

## Climate Change and Agriculture: No Longer Business as Usual

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**A changing climate:** The climate is changing—it is getting warmer, and the evidence is all around us. Growing seasons are longer and hotter, winter temperatures are warmer and the weather is getting more erratic. The average annual temperature in the Northeast US has risen almost 2°F over the last 100 years. Winter temperatures have risen even faster, as much as 4°F in the last 40 years. Consistent with a warmer and moister atmosphere, we are also observing more severe weather and shifts in precipitation patterns.<sup>1</sup> The decade from 2001-2010 was the hottest ever recorded and 2012 the hottest year. If we continue business as usual the trajectory is set for the average global temperature to continue to warm into the future—by as much as 8°F by 2100 with smaller increases near the equator and greater change at the poles.<sup>2</sup>

**The cause:** The climate is warming due to human activity, primarily the burning of fossil fuels that release greenhouse gases (GHGs) into the atmosphere.<sup>2</sup> It is not necessarily easy to accept that we are the cause of the rapid climate change we are now experiencing, but the evidence supporting this is substantial and 97 out of 100 experts who work on this topic agree.<sup>3</sup> GHGs are essential to life on earth, and as the name implies, they act somewhat like a greenhouse for the earth, helping to retain heat in the lower atmosphere (a thin layer of atmosphere, only 7 miles thick). Unfortunately, since the late 1800's when we started to increase the use of fossil fuels, the concentration of GHGs in the atmosphere has increased rapidly. Today's global atmospheric CO<sub>2</sub> level is 40% above historical levels and in fact is now the highest it has been in several million years. And the current concentration of 400 ppm may reach 900 ppm by 2100 because of all the GHGs we continue to emit.<sup>2</sup> Not only has the actual concentration of CO<sub>2</sub> increased substantially in the atmosphere, but also the type of carbon that comes from the burning of fossil fuels. There is a direct link between human activity and climate change.

**Evidence all around us:** In the Northeastern US, lilacs, grapes and apples are blooming earlier,<sup>4</sup> and since 1990 plant hardiness zones have shifted northward.<sup>5</sup> Extreme weather has increased - since the 1950's, heavy rainfall events have increased 74% in our region.<sup>6</sup> Sea level is rising, in part due to glacial ice melting worldwide and because seawater expands as it warms. We are also seeing a northward expansion of new pests that can survive as the winters warm. For example, the corn earworm, a pest of sweet corn, used to arrive late in the summer on storm fronts. It now is present at the start of the season, presumably because it can now successfully overwinter in New York. The evidence for climate change is extensive.

**Natural versus human-caused climate change:** The climate is always changing due to changes in the earth's orbit around the sun and fluctuations in the sun's radiant energy (which is actually in a cooling phase right now). However, these events occur at intervals of thousands of years. Compared with these natural events, the current rate of change is extremely fast. For example, it took >10,000 years to warm about 15°F since the last ice age, yet it is predicted that in less than 100 years from now, it will warm another 8°F.<sup>2</sup> This human induced change is 50 times faster than the natural warming that occurred since the last ice age. In comparison, other natural factors such as volcanic activity may release large quantities of dust that has a shading effect and results

in a cooling effect of a few tenths of a degree for several years – but they cannot explain the unprecedented climate change that is being observed.

**Weather vs. climate:** It is important to distinguish between weather and climate. Weather is the day-to-day state of the atmosphere (including the temperature, precipitation, humidity, wind, etc.), and its short-term variation in minutes to weeks or even one year to the next. In contrast, climate refers to the weather of a particular place averaged over a period of time, usually longer than a decade and often 30 years or more. For example, a common way of describing the warming trend is by noting that each decade has been warmer than the previous one since the 1950's. Just because the normal weather variation is occurring (such as a winter storm) does not mean that the long term climate of New York or our planet is not changing.

**Agriculture - no longer business as usual:** The anticipated increases in temperature, along with changes in precipitation patterns and greater variability in the weather, have major implications for agriculture and the security of our food supply. The effects will be felt locally, regionally and internationally and they will not be uniform. For example, long-term changes in patterns of winter snowfall and spring snowmelt in the western US mountain ranges will reduce the availability of irrigation water for agriculture in California—a major source of fruit and vegetables for the US.<sup>7</sup> Likewise, climate change related stresses in California are also of concern to the future of the grape and wine industry with a potential reduction in acreage of 50% by 2050.<sup>8</sup> These increasing challenges to agriculture in the West may create opportunities for agriculture in New York State, if the agricultural sector is adaptable. We will still face challenges because of climate change, but with overall warmer conditions and the projected increase in average annual precipitation in the Northeast, there are opportunities for agriculture in the Northeast, if farmers can adapt to changes and begin to plan strategically for the future. In fact, increases in agricultural production in the Northeast may be necessary to help offset losses from climate change in other regions of the world.

In addition to opportunities with fruit and vegetables, other crops such as winter canola, which has been historically difficult to grow in the Northeast because of cold winter temperatures, may now become a potentially new and economically important crop for use as food-grade cooking oil. There is the potential for higher yields from longer-season varieties of field corn. Double cropping will become more viable and offer greater economic returns to farmers. Private and public plant breeding programs have an opportunity to develop new crop varieties that are more tolerant of heat, drought, and pests and can take advantage of elevated levels of CO<sub>2</sub>—the changing conditions we expect to see in the region.

Taking advantage of the changes makes good business sense for agriculture in New York and the Northeast, but providing the answers to a long list of rapidly evolving questions will be critically important. For agricultural producers, timing of investments will be everything. With increasing variability in precipitation, when should farmers invest in irrigation equipment or install more field drainage tiling to address excess water? With rising summer temperatures, when should dairy farmers invest in improved ventilation or cooling systems? With longer seasons, what is the optimal planting date as well as expected date of harvest? These questions need to be answered from a multitude of perspectives—not just agronomic and economic, but also social and environmental.

Along with adapting to the changes, agriculture also has the opportunity to mitigate (or lessen the effects of) climate change through improved practices such as improved energy efficiency, conversion of waste streams to energy, improved fertilizer and manure management, increased soil organic matter (carbon) through reduced tillage and cover cropping, and perhaps even

application of biochar as a soil amendment. Many of these mitigation practices make good business sense, offering benefits on the farm, as well as throughout the entire food system.

**Conclusion:** We face one of the greatest challenges ever. A warming climate is a global issue, affecting all people and the life support systems they depend on. Agriculture has the opportunity to help mitigate the challenge as well as adapt to the changes that will occur. Agriculture in New York is positioned to take advantage of the near-term changes in climate—adequate water resources and longer and warmer growing seasons, allowing for an expansion and diversification of the agricultural commodities grown. These factors, when coupled with the enormous and diverse markets available in the Northeast provide the basis for expanded agricultural sectors that can help contribute to providing for both local and global food security.

### **Selected References:**

- <sup>1</sup>NYSERDA, 2012. Report 11-18: *ClimAID: the Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State* (<http://www.nyserra.ny.gov/climaid>).
- <sup>2</sup>Intergovernmental Panel on Climate Change (IPCC), 2013. *Fifth Assessment Report: Climate Change 2013* (<http://www.ipcc.ch/report/ar5/wg1/#.Usq7RGRDtRd>).
- <sup>3</sup>Anderegg et al., 2010. *Expert credibility in climate change*. PNAS.
- <sup>4</sup>Wolfe, et al., 2005. *Internat. J. Biometeor.* 49: 303-309.
- <sup>5</sup>Arbor Day Foundation: 2013. 2006 Hardiness Zone Map (<http://www.arborday.org/media/zones.cfm>).
- <sup>6</sup>A. DeGaetano, Northeast Regional Climate Center (NRCC), Cornell University (<http://www.nrcc.cornell.edu/>).
- <sup>7</sup>California Agriculture, 2009. “*Unequivocal*” – *How climate change will transform California Agriculture*. 63:2.
- <sup>8</sup>Hanah, et. al., 2013. *Climate change, wine and conservation*. PNAS.

### **Additional reading and information:**

- A revised Cornell Climate Change website has just been released that contains a wealth of information related to agriculture, communities and natural resources (<http://climatechange.cornell.edu/>).
- The Cornell Institute for Climate Change and Agriculture will work across Cornell departments and with stakeholders to help coordinate and facilitate working with farmers and decision makers to adapt to changing conditions, as well as helping to reduce greenhouse gas emissions ( <http://cuaes.cornell.edu/cals/cuaes/sustainability/icca.cfm>).
- USDA Regional Hubs for Risk Adaptation and Mitigation to Climate Change will help facilitate and coordinate adaptation and climate change mitigation practices across the US ([http://www.usda.gov/oce/climate\\_change/regional\\_hubs.htm](http://www.usda.gov/oce/climate_change/regional_hubs.htm))
- This paper includes excerpts from Hoffmann and Smith. 2011. Feeding Our Great Cities: Climate Change & Opportunities for Agriculture in Eastern Canada & the Northeastern US.