Drought Resilience in Michigan Dry Beans

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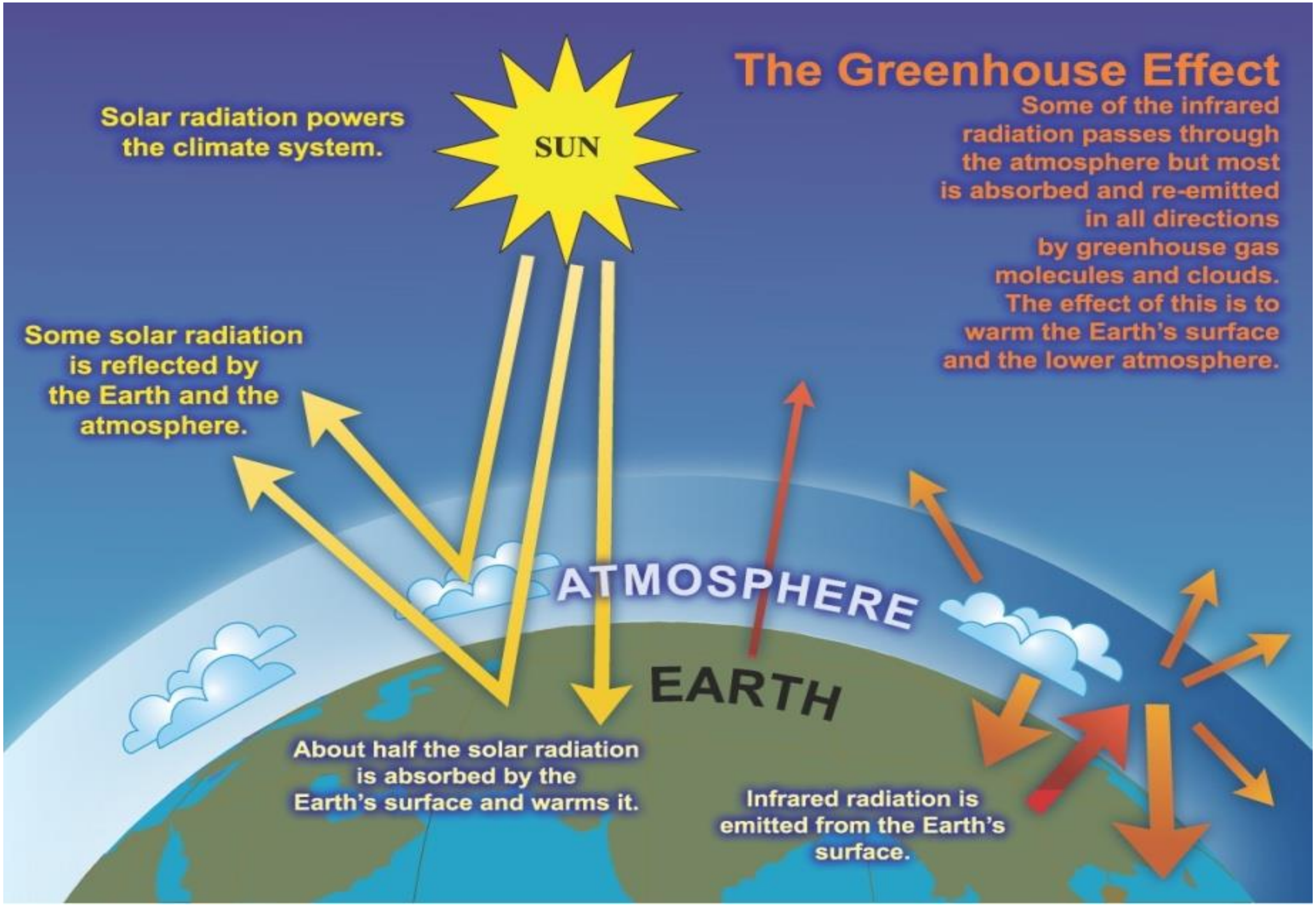
Overview

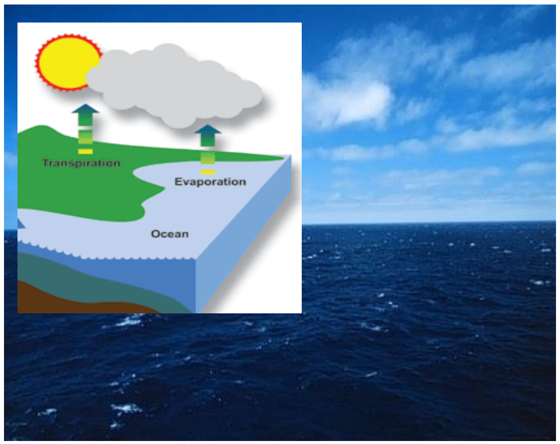
- Climate Change Primer
- Precipitation and Drought
- PRI Drought Resilience Project
- GLISA Climate Impact Scenarios Project


The Greenhouse Effect
Solar radiation powers the climate system.
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth's surface and the lower atmosphere.
ATMOSPHERE
EARTH
About half the solar radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

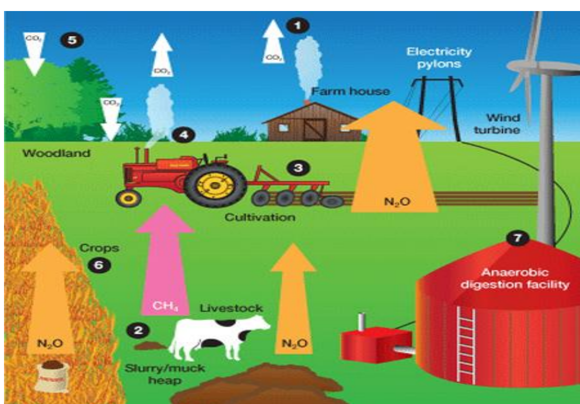
(EPA, 2007)

Sources of Greenhouse Gas

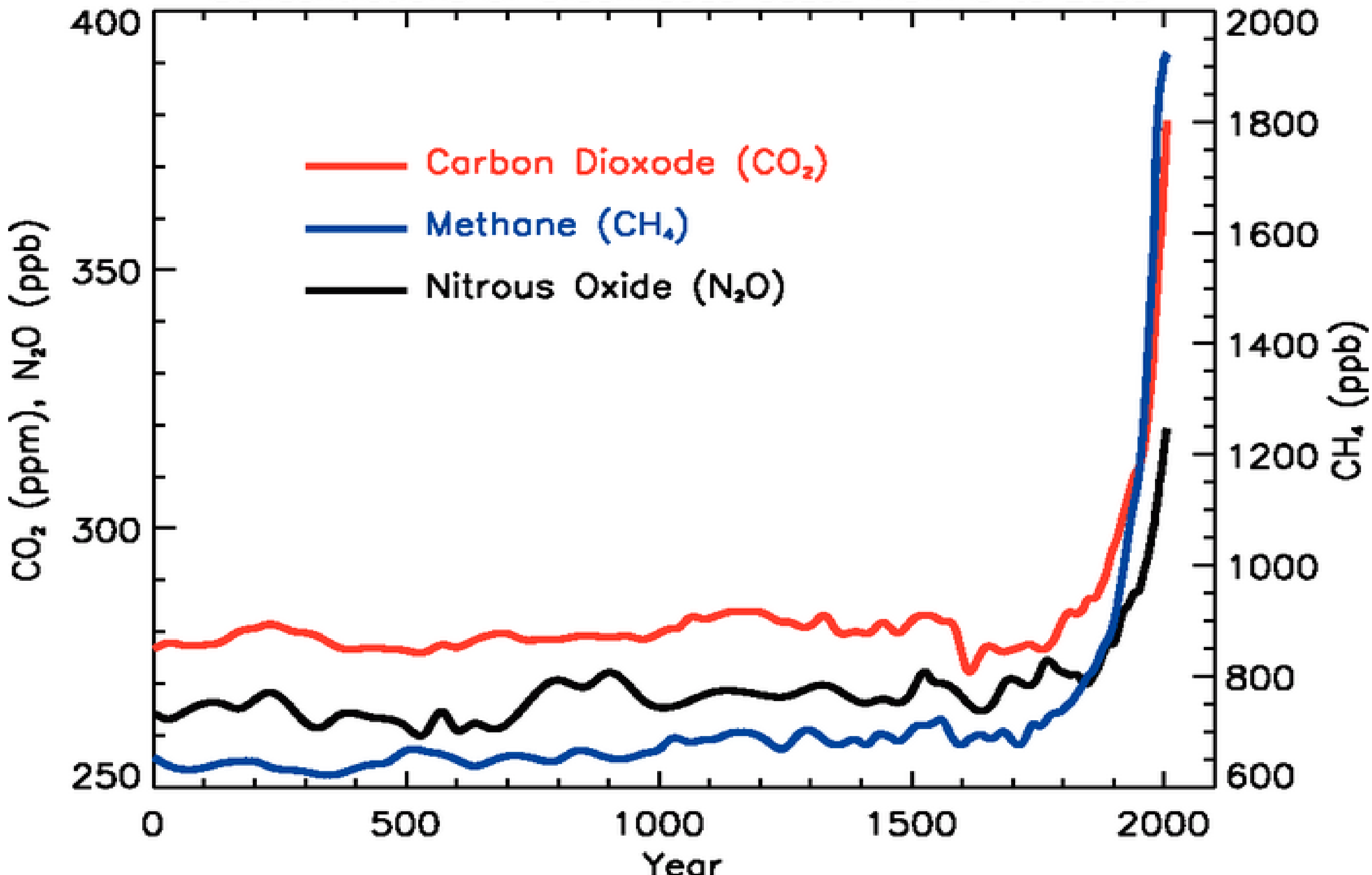
Natural sources



Human (anthropogenic) sources

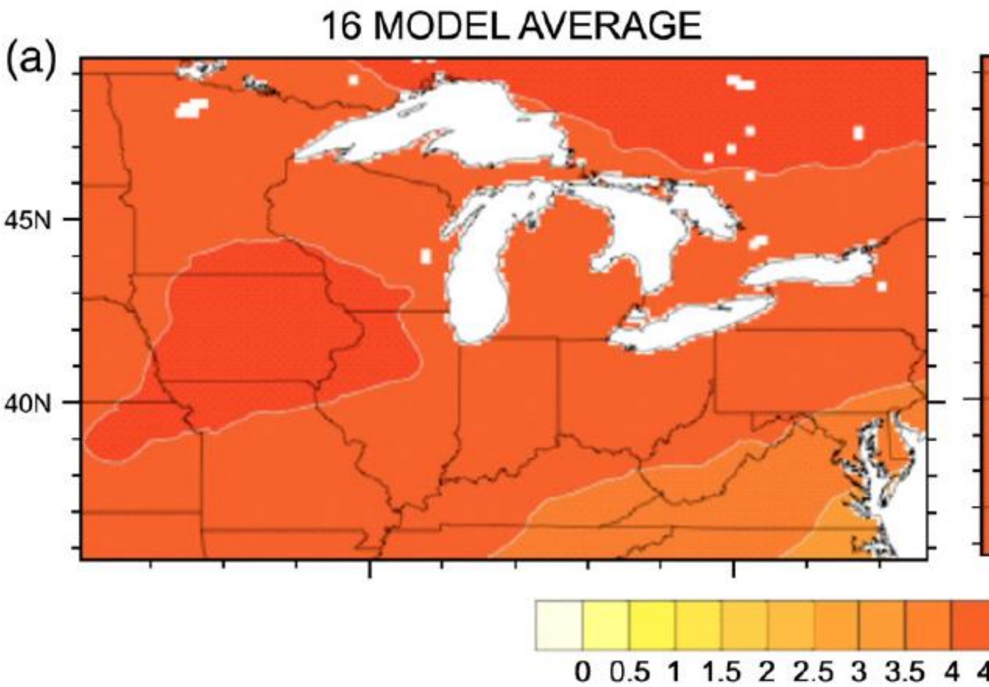


Human Impact: Greenhouse Gases

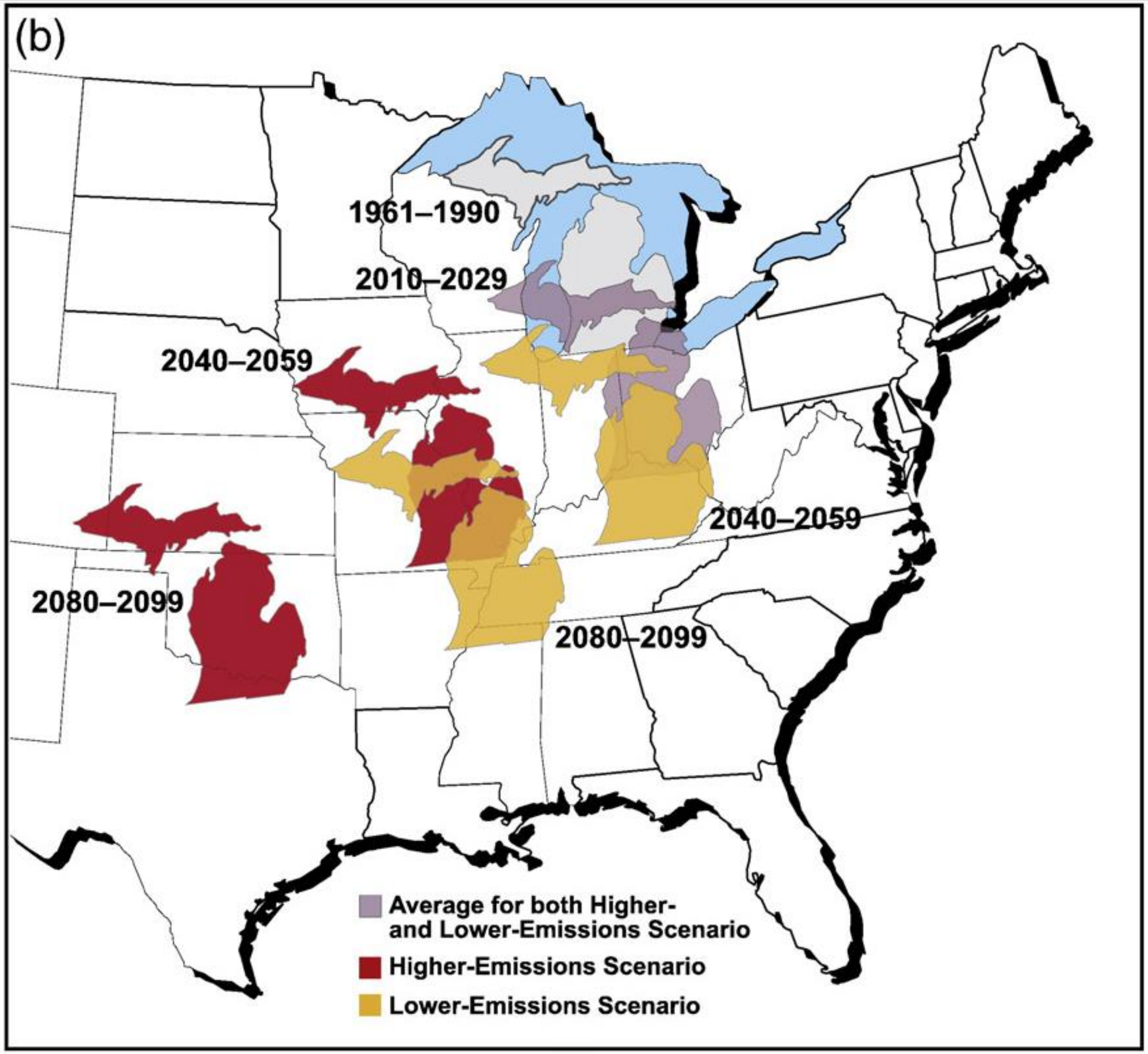


(IPCC, 2007)

Temperature 2070-2099

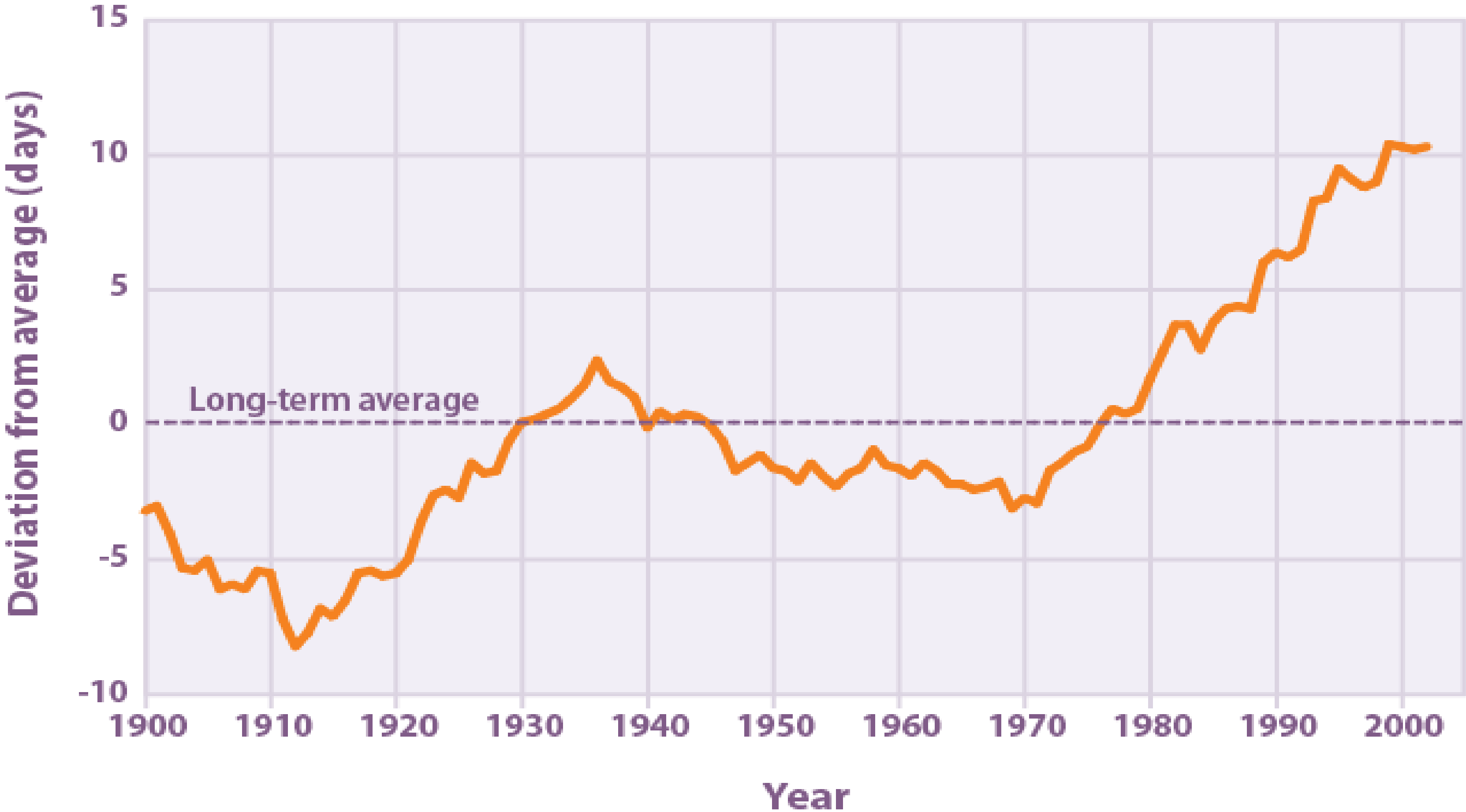


(Hayhoe et al., 2010)



(Hayhoe et al., 2010)

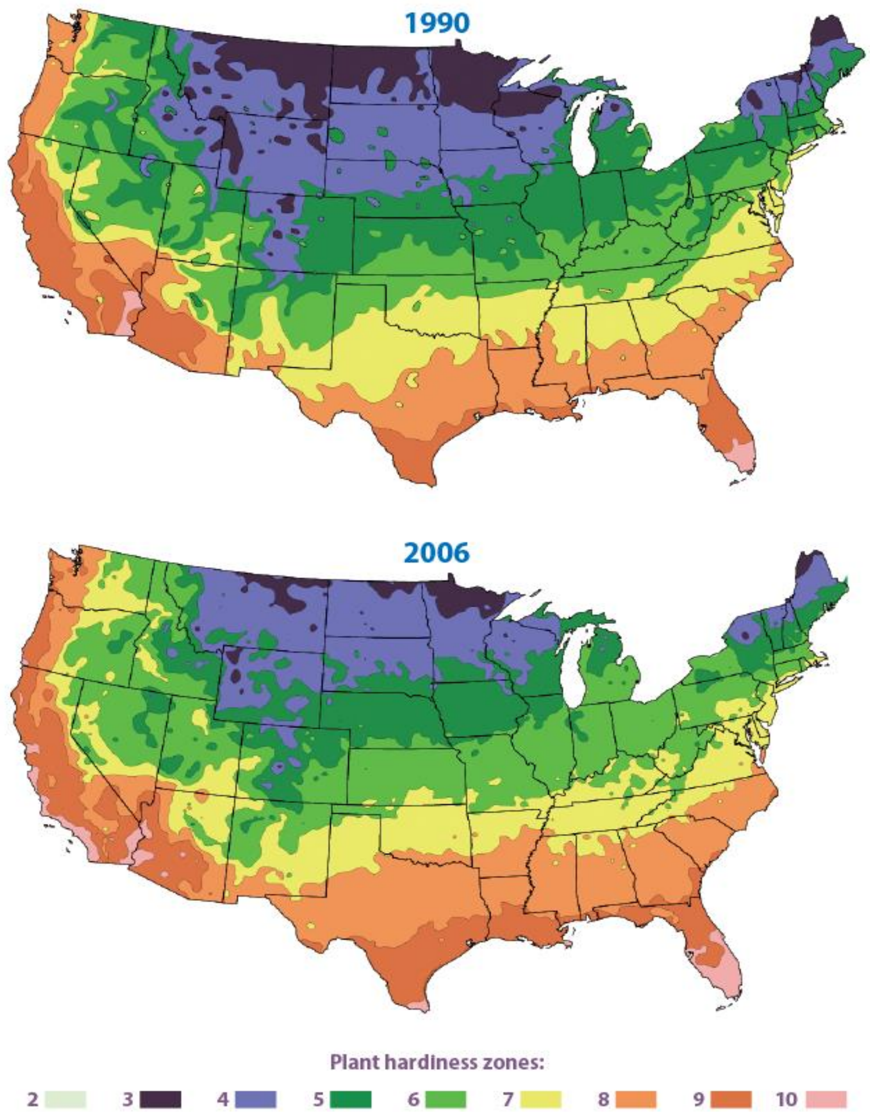
Length of Growing Season in the Lower 48 States, 1900–2002



Data source: Kunkel, K.E. 2009 update to data originally published in: Kunkel, K.E., D.R. Easterling, K. Hubbard, and K. Redmond. 2004. Temporal variations in frost-free season in the United States: 1895–2000. Geophys. Res. Lett. 31:L03201.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/science/indicators.

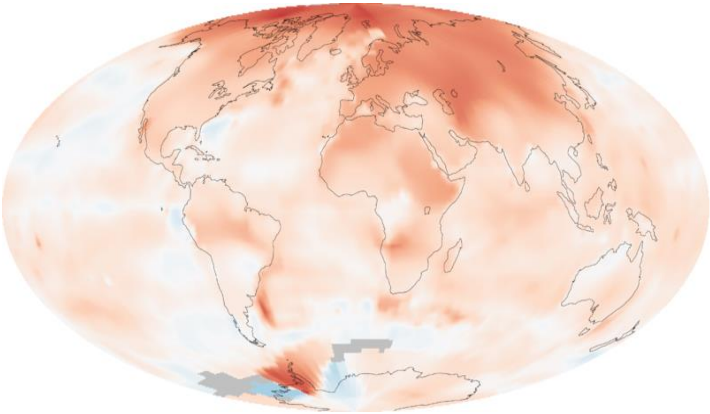
United States Plant Hardiness Zones, 1990 and 2006



Data source: Arbor Day Foundation. 2006. Differences between 1990 USDA hardiness zones and 2006 arborday.org hardiness zones reflect warmer climate. www.arborday.org/media/map_change.cfm.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/science/indicators.

Global Warming

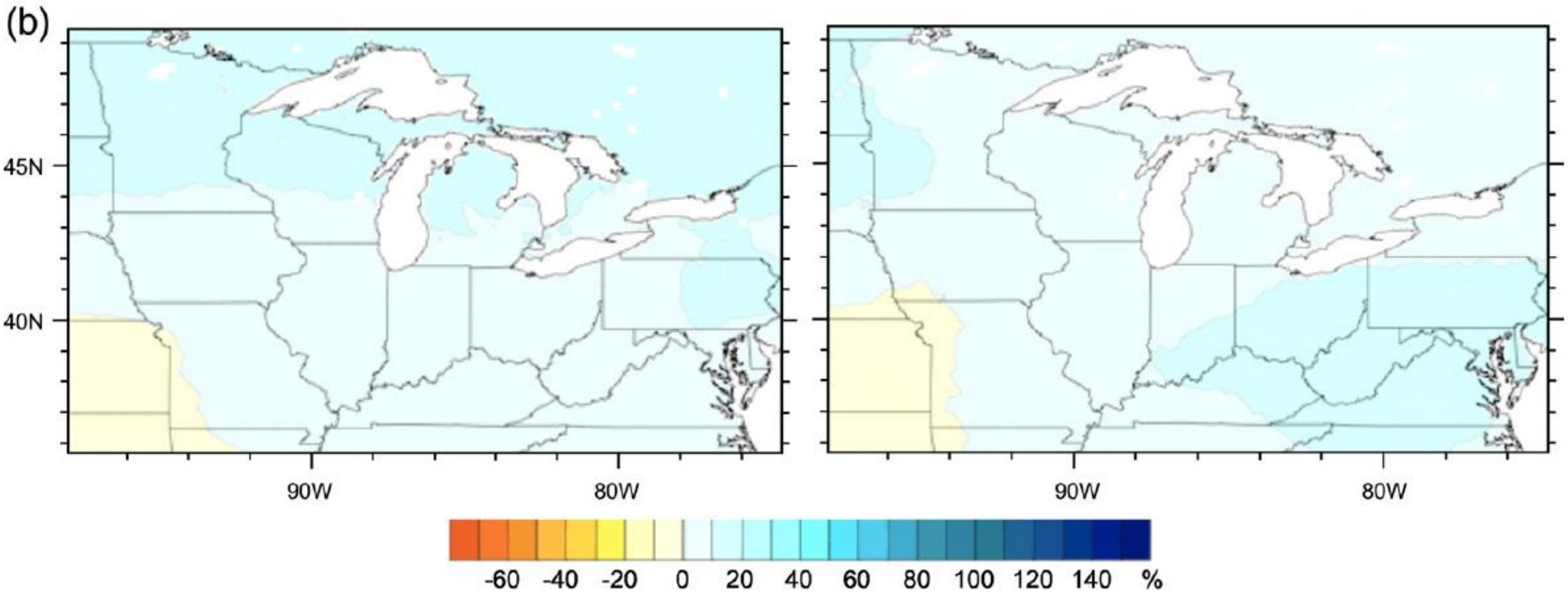


- Increase in the average temperature due to increased concentrations of greenhouse gases in the atmosphere.

Climate Change

- Changes in climate variables such as precipitation, snow, and wind patterns, sea level, extreme events in addition to temperature changes.

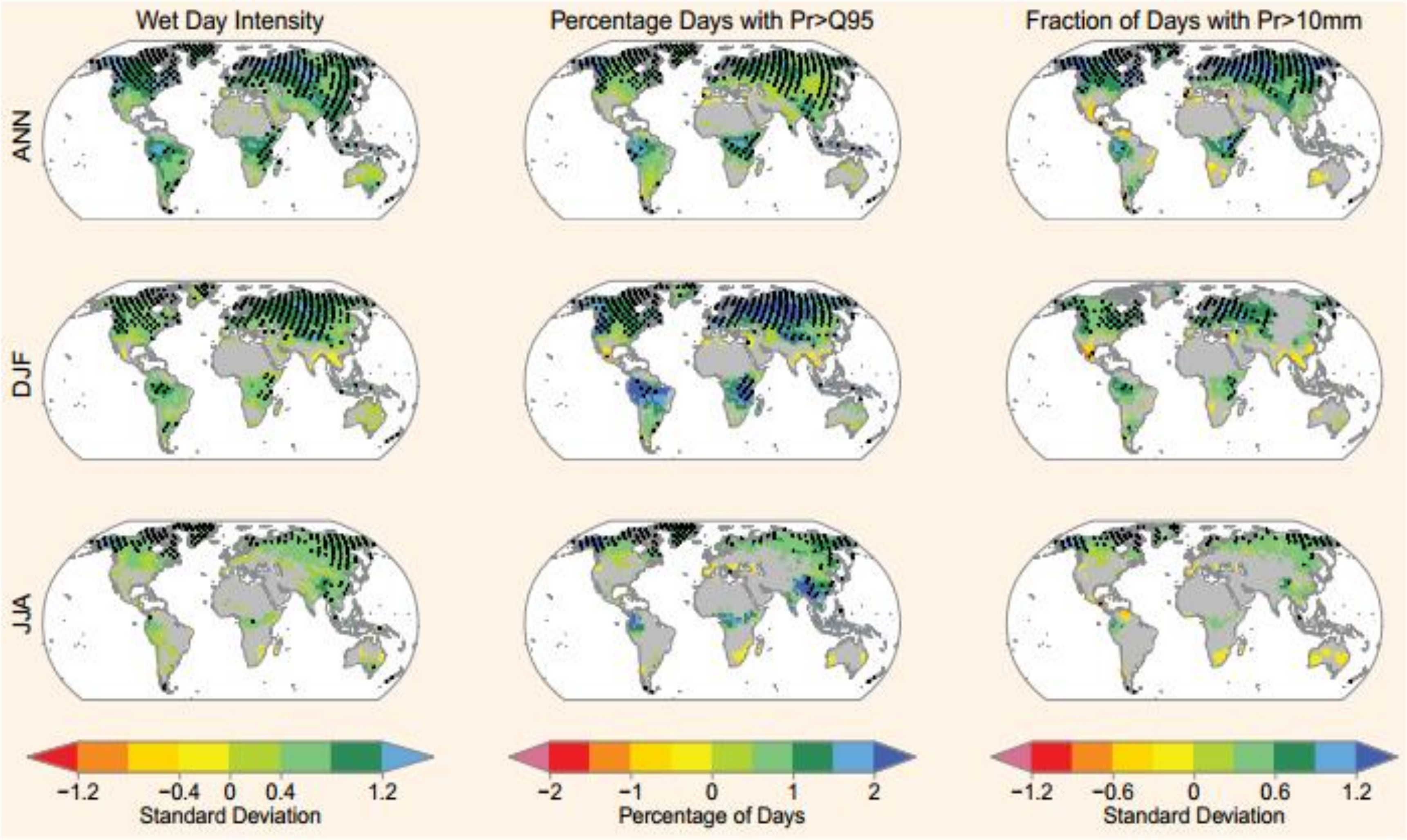
Precipitation 2070-2099



(Hayhoe et al., 2010)

Projected Changes in Daily Precipitation

2081-2100 vs. 1981-2000



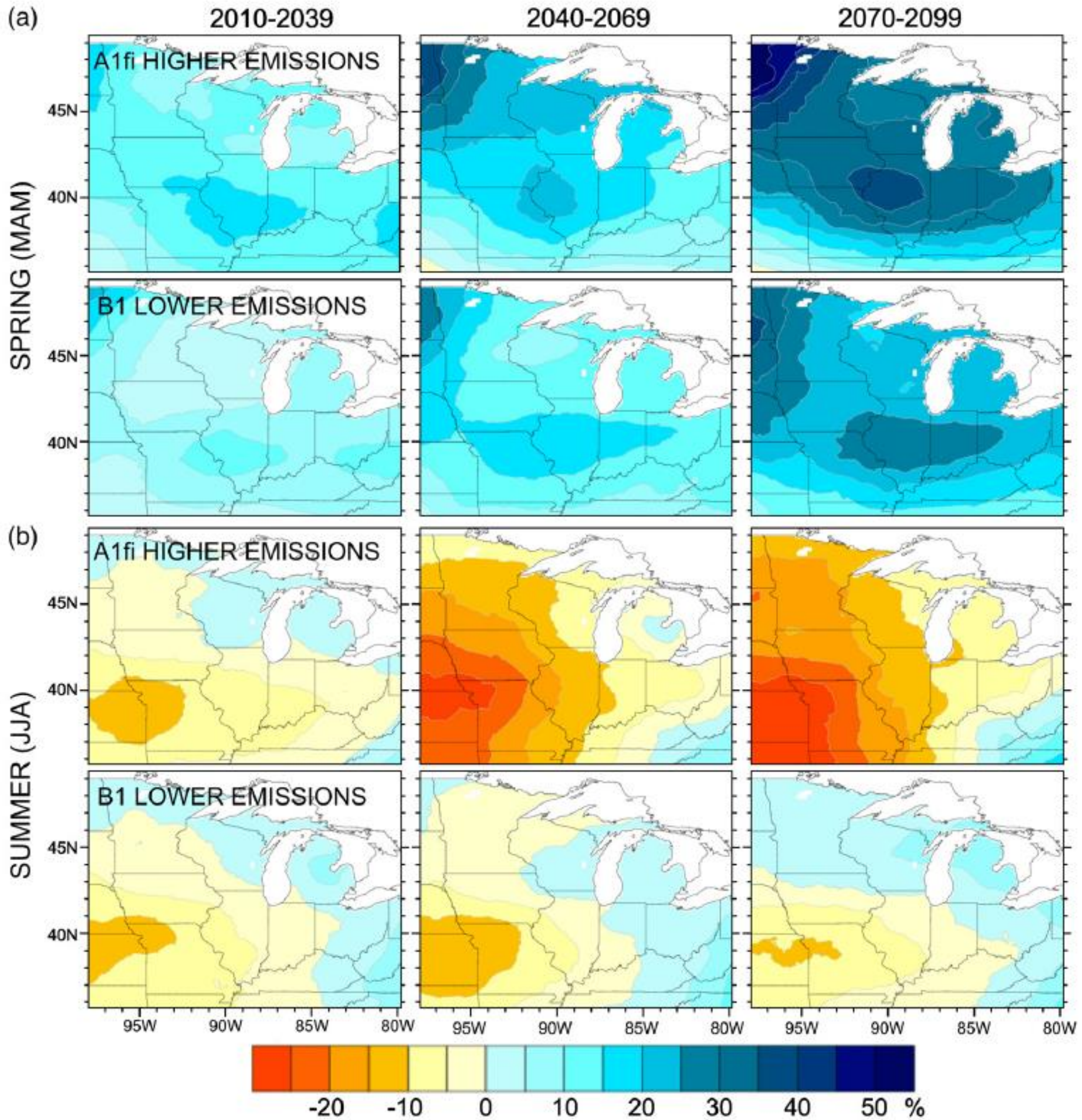


Fig. 7. Projected change in (a) spring (Mar–Apr–May) and (b) summer (Jun–Jul–Aug) average precipitation as simulated under the SRES A1fi (higher) and B1 (lower) emissions scenarios by the average of the subset of 3 AOGCMs used for the impact analyses presented in this volume. Precipitation projections are in units of percentage change relative to the 1961–1990 average and have been statistically downscaled to a spatial resolution of one-eighth degree.

How can climate change impact growers?

- Temperature
- Precipitation
- Extreme events
- Cloud cover
- Carbon dioxide levels

- Planting and harvest times
- Plant growth and development
- Weed, disease, & insect outbreaks
- Water quantity and quality
- Irrigation needs

(Tubiello et al. 2007)

Adaptation for MI Dry Beans

- An already resilient crop
  - Flexible growth habit
  - Fixes atmospheric N
  - Benefits from CO2 enrichment
- Adaptation to drought
  - Beed new tolerant cultivars
  - Plant earlier in the year
  - Improve irrigation
  - Move production northward

Objectives

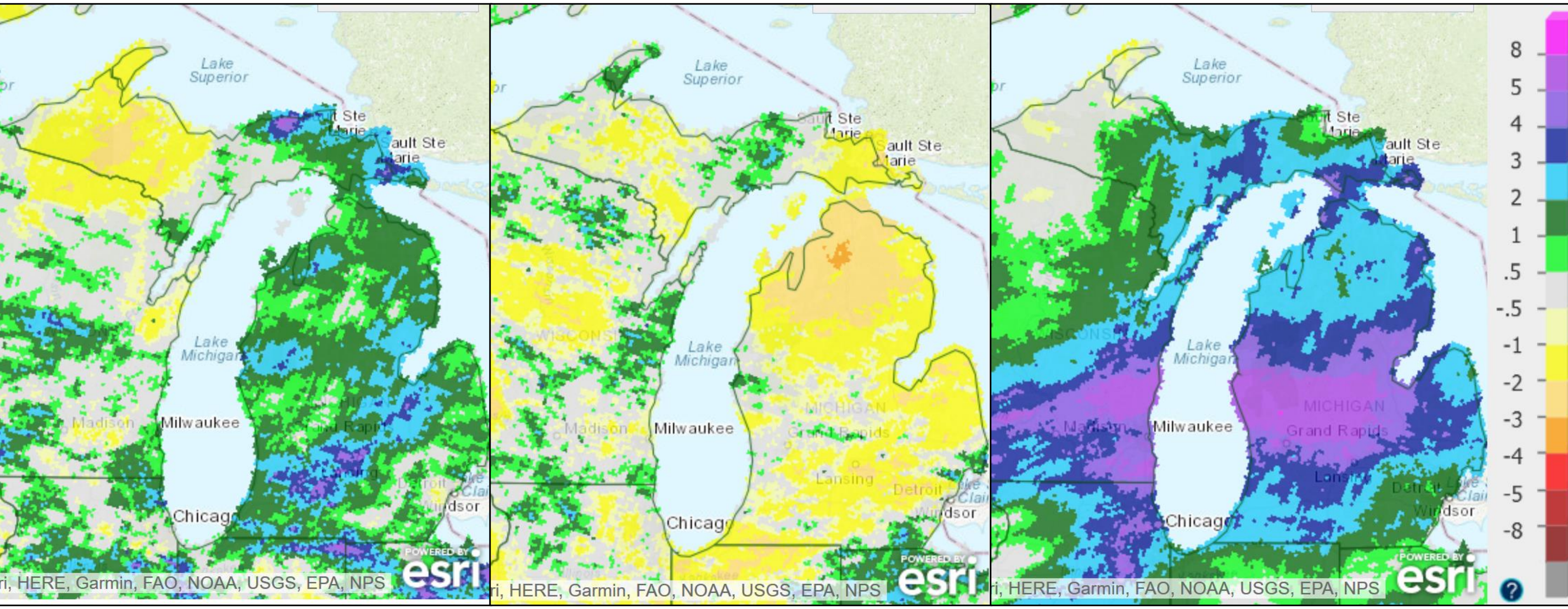
1. Investigate drought tolerance of dry bean cultivars adapted to organic production in Michigan, including N fixation and yield
2. Share climate data, projections and research results with Michigan dry bean producers
3. Gather grower and expert input to improve understanding of potential risks and benefits of climate change in MI dry bean systems

Methods

- Two locations in Chatham and East Lansing, MI
- 4 dry bean varieties, including R-99 a non-nodulating mutant
- Planted June 11 (UP) and June 20 (EL) at 120,000 seeds/acre
- Plots 25’ long with 14” (UP) and 30” (EL) row spacing
- No N fertilizer applied, only K and S
- Rainout shelters installed R1-R2 over half of each plot
- Precipitation and soil moisture monitored weekly

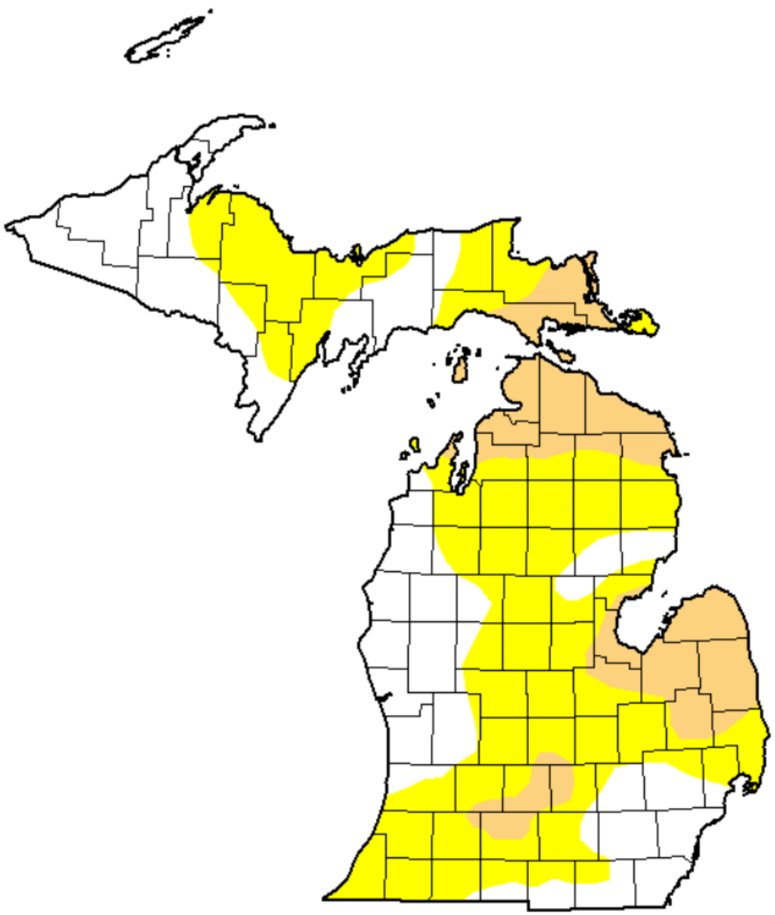
Border	108 Cayenne	Border	208 Rosetta	Border	308 B18504	Border	408 Rosetta	Border
	107 Cayenne		207 Rosetta		307 B18504		407 Rosetta	
Border	106 Rosetta	Border	206 R-99	Border	306 R-99	Border	406 Cayenne	Border
	105 Rosetta		205 R-99		305 R-99		405 Cayenne	
Border	104 B18504	Border	204 B18504	Border	304 Rosetta	Border	404 R-99	Border
	103 B18504		203 B18504		303 Rosetta		403 R-99	
Border	102 R-99	Border	202 Cayenne	Border	302 Cayenne	Border	402 B18504	Border
	101 R-99		201 Cayenne		301 CAyenne		401 B18504	

2019 Precipitation vs. Normal



June August September

U.S. Drought Monitor
Michigan



September 3, 2019
(Released Thursday, Sep. 5, 2019)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.75	64.25	17.29	0.00	0.00	0.00
Last Week 08-27-2019	34.16	65.84	6.96	0.00	0.00	0.00
3 Months Ago 06-04-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	72.18	27.82	8.67	0.00	0.00	0.00
One Year Ago 09-04-2018	64.13	35.87	14.96	0.00	0.00	0.00

Intensity:
- None
- 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.

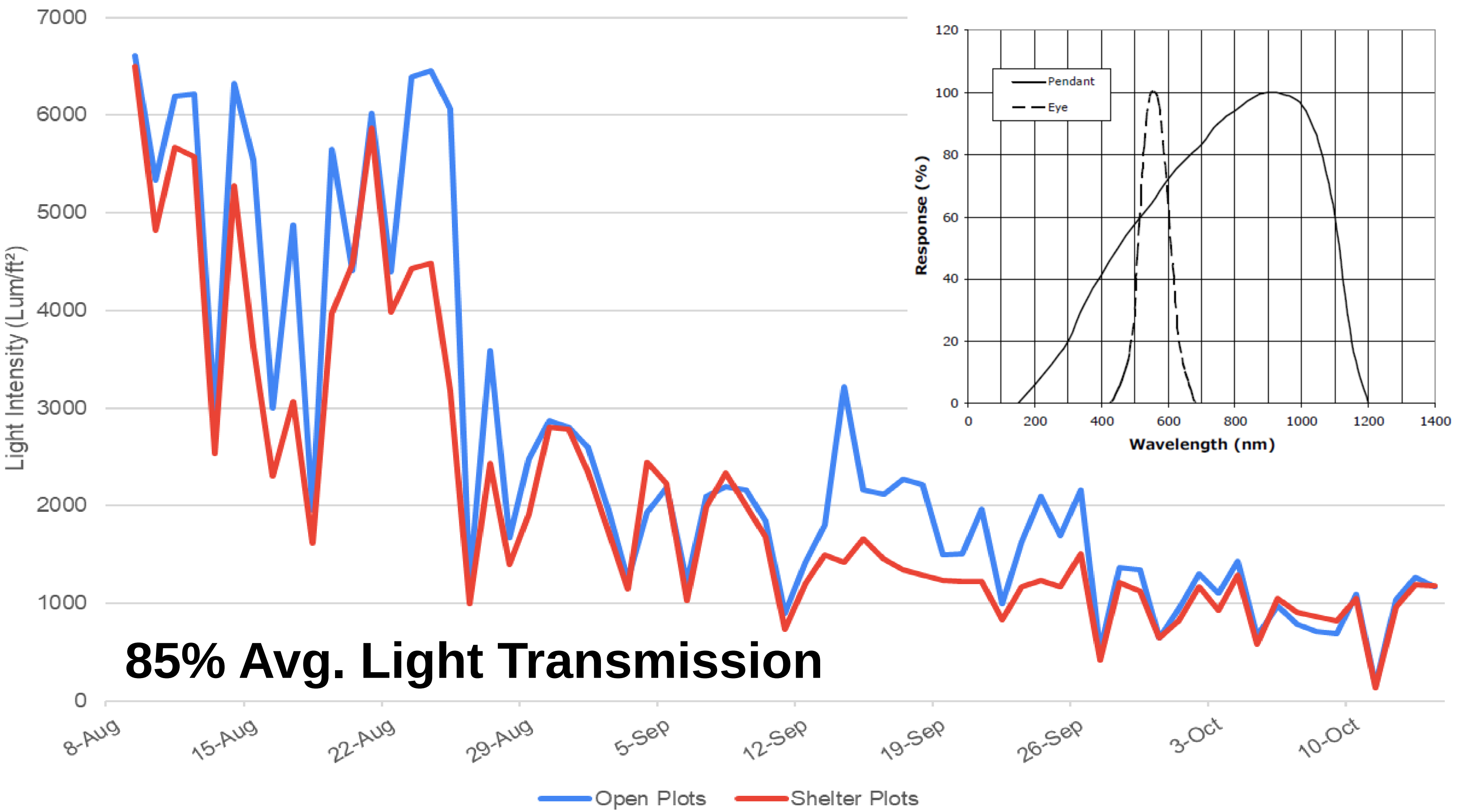
Author:
David Miskus
NOAA/NWS/NCEP/CPC

droughtmonitor.unl.edu

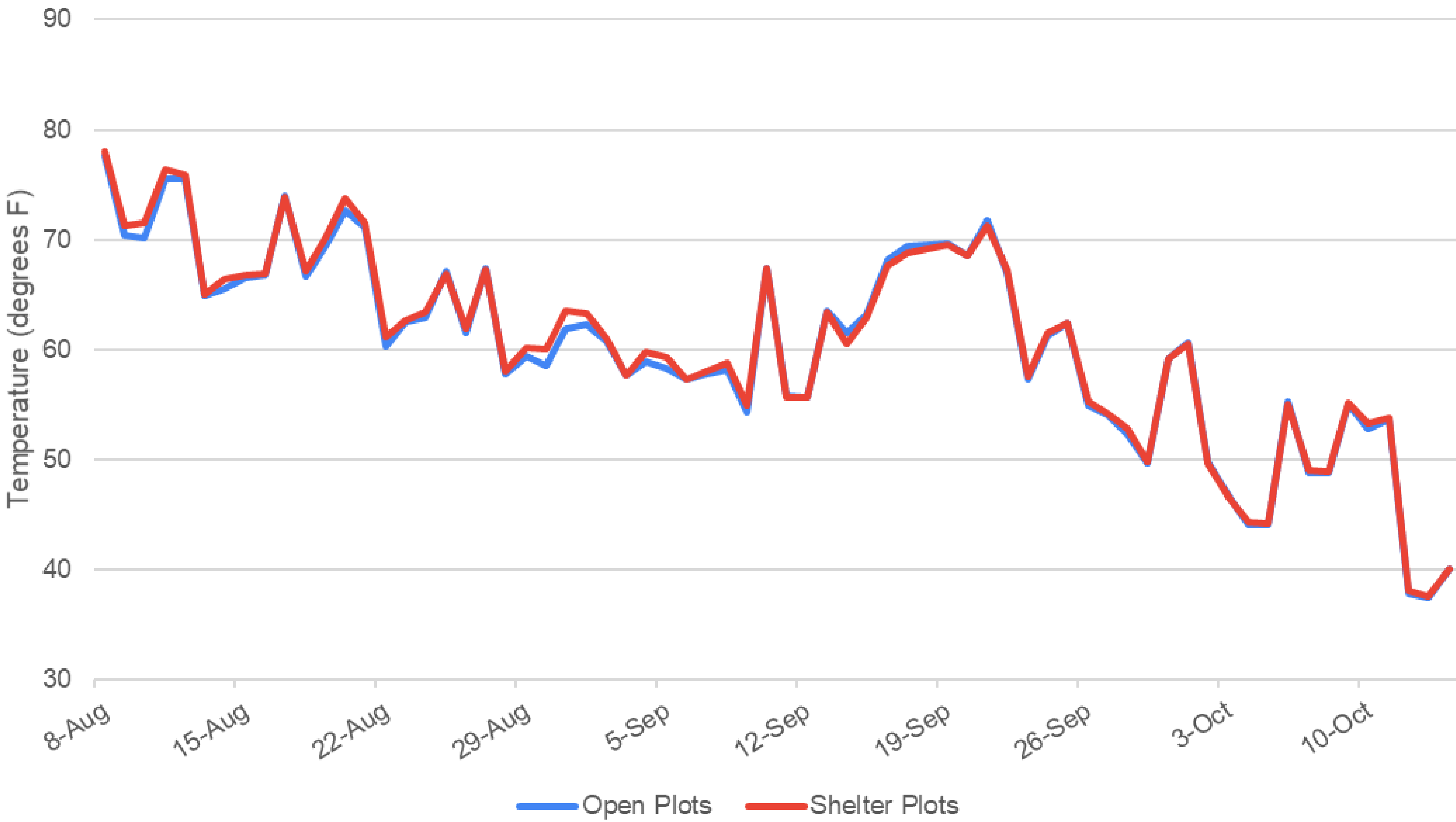
AgBioResearch MICHIGAN STATE UNIVERSITY

MICHIGAN STATE UNIVERSITY Extension

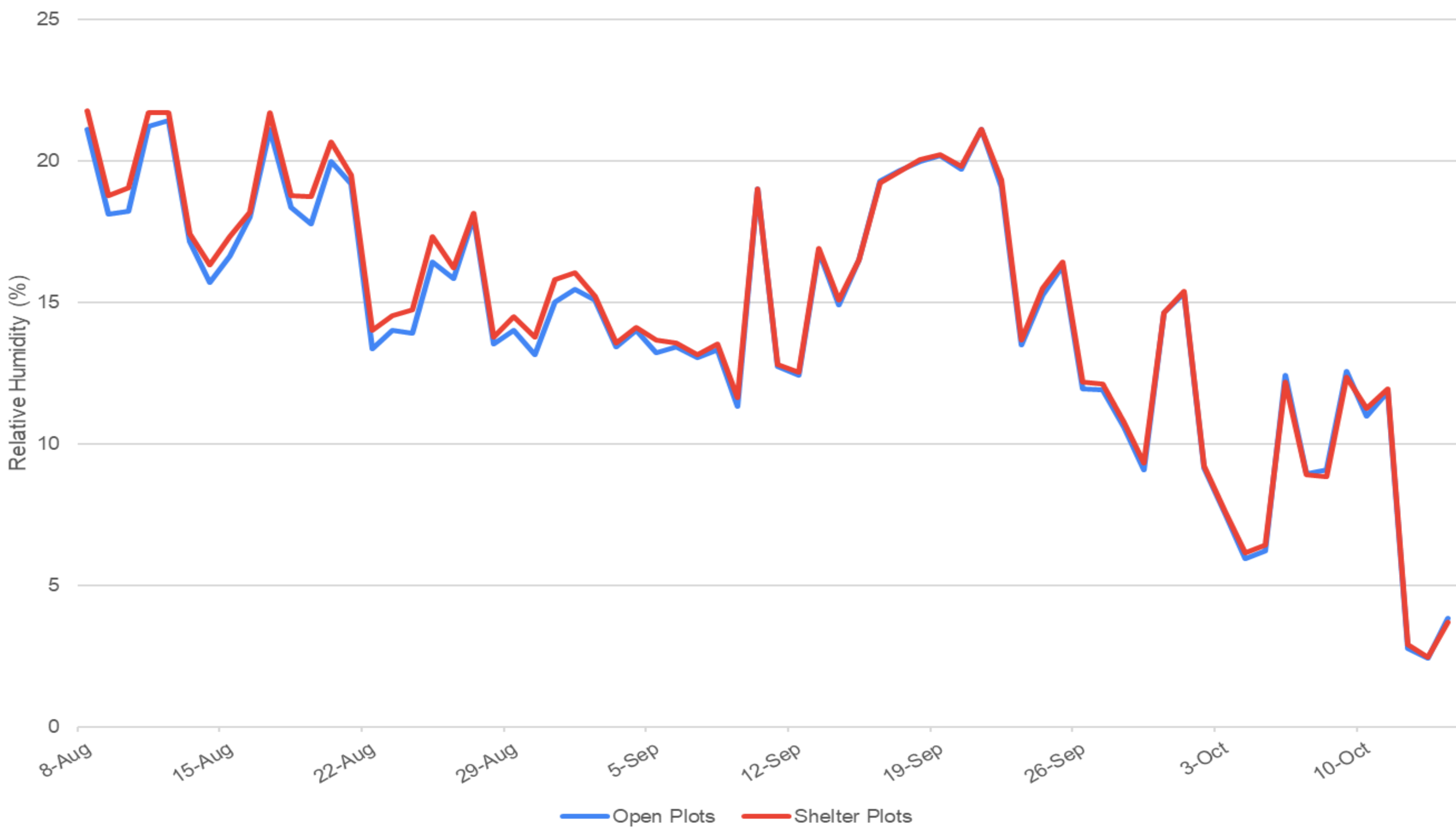
Mean Daily Light Intensity at Chatham, MI

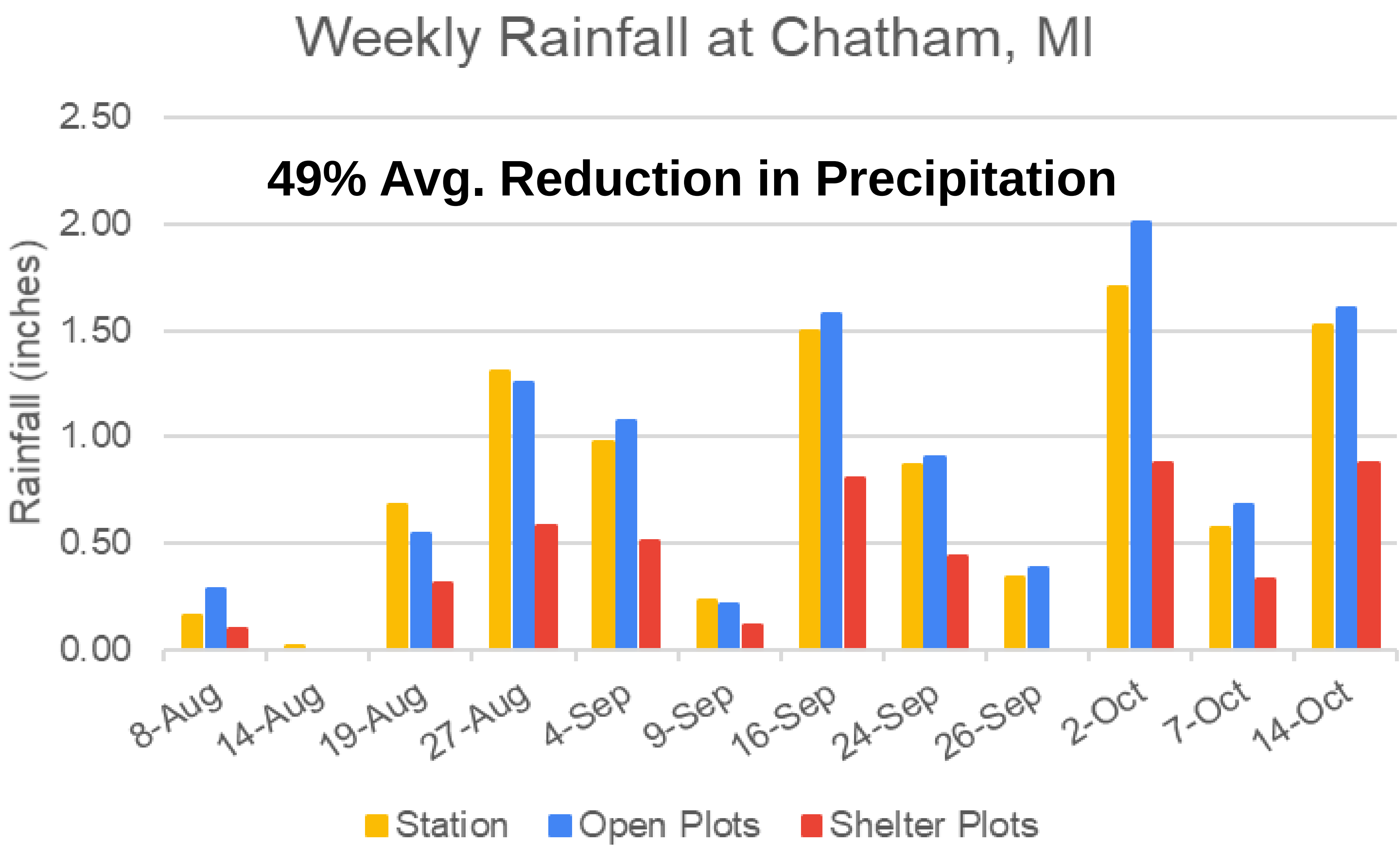


Mean Daily Canopy Temperature at Chatham, MI

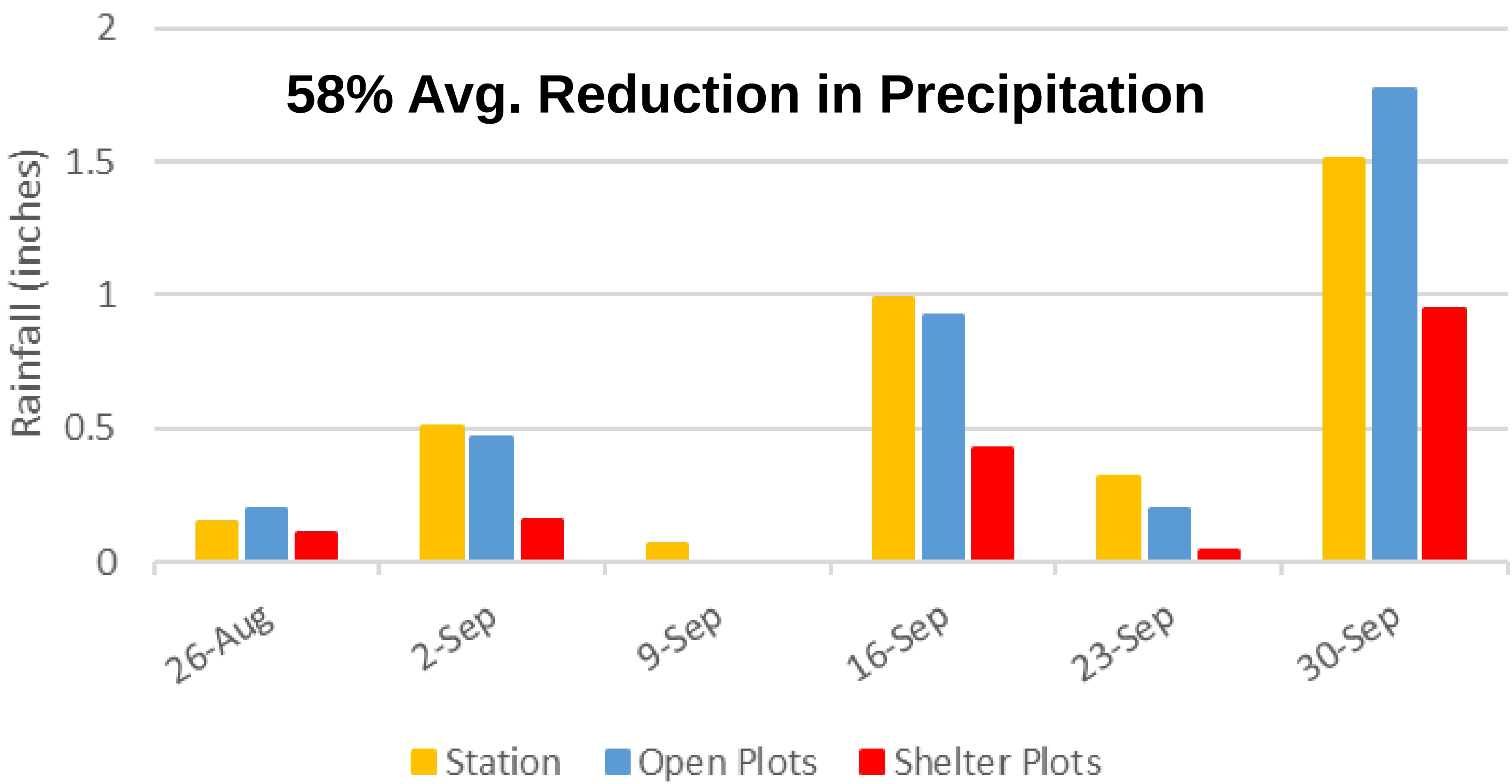


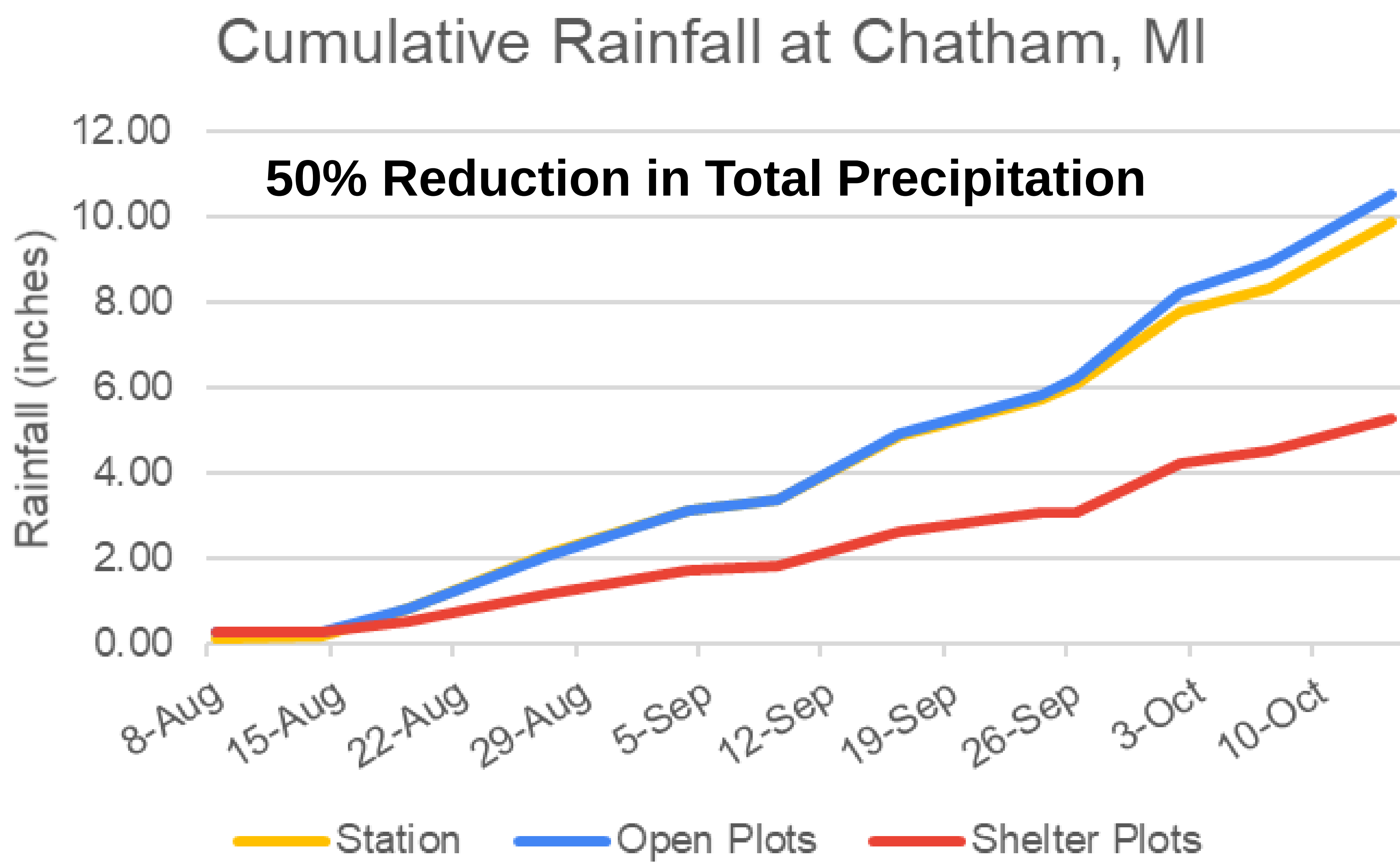
Mean Daily Relative Humidity at Chatham, MI

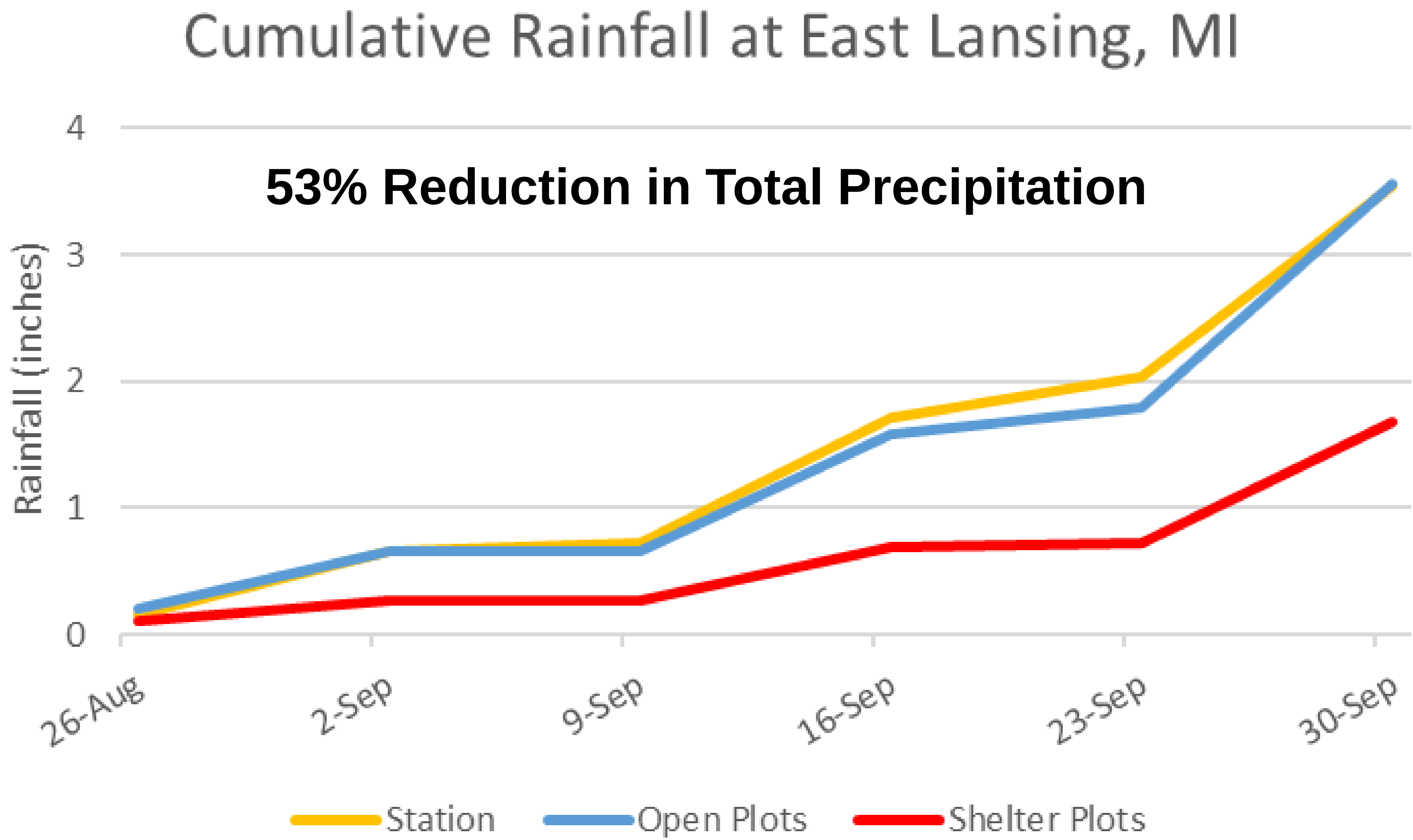


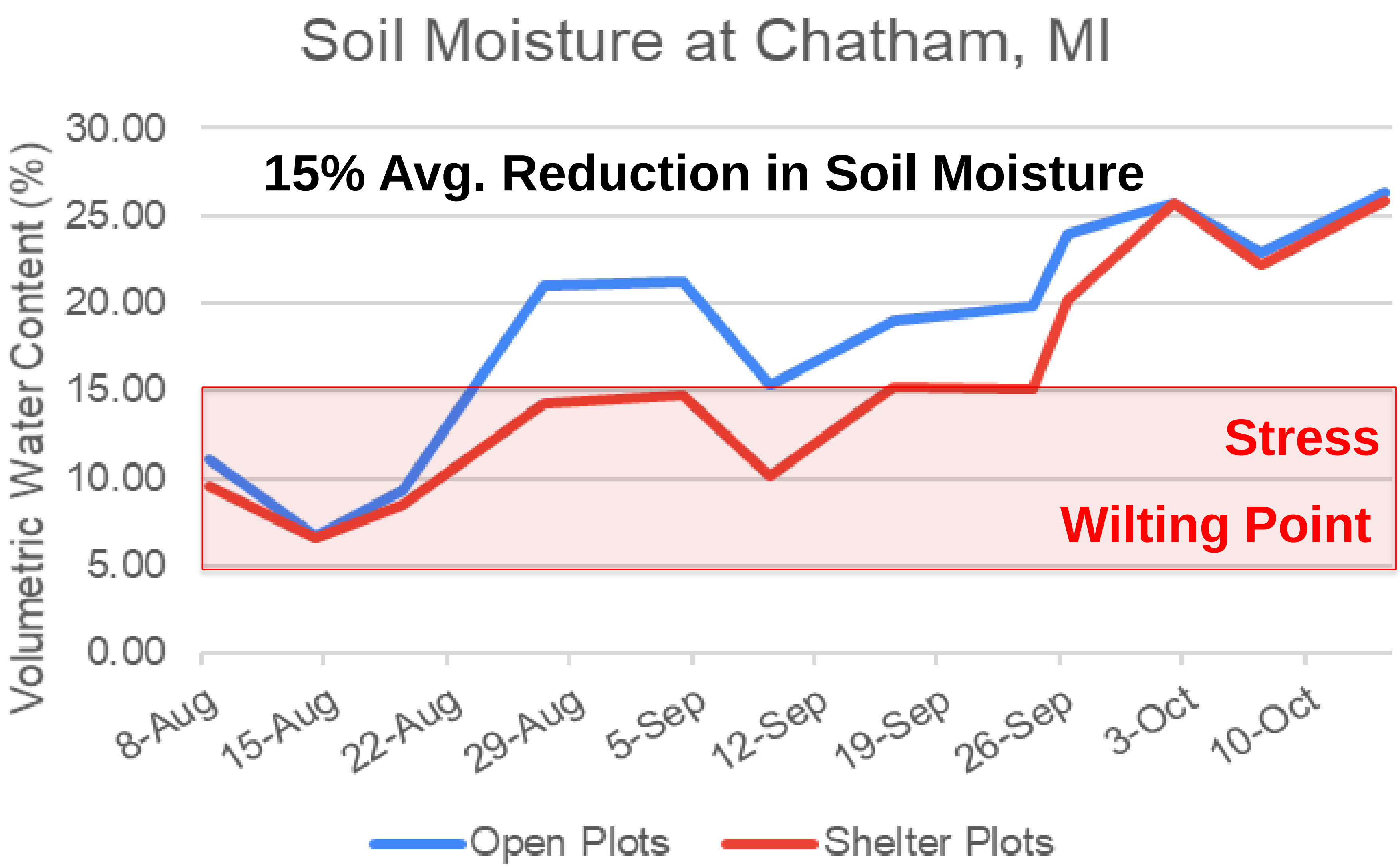

Weekly Rainfall at Chatham, MI
49% Avg. Reduction in Precipitation
Rainfall (inches)
2.50
2.00
1.50
1.00
0.50
0.00
8-Aug
14-Aug
19-Aug
27-Aug
4-Sep
9-Sep
16-Sep
24-Sep
26-Sep
2-Oct
7-Oct
14-Oct
Station
Open Plots
Shelter Plots

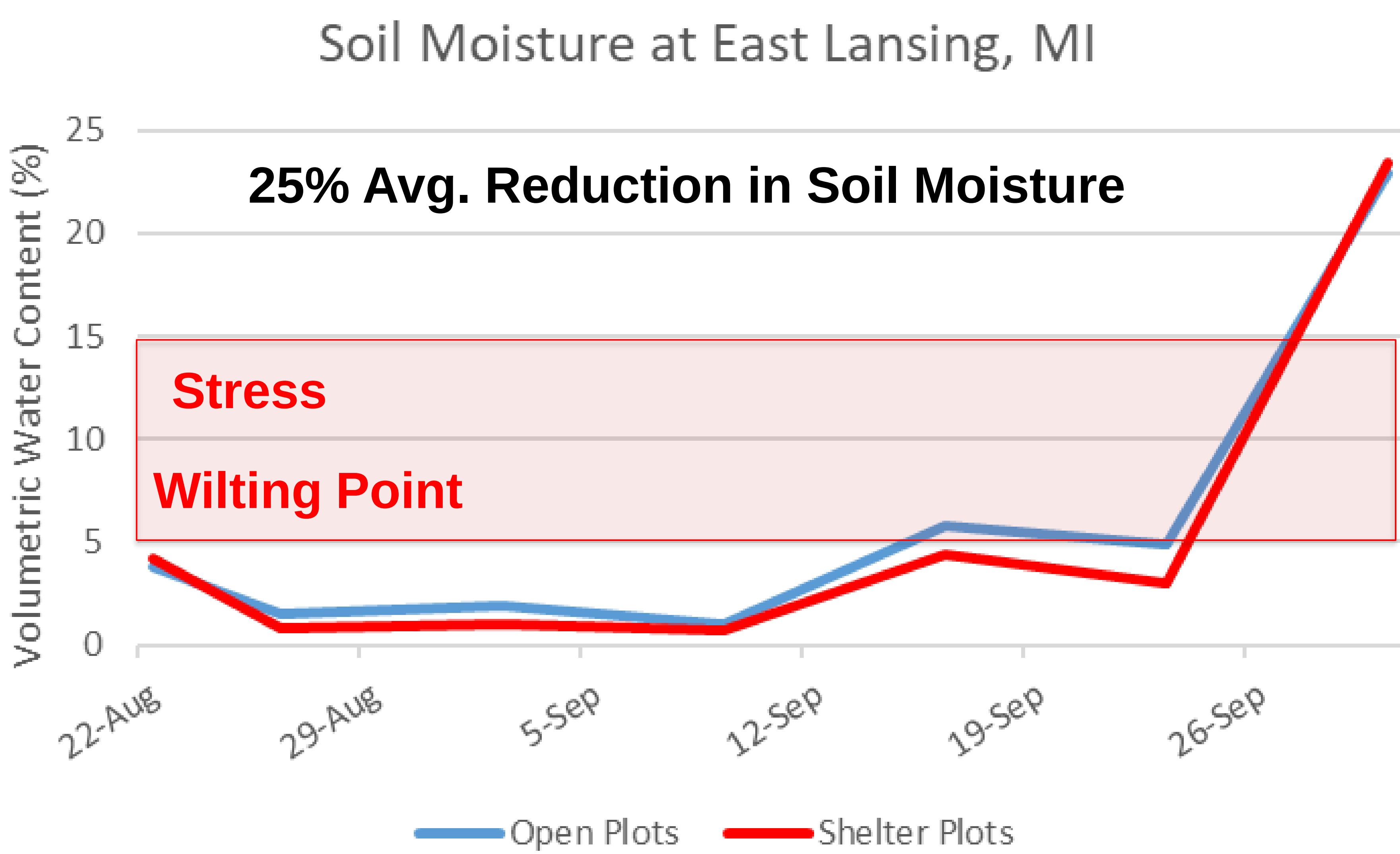
Weekly Rainfall at East Lansing, MI



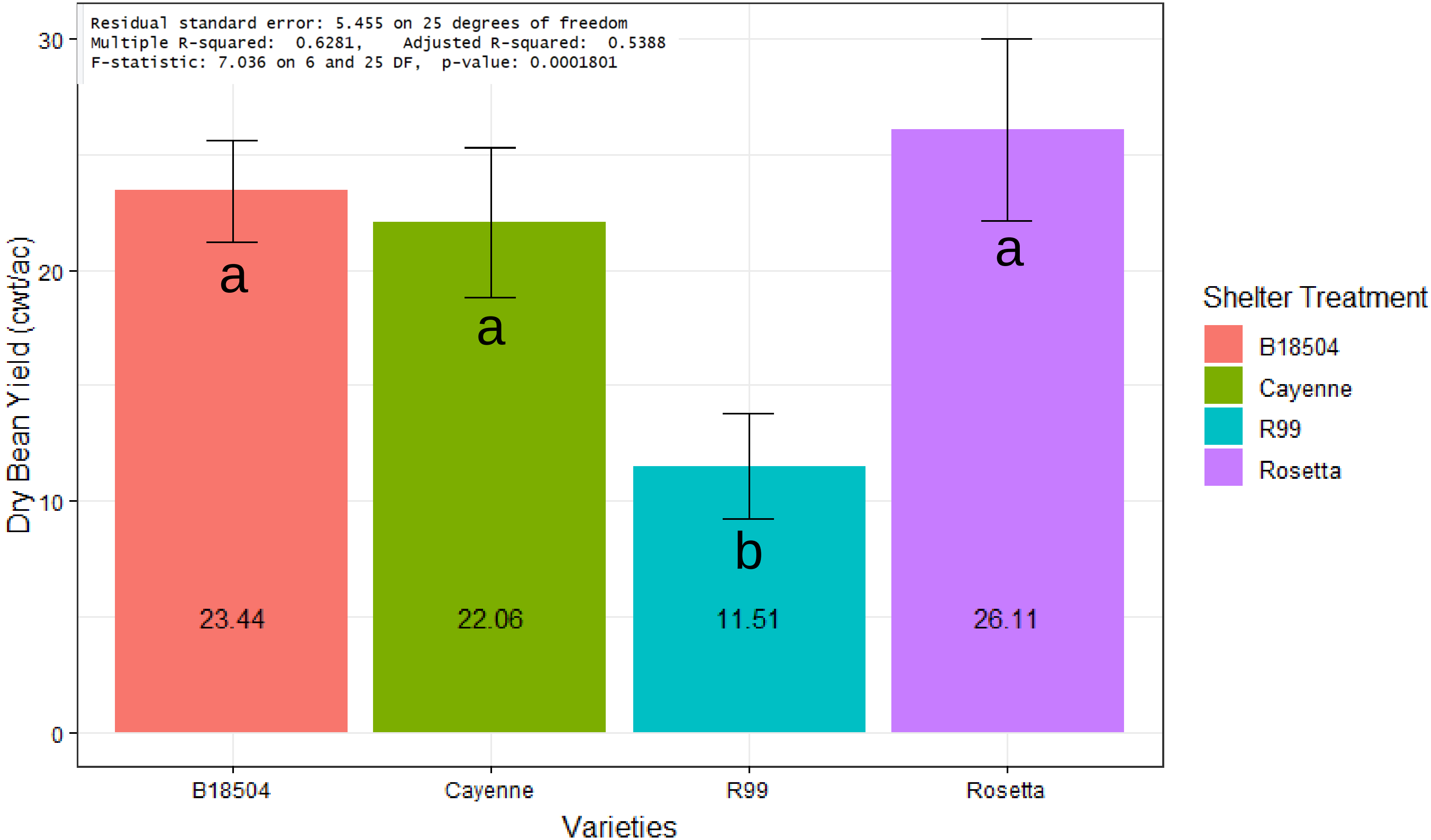

Cumulative Rainfall at Chatham, MI
50% Reduction in Total Precipitation
Rainfall (inches)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
3-Oct
10-Oct
Station
Open Plots
Shelter Plots


Cumulative Rainfall at East Lansing, MI
53% Reduction in Total Precipitation
Rainfall (inches)
0
1
2
3
4
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
Station
Open Plots
Shelter Plots

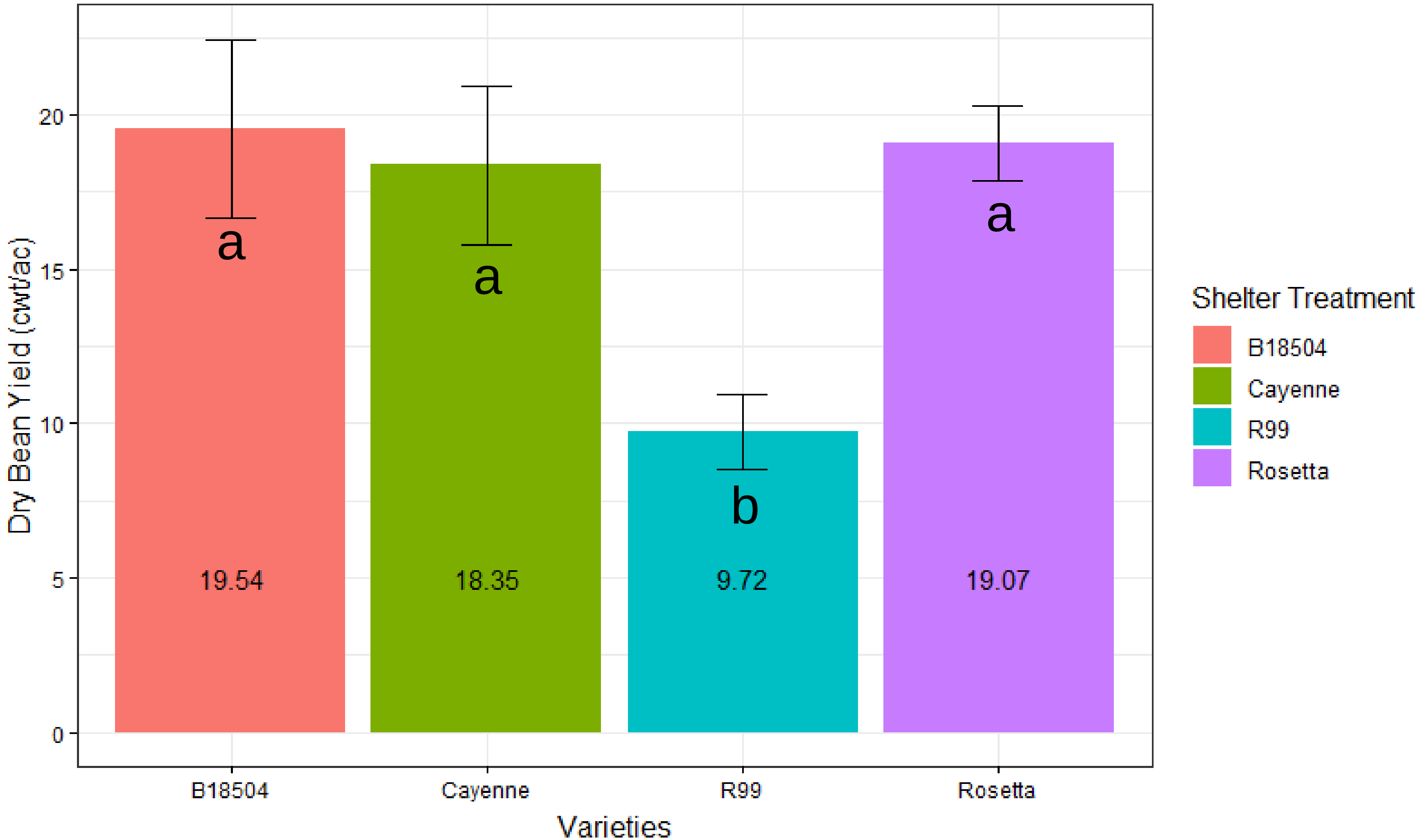

Soil Moisture at Chatham, MI
15% Avg. Reduction in Soil Moisture
Volumetric Water Content (%)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Stress
Wilting Point
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
3-Oct
10-Oct
Open Plots
Shelter Plots


Soil Moisture at East Lansing, MI
25% Avg. Reduction in Soil Moisture
Volumetric Water Content (%)
25
20
15
10
5
0
Stress
Wilting Point
22-Aug
29-Aug
5-Sep
12-Sep
19-Sep
26-Sep
Open Plots
Shelter Plots

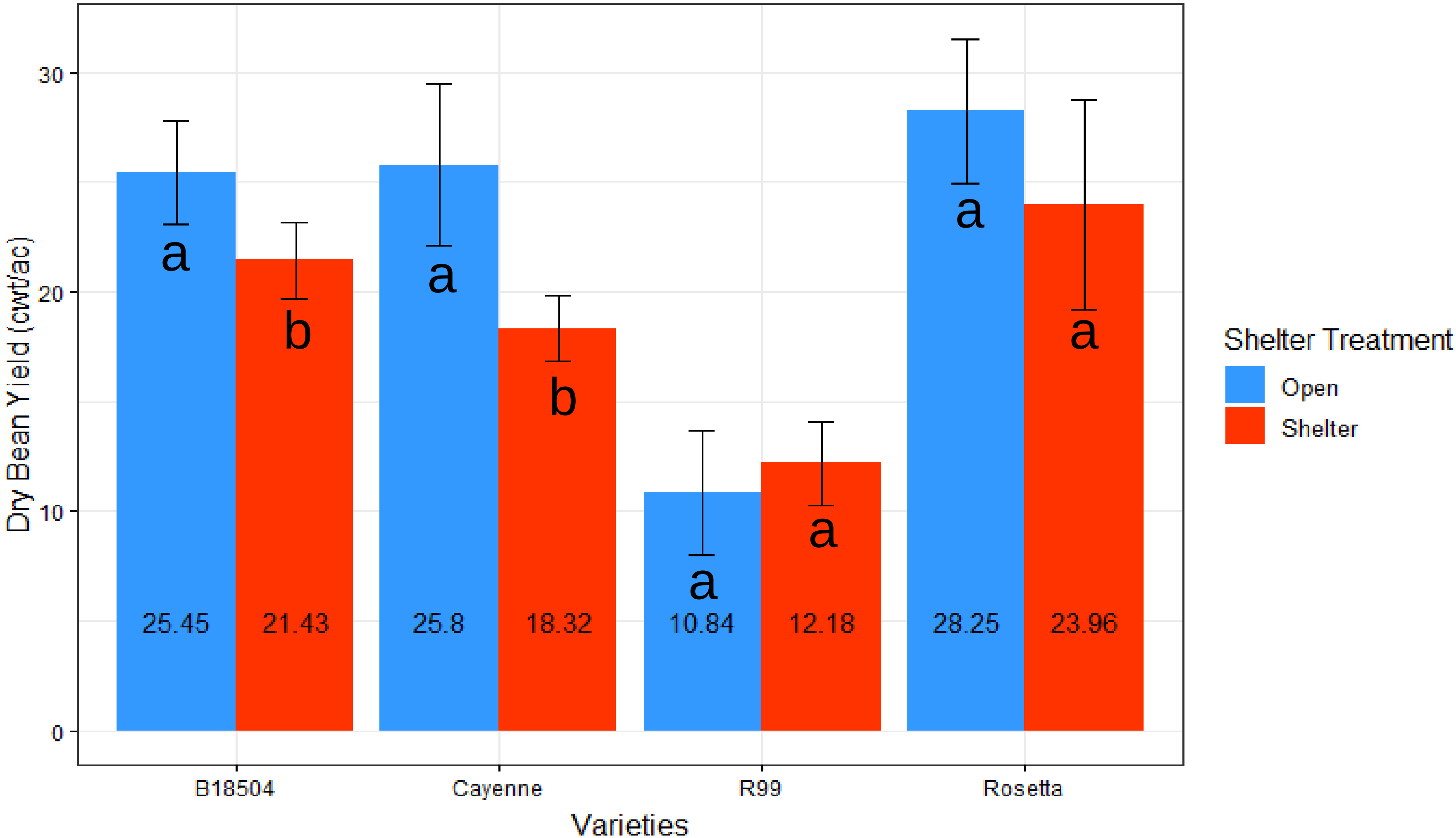
Dry Bean Yield by Variety at Chatham, MI



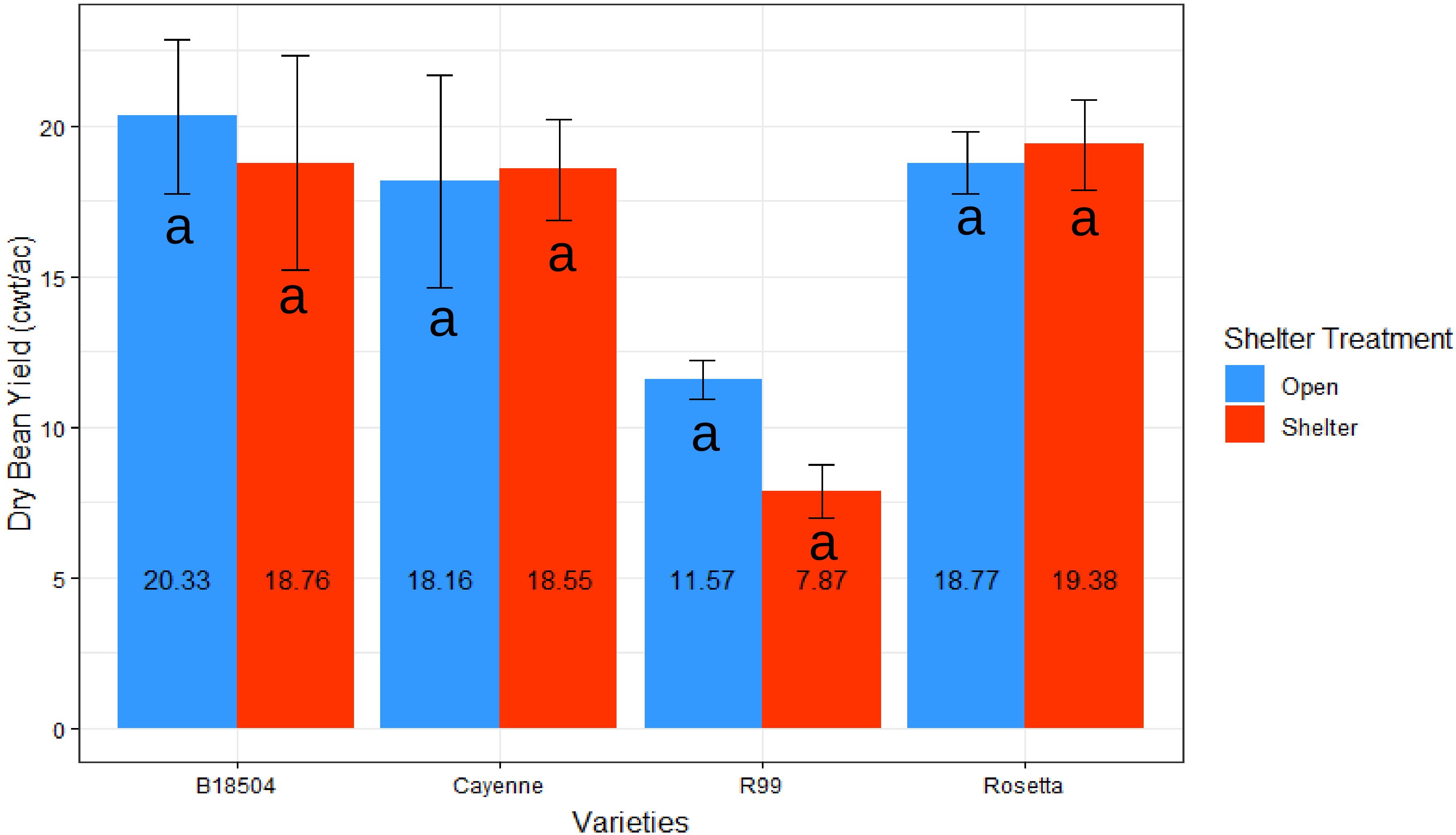
Dry Bean Yield by Variety at East Lansing, MI



Dry Bean Yield by Treatment at Chatham, MI



Dry Bean Yield by Treatment at East Lansing, MI



Conclusions and Next Steps

- Achieving controlled soil moisture conditions is challenging with static rainout shelters, no irrigation
- N fixation is important for yield, esp. in organic
- Of the four varieties, Rosetta yield was least affected by drought
- Still analyzing effect of treatment on maturity, height, N fixation and seed microbiome
- Opportunities for northward expansion of MI dry bean production exist
- GLISA dry bean climate impact scenarios project

GLISA Climate Impact Scenarios

Phase I

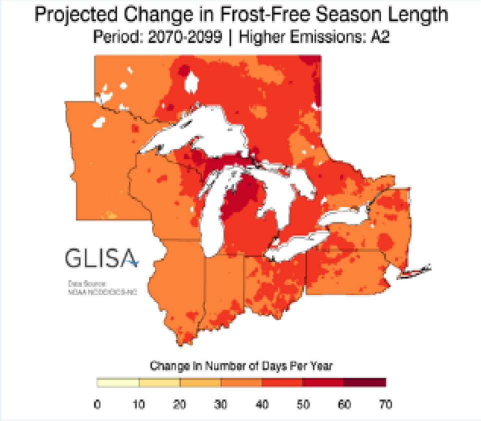
Assess vulnerabilities of organic dry bean production and associated climate variables

- Stakeholder meetings
- Identify climate variables that will impact future dry bean production systems:
  - ✓ Growing degree days
  - ✓ Precipitation
  - ✓ Temperature
  - ✓ Frost free dates
  - ✓ Drought and soil moisture
  - ✓ Etc…

Phase II

Develop climate impact scenarios based on GLISA projections

- Model future climate variability and its potential impacts on organic dry bean production

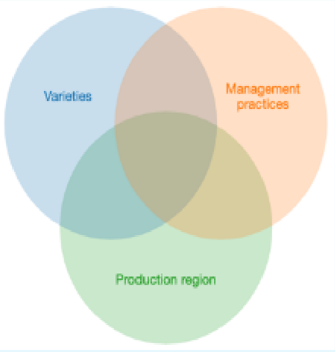


http://glisa.umich.edu/resources/great-lakes-regional-climate-change-maps

Phase III

Integrated research and extension to disseminate key findings to primary stakeholders

- Interactive extension meetings (fishbowl approach)
- Facilitate improved dry bean production, via:
  - ✓ Climate resilient varieties
  - ✓ Optimized agronomic management practices
  - ✓ New production regions (or climate havens)



Acknowldegements

- MSU Plant Resilience Institute
- Jim Kelly and Andrew Wiersma
- Chris Kapp and Evan Wright
- Joe Charlebois, Andy Bahrman, Allison Stawara
- Erin Burns
- GLISA