Environmental Stewardship

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Mitigating the impacts of climate change

Farmers and communities across the United States are already experiencing the effects of climate change. Shifts in temperature, precipitation and pest and pathogen populations impede crop and livestock production, and rising sea levels and "superstorms" threaten coastal communities. The severity and frequency of these effects could continue to increase. To sustain agricultural productivity, food security and community well-being, researchers at land-grant universities across the United States are gathering nuanced data on the causes and consequences of climate change and developing science-based tools and strategies to mitigate the impacts.

Successful examples include:

- University of **New Hampshire** scientists are identifying ecological factors that affect changes to microbial communities as the Arctic warms. When permafrost thaws in the Arctic, organic matter becomes available to microbes. As these microbes feast on organic matter, they release greenhouse gases. Due to rapid global circulation of the atmosphere, heat-trapping gases produced in the Arctic may increase the greenhouse effect in the northeastern U.S.
- The **Ohio** State University led a new study that analyzed 20 land-based strategies to reduce or remove greenhouse gases from the atmosphere. The study identified practices for specific regions and demonstrated their cost, feasibility and efficiency. Findings suggest that implementing conservation practices like conservation tillage and cover crops on farms could store up to 546 million tons of carbon dioxide per year for under $100 per ton of carbon dioxide. Forest protection, planting and managing trees is also one of the more affordable options and could sequester 6.6 billion tons of carbon dioxide globally.
- Climate change will likely increase freeze-thaw events in New England, which can destabilize roads and buildings, cause flooding, and damage the root systems of plants and trees. **New Hampshire** scientists developed fully automated, wireless, in-ground soil frost sensors and an unmanned aerial vehicle with ground penetrating radar to collect data about how soil frost varies over time and space, how rapidly changing winters will impact soil frost and how changes in soil frost will affect ecosystem processes.
- Droughts reduce forage and water resources, creating serious challenges for grazing beef cattle on rangelands. **New Mexico** scientists identified genes that help beef cattle use forage and water efficiently

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in hopes of helping ranchers identify and breed cattle that use the resources available on grazing lands more efficiently. These cattle would require less supplementation from other sources, lowering annual input costs for producers and helping them withstand droughts.

- Cool season grasses called "pooids" are native to **Vermont** and make up the majority of forage, cereal and turf grasses grown in the state. Using CRISPR gene-editing technology, Vermont researchers have provided critical information on how pooids have evolved in response to drought, freezing and colder temperatures over time. This look at the past provides insights into how these species may further evolve in response to continued climate change. This work will also help identify further genetic modifications that can enhance plant protection against drought, freezing and other weather phenomenon.
- As part of a **multistate** project, scientists provided nuanced data and realistic models that predict water supply in different future climate scenarios. Better data and models enable water users, managers and policymakers to objectively and accurately weigh the costs and benefits of proposed climate change mitigation strategies. Researchers also shared recommendations to help water management institutions prepare for climate change.
- Scientists in **multiple states** are working together to better understand the properties of particulates, how they behave and move through soil, air and water, and how they adapt to the climate over time and space. To do this, researchers designed state-of-the-art tools for molecular and microscopic analysis and conducted field studies. In particular, University of **Illinois** researchers looked at the impact of extreme weather conditions, like drought, on phosphorus loss. Scientists at Rutgers University in **New Jersey** showed that increased concentrations of atmospheric carbon dioxide could lead to changes in soil structure. In **Delaware**, scientists demonstrated that sea level rise could speed up arsenic release from coastal soils. University of **California** scientists developed new instruments and analysis techniques that provide new insights into the sources and chemistry of atmospheric aerosols and the role they play in global climate. These insights help create models of human impacts on climate and help government agencies and others develop evidence-based pollution reduction policy and climate change mitigation strategies.

Multistate research leads to climate-resilient septic systems that protect water quality

Shifts in precipitation and temperature along with rising sea levels and water tables can impair septic system performance, releasing pathogens, chemicals and other pollutants into the soil and water. As part of a multistate project, researchers are studying the impacts of climate change on septic systems and making recommendations to improve their resilience. For example, ***Rhode Island*** *researchers showed that more bacteria and phosphorus will be released from septic systems in climate change scenarios, and rising water tables are leading to near-shore septic systems with inadequate separation distance between drain fields and groundwater.*

- Scientists estimated that thousands of septic systems along the southern coast of Rhode Island would be affected by and need repair due to large flood events, which may become more common due to climate change. **North Carolina** State University scientists identified septic systems in coastal North Carolina that are at risk of impaired performance due to flooding, salinization and groundwater rise related to sea level rise. Researchers and Extension educators at land-grant universities in **multiple states** led workshops that helped septic system professionals gain regulatory approval to install bottomless sand filters, which help mitigate the impacts of rising water tables.