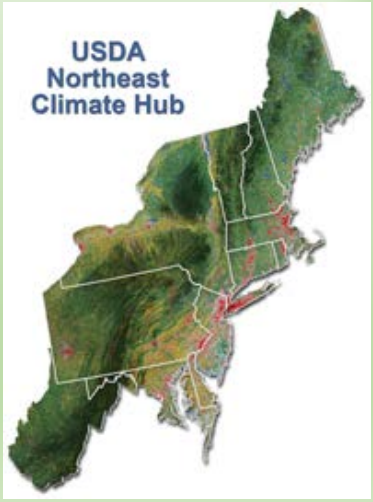
Agricultural Decision Tools from the Cornell Climate Smart Farming (CSF) Program and the Network for Environment and Weather Applications (NEWA)

Dan Olmstead – NEWA

Jonathan Lambert – Cornell CSF

USDA Conservation Webinar

May 4th, 2016



NEWA

Network for Environment and Weather Applications

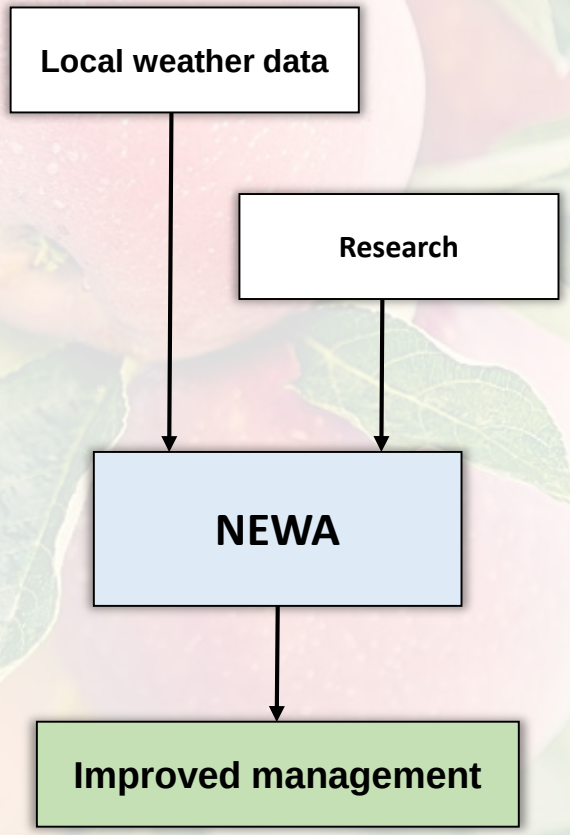
newa.cornell.edu

Dan Olmstead, Extension Associate
NEWA Coordinator, New York State IPM Program
Cornell Cooperative Extension

dlo6@cornell.edu

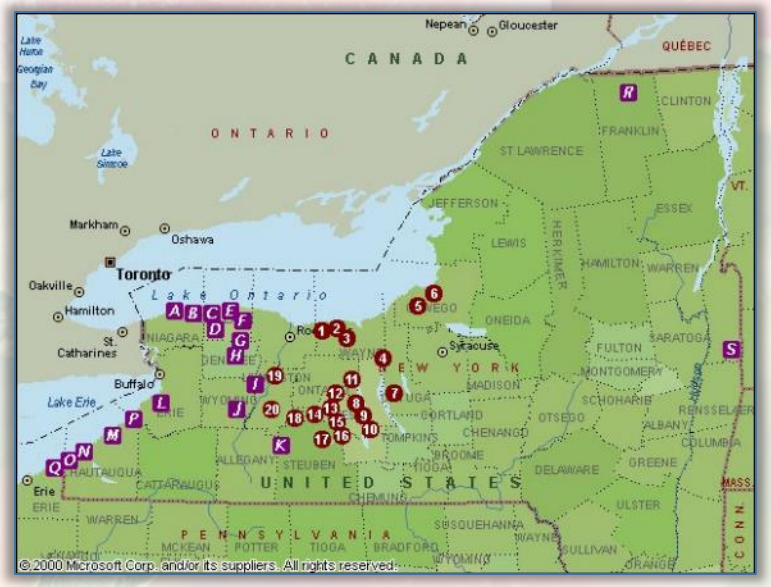
What is NEWA?

- Online grower tools and resources
- Weather station network
- Near real-time weather data
- Local (vs. regional) weather information



History

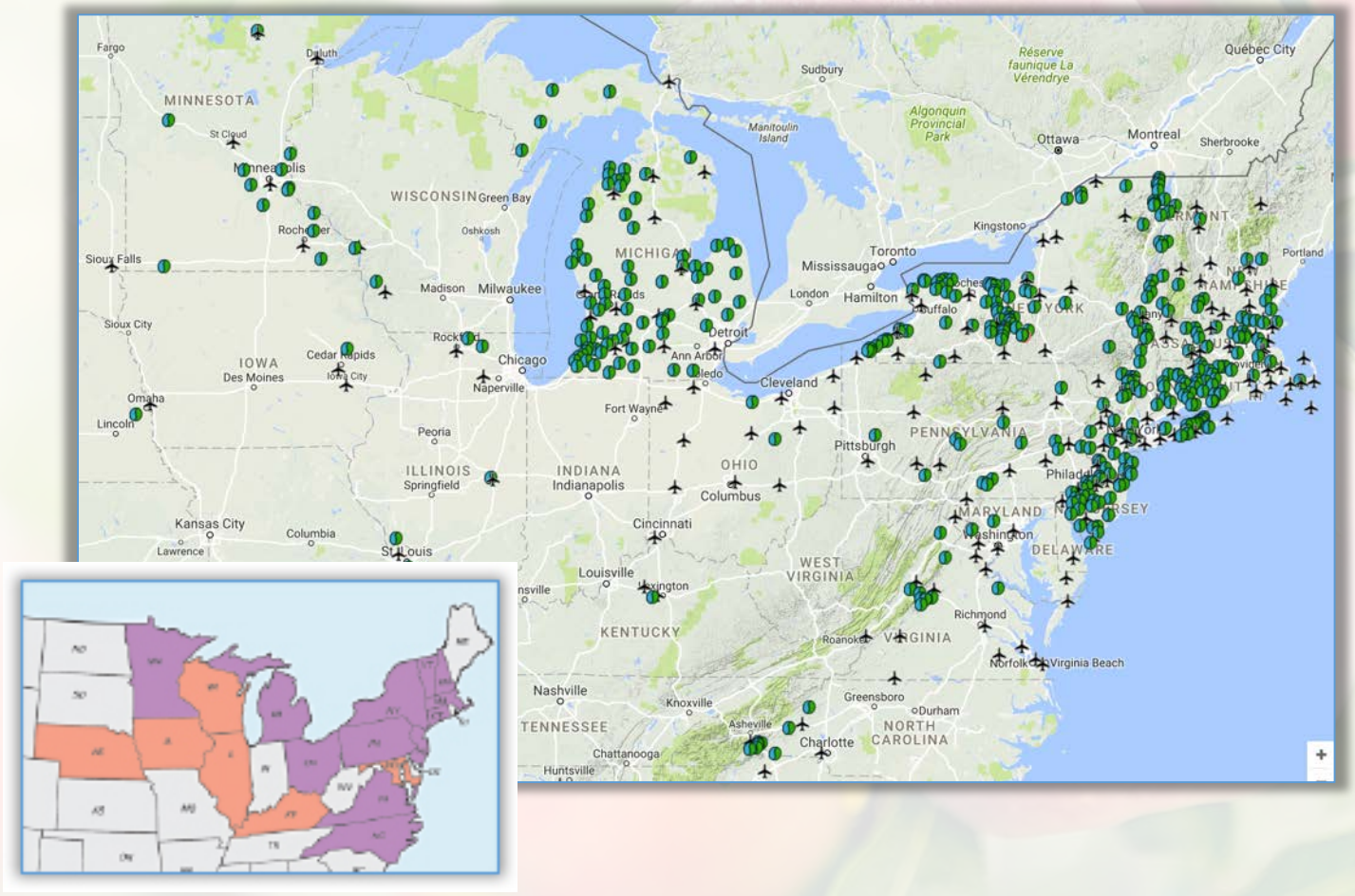
- Circa 1996
  - NYS IPM Program
  - Curt Petzoldt (founder)
  - Juliet Carroll (NEWA Leader)
  - Tim Weigle (NYSIPM, Grape Extension area educator)
- Manual downloads, fax, modem



NEWA now

- Rainwise stations
- State mesonets
- NWS airport locations

2017


Fargo
Duluth
MINNESOTA
St Cloud
Minneapolis
WISCONSIN
Green Bay
Oshkosh
Rochester
Sioux Falls
Madison
Milwaukee
Sioux City
Rockford
Cedar Rapids
IOWA
Des Moines
Iowa City
Chicago
Naperville
Omaha
Lincoln
Peoria
ILLINOIS
Springfield
Kansas City
Lawrence
Columbia
St Louis
INDIANA
Indianapolis
Fort Wayne
MICHIGAN
Detroit
Ann Arbor
Toledo
Cleveland
OHIO
Columbus
Cincinnati
Louisville
KENTUCKY
Nashville
TENNESSEE
Knoxville
Chattanooga
Huntsville
Asheville
Charlotte
NORTH CAROLINA
Greensboro
Durham
Richmond
Roanoke
VIRGINIA
Norfolk
Virginia Beach
WEST VIRGINIA
Pittsburgh
PENNSYLVANIA
MARYLAND
Washington
DELAWARE
Philadelphia
Sudbury
Manitoulin Island
Algonquin Provincial Park
Réserve faunique La Vérendrye
Québec City
Ottawa
Montreal
Sherbrooke
Kingston
Toronto
Mississauga
London
Hamilton
Buffalo
Portland

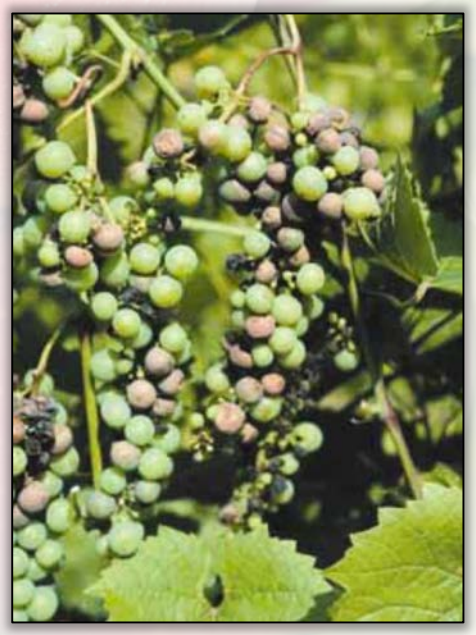
Collaboration

- Land grant universities
- Grower organizations
- Northeast Regional Climate Center

What does NEWA provide?

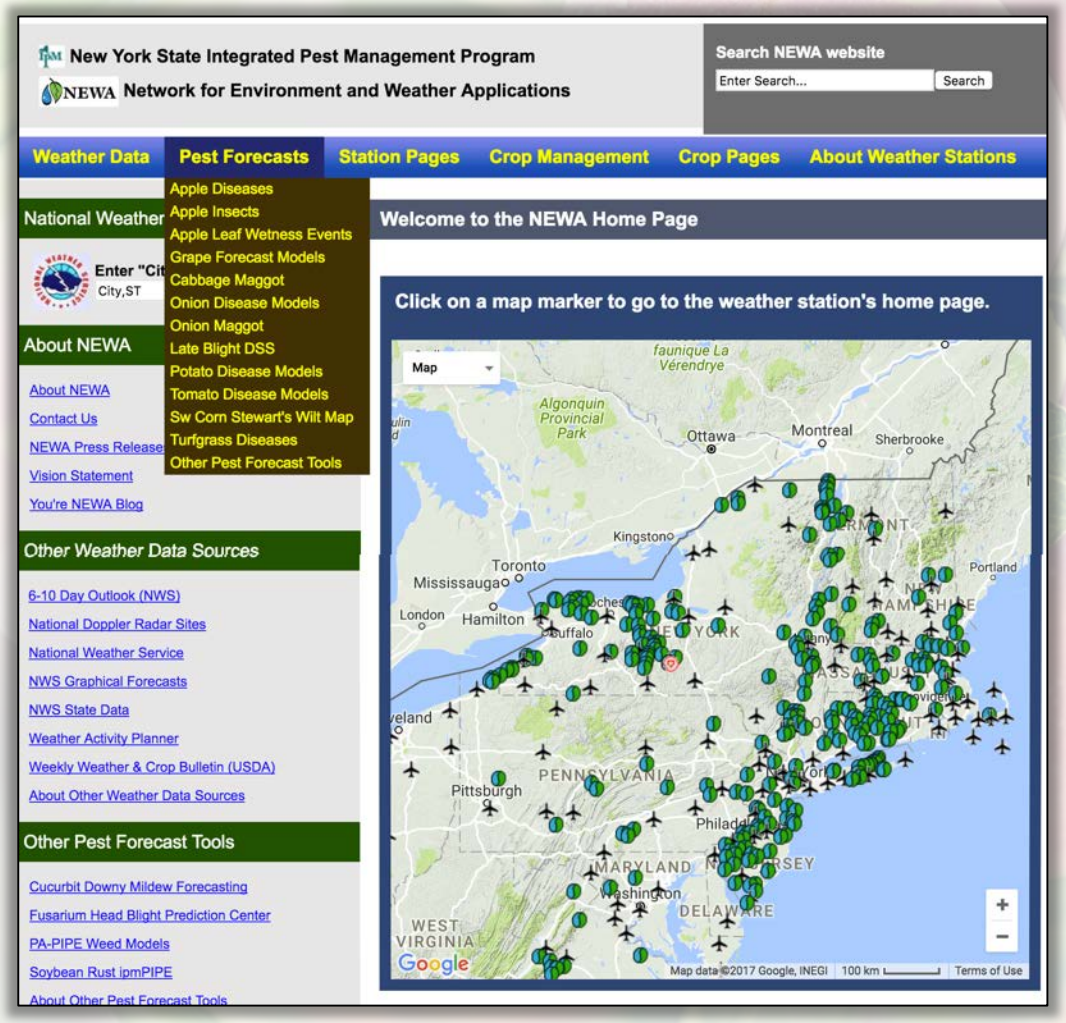
- Weather data products
- Insect pest resources
- Plant disease resources

Clemson University



W Wilcox, Cornell University

The NEWA website



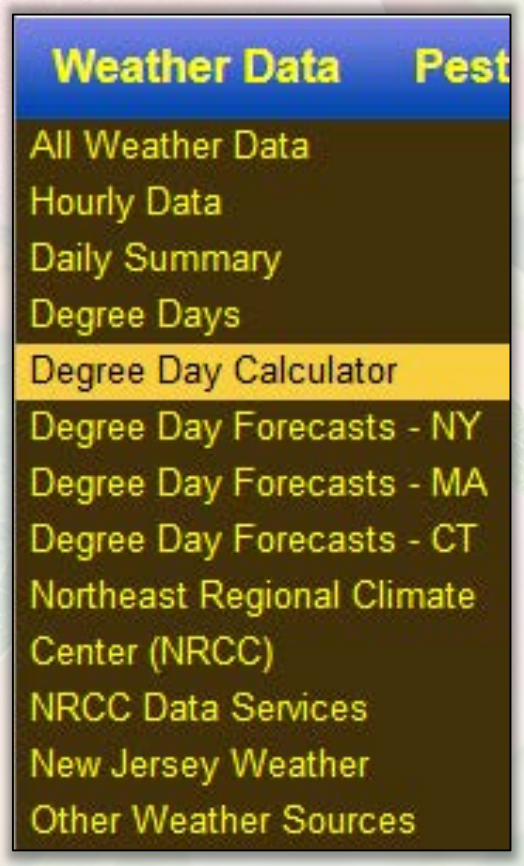
NEWA station page

Tools and Resources

- Fruit production
  - Apples
  - Grapes
- Vegetable production
  - Onion
  - Cabbage
- Weather products
  - Degree day resources

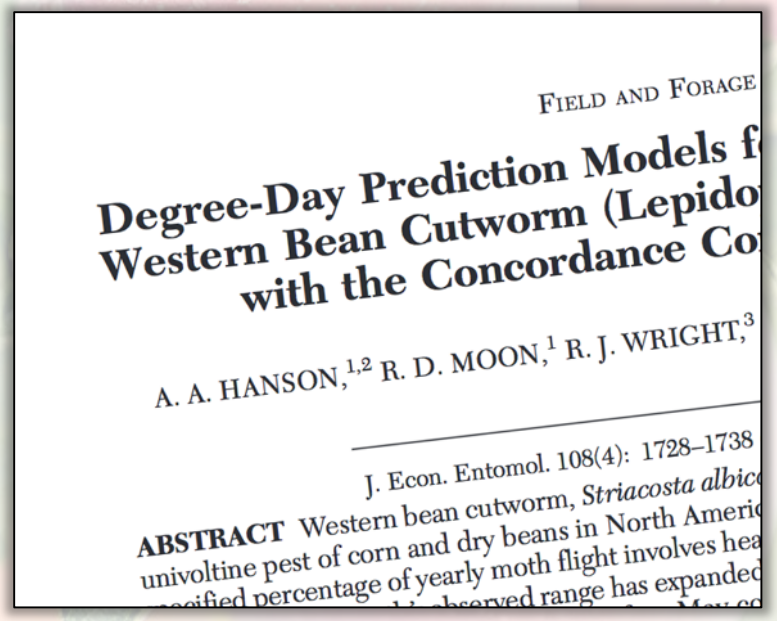
Other resources

- Weather products
  - Hourly summary
  - Daily summary
  - Degree day tables
  - Degree day calculator
    - Custom start/end
    - Different base values
    - (°C) 4, 14.3
    - (°F) 32, 39, 40, 43, 43BE, 45, 48, 50, 50BE, 55, 44.14, 86/50



Adding new tools

- Growers
  - Real world problems
- Extension
  - Education
  - Outreach
- Researchers
  - Entomology
  - Plant pathology
  - Horticulture



FIELD AND FORAGE

Degree-Day Prediction Models f
Western Bean Cutworm (Lepido
with the Concordance Co

A. A. HANSON,[1,2] R. D. MOON,[1] R. J. WRIGHT,[3]

J. Econ. Entomol. 108(4): 1728–1738

ABSTRACT Western bean cutworm, *Striacosta albic*
univoltine pest of corn and dry beans in North Americ
percentage of yearly moth flight involves hea
observed range has expanded

Looking to the future

- 8 berry tools
- 100+ ornamental tools
- Vegetable tools
  - Cercopora in beets
  - Western bean cutworm
- Field crops
  - Data support
- Forestry and natural resources
  - Hemlock woolly adelgid?
  - Emerald ash borer?
  - Asian longhorn beetle?
  - Spotted wing drosophila?
  - Brown marmorated stink bug?
  - Black swallow wort?
  - Giant hogweed?

Climate Smart Farming: Using Climate-Based Decision Tools to Prepare for Climate Variability and Change

Jonathan Lambert
Cornell Institute for Climate Smart Solutions
Climate Smart Farming Program

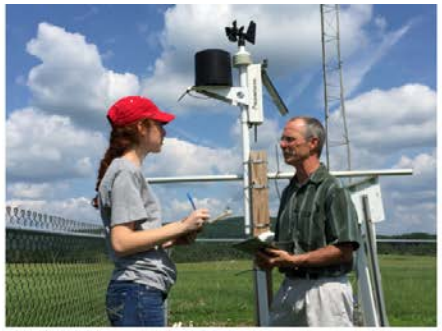
USDA Conservation Webinar
May 4th, 2017

Cornell University

CICSS

Cornell Institute for Climate Smart Solutions

- Formed in 2013
- Working toward resilient and sustainable agricultural, ecological, and social systems in the face of a rapidly changing climate
- Launched Cornell Climate Smart Farming (CSF) Program and CSF Extension Team in 2015



Research

Education/Outreach

Partnerships

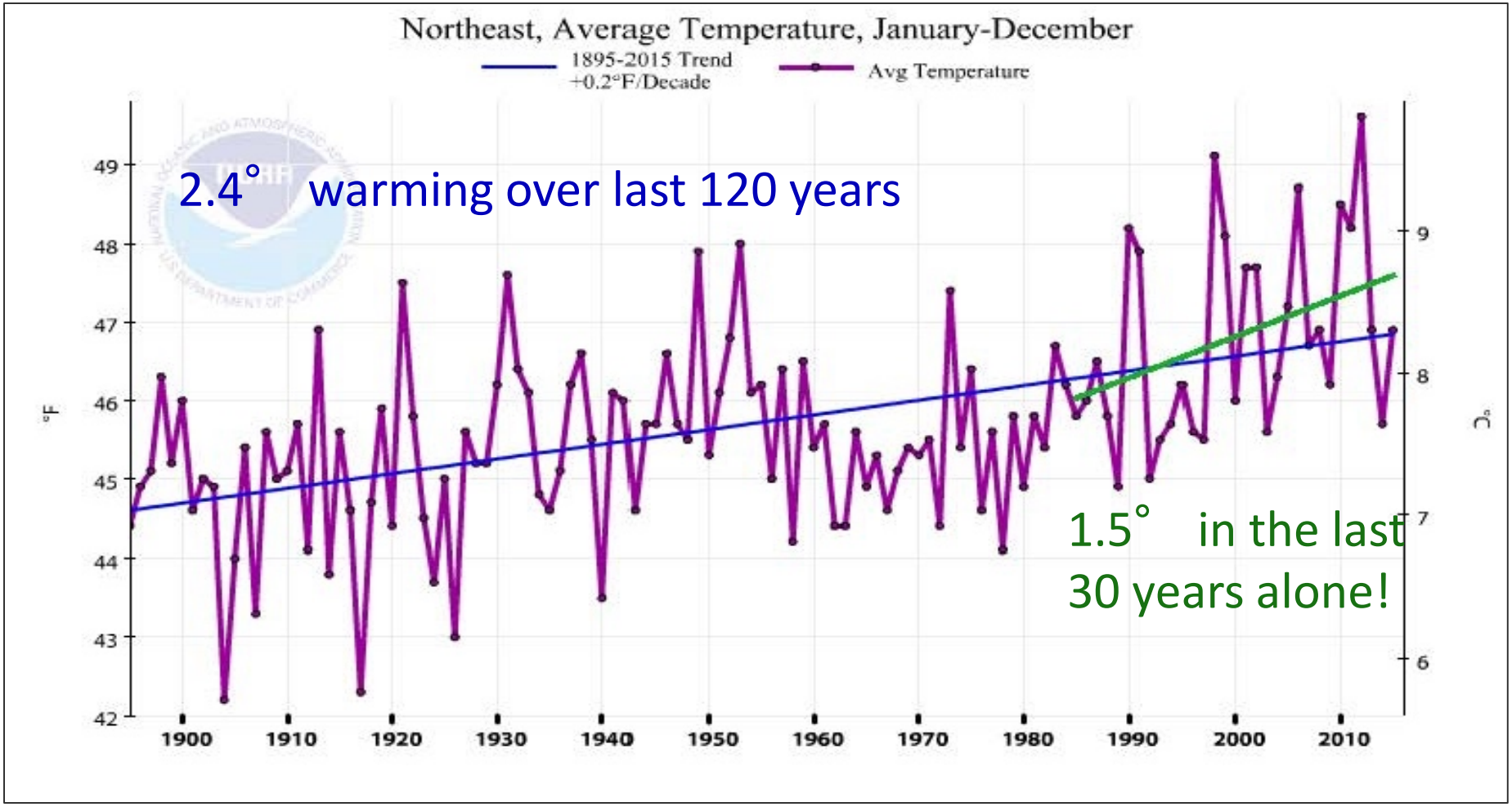
climateinstitute.cals.cornell.edu/

Climate Smart Farming Program Goals

- Increase farm resiliency to extreme weather events, climate variability and change, through assessing risk & adopting BMPs (**adaptation).**
- Increase energy efficiency and renewable energy capacity to reduce GHG emissions and operating costs, and utilize BMPs (**mitigation**).
- Sustainably **increase agricultural productivity** and farming incomes, to contribute to regional & global **food security**.

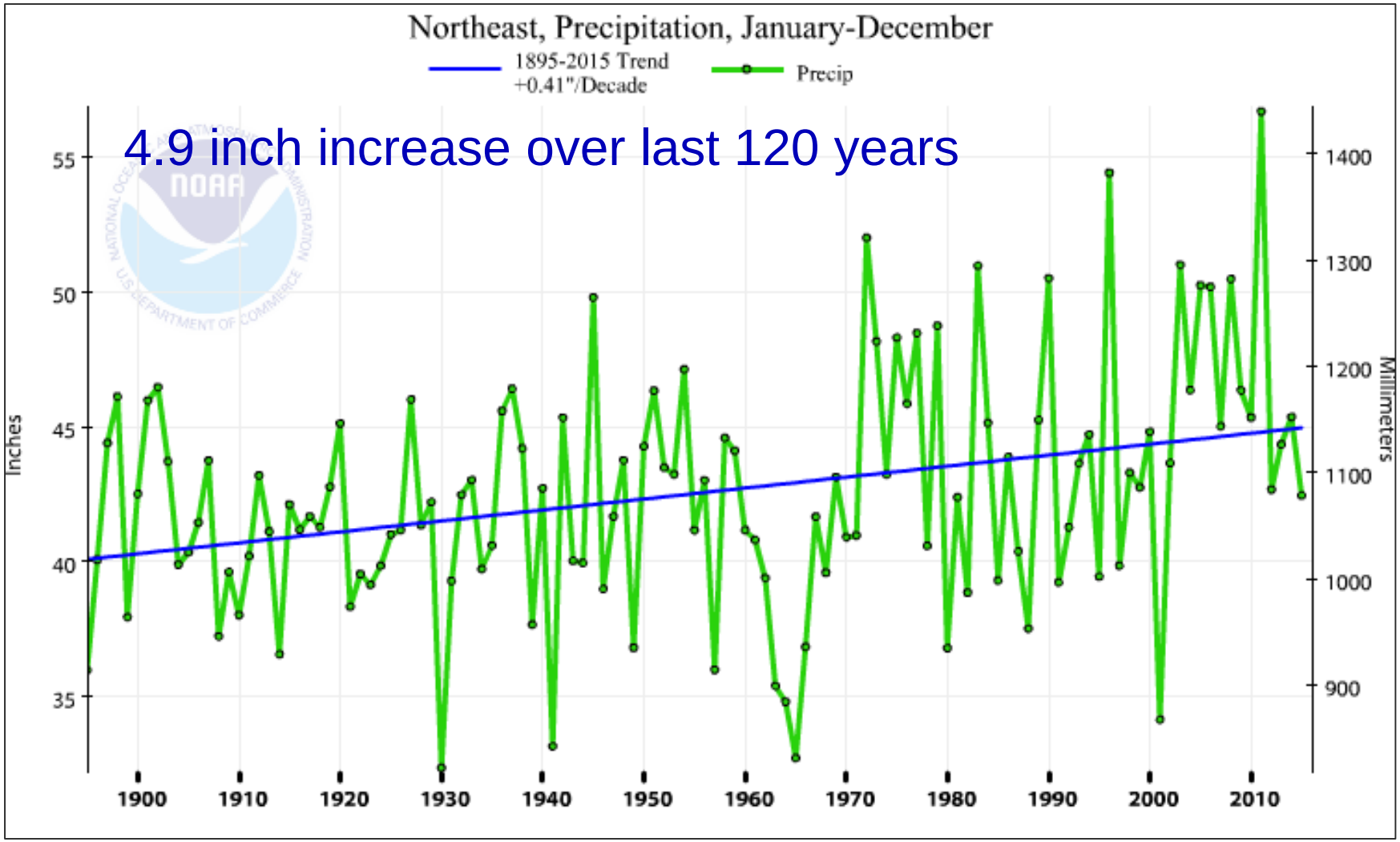
Observed Climate Data and Impacts

NE Temperature Trend



Source: NOAA NCDC. Data 1895-2015.

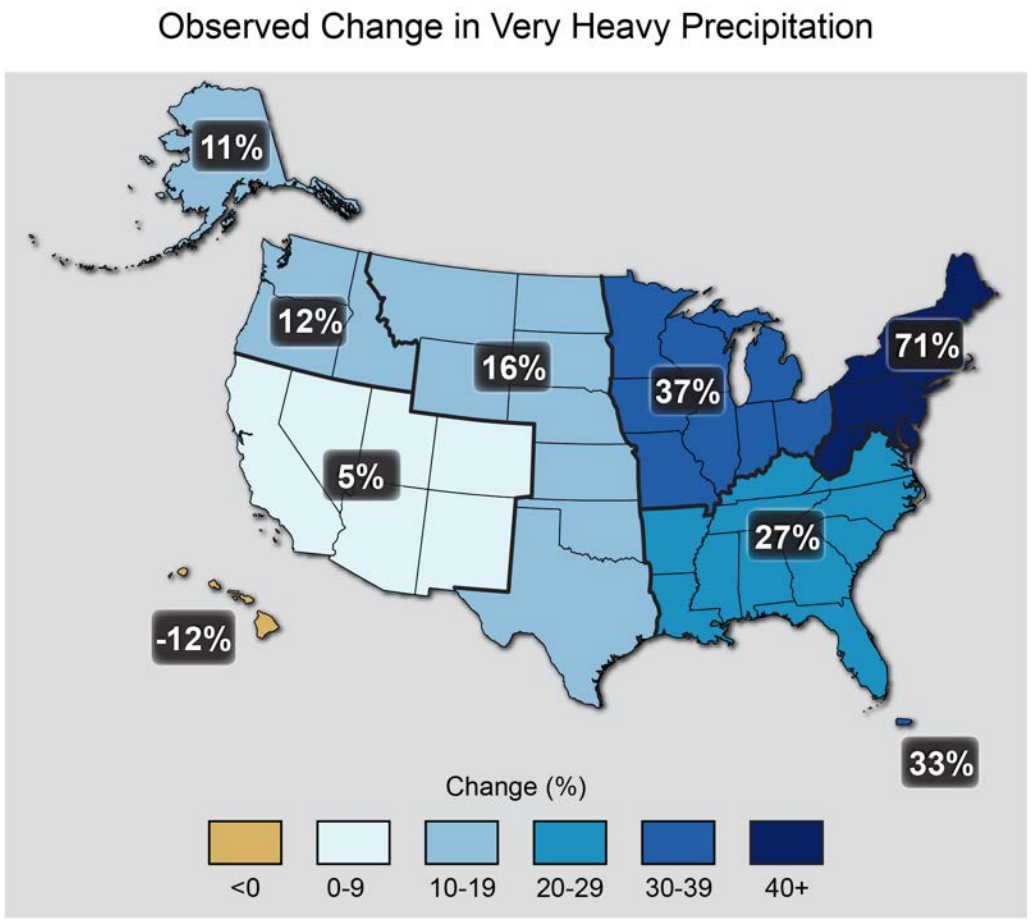
NE Precipitation Trend



Source: NOAA NCDC. Data 1895-2015.

Observed Trends in 1-day Very Heavy Precipitation (1958 to 2012)

The Northeast has had the greatest increase in heavy precipitation in the United States.



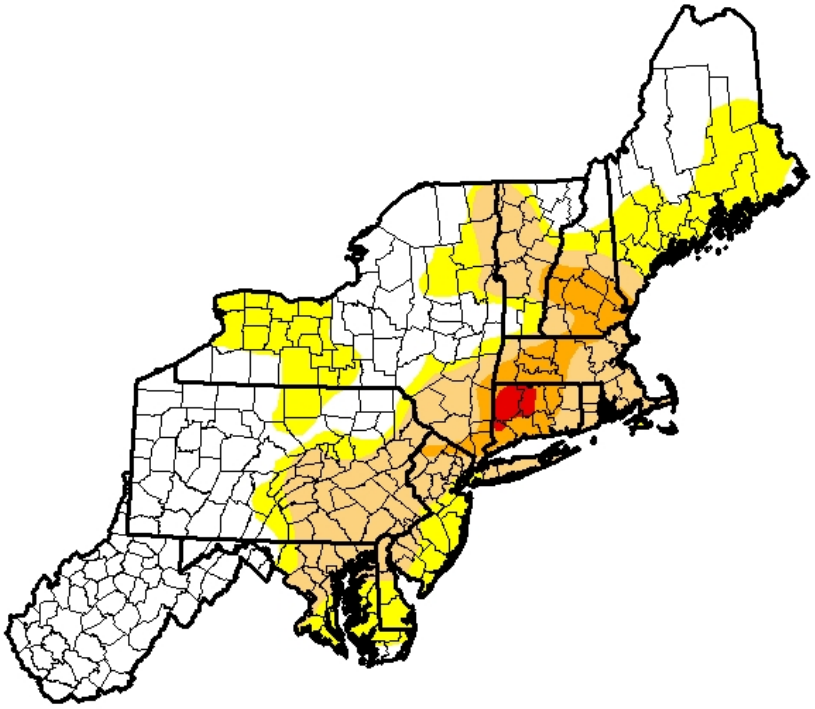
Source: NOAA/NCDC

Short-Term Drought

Cornell Climate Smart Farming

U.S. Drought Monitor

Northeast



February 21, 2017

(Released Thursday, Feb. 23, 2017)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	48.49	51.51	28.01	6.53	0.70	0.00
Last Week 2/14/2017	48.78	51.22	28.17	6.53	0.70	0.00
3 Months Ago 11/22/2016	21.60	78.40	55.03	20.87	3.40	0.00
Start of Calendar Year 1/3/2017	30.54	69.46	43.67	11.68	1.39	0.00
Start of Water Year 9/27/2016	21.72	78.28	40.32	19.59	6.68	0.00
One Year Ago 2/23/2016	83.96	16.04	2.33	0.00	0.00	0.00

Intensity:

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

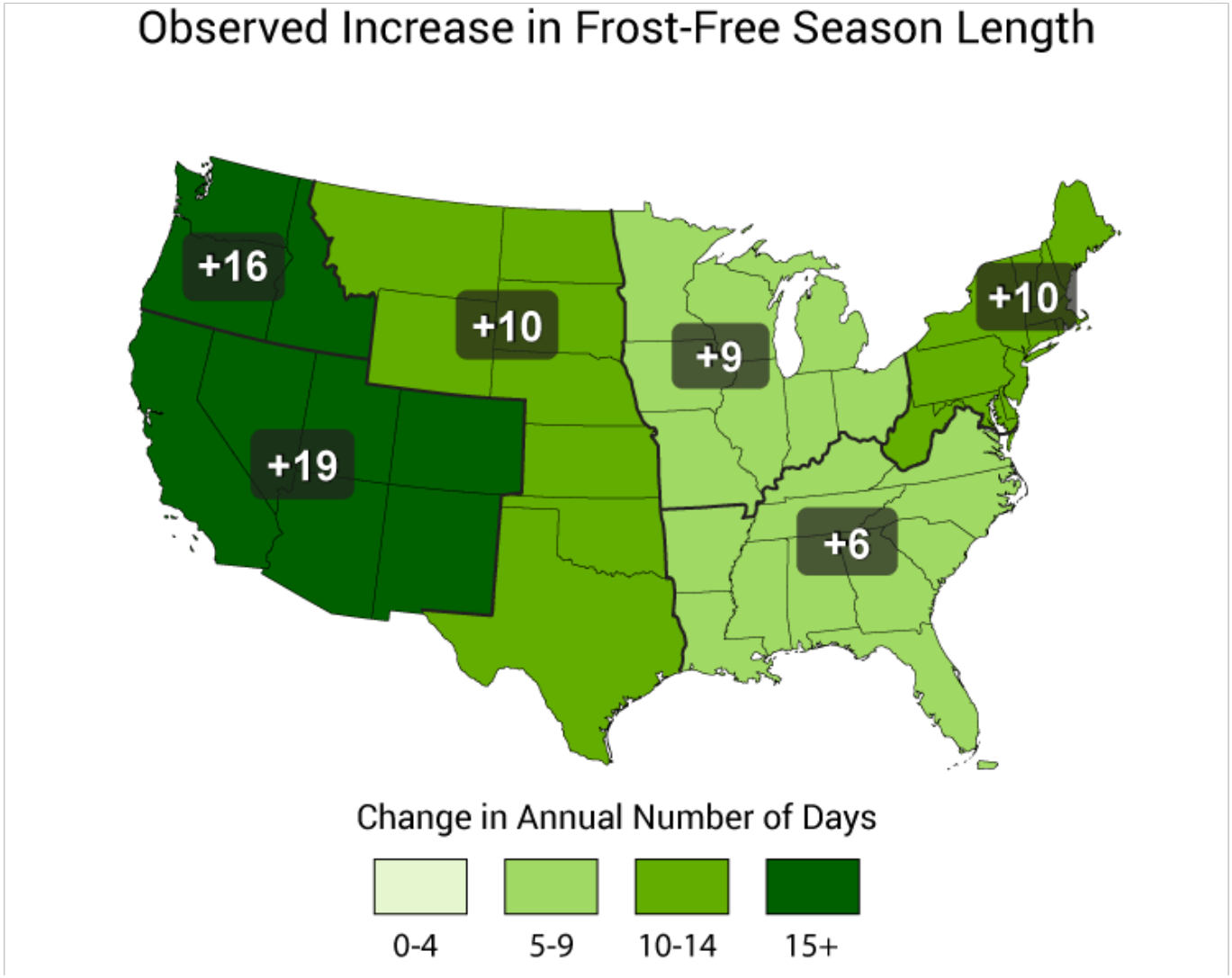
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:

Richard Heim

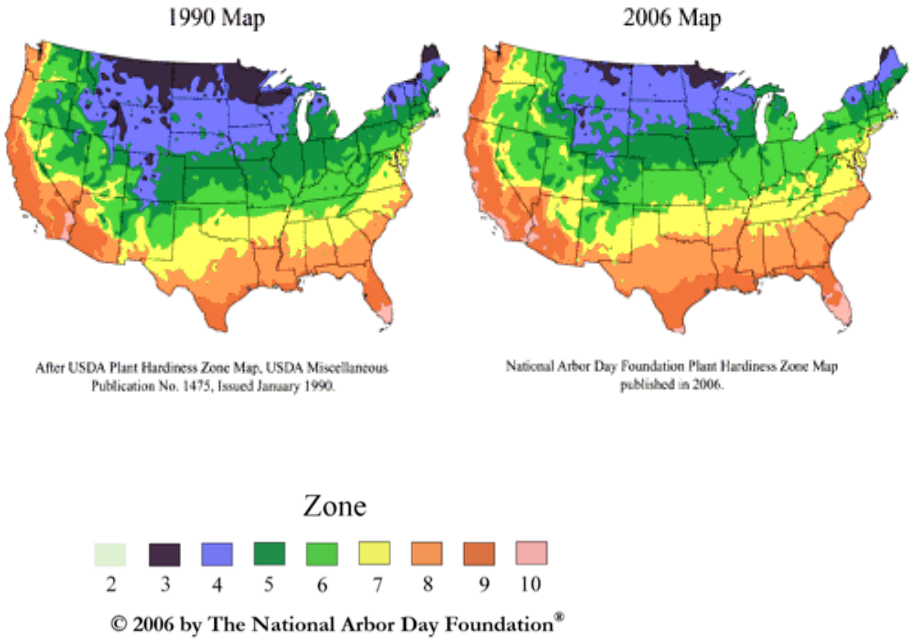
NCEI/NOAA

http://droughtmonitor.unl.edu/



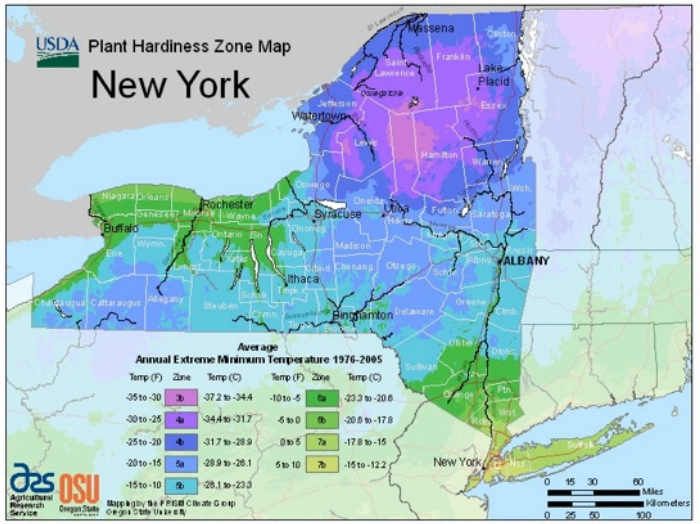
The period between the last occurrence of 32˚ F in the spring and the first occurrence of 32˚ F in the fall, has increased in each U.S. region during 1991-2012 relative to 1901-1960. NOAA/NCDC / CICS-NC.

Changes in Plant Hardiness Zones



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

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

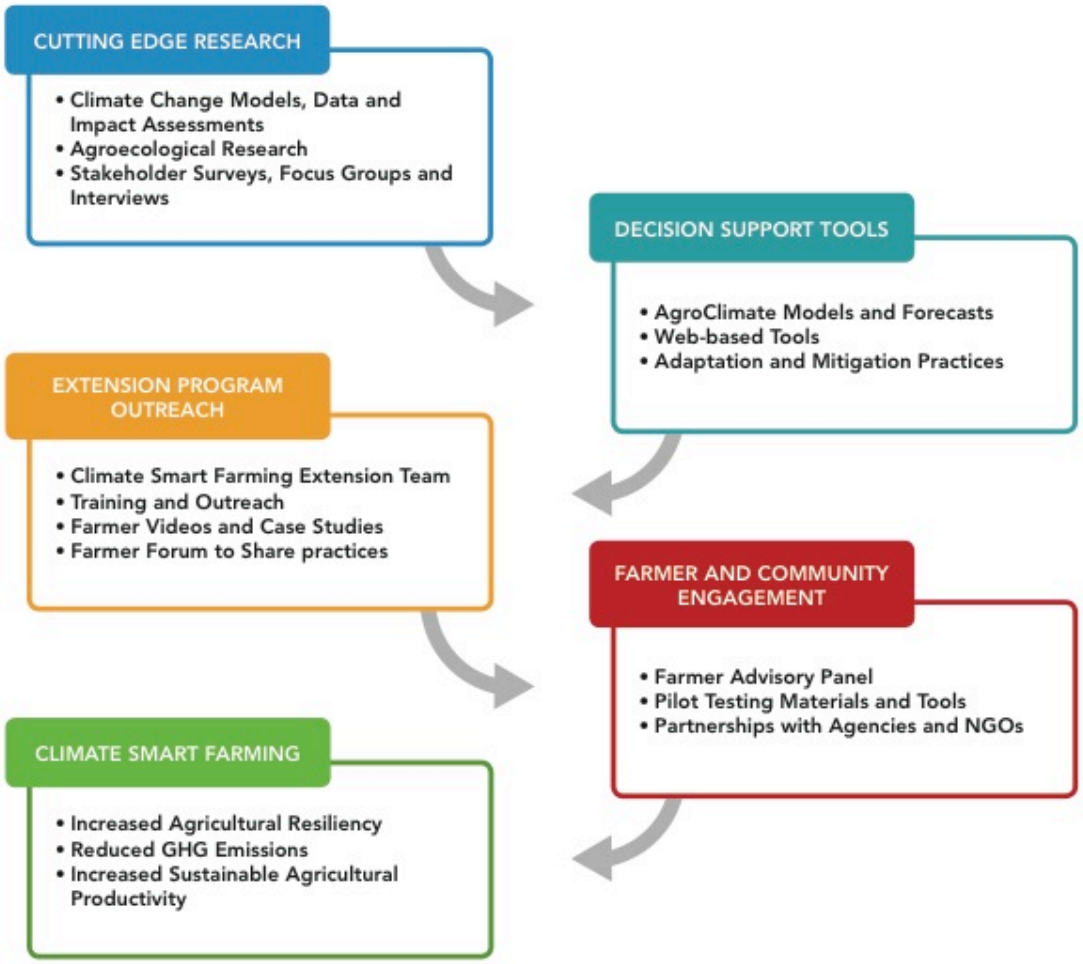


Source: http://www.arborday.org/media/zones.cfm

New USDA Plant Hardiness Zone Map 2012

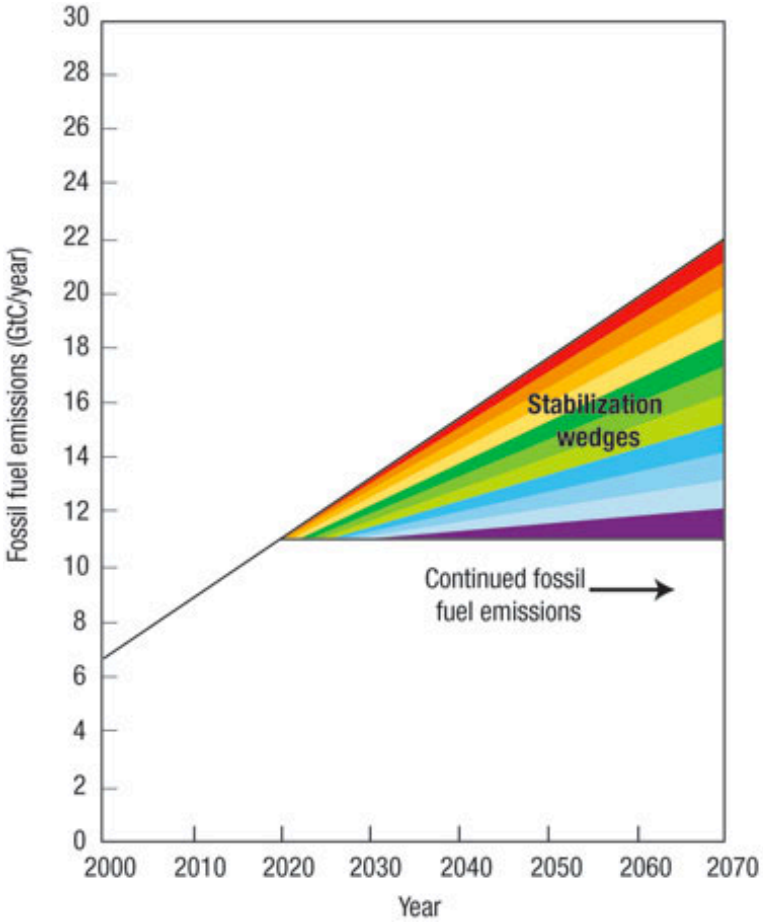
Cornell Climate Smart Farming

Stakeholder-Driven Research & Extension



Climate Change Mitigation:

Actions that will reduce the ultimate magnitude of climate change. What are some Examples?

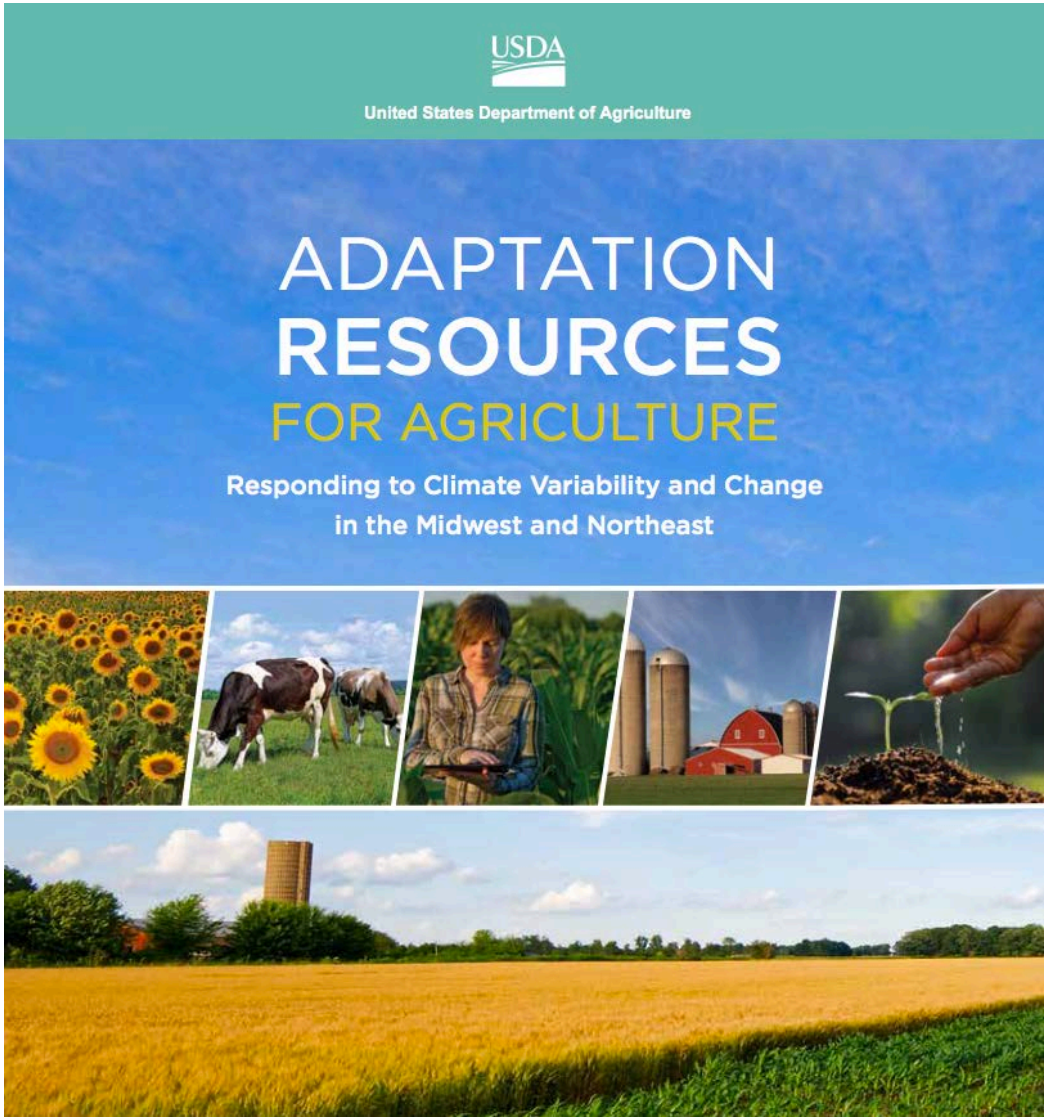


- Coal: 800 gigawatt-sized plants with all the carbon captured and permanently sequestered
- Nuclear: 700 new gigawatt-sized plants (plus replacement plants)
- Concentrated solar thermal electric: 1,600 gigawatts peak power
- Solar photovoltaics: 3,000 gigawatts peak power
- Efficient buildings: savings totalling 5 million gigawatt-hours
- Efficient industry: savings totalling 5 million gigawatt-hours, including co-generation and heat recovery
- Wind power: 1 million large wind turbines (2 megawatts peak power)
- Vehicle efficiency: all cars 60 miles per US gallon
- Wind for vehicles: 2,000 gigawatts wind, with most cars plug-in hybrid electric vehicles or pure electric vehicles
- Cellulosic biofuels: using up to one-sixth of the world's cropland
- Forestry: end all tropical deforestation

Climate Change Adaptation:

- Reduce the level of physical, social, or economic impact of climate change and variability
- Take advantage of new opportunities emerging from climate change
- Examples?

USDA Adaptation Resources for Ag (2016)



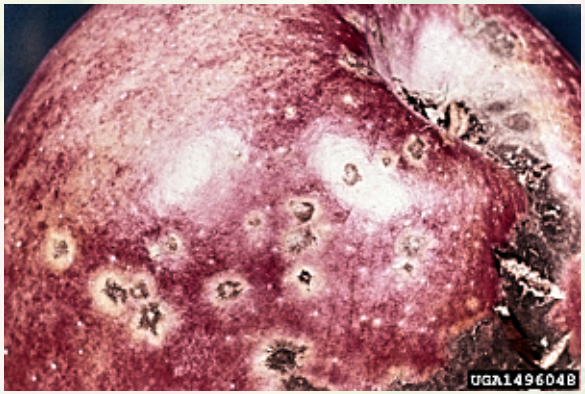
http://www.climatehubs.oce.usda.gov/sites/default/files/adaptation_resources_workbook_ne_mw.pdf

USDA Ag Adaptation Framework (2016)

- Step 1: DEFINE management goals & objectives
- Step 2: ASSESS site-specific climate change impacts & vulnerabilities
- Step 3: EVALUATE management objectives given projected impacts & vulnerabilities
- Step 4: IDENTIFY adaptation approaches & tactics for implementation
- Step 5: MONITOR & evaluate effectiveness of implemented actions

Part II – Using NEWA tools

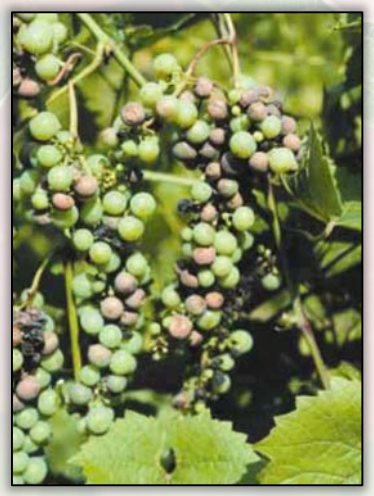
Disease management



University of Georgia Plant Pathology, forestryimages.org

HF Schwartz, Colorado State University, bugwood.org

P Nitzsche and A Wyenandt, Rutgers University



W Wilcox, Cornell University

Onion diseases

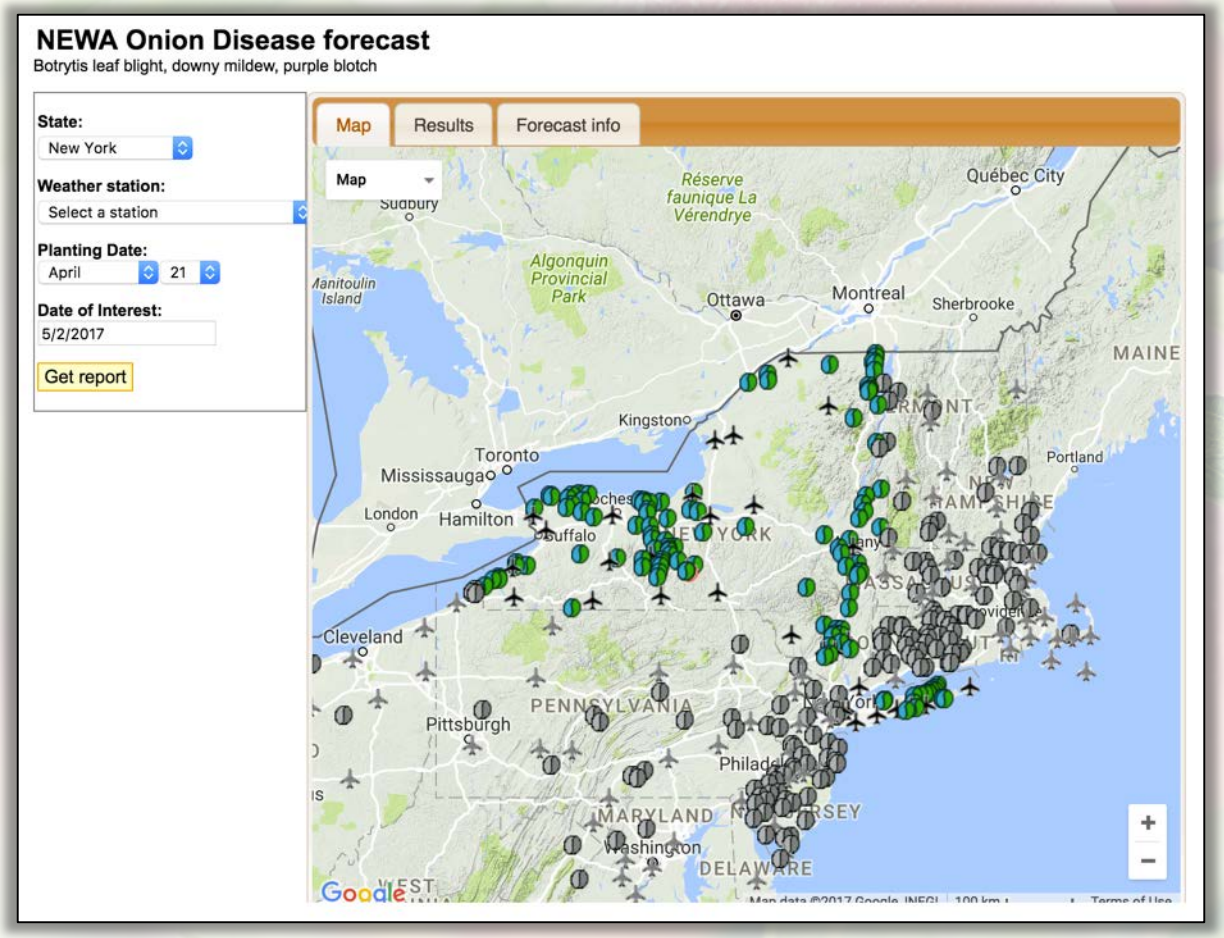
- Botrytis leaf blight
- Downy mildew
- Purple blotch

HF Schwartz, Colorado State University, bugwood.org

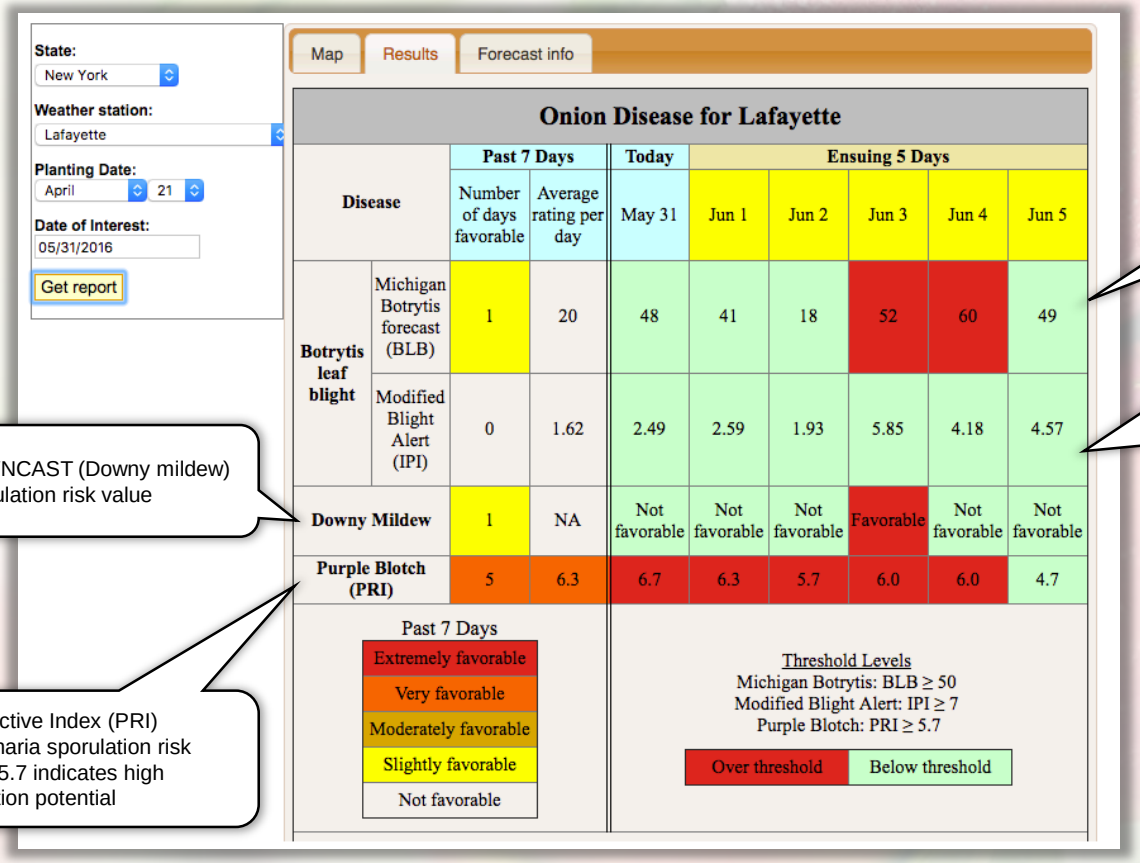
HF Schwartz, Colorado State University, bugwood.org

HF Schwartz, Colorado State University, bugwood.org

On-farm management



NEWA onion disease tools



Predicts Botrytis spore release. BLB indicates inoculum potential. >50 indicates significant risk.

Use in combination with scouting and >30% chance of rain. Inoculum Production Index (IPI) IPI>7, one lesion and change of rain indicates treatment

DOWNCAST (Downy mildew) Sporulation risk value

Predictive Index (PRI) Alternaria sporulation risk PRI>5.7 indicates high infection potential

Insect Pest Management

BA Nault, Cornell University

Clemson University

S Bauer, USDA Agricultural Resesarch Service, bugwood.org

TM Gilligan and ME Epstein, USDA APHIS ITP, bugwwod.org

Onion Maggot

- ***Delia antiqua***
  - Pupae overwinter
  - Adults emerge mid-spring
  - First instars destroy onion seedlings
  - Management
    - Avoidance
    - Chemical treatment
- Key life stages
  - 50% overwintering adult emergence
  - 50% 1st generation adult emergence

BA Nault, Cornell University

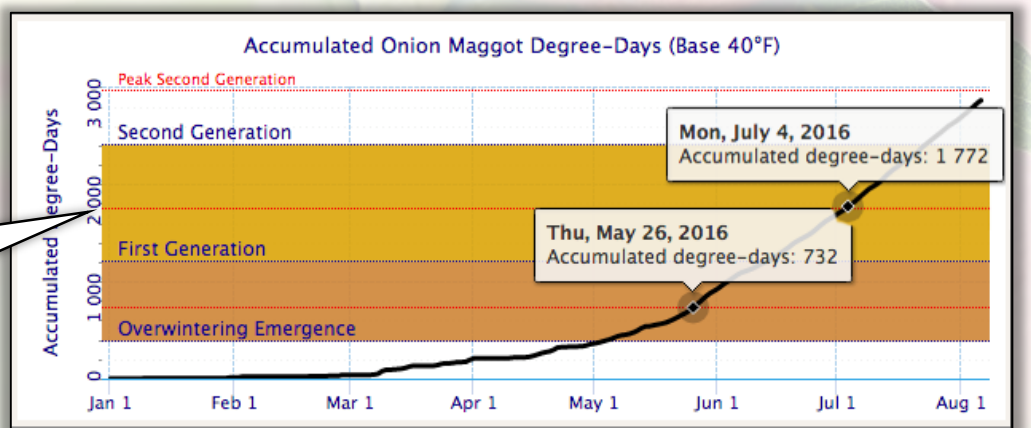
Overwintering adult management

Red line indicates 50% emergence. Treatment or avoidance should be implemented by this point

Onion Maggot Degree-Days (Base 40°F) for Lafayette

	Past	Past	Current	Ensuing 5 Days				
Date	May 20	May 21	May 22	May 23	May 24	May 25	May 26	May 27
Daily Degree-Days	16	19	22	22	21	25	33	36
Seasonal Accumulation	591	610	631	653	674	699	732	767
Generation (OW=overwintering)	OW	OW	OW	OW	OW	OW	OW	OW

Red cells indicate estimated 50% emergence (peak flight).

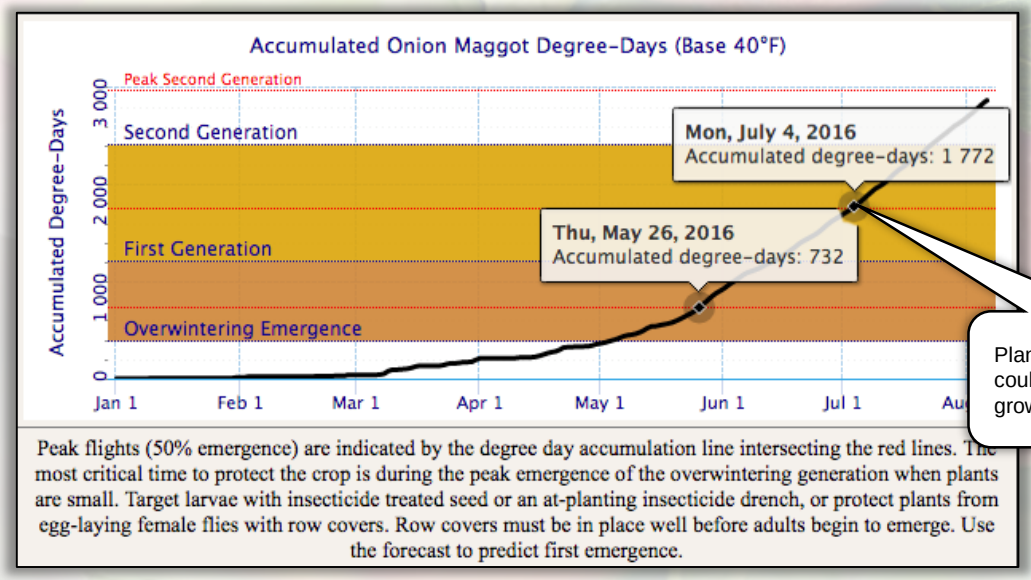


Peak flights (50% emergence) are indicated by the degree day accumulation line intersecting the red lines. The most critical time to protect the crop is during the peak emergence of the overwintering generation when plants are small. Target larvae with insecticide treated seed or an at-planting insecticide drench, or protect plants from egg-laying female flies with row covers. Row covers must be in place well before adults begin to emerge. Use the forecast to predict first emergence.

First generation adult management

Onion Maggot Degree-Days (Base 40°F) for Lafayette								
	Past	Past	Current	Ensuing 5 Days				
Date	Jun 21	Jun 22	Jun 23	Jun 24	Jun 25	Jun 26	Jun 27	Jun 28
Daily Degree-Days	25	22	23	23	30	35	36	33
Seasonal Accumulation	1415	1437	1460	1483	1513	1547	1583	1616
Generation	First	First	First	First	First	First	First	First

Red cells indicate estimated 50% emergence (peak flight).

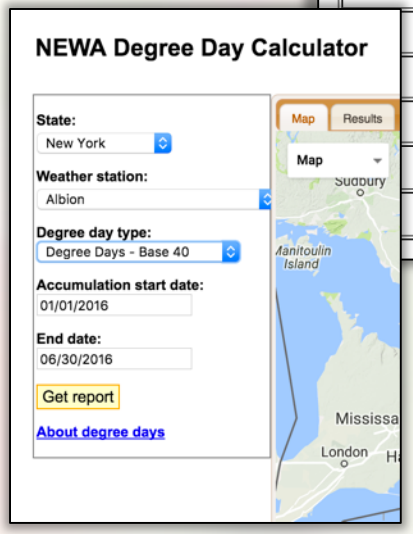


Plants are more robust, but could still be susceptible if growth has been slow

Peak flights (50% emergence) are indicated by the degree day accumulation line intersecting the red lines. The most critical time to protect the crop is during the peak emergence of the overwintering generation when plants are small. Target larvae with insecticide treated seed or an at-planting insecticide drench, or protect plants from egg-laying female flies with row covers. Row covers must be in place well before adults begin to emerge. Use the forecast to predict first emergence.

Degree Day Calculator

Base Temperature	Insect Phenology Model or Disease Development Model
14.3°C	brown marmorated stink bug
4°C	cabbage maggot
0°C	apple scab
40°F	onion maggot
43°F	obliquebanded leafroller, spotted tentiform leafminer
45°F	oriental fruit moth
47.14°F	grape berry moth
48°F	alfalfa weevil
50°F	growing degree days (GDD), codling moth, plum curculio, apple maggot
55°F	fire blight shoot blight symptom development



Case study

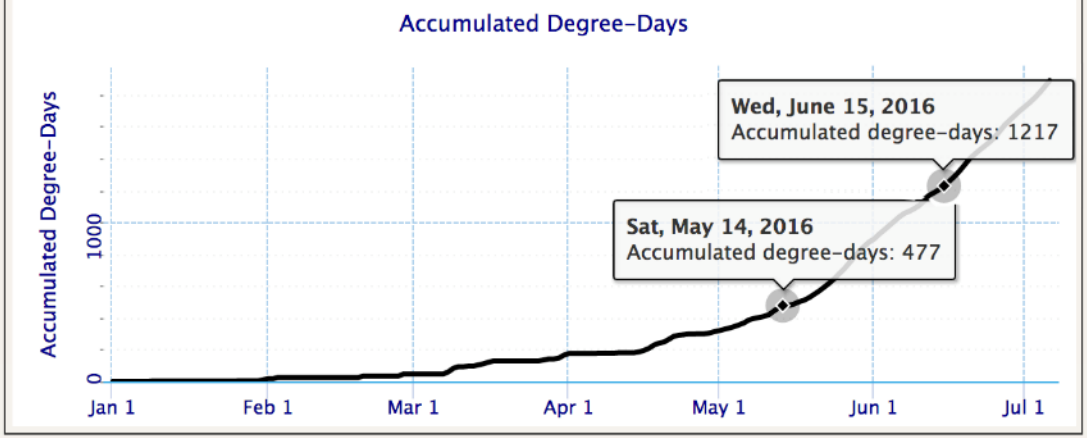
- New insect pest
- Base 40(F)
  - Accumulation from Jan 1
  - Susceptible life stages
    - First generation, first instar (450 DD)
  - Secondary infestation risk
    - Second generation, third instar (1200 DD)

Management Timing

Map | Results

Degree Days (Base 40) for Albion

	Past	Past	Current	Ensuing 5 Days				
Date	Jun 28	Jun 29	Jun 30	Jul 1	Jul 2	Jul 3	Jul 4	Jul 5
Daily Degree Days	31	29	30	26	26	30	32	38
Seasonal Accumulation	1628	1657	1686	1712	1739	1769	1801	1839



NEWA

Powered by ACIS Northeast Regional Climate Center

Developmental Variation

Location	G1 first instar	G2 third instar
Green Creek, SC	March 12	April 19
Ashtabula, OH	April 25	June 5
Geneva, NY	May 7	June 11
Lebanon, NH	May 19	June 17

NEWA summary

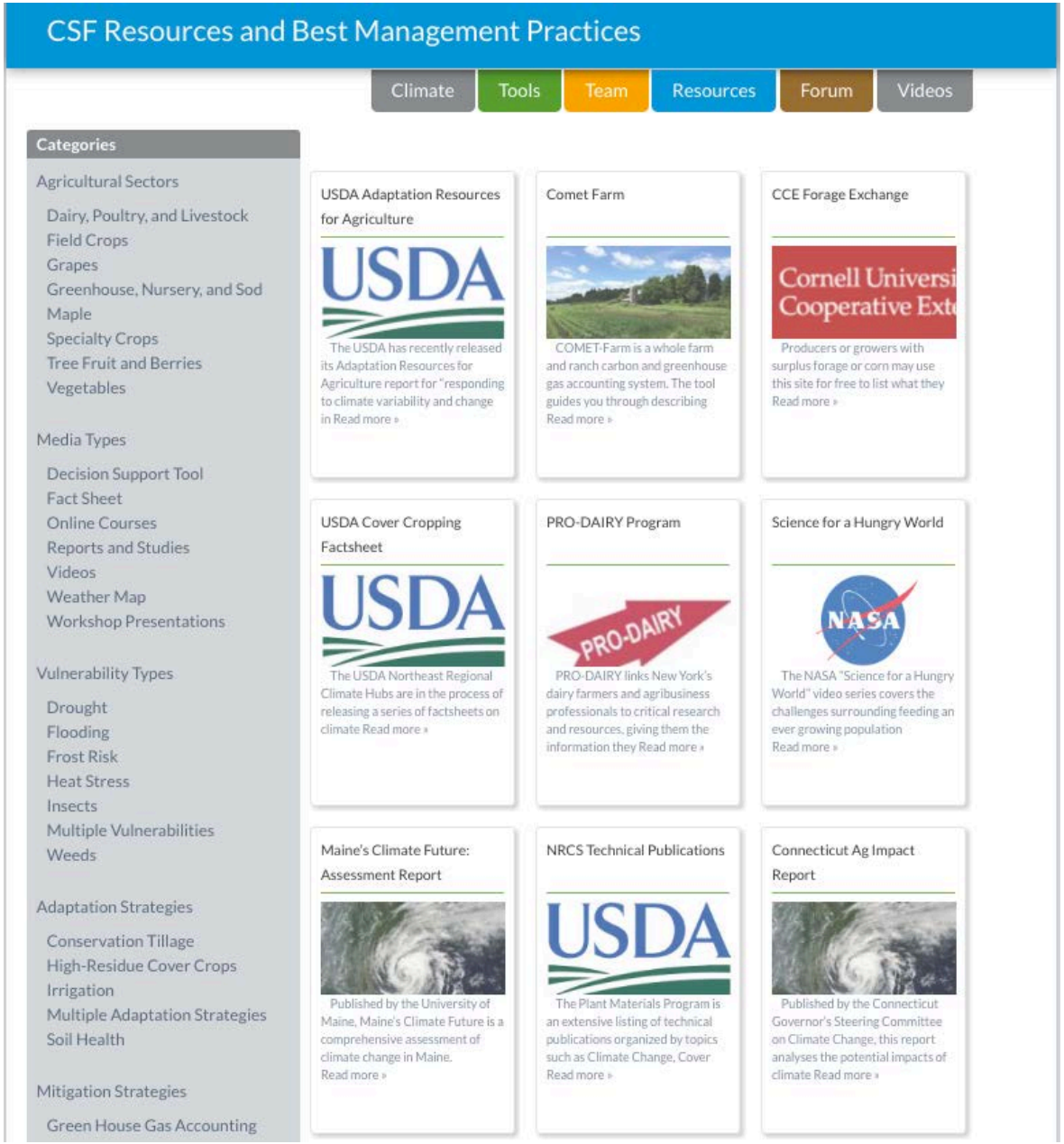
- Current fruit and vegetable tools
  - Apples and grapes
  - Onion and cabbage
- Future efforts
  - Strengthen fruit, more vegetables
  - Field crops
  - Forestry?
  - Invasive species?
  - Others?

Part II – Decision Tools

www.climatesmartfarming.org

CSF Resources & BMPs

http://climatesmartfarming.org/resources/



http://climatesmartfarming.org/resources/

CSF Extension Team for NYS

http://climatesmartfarming.org/climate-smart-farming-extension-team/

Extension Team

Dr. Kitty O'Neil, Field Crops & Soil Health

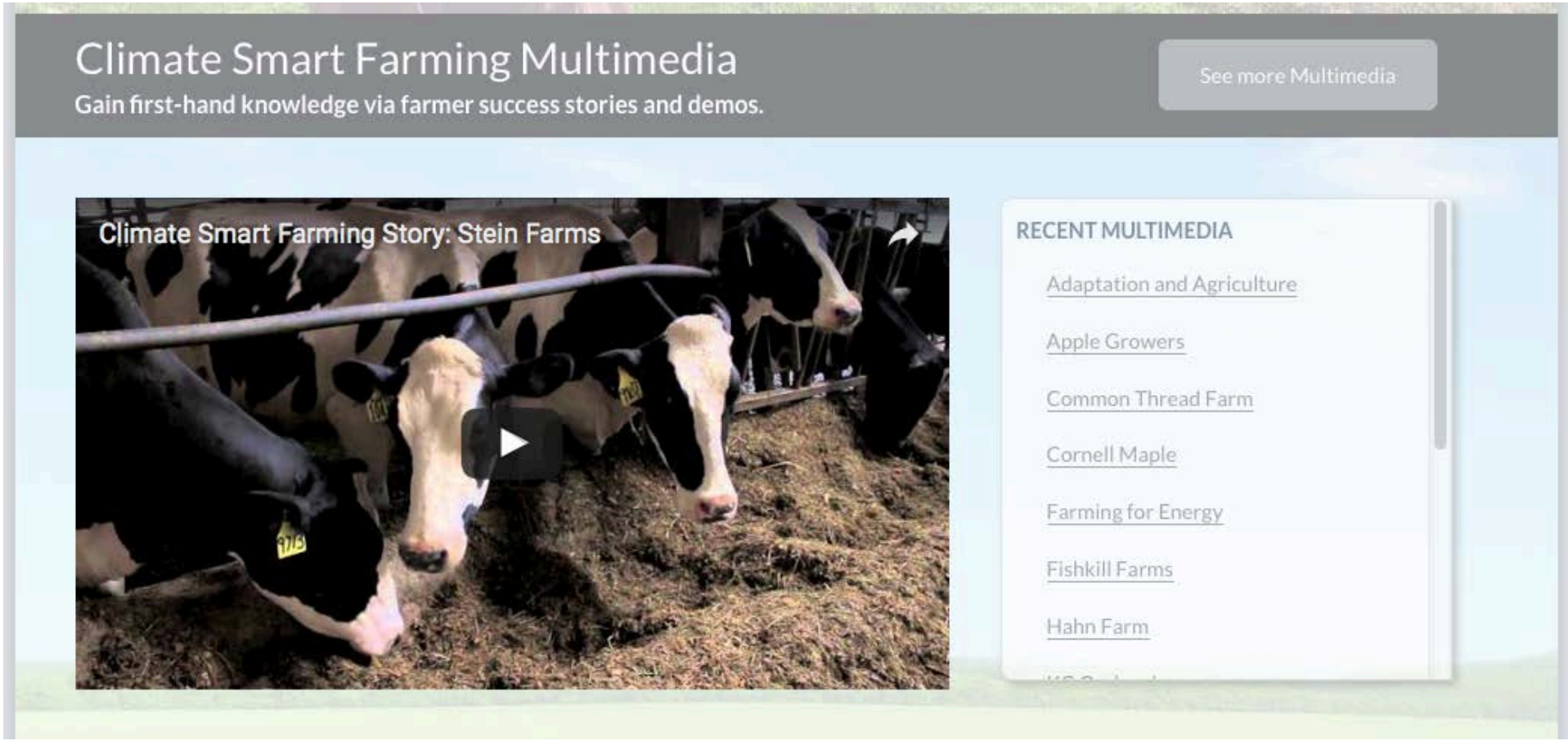
Dr. Kim Morrill, Dairy Management

Laura McDermott, Small Fruit

Dr. Darcy Telenko, Vegetables & IPM

Cornell Cooperative Extension System: 1000s Educators/Every County:
http://climatesmartfarming.org/climate-smart-farming-extension-team/

CSF Farmer Interview Videos

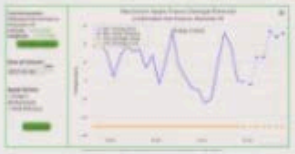


http://climatesmartfarming.org/videos/

Climate Smart Farming Tools

Climate | Tools | Team | Resources | Forum | Videos

CSF Apple Stage / Freeze Damage Probability

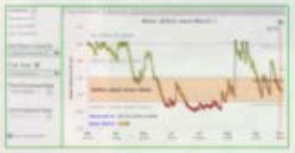


Charts model development stage plus T10, T50 & T90 Apple hardiness temperatures vs. daily minimum observed/forecast temperature. May be used to assess potential risk for freeze damage.

CSF Grape Hardiness & Freeze Risk

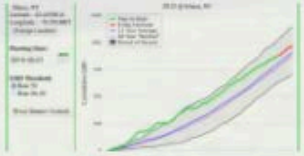
Charts hardiness temperature vs. daily observed/forecast temperatures for several varieties of grapes.

CSF Water Deficit Calculator



Monitors current and forecasted soil water deficit at your location to allow efficient water management and smart scheduling of irrigation.

CSF Growing Degree Day Calculator



Plots Growing Degree Days (GDD) to help predict plant development and pest/disease outbreaks, and provides a climatological context.

Climate Normals - Northeast Regional Climate Center

Climate normals are an arithmetic average of a variable such as temperature over a prescribed 30-year period.

Network for Environment and Weather Applications

NEWA makes it possible for farmers to share resources for weather data collection, analysis, distribution, and archiving

U.S. Drought Monitor

The map is based on measurements of climatic, hydrologic and soil conditions as well as reported impacts and observations from more than 350 contributors around the country.

New York State / Northeast Drought Atlas

This brand new product, courtesy of Dr. Toby Ault and his research group, is designed to portray drought and drought risk in new and useful ways to agriculturalists.

http://climatesmartfarming.org/tools

Apple Stage/Freeze Risk
30-Day Trend & Forecast

Cornell Climate Smart Farming

Current Location :
Johnny Appleseed's Orchard
DeMunn Rd, Beaver Dams, NY
Latitude : 42.282480
Longitude : -76.934862

Change Location

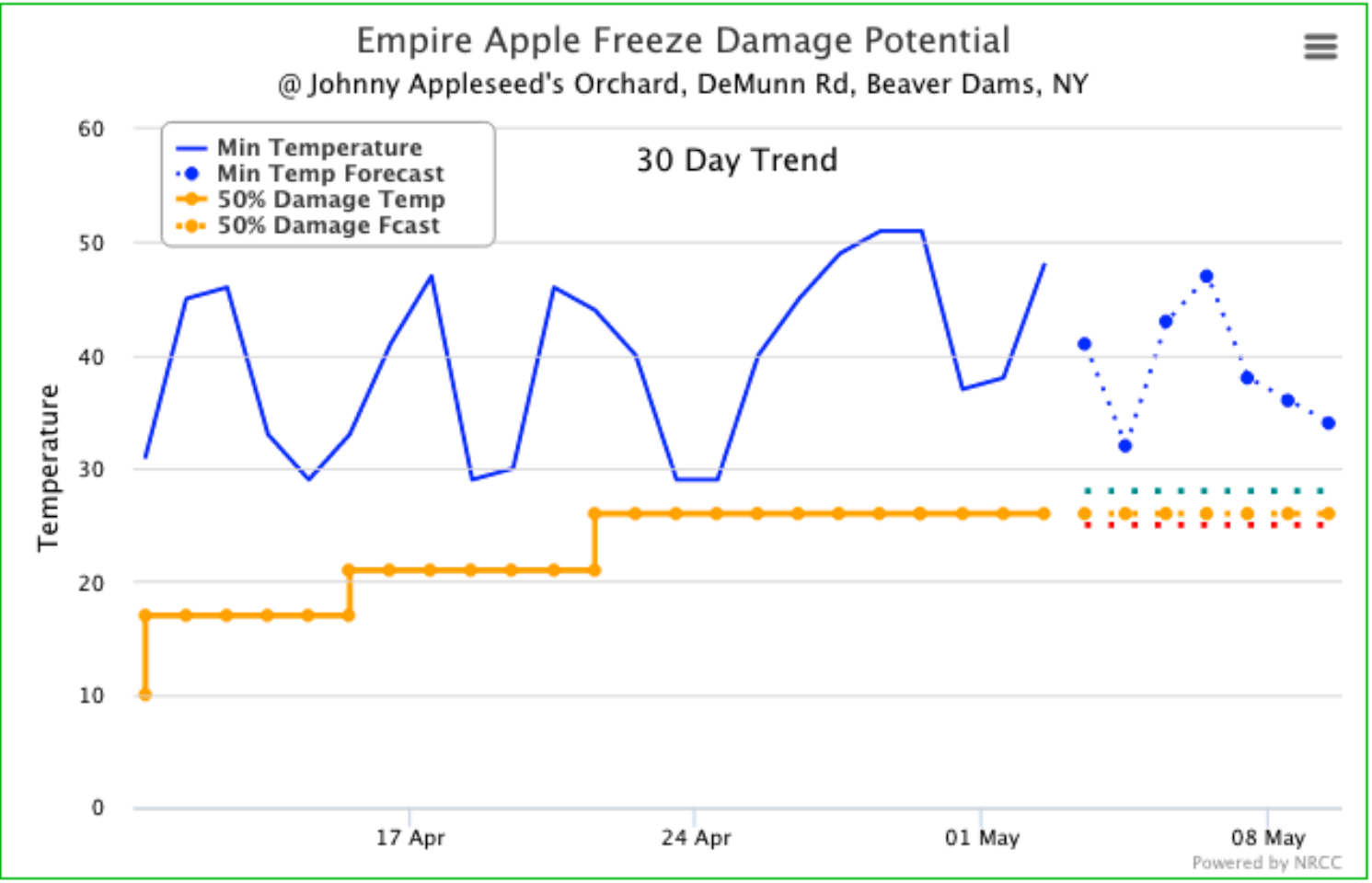
Date of Interest:

2017-05-02

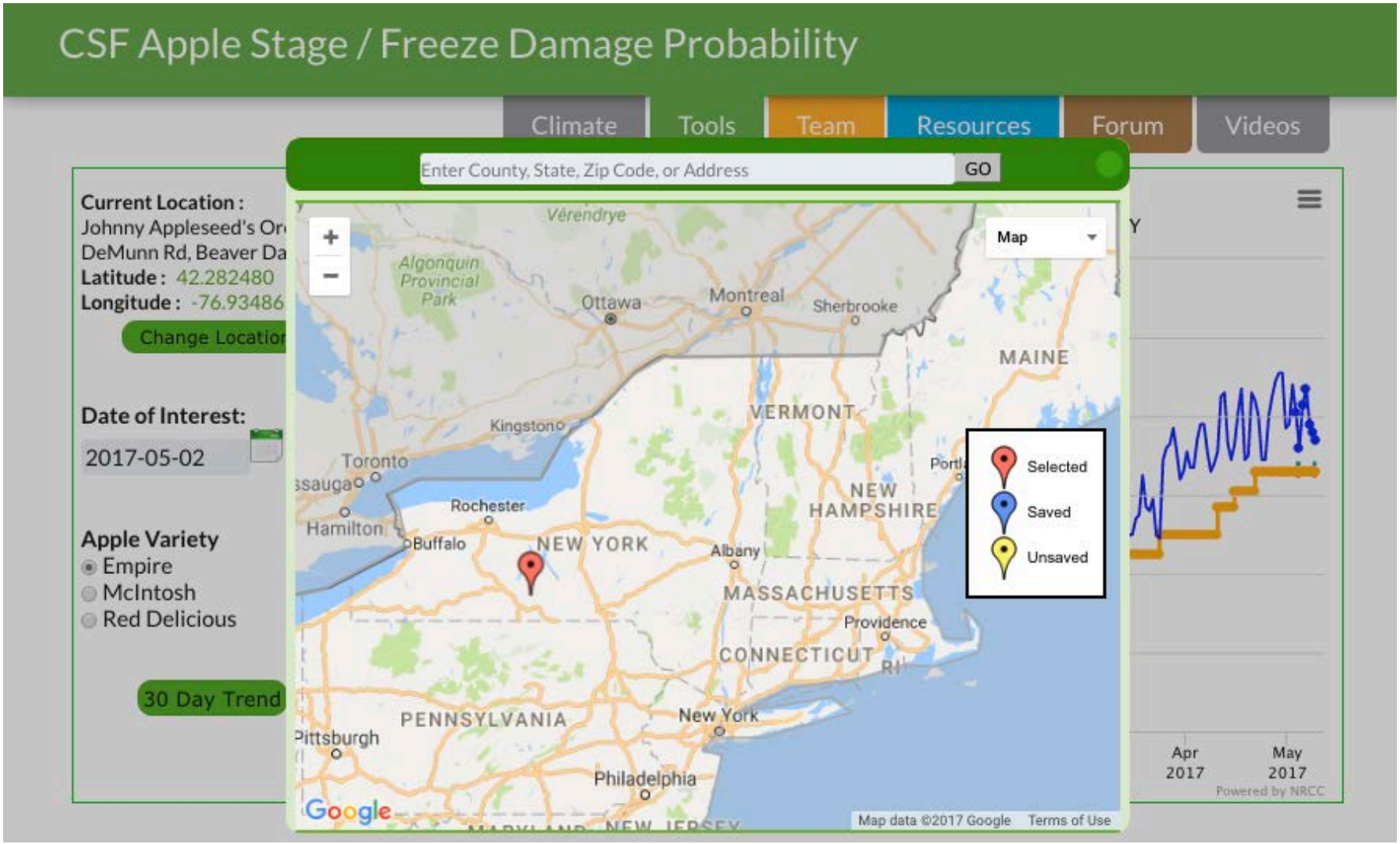
Apple Variety

- (•) Empire
- ( ) McIntosh
- ( ) Red Delicious

Full Season



Apple Stage/Freeze Risk 30-Day Trend & Forecast



Apple Stage/Freeze Risk
30-Day Trend & Forecast

Cornell Climate Smart Farming

Current Location :
Johnny Appleseed's Orchard
DeMunn Rd, Beaver Dams, NY
Latitude : 42.282480
Longitude : -76.934862

Change Location

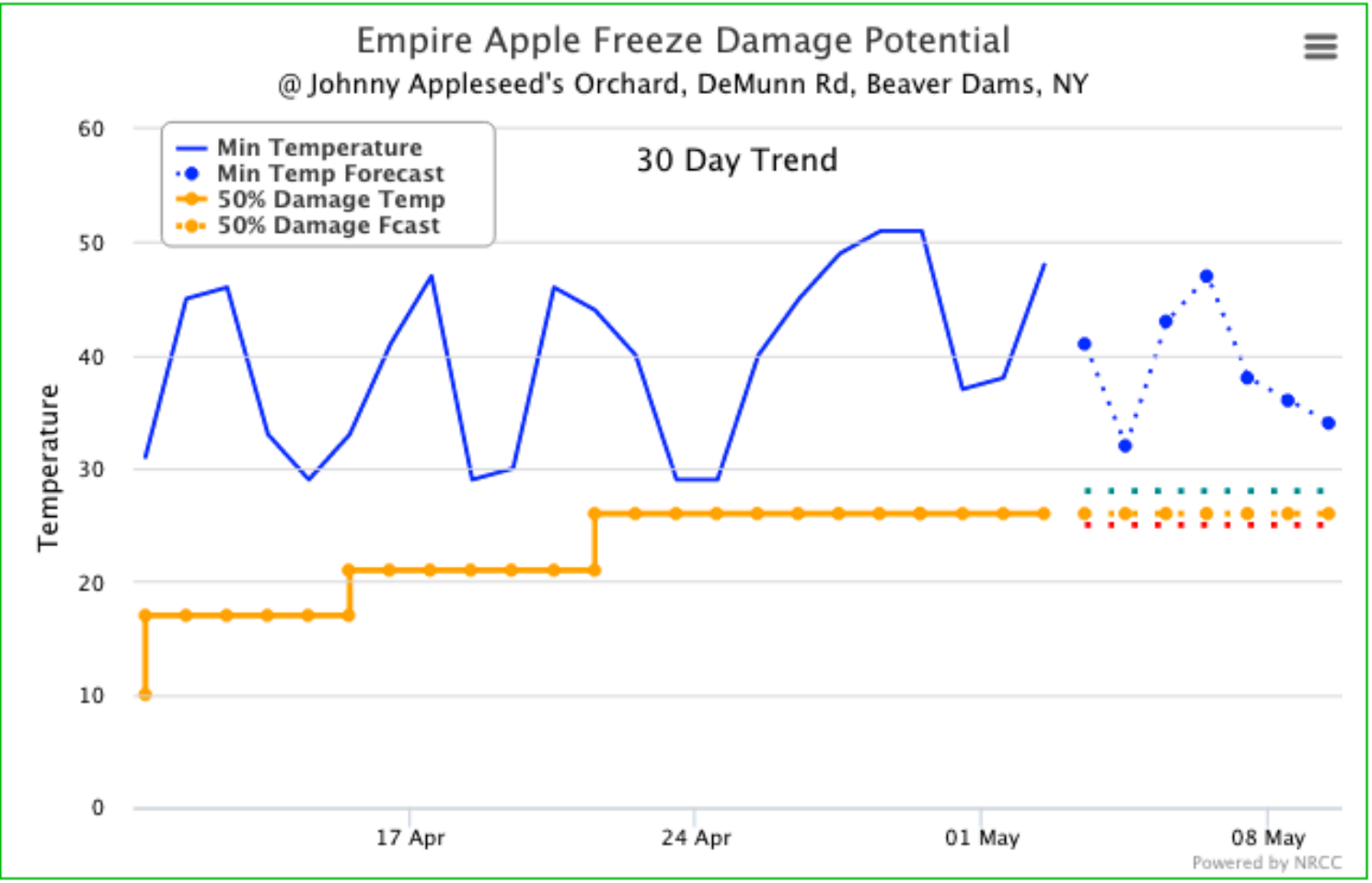
Date of Interest:

2017-05-02

Apple Variety

- (•) Empire
- ( ) McIntosh
- ( ) Red Delicious

Full Season



Apple Stage/Freeze Risk Full Season

Cornell Climate Smart Farming

Current Location :
Johnny Appleseed's Orchard
DeMunn Rd, Beaver Dams, NY
Latitude : 42.282480
Longitude : -76.934862

Change Location

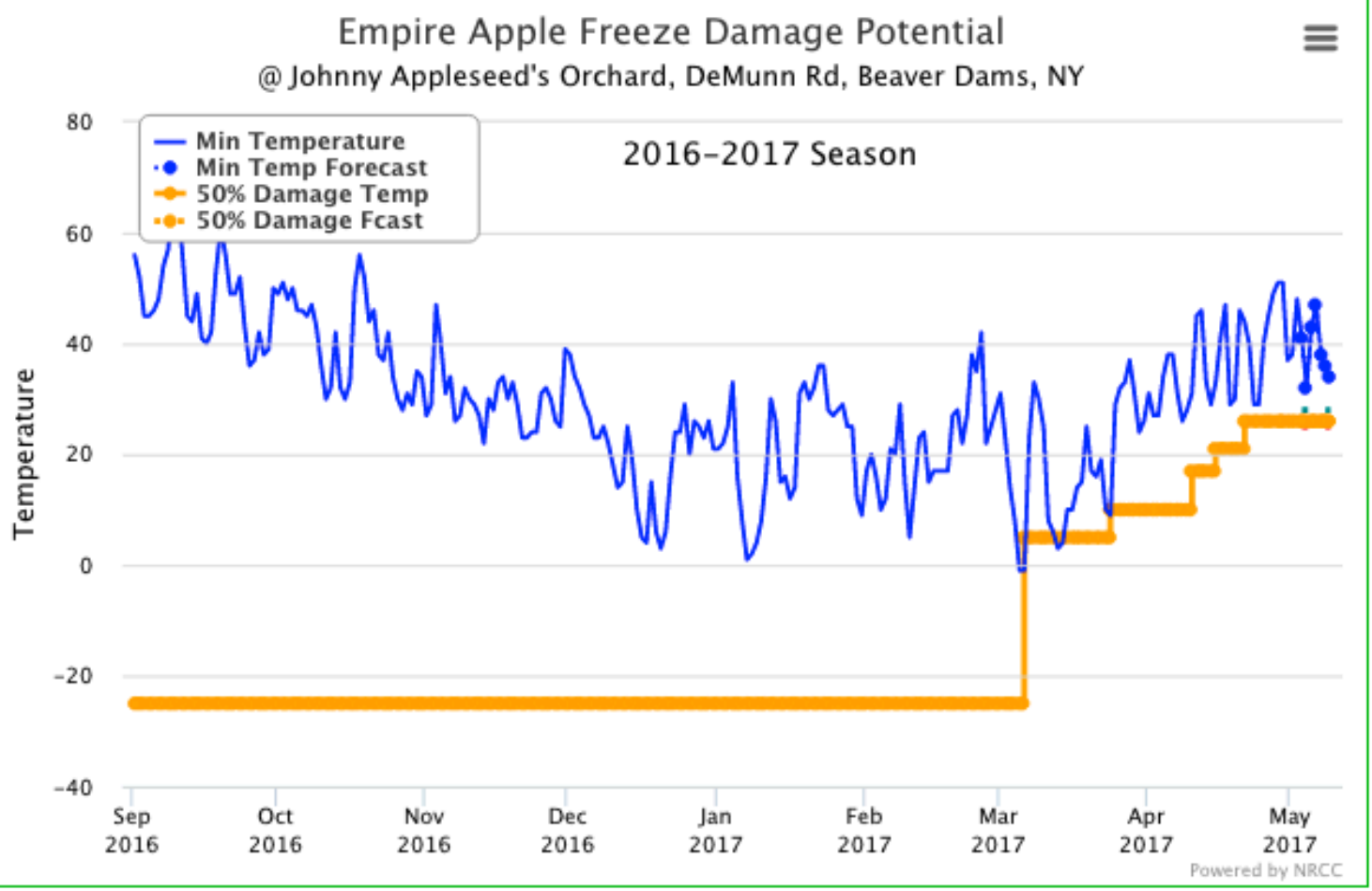
Date of Interest:

2017-05-02

Apple Variety

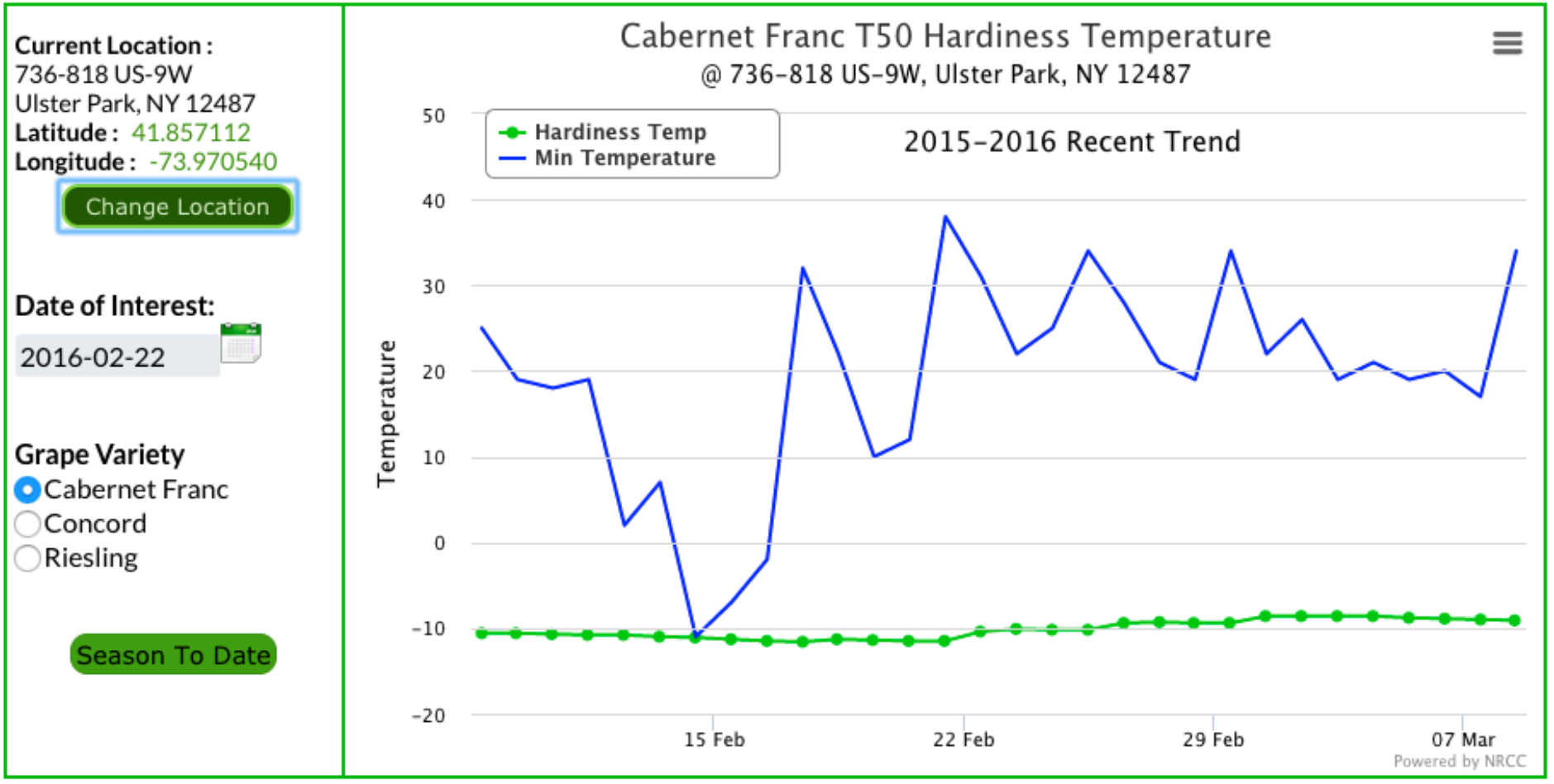
- (•) Empire
- ( ) McIntosh
- ( ) Red Delicious

30 Day Trend



Grape Hardiness Tool

- Spring frosts not receding as quickly as flowering is advancing
- Can be used to determine level of freeze injury to grapes as a product of weather conditions and stage of plant development



Grape Hardiness Tool

- See the whole season at a glance to know where the most risk occurred

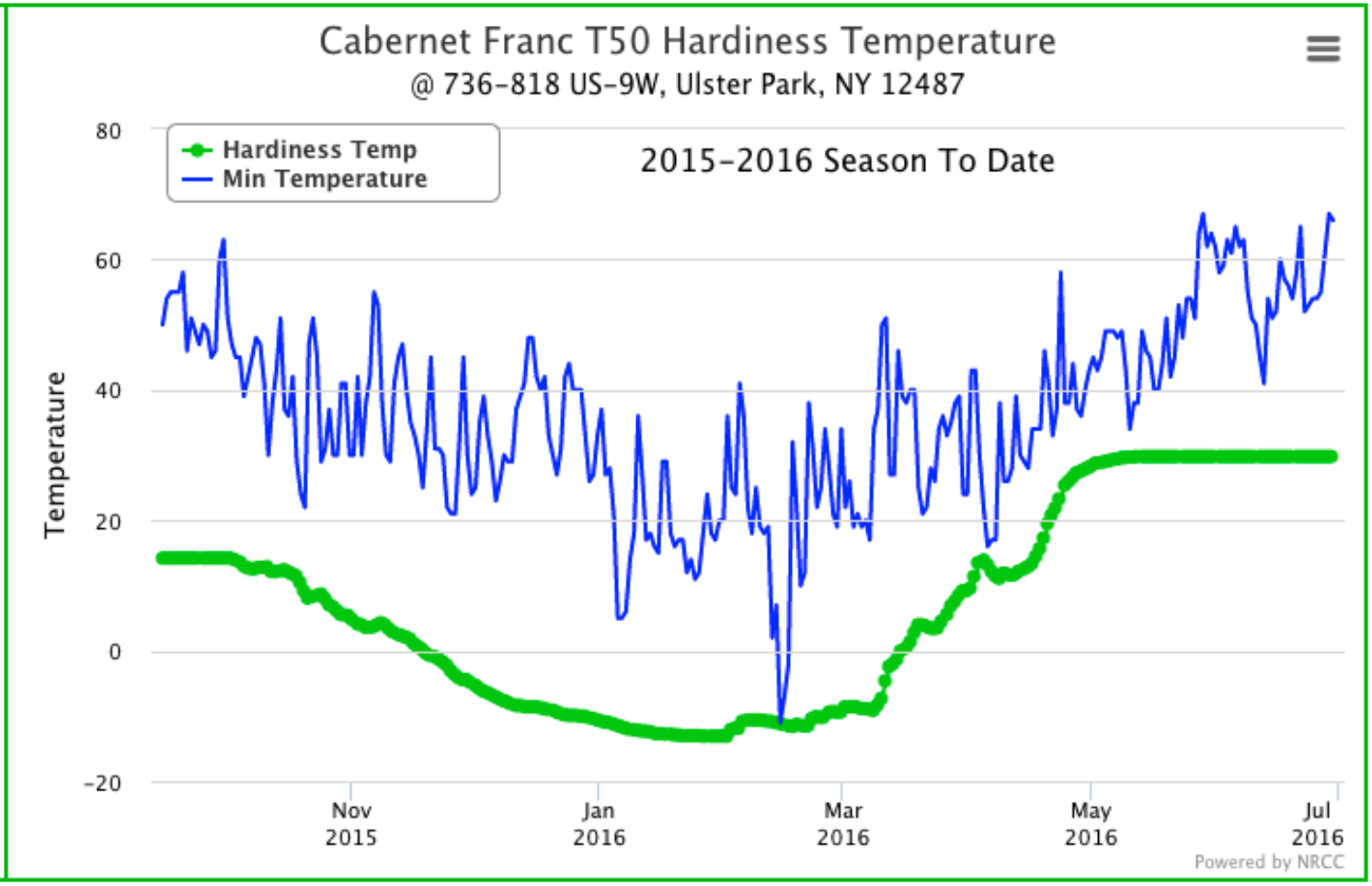
Current Location :
736-818 US-9W
Ulster Park, NY 12487
Latitude : 41.857112
Longitude : -73.970540

Change Location

Date of Interest:
2016-02-22

Grape Variety
- (•) Cabernet Franc
- ( ) Concord
- ( ) Riesling

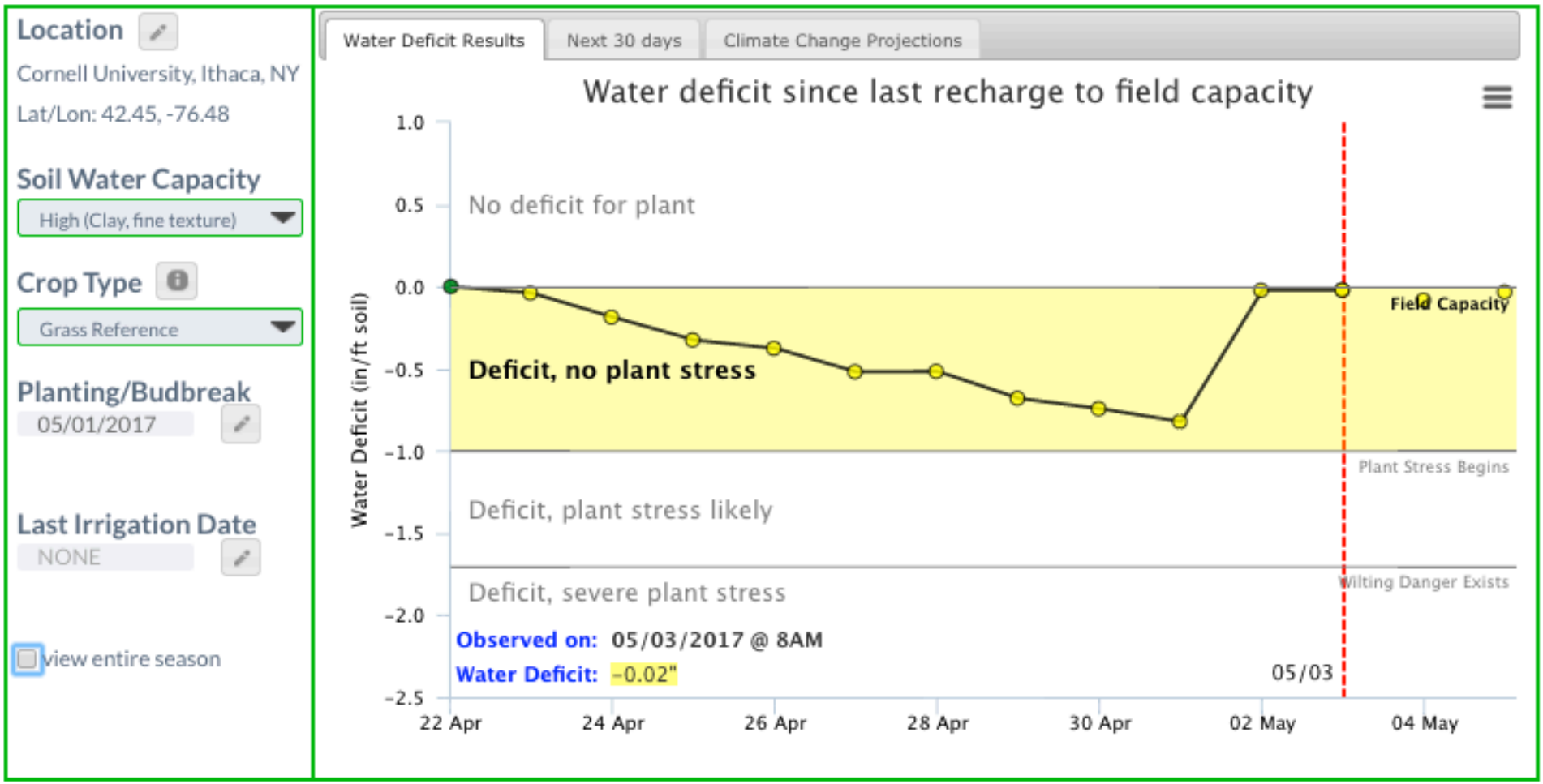
Recent Trend



Water Deficit Calculator

Cornell Climate Smart Farming

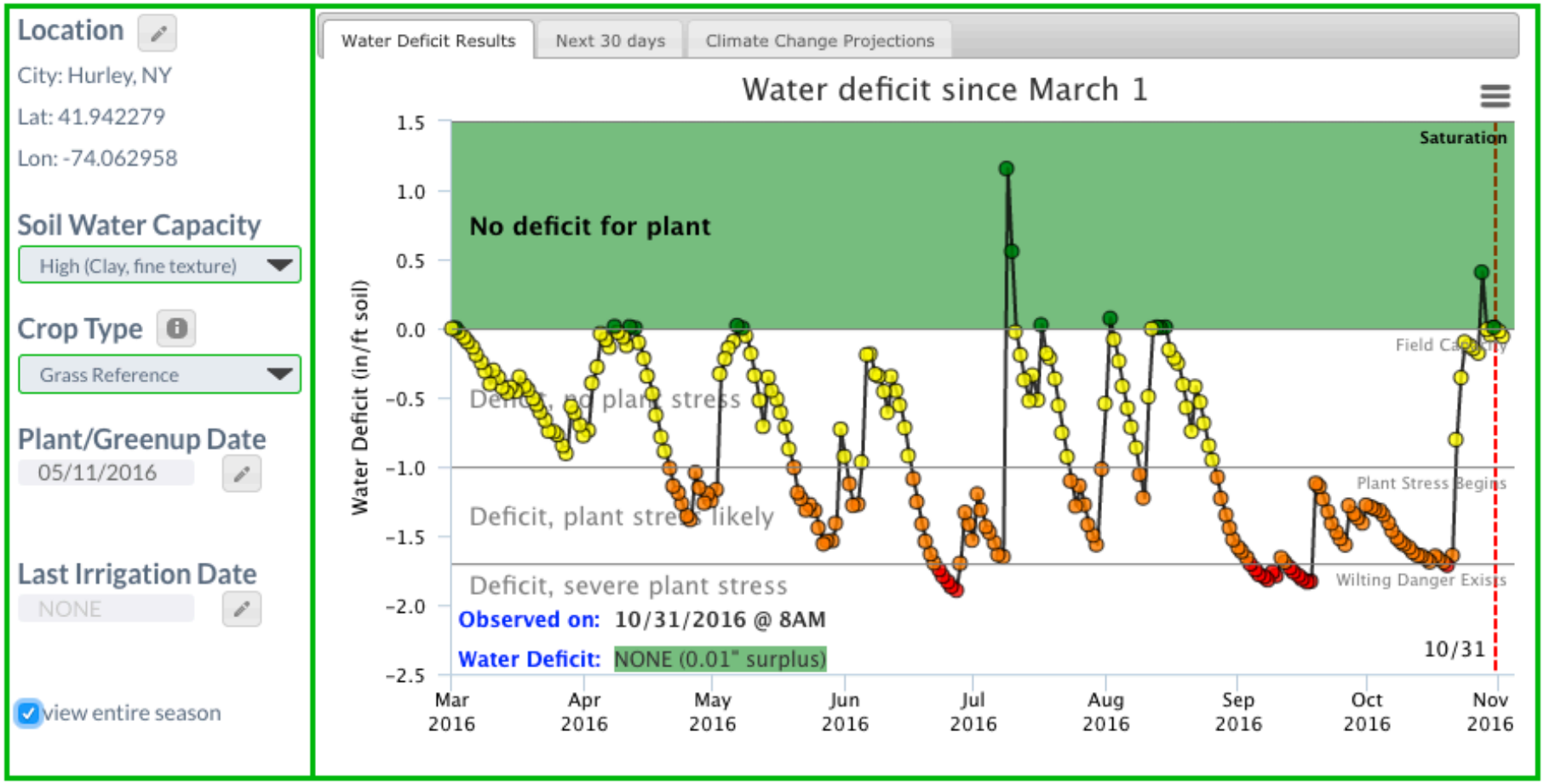
- Estimates effective root zone soil water content to inform decision makers about current and forecasted water deficits
- Uses precipitation, evapotranspiration, drainage, and runoff



Water Deficit Calculator

Cornell Climate Smart Farming

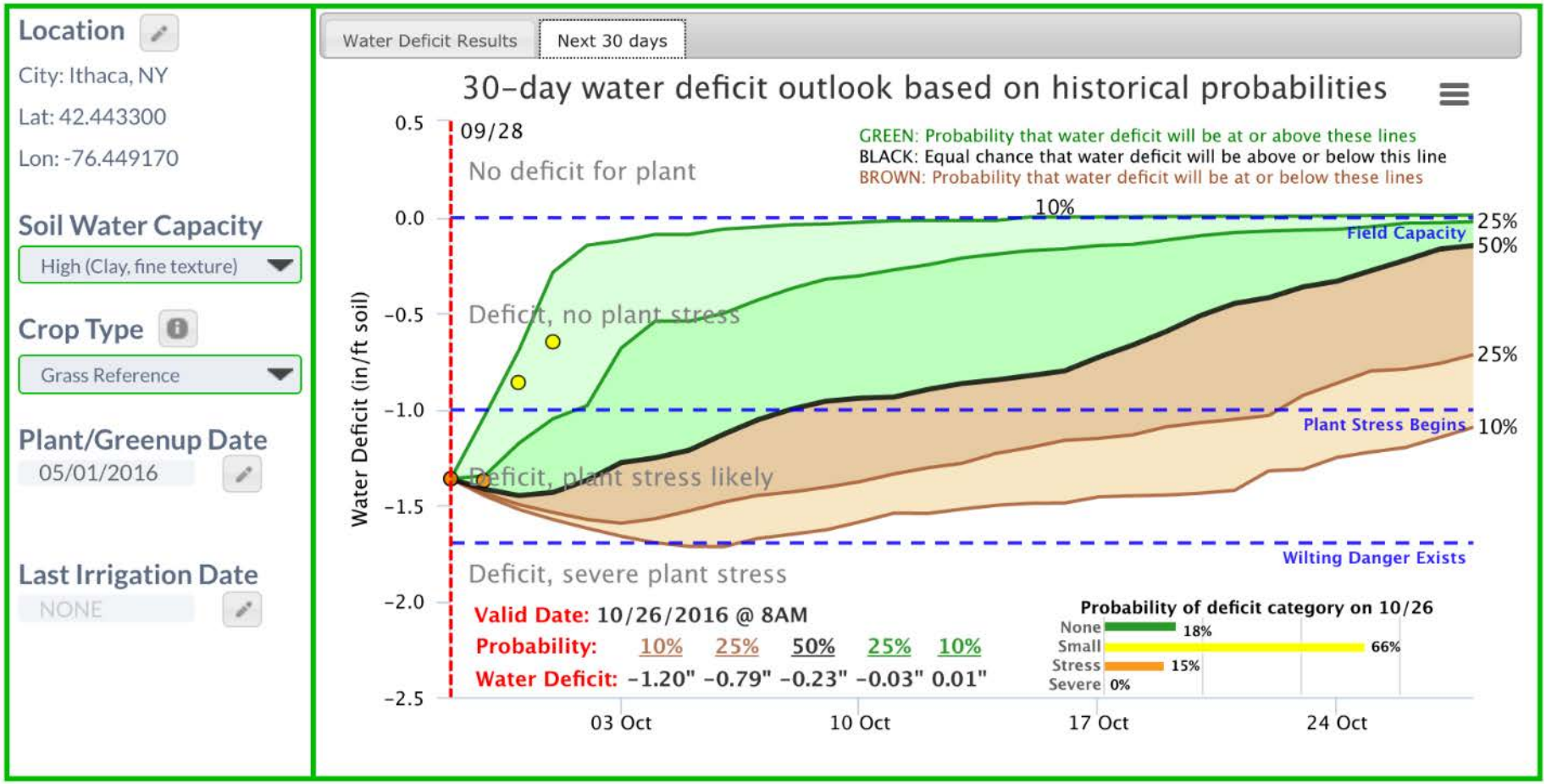
- Estimates effective root zone soil water content to inform decision makers about current and forecasted water deficits
- Uses precipitation, evapotranspiration, drainage, and runoff



Water Deficit Calculator

Cornell Climate Smart Farming

- Can be used to plan water applications to minimize plant stress and maximize water conservation
- Assesses the probability of naturally reaching certain levels of soil water content over the next month



Water Deficit Calculator

- Long-Term Climate Change Context

Growing Degree Day Tool

Cornell Climate Smart Farming

- Shows seasonal outlook during and out of season

Current Location :
1289 Hurley Mountain Rd
Hurley, NY 12443
Latitude : 41.942710
Longitude : -74.061016

Change Location

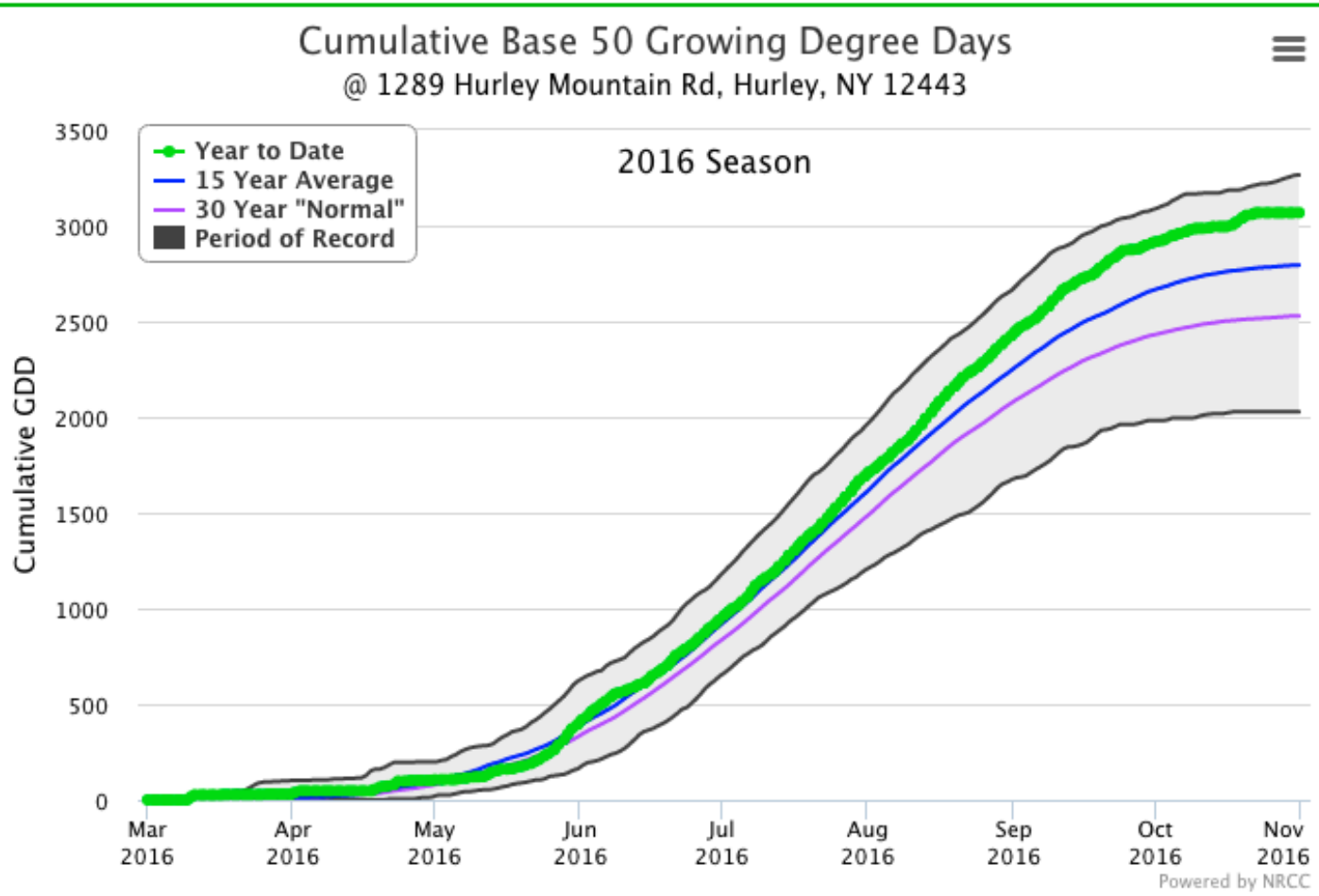
Planting Date:

2016-03-01

GDD Threshold

- (•) Base 50
- ( ) Base 8650

Growing season is over.



Growing Degree Day Tool

Cornell Climate Smart Farming

- Displays forecast when in season

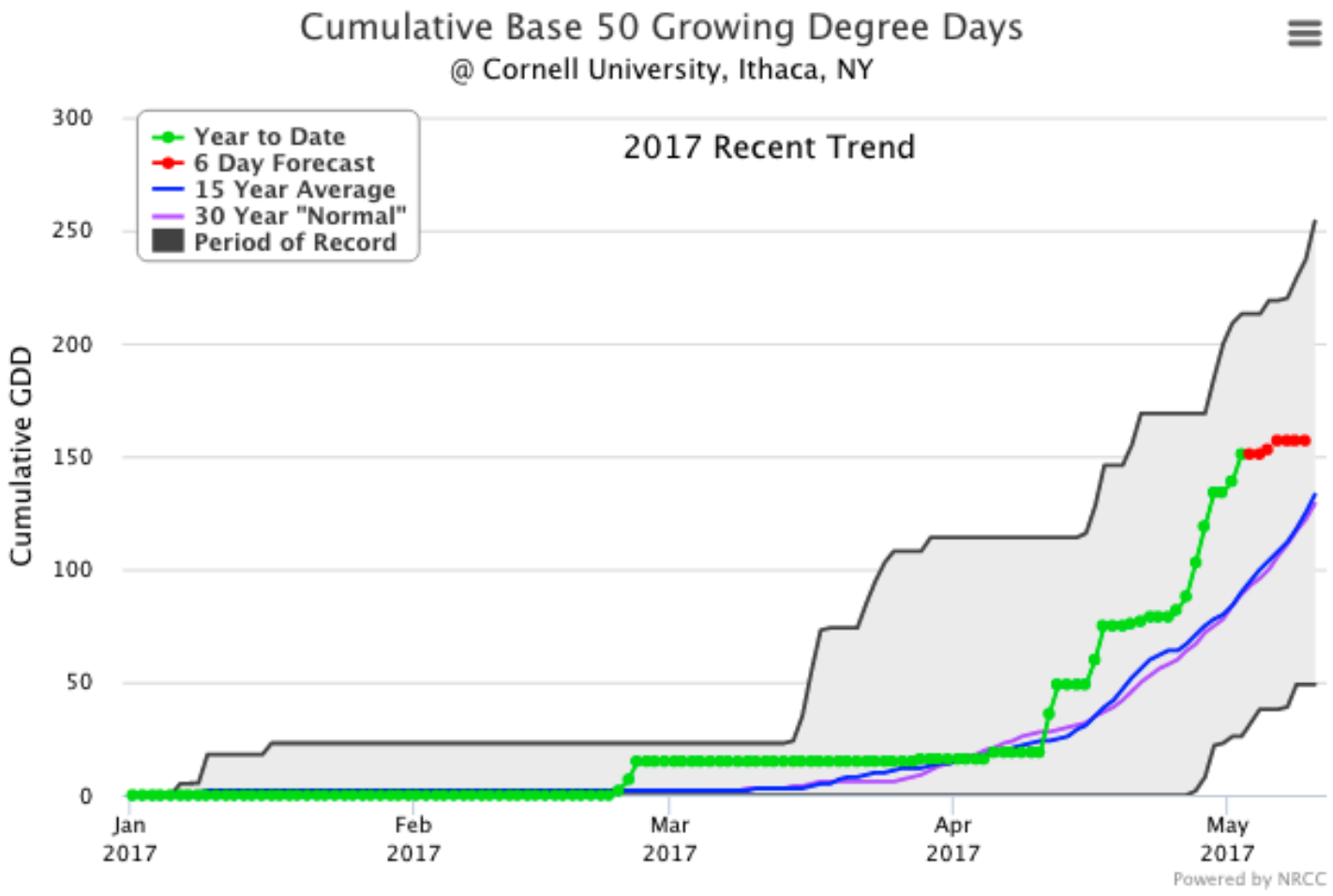
Current Location :
Cornell University
Ithaca, NY

Change Location

Planting Date:
2017-01-01

GDD Threshold
- (•) Base 50
- ( ) Base 8650

Season Outlook



Thank You! Contact Us

Jonathan Lambert
Cornell Institute for Climate Smart Solutions
Climate Smart Farming Program
jl3356@cornell.edu
www.climatesmartfarming.org