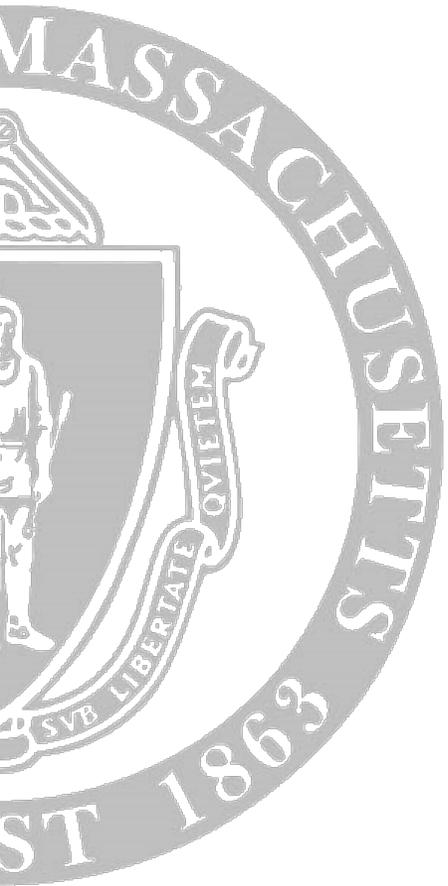


# Climate Change and Agriculture in Harvard MA

**Harvard Municipal Vulnerability Preparedness  
Agricultural Workshop I**

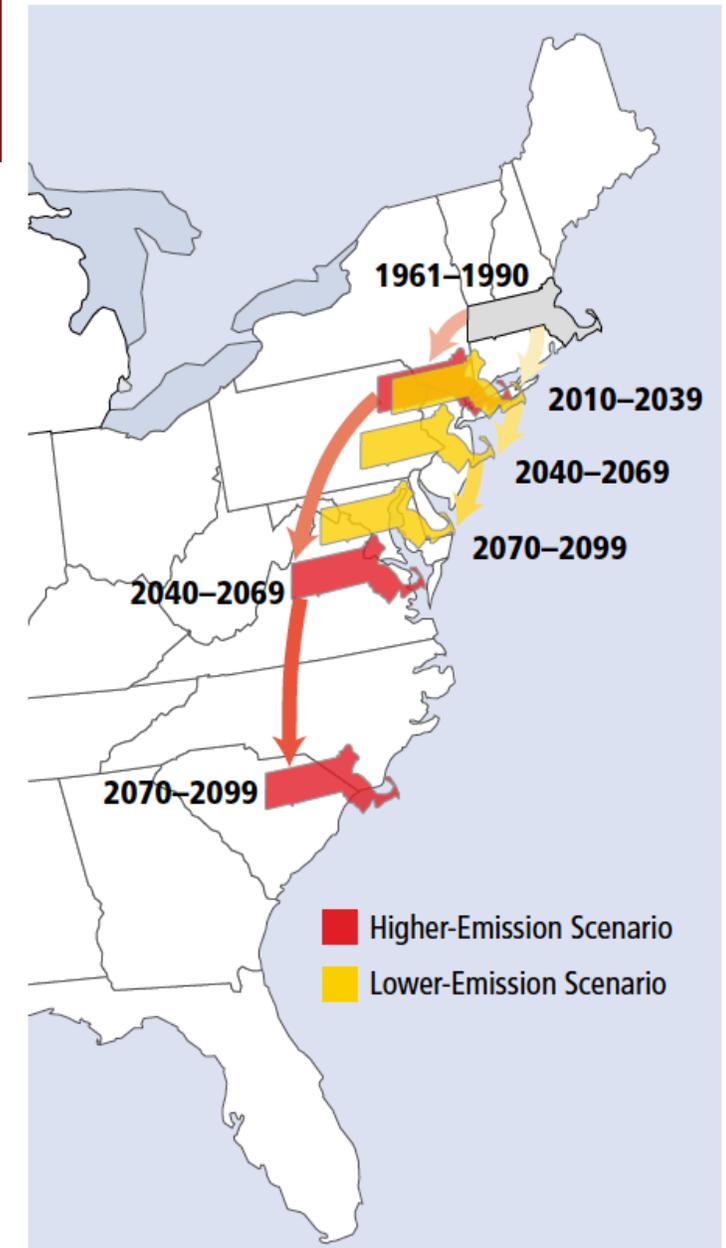
February 2, 2019

Daniel Cooley  
Stockbridge School of Agriculture  
University of Massachusetts Amherst



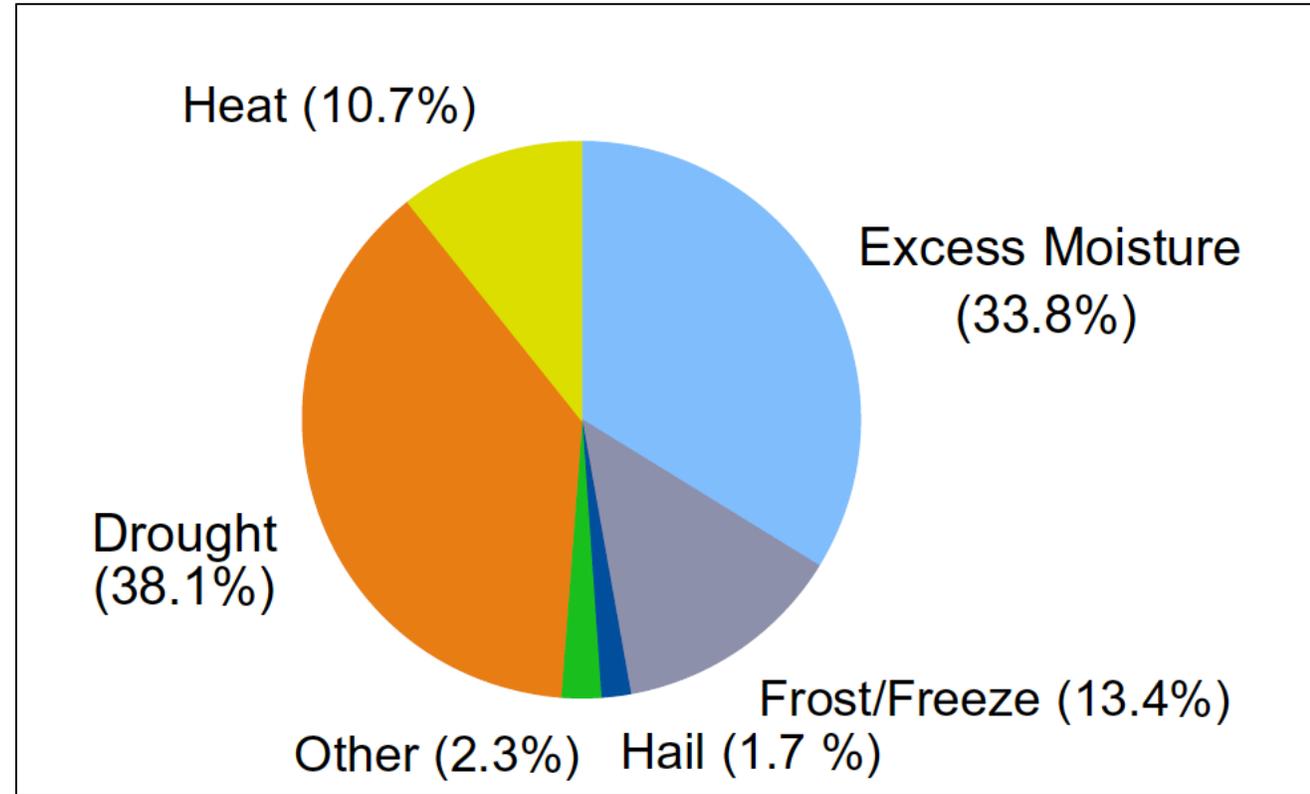
# The basic problem

- Climate is changing
- Impacts average temperatures and precipitation
- Impacts weather patterns – more extremes
- Both will impact what we grow and how well we grow it in MA
- Not as simple as switching from apples to oranges



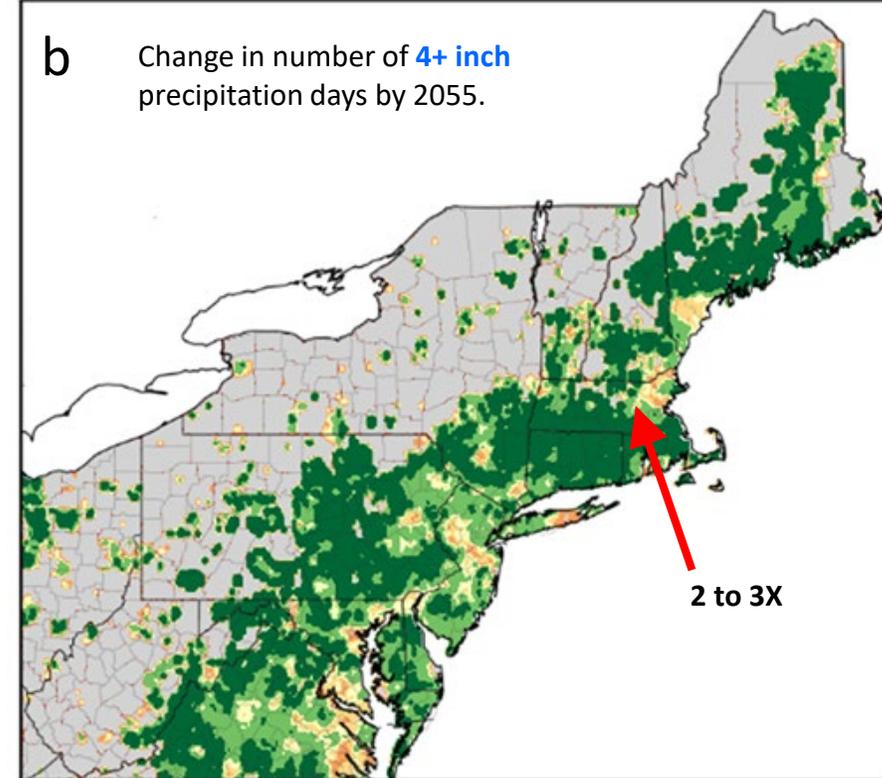
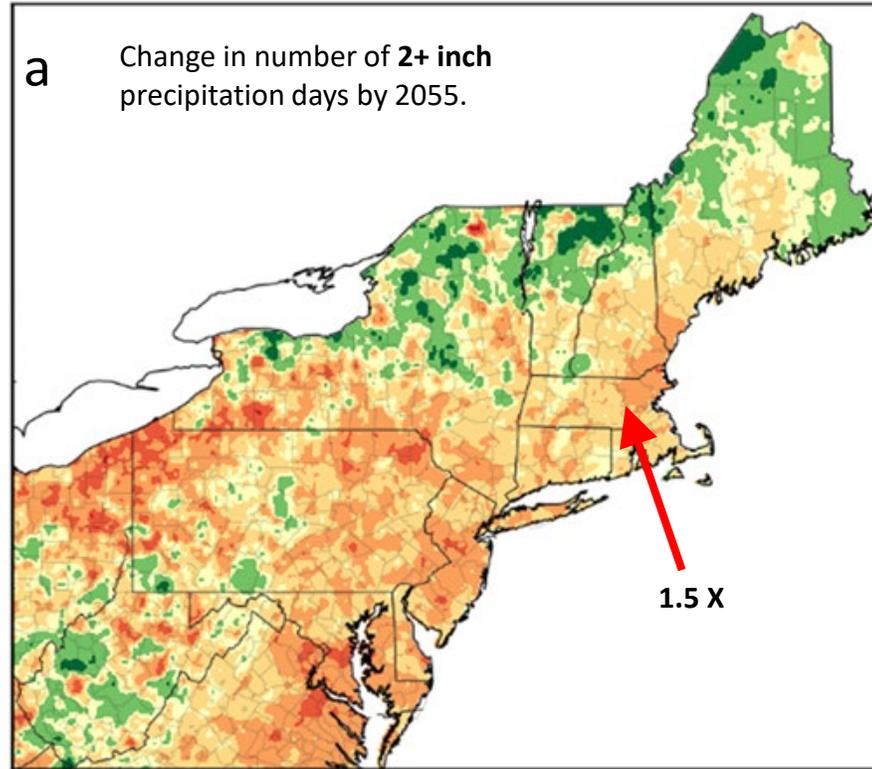
# Climate change impacts on Northeast agriculture

- 2013-16 snapshot of weather-related crop loss
- About 1/3 of losses caused by excess precipitation
- An increase of 71% in extreme precipitation events since mid-1990s.



Weather-related crop loss reported to USDA for all crops in the Northeastern US 2013 – 2016. From Wolfe et al 2018.

# More extremes in precipitation



1.00 = no change. 1.50 = 50% more days. 2.00 = Twice as many days.

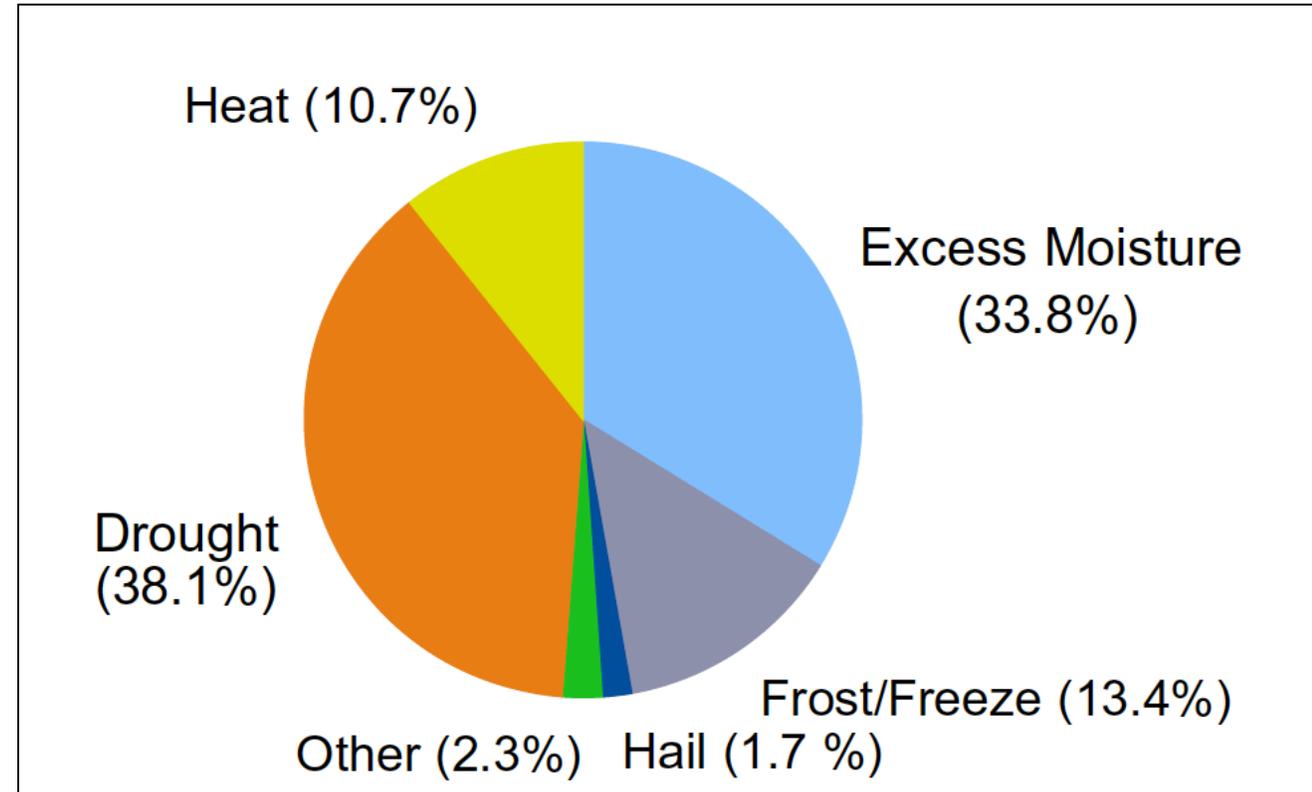
# More extreme rainfall

- Root suffocation
- Increased root diseases from fungi
- More crop diseases e.g. potato and tomato late blight, apple scab
- Soil erosion
- Runoff of sediment, chemicals, animal manure to surface water
- Planting delays due to wet soil - shortens the growing season even if “frost-free periods” lengthen
- Requires more drainage, other mitigation for soil and surface water



# Drought

- About 40% of crop loss in 2013-16 caused by drought – data skewed by severe 2016 drought
- High-value fruit, vegetables and ornamentals already require irrigation
- Projected higher evapotranspiration, plus steady or decreased summer precipitation, plus precipitation concentrated in high-rainfall events would increase the need for water storage and irrigation



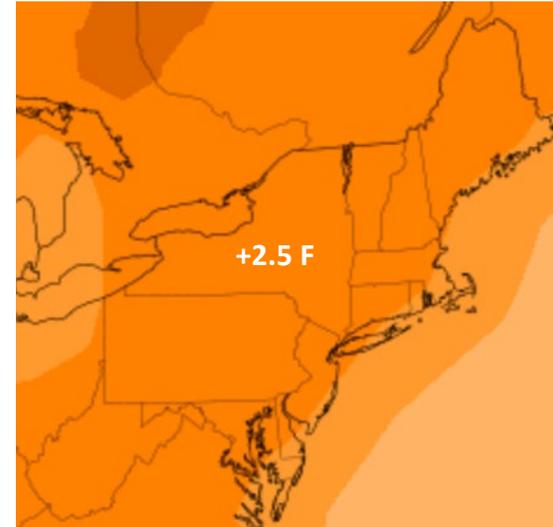
Weather-related crop loss reported to USDA for all crops in the Northeastern US 2013 – 2016. From Wolfe et al 2018.



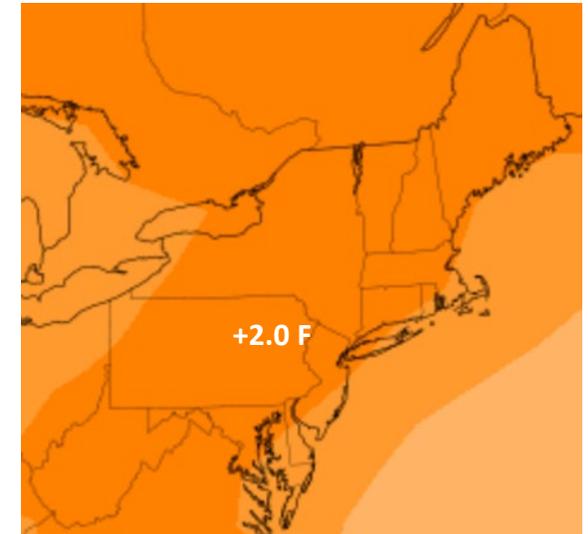
# Summer heat stress

- About 11% of losses in study related to heat, including higher night temps, as well as extremes
- Higher night temps > lower yields
- Projected 3 to 4°C (5.5 to 7°F) increase in summer max and min
- Warmer temps change quality of some fruit and vegetables, e.g. firmness decreases, more grainy texture
- May allow insects, diseases to survive better

Change in seasonal average temperature, from 2017 to 2047



Summer Jun., Jul. Aug.



Fall Sept., Oct., Nov.

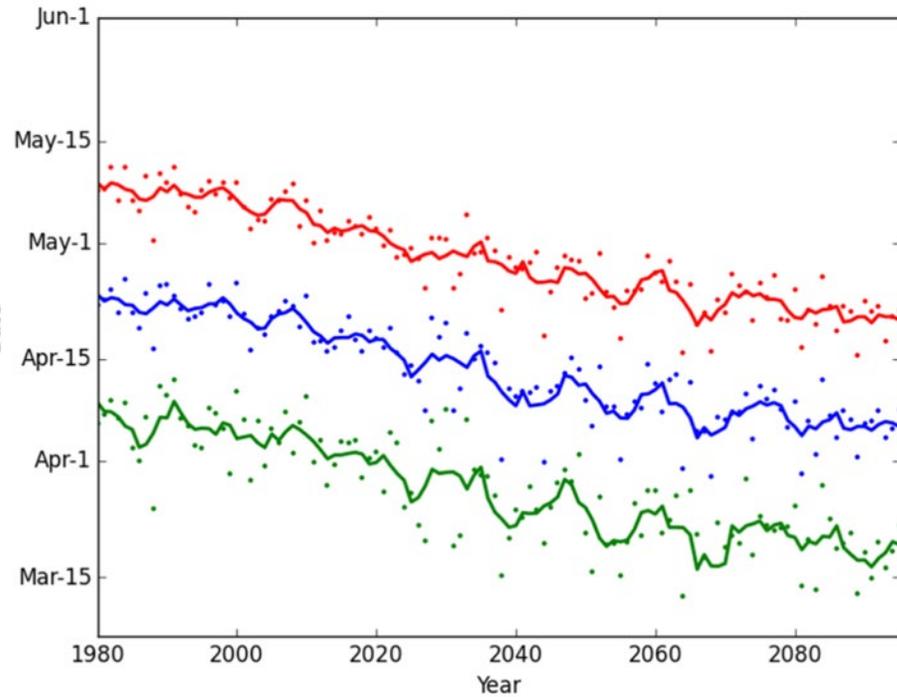
# Frost and freeze damage

- Warmer winters and springs will lead to earlier bloom in perennial crops, e.g. apples, peaches, grapes
- For example, 2012 apple bloom 3 to 4 weeks earlier than historical norms – followed by several frosts
- After warm weather in Jan. and Feb. 2016, severe freeze killed peach crop in southern New England

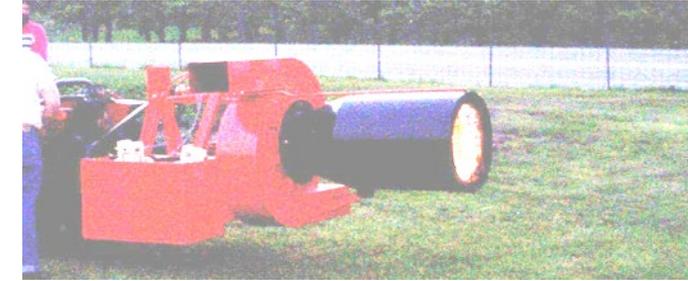


Frank Carlson surveys lost peach crop from Feb. 2016 freeze. Frost damaged flowers on apple above right, and flower bud killed by freezing left.

# Complicated relationship between chilling, early season, frost



Oil-soaked hay bales also used for frost. Overhead irrigation on berries.

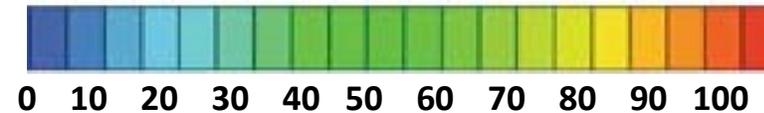
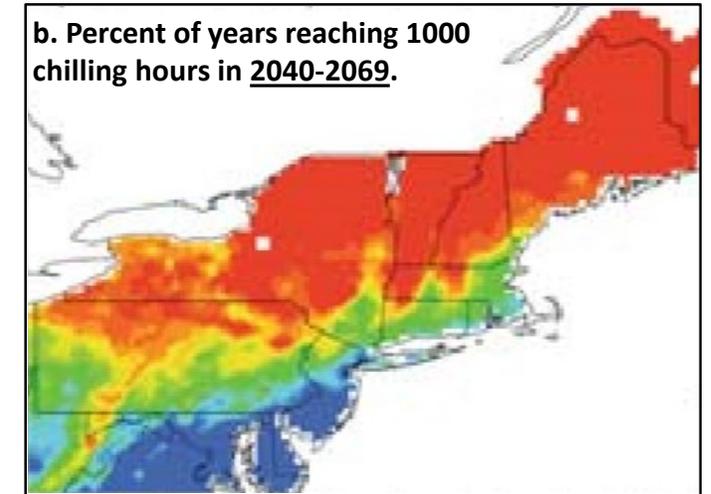
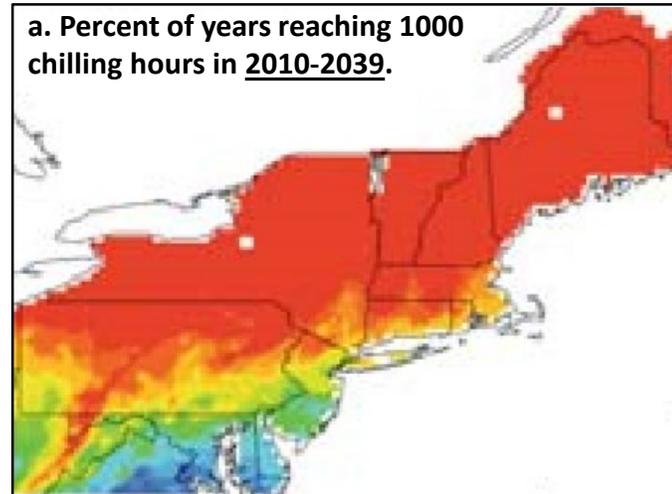


In some frosts, mixing air using a wind machine or helicopter helps. Maybe drones? Tractor mounted heater can also be used.



# Change in chilling hours

- Perennial crops require cold during their winter dormancy
- Once fulfilled, they can lose cold tolerance
- If not fulfilled, they won't grow normally
- Southern New England now gets 900 to 1000 hours, but this is projected to drop significantly > changes in varieties, maybe crops



Projected percentage of years during 2010-2039 when a 1000 hour winter chill requirement will be met. Adapted from Wolfe et al. 2008.

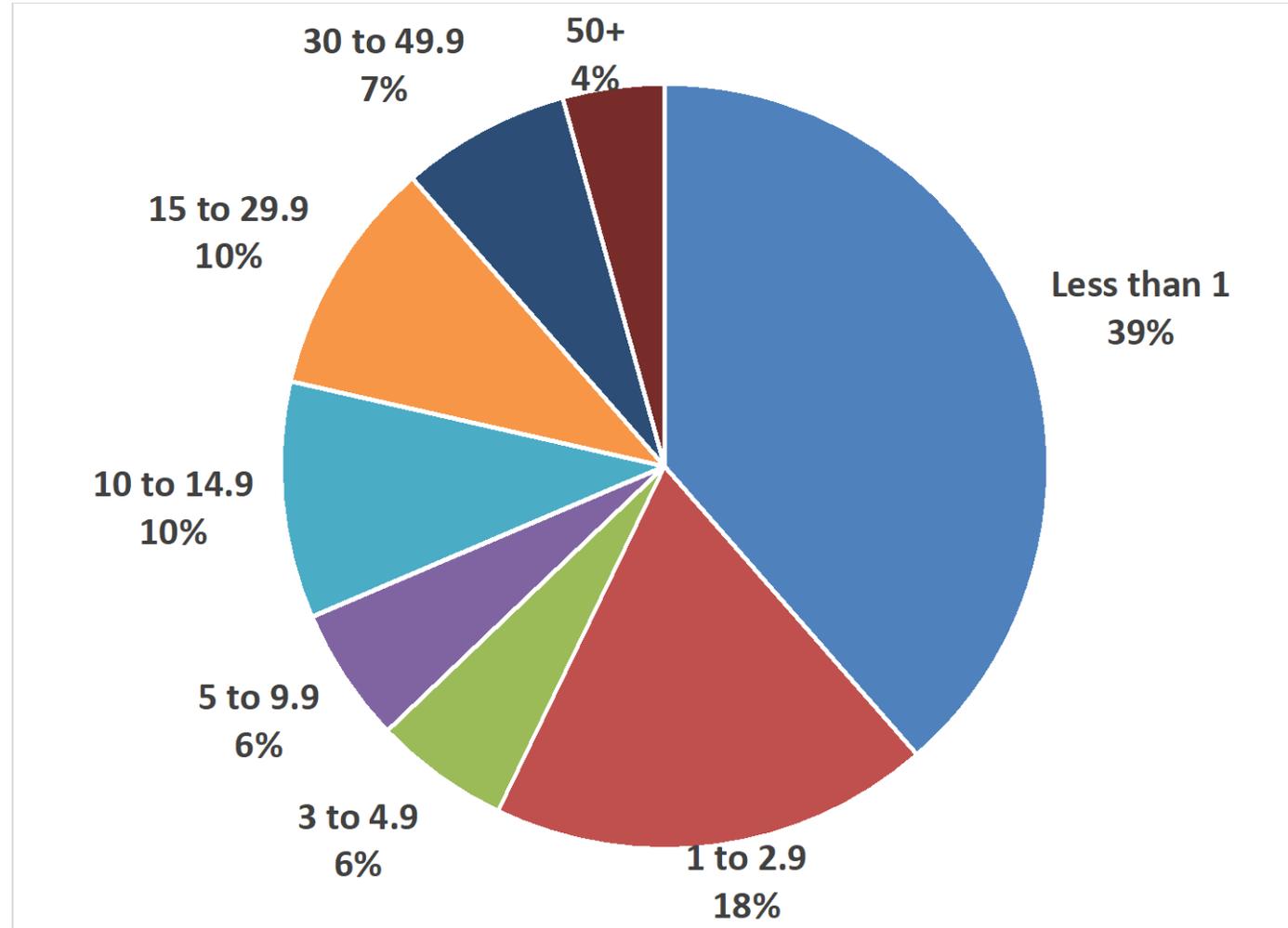
# Harvard agricultural survey

- Gather information about who is involved in agriculture in Harvard
- What is being produced
- What are the issues related to agriculture, particularly climate-related issues, as far as farmers are concerned



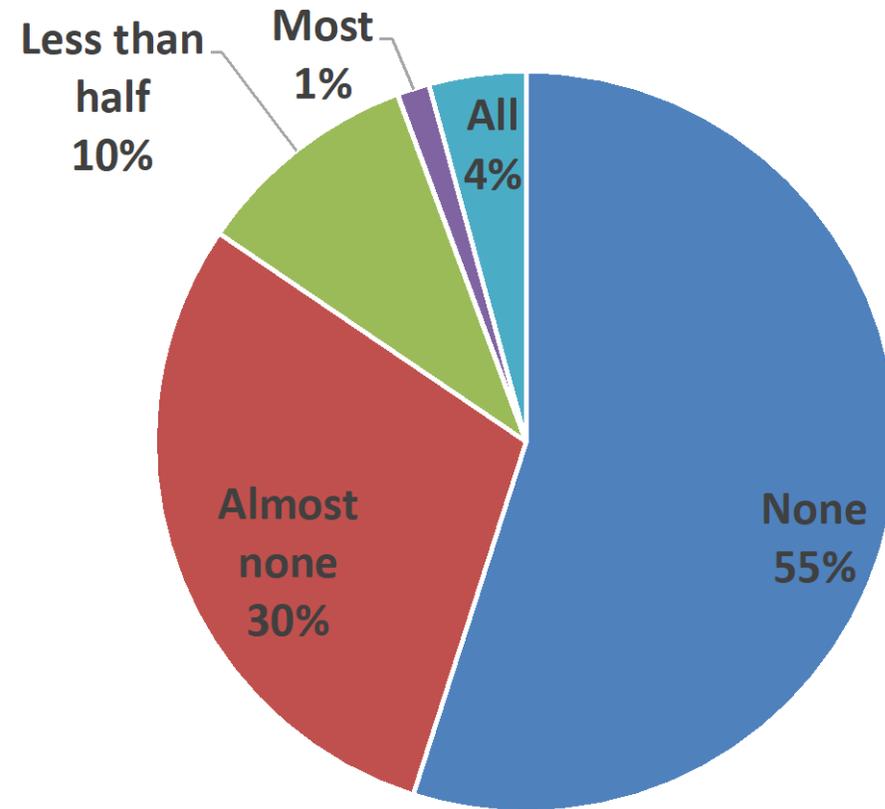
# How many acres do you have in production during your growing season?

- Of 70 responding:
- Highest category less than 1 acre, 39%
- Most production on less than 3 acres, 57%
- Lowest category 50 acres or more, 4%
- About a third of production on parcels over 10 acres, 31%



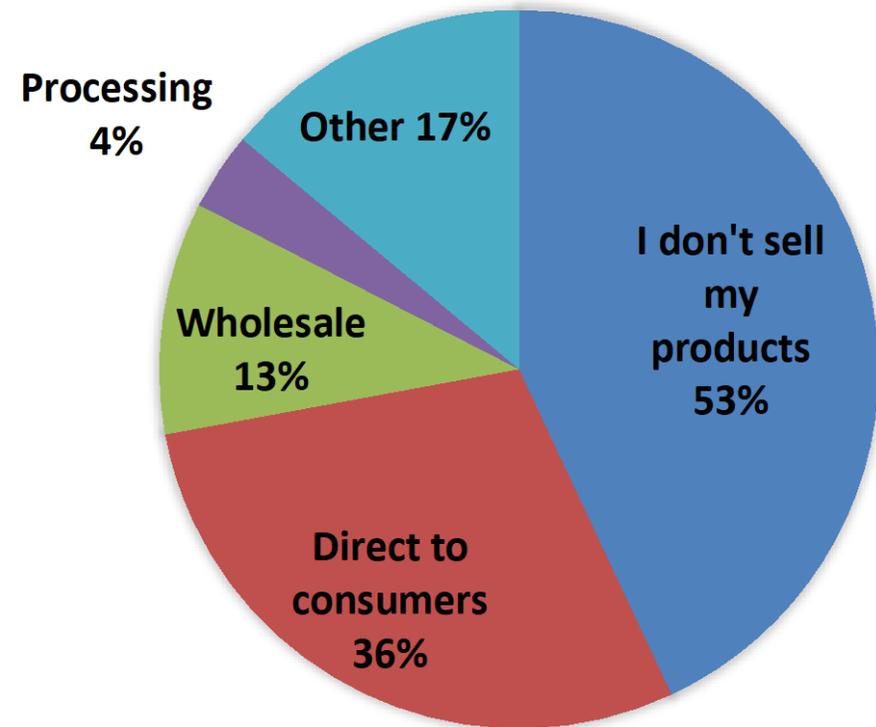
# Amount of total household income supported by farm or orchard

- Of 70 responding:
- Over half report none, 55%, and 85% report none to almost none.
- Only 5% report most or all.
- Conclusion: most respondents are doing small-scale, hobby farming



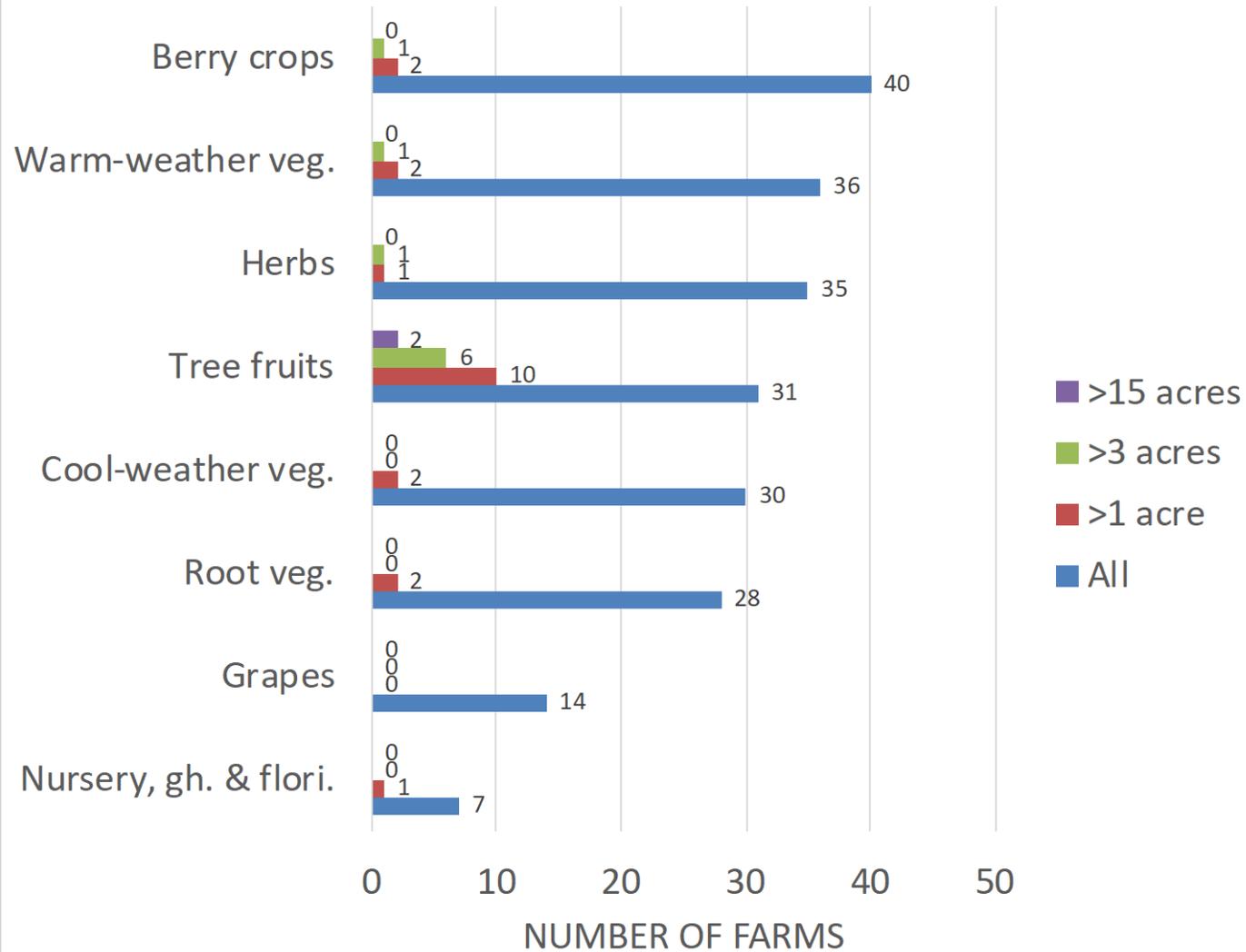
# How do you sell your products

- Of 70 responding:
- Over half report don't sell products
- Direct sales are most important for those who do
- Other
  - Use hay for feed or have another farmer use it
  - Haven't needed to sell wood
  - Personal use, give away



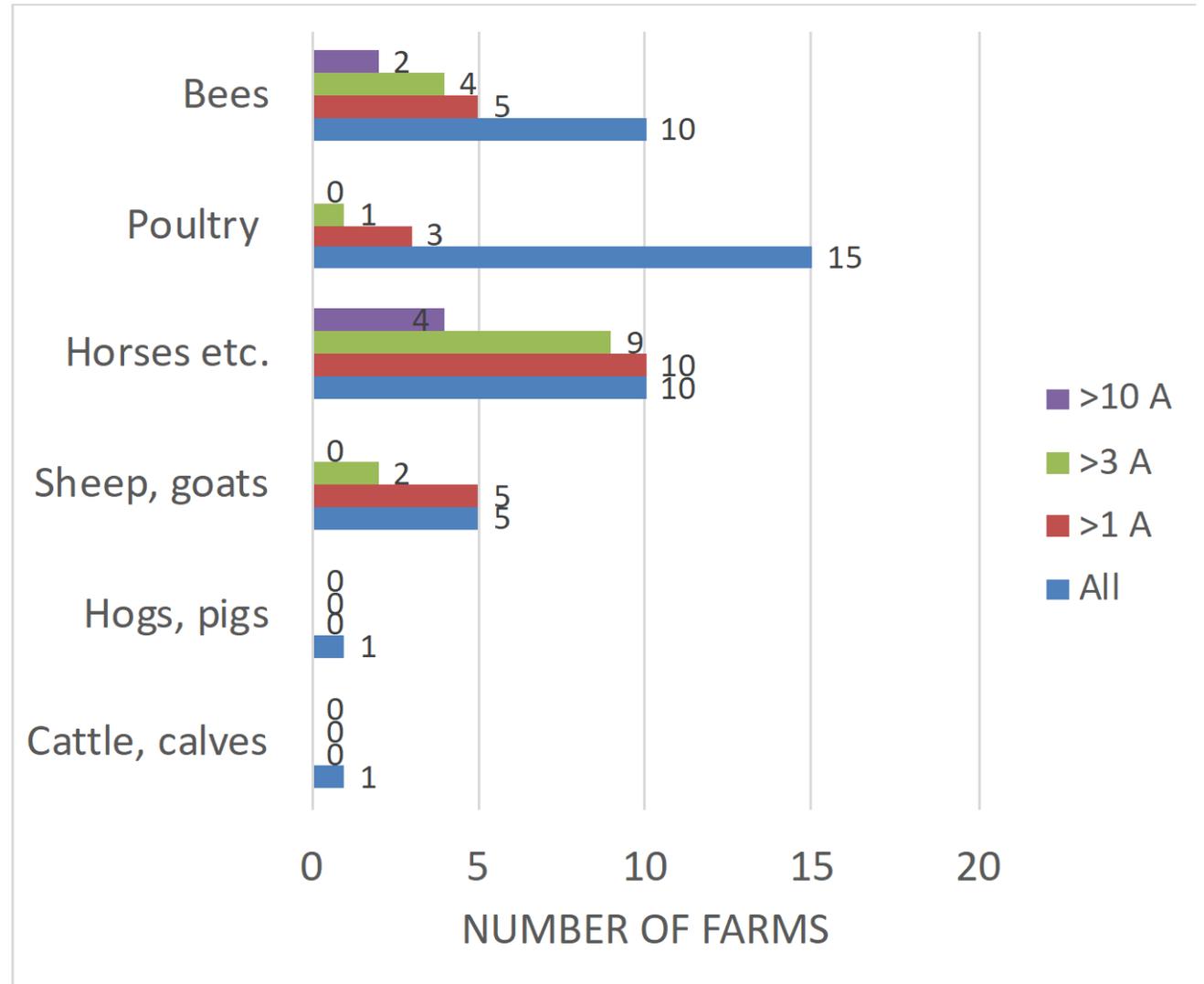
# Acres of fruits, vegetables and other horticultural products

- Most respondents produce berry crops, warm-weather vegetables such as tomatoes, herbs, tree fruit and other vegetables
- Most larger farms produce tree fruit
- Production over 3 acres limited to tree fruit, warm-weather vegetables, berries and herbs.



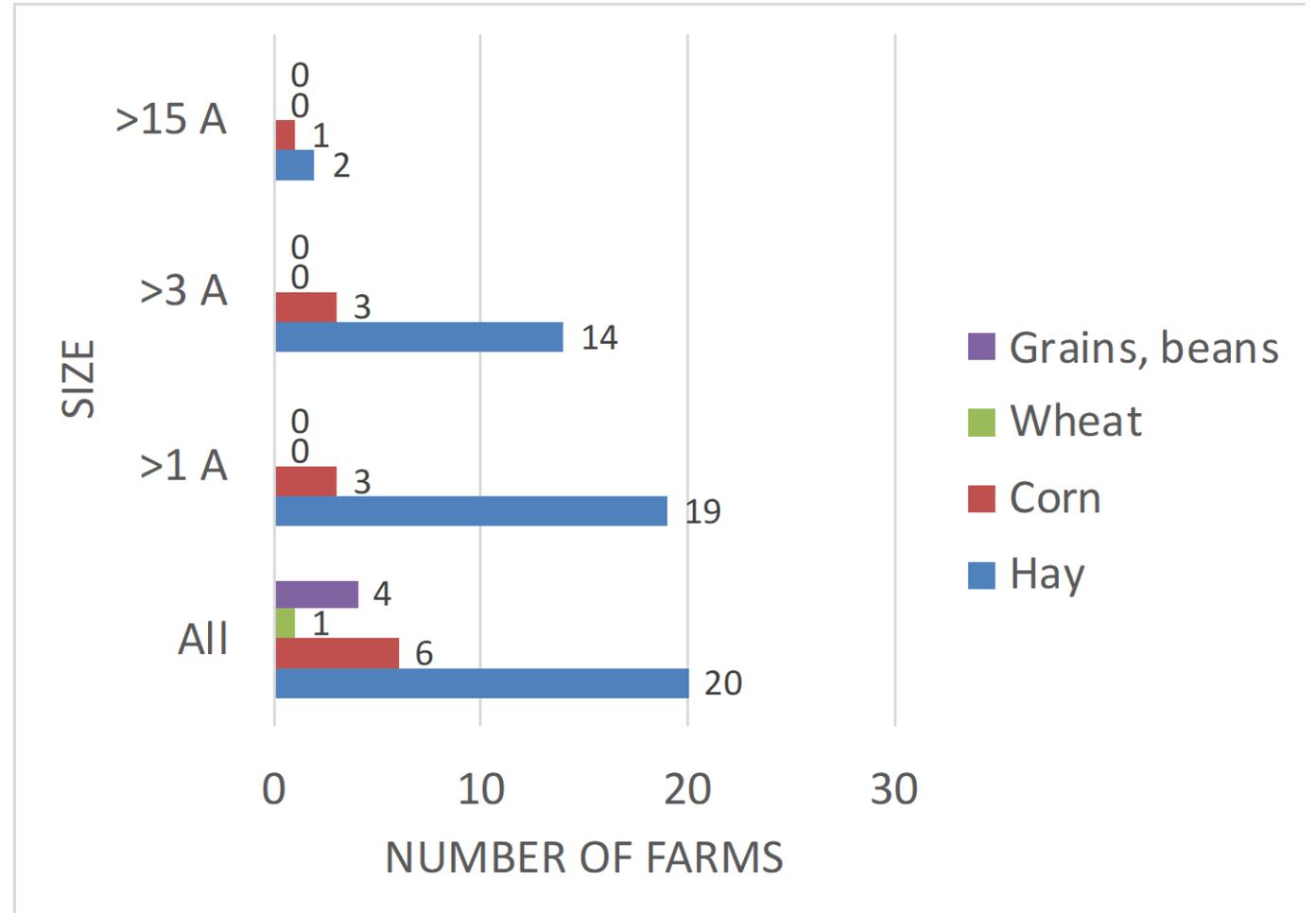
# Animal agriculture

- Chickens, horses, sheep & goats, and bees are most important
- Horses dominate in farms over 3 acres
- No animal agriculture over 30 acres
- So horse farms are between 3 and 30 acres



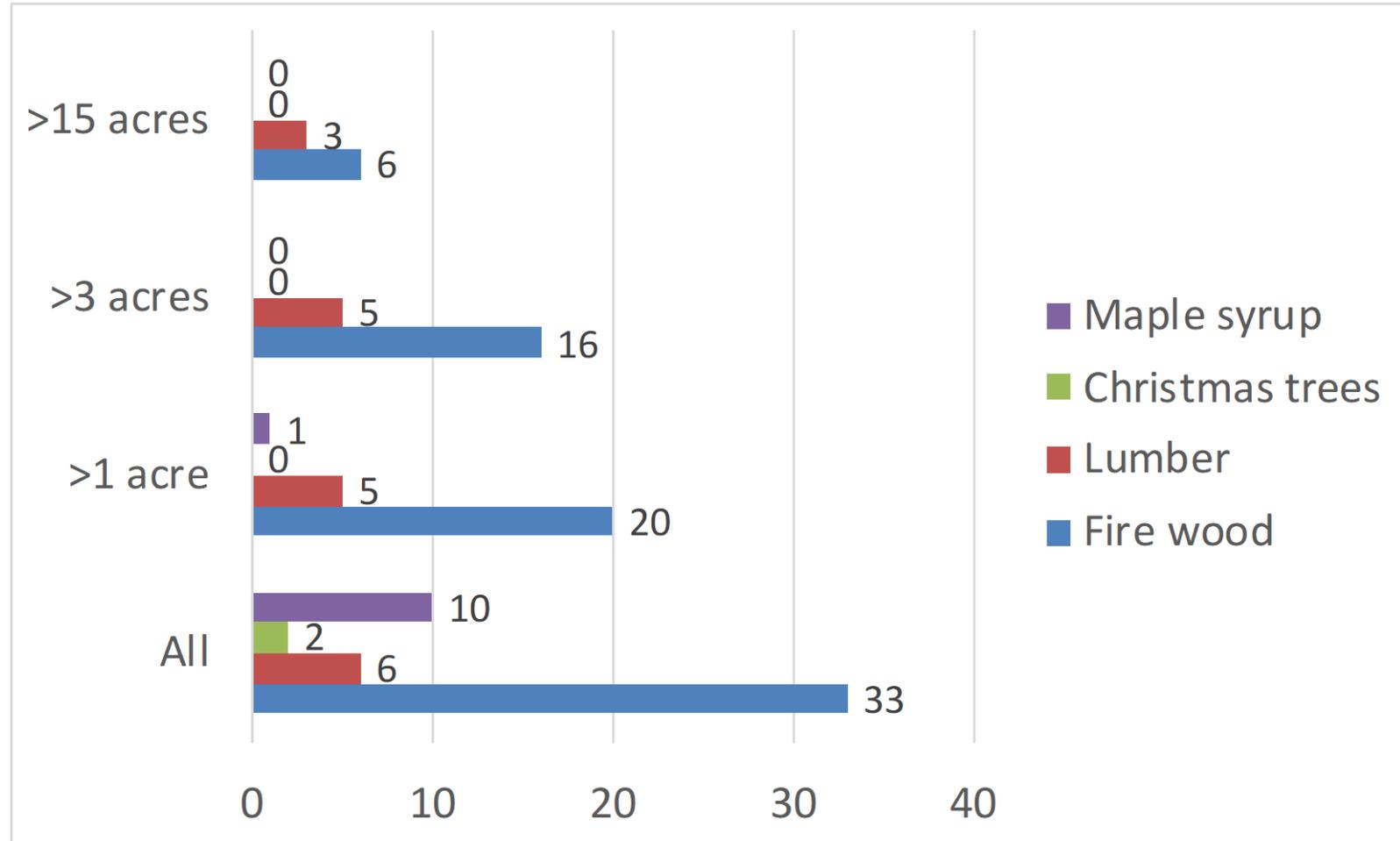
# Field crops

- Most in hay and corn
- None over 50 acres
- Three over 15 acres



# Forest related products

- A total of 33 respondents, all of whom produced firewood
- Larger acreage parcels produced lumber
- Small scale maple syrup and Christmas trees

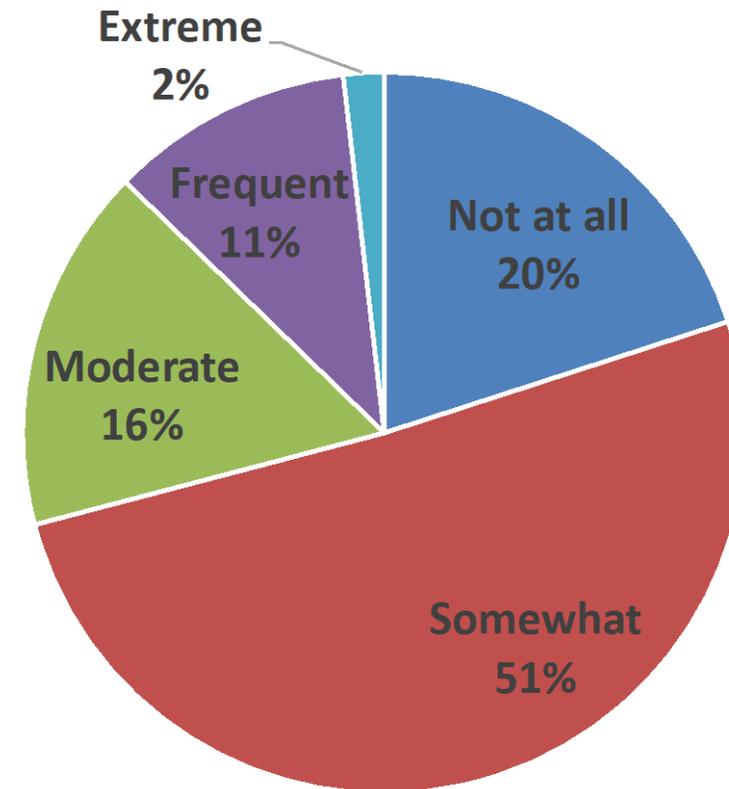


# What could the Town of Harvard do to support your viability?

- Taxes – 6
  - Lower
  - Lower taxes on farms < 5 acres
- Land use regulations - 6
  - Decrease
  - Don't use suburban regs. on farms
  - Fewer regs. on farmstands, farm buildings
  - Clarify home kitchen vs. commercial
- Classify more land as farmland - 5
  - Horses should be agriculture
  - Increase ag. land zones
  - Include small farms in ag. overlay
  - Allow farming on conservation land
  - Allow firewood harvest on cons. land
- Water - 5
  - Free water testing, esp. for irrigation
  - Priority for farm irrigation vs. residential
  - Well for community garden
- Wildlife and bees -3
  - Cull deer, encourage foxes
  - Pesticide regs. to help pollinators
- Keep on the present course – 2
- More support for hemp, cannabis - 1

# Recent extreme weather events have affected my long-term farm/ agricultural/ forestry management goals

- Of 55 responding:
- Over half said somewhat
- One fifth said not at all
- About one third said moderate to extreme
- Ice storm
- Wind
- Too much rain
- Freeze
- Drought



# How concerned are you about potential impact of the following?

More frequent or new pest pressures related to weather (e.g., insects, fungus, disease)	3.2
Longer dry periods or drought	3.1
More frequent crop diseases related to weather	3.0
More frequent unpredictable seasonal temperatures (early bud break, early or late frosts)	3.0
More frequent or new weed/invasives pressure related to weather	3.0
More frequent heat stress on my crops	2.8
More frequent saturated soils and ponded water	2.8
Loss of nutrients due to heavy and abundant precipitation	2.7
Hail and ice storm damage	2.7
Wind damage	2.5
Reduced winter snow cover	2.4
More frequent erosion	2.2
More frequent flash flooding	2.2
More frequent river flooding events	2.0
More frequent stress/runtime on cold storage/refrigeration due to increased temperatures	1.7

# Which of the following have the largest impacts on your success?

Extreme and variable weather	1.76
Land use regulations, such as zoning	2.48
Pest control	2.69
Crop failure	2.89
Weekend weather conditions	2.94
Local tax structure	2.98
Equipment purchasing and/or maintenance	3.13
Increased operation costs (e.g., fuel, electricity, hourly wage, insurance)	3.38
Cost of mitigation (e.g., irrigation, row covers/hoop houses, increased pesticides and/or fertilizers)	3.4
Pesticide notification laws	3.47
Food safety regulations	3.81
Succession planning	3.89
Market volatility	4.05
Labor regulations	4.19
Part-time labor shortages	4.19

# Summary

- People are concerned that climate change will have a negative impact on horticulture and agriculture in Harvard
- Largest concerns relate to extreme weather events, drought and other water-related issues, excessive heat and consequent increases in pest problems (insects, diseases and weeds).
- Most people who responded are not farming commercially and are managing small areas.
- Most larger parcels farmed for tree fruit, vegetables, berries, herbs horses, hay, corn, firewood and lumber.
- Suggestions for town changes to encourage ag. are varied, with most common being tax changes, land use regulation and classifying more land as farmland.