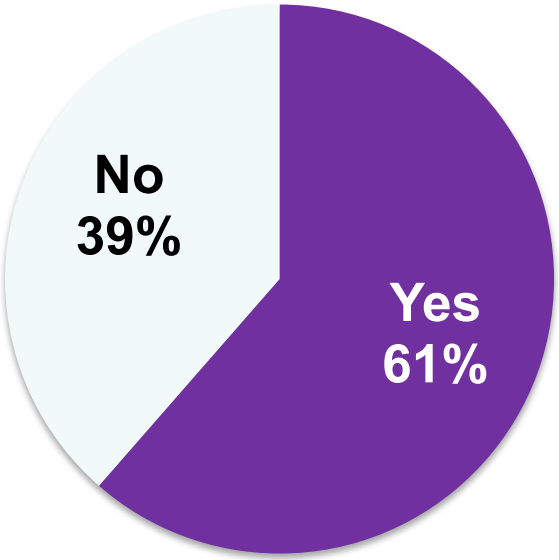
In WNY, more than a third of irrigated vegetable acreage had >30% loss

Across <u>all of NY State</u> Irrigation Equipment and Water Supply Was Lacking During 2016 Drought

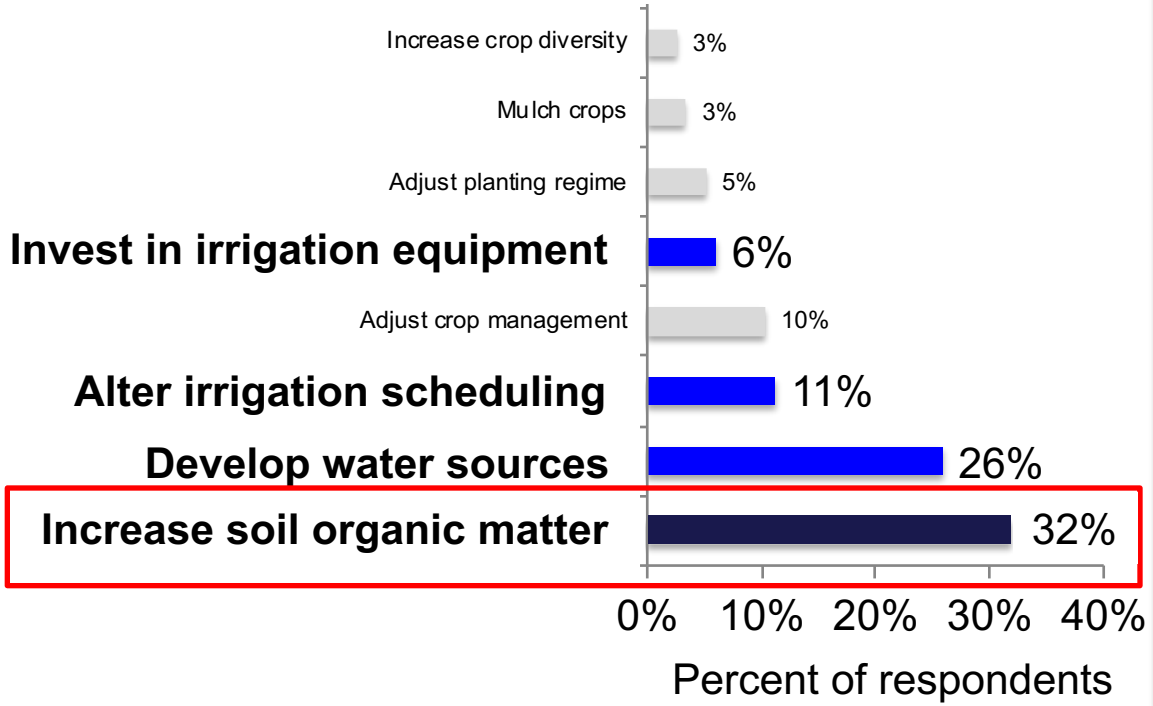


The 2016 Drought Affected Farmer Perceptions This Will Affect Future Behavior

Did what you experienced in 2016 changed your perspective on future drought?



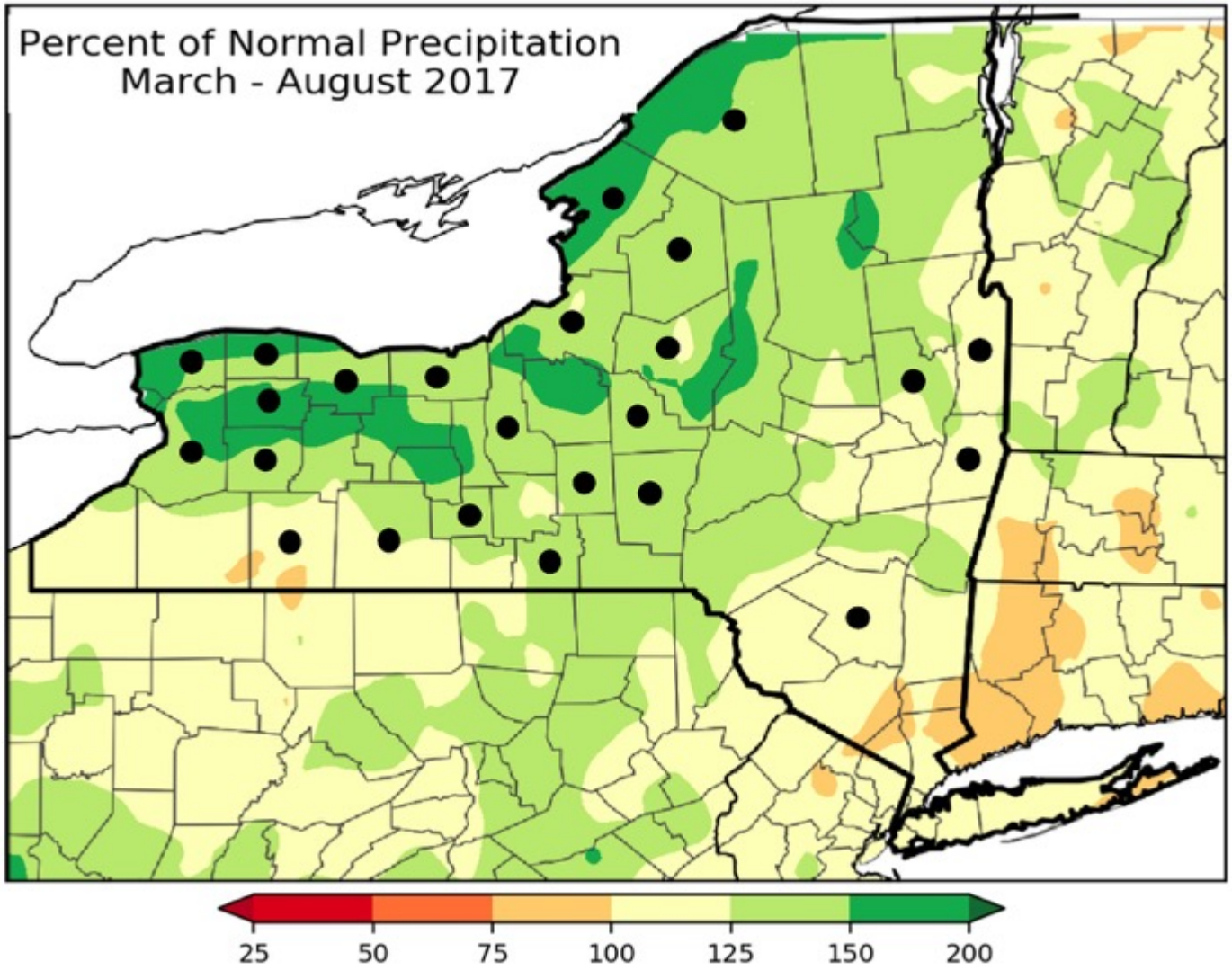
Are you planning to do anything different after experiencing the 2016 drought?



And then flooding in WNY in 2017! Impacts and Farmer Response

Dots =

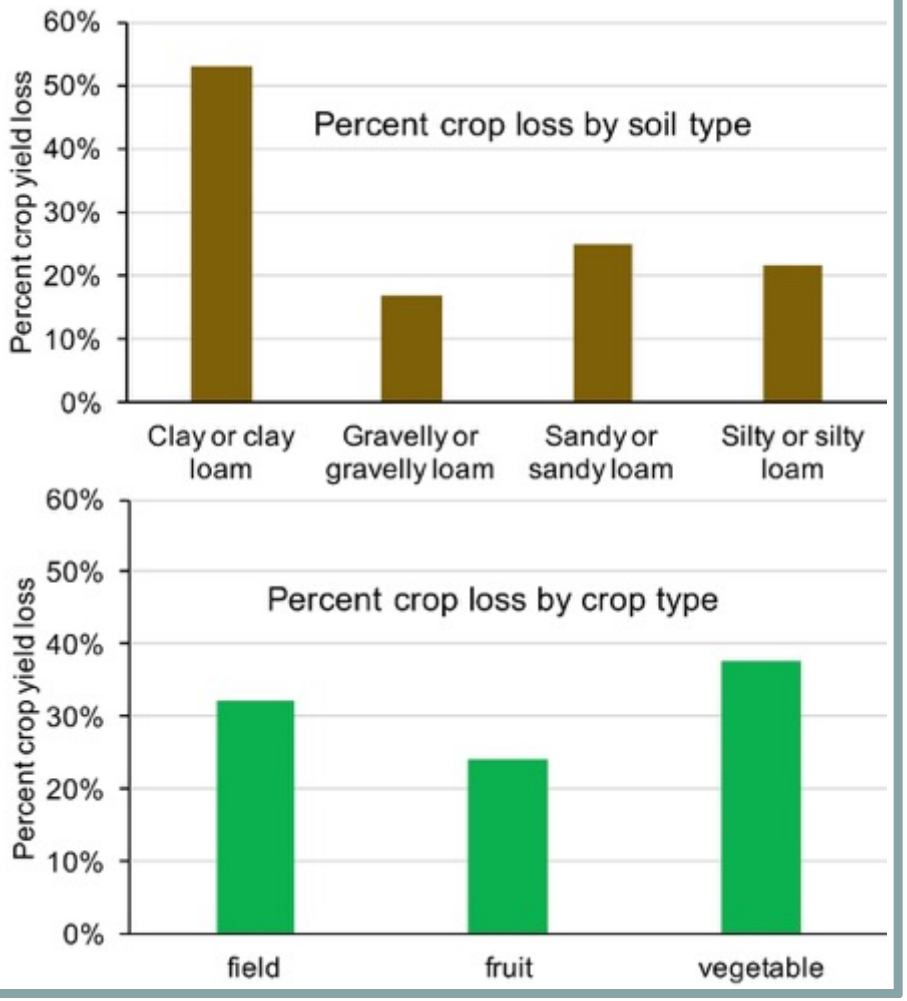
counties where farmers responded to heavy rainfall/ flooding survey



Sweet et al. 2018. Anatomy of a wet year: insights from New York farmers. *What's Cropping Up?* Cornell Univ (in press).

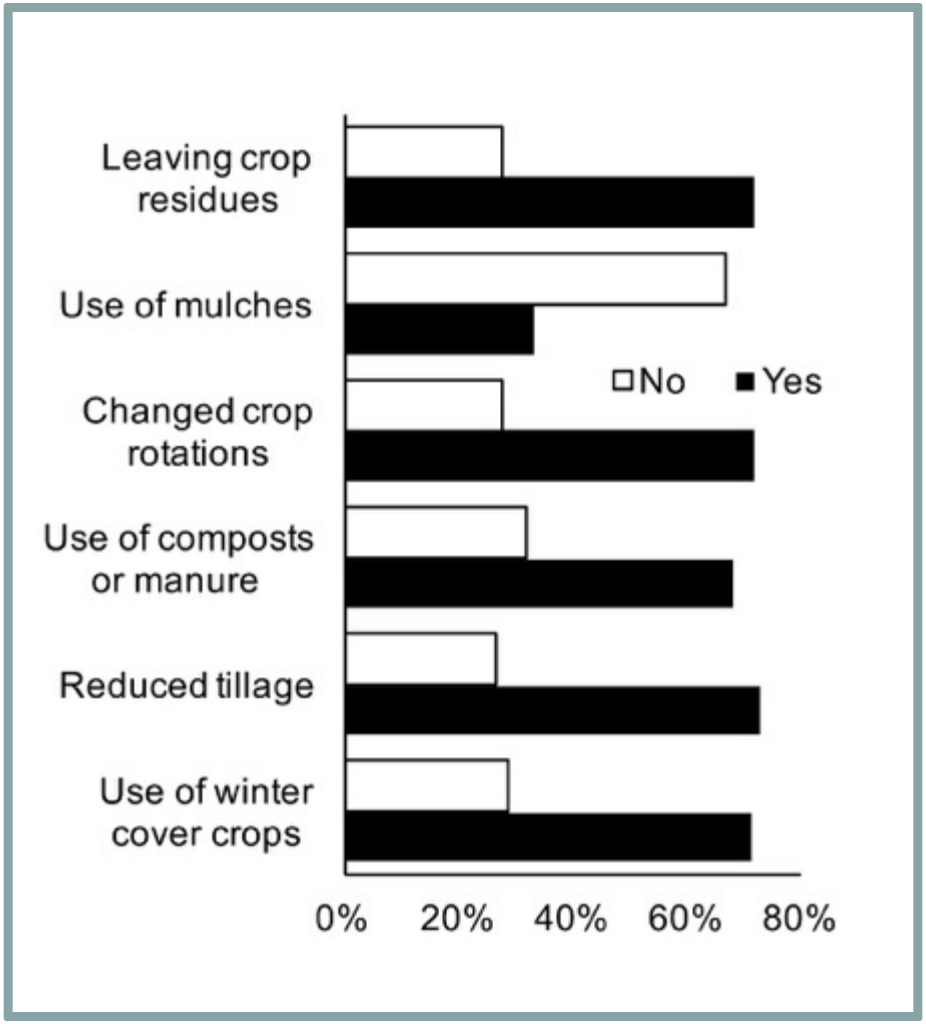
Factors contributing to flooding losses:

crop disease, lack of field access, erosion



Soil Management and Flooding Resilience

Did any soil health practices you have adopted on your farm lessen the impact of heavy rainfalls in 2017?

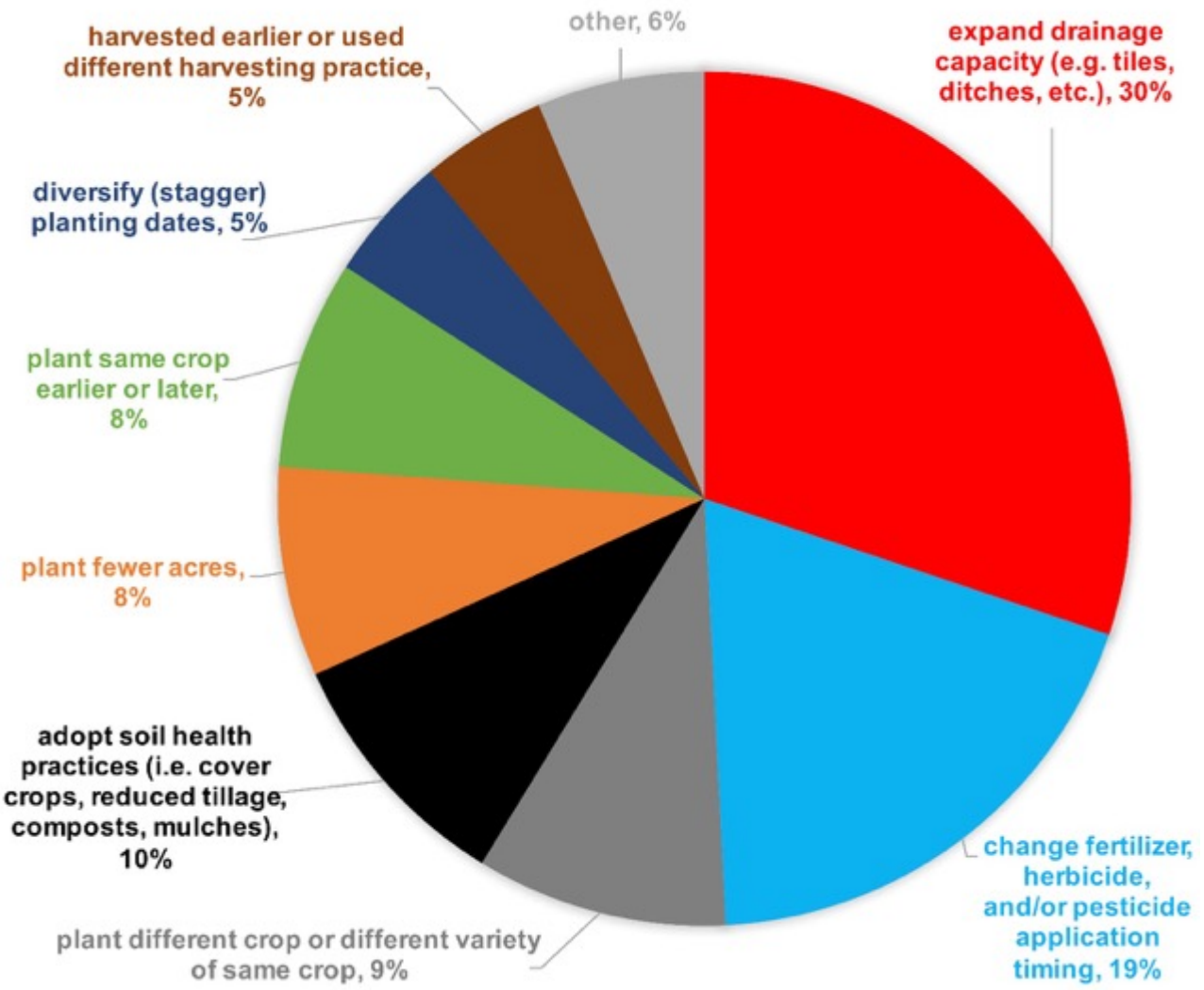


Soil Health Management:
Low-Cost Climate Change Resilience
While Reducing the Carbon Footprint of Agriculture:

Building soil organic matter (reducing tillage, using cover crops, manure and composts):

- Adaptation: increases resilience to drought and flooding
- Mitigation: stores carbon in the soil that otherwise would be in the air as CO_2

What would you have done differently if you had known how wet this summer would be?



Farmers and Climate Change

All farmers are concerned about extreme weather events and uncertainty about the weather.

Many farmers are concerned that extreme weather is becoming more frequent and less predictable

Many farmers have recognized they cannot rely on historical weather patterns for making farm management decisions

Recent polls indicate the majority of farmers accept that the climate is changing (e.g., Arbuckle et al. 2013. *Climatic Change* 118:551-563)

Farm-level adjustments ("adaptation") to build resilience to climate change

Crop, Soil, and Water Management

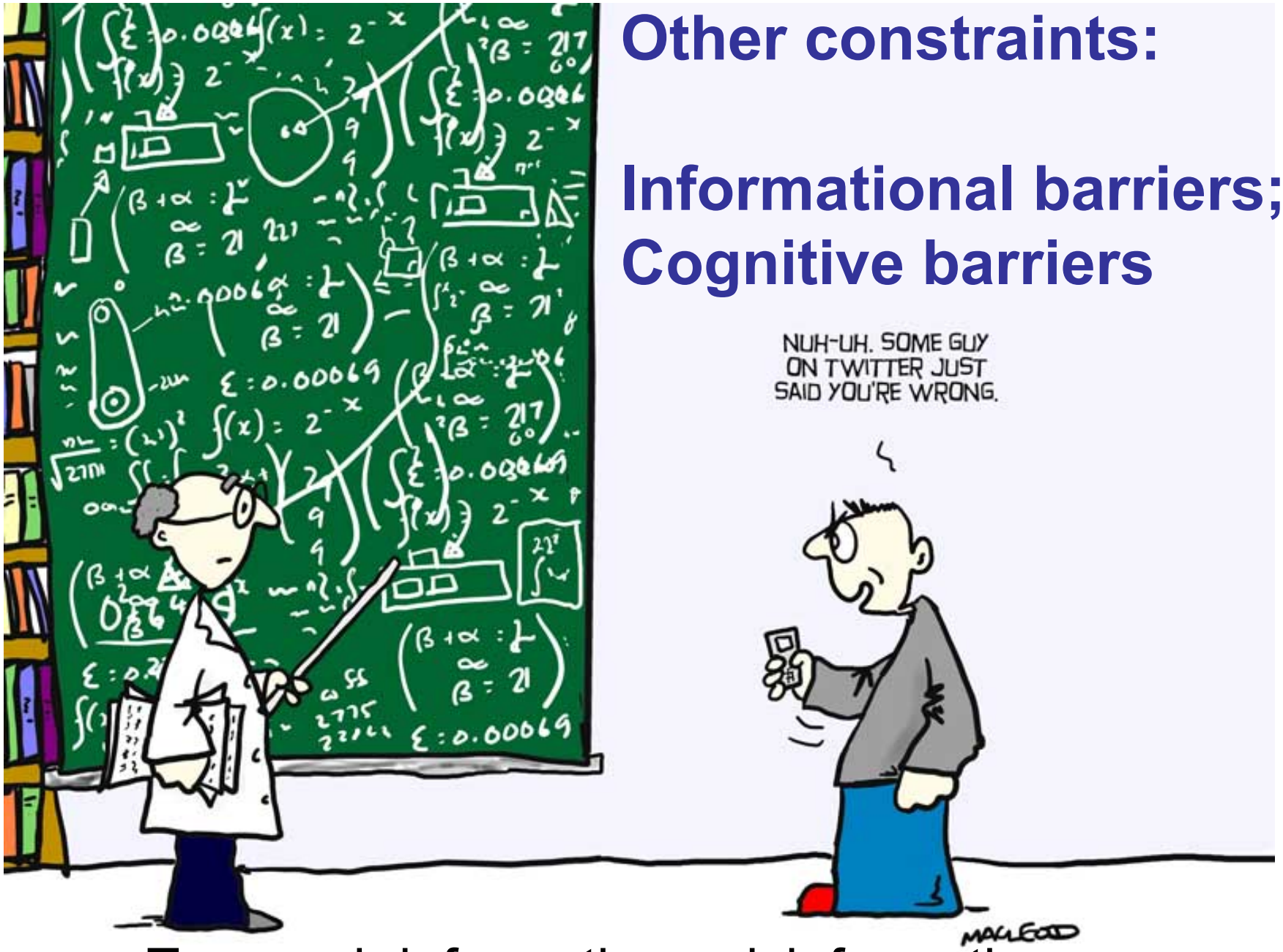
- **Diversify** cropping systems at farm and regional scales
- **New varieties** (breeding and biotechnology)
- **Integrated Pest Management (IPM) strategies for new pests**, diseases and weeds
- **Improve soil resilience** to drought and flooding; expand into new sites less prone to water stress;
- **New irrigation and drainage systems**
- **Fruit crop frost protection** (site selection, misting, air circulation fans)
- **Larger scale farm equipment** to cover more acreage faster, to cope with shrinking windows for field access

Financial Barriers; Equity Issues

Will small family farms have the capital and strategic information to adapt?

Other constraints:

Informational barriers;
Cognitive barriers



Too much information; misinformation

Constraints to Farmer Adaptation

- ***Financial barriers*** (e.g., an individual farmer, region, or nation, lacks the capital for strategic adaptation)

- ***Informational barriers*** (e.g., lack of weather and climate information, lack of Extension support for farmers, too much or misinformation)

- ***Cognitive barriers*** (e.g., underestimates of risks of inaction; confused by uncertainties, statistics, models, scientific jargon)

- ***Technological limits*** (e.g., suitable varieties, or systems to protect from extreme weather risks not available)

- ***Social and cultural barriers*** (e.g., the social, cultural group(s) one belongs to can limit adaptation response)

- ***Physical and ecological limits*** (e.g, when the magnitude and pace of climate change are beyond our capacity to adapt)

Farmers will require new weather and climate-based decision tools for strategic adaptation

- Is this “normal” bad weather or climate change??
- Do I invest in a new drainage system?...
- Or irrigation system
- Or both?
- And when?

CSF
Climate Smart Farming
A program of Cornell University

Providing decision support tools for farmers

Agriculture Adaptation Beyond the Farm

A role for universities, government agencies, NGOs, communities

- **New decision tools** to explore costs, risks, benefits, and strategic timing of adaptation
- **Financial assistance for adaptation** investments
- **Improved weather and seasonal climate forecasts**
- **Plant breeding and biotechnology**
- **Enhanced pest monitoring** and regional data sharing
- **Disaster risk management** and better **crop insurance** programs
- **Land use and climate change policies** that integrate economic, environmental and equity issues
- **Community planning for "bad" years**, threats to food security

Plant Breeding and Biotechnology: crucial, but not a "silver bullet"

- Given unpredictable nature of climate change, difficult to identify an optimum crop trait for any region
- Stress tolerant varieties often have low yield in optimum years
- Stress tolerance is often complex and multi-genic
- Unique suites of genes are required depending on timing of stress (e.g. at germination vs. at pollination)
- Need more research investment in high-value fruit and vegetable crops important to the NE economy
- For some farmers:
  - Concerns about corporate control and/or access to seed and other products of biotechnology
  - Concerns about consumer and trade partner acceptance of "GMO" crops

New decision tools, field sensor technology, data analytics can assist farmer adaptation

Temperature

Leaf wetness

Farming Success in a Changing Climate:
Being Prepared Makes Good Business Sense

- Taking advantage of changing market opportunities
- Strategic decisions such as:
  - Diversifying crops, varieties, planting dates, etc.
  - Capital investments such as new drainage or irrigation systems
- Anticipating new weed, disease, insect pests
- Avoiding unintended consequences, such as:
  - Increased chemical loads to waterways
  - Undesirable land use change and degradation
- Promoting policies that support farmer needs for adaptation and mitigation
- Increasing profits by better energy and greenhouse gas management; knowledge of energy policy incentive programs
- Protecting national interests: ag economy, food prices, food security