Addressing the agricultural impacts and vulnerabilities of climate change

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The U.S. Global Change Research Program's National Climate Assessment of 2014 observes that key vulnerabilities to climate change in the United States include increasing temperatures across the country, less rapid warming in coastal regions of the continental United States compared to inland regions, more frequent heat waves across North America, and more intense precipitation and frequent flood-producing storms. In light of these predicted impacts and vulnerabilities, particularly in agricultural, forestry, and rangeland production systems but also in natural systems, the report calls on federal and state agencies and governments to be prepared to deal with these shifts in climate, and to develop approaches to adapt to and mitigate the impacts of these shifts.

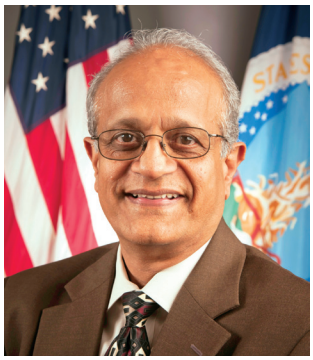
IMPACT

Climate change is one of several "wicked" problems facing agriculture and food production across the globe. In light of the predicted impacts and vulnerabilities associated with shifts in climate, federal and state agencies and governments are improving modeling and scientific methodologies and outreach methods. These will provide decision makers with science-based tools and outreach materials that will help them make effective policies, address immediate local needs, and ensure the long-term sustainability of food and fiber production.

Agricultural and forestry producers, land managers, and other decision makers need information, technologies, and decision-support tools regarding greenhouse gas (GHG) mitigation, adaptation strategies, and policy outcomes. Crop, animal, forest, range, and even urban and rural management approaches must take climate variability into account to improve long-term sustainability. The potential for forest and agricultural lands to serve as carbon sinks and to reduce GHG emissions must be quantified to support sound policies and environmental markets. Outreach and extension networks must be implemented to incorporate climate change mitigation and adaptation strategies into management practices and to support restoration projects, planning, interventions, and prescriptions with scientific findings.

To address these needs, the National Institute of Food and Agriculture's (NIFA) Agricultural Science for Climate Variability and Change Programs include:

- Forecasting climatic stress at relevant scales. It is critically important to understand current projections of climatic change, and to be able to anticipate the causes and impacts at regional and national scales. The impacts on local individual landowners are exceedingly difficult to predict.



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- Creating tools to identify and predict climate change impacts at appropriate time and spatial scales. It is difficult to definitively decouple impacts that can be attributed to climate change from other factors that traditionally affect agronomic operations, and we need better tools and metrics to measure these so that adaptation and mitigation strategies are more effective.
- Projecting how and where climate change is most likely to influence risk pathways for pests, notably agricultural diseases; forest, crop, and livestock pests; and food-borne pathogens that could potentially affect global agricultural systems.
- Addressing uncertainties in methodologies (empirical and process based) used to evaluate changes in climate with specific resource impacts and the feedbacks of interventions and actions for adapting to and mitigating the climate system and the environment.
- Increasing our understanding of climate dynamics and uncertainties for policy and strategic planning. Climate dynamics are extremely complex and are associated with a great deal of uncertainty. New approaches are needed to reduce uncertainty and incorporate what cannot be eliminated into approaches for sustainable production.
- Developing usable information and effective communication. Public perceptions of climate change can create resistance to the importance of climate change education. Information needs to be presented in a manner that stakeholders can identify, understand, and accept more easily.

As part of its strategy to address different sectors of the climate change portfolio, NIFA has developed a set of applied climate tracks that identify major areas of application of research, education, and extension activities. Each track has a set of achievable outcomes during the next 10 years, which were used to populate the outcomes of logic models as part of a roadmap for NIFA's climate change portfolio. These tracks and outcomes include:

- Agroecosystem production and resource management
- Genomics and breeding
- Social and economic dimensions
- Formal and informal education
- Extension and outreach

In addition, NIFA proposes to measure in its portfolio the public, animal, plant, and environmental health impacts of climate change as related to food, agricultural, forestry, rangeland, and natural systems.

REACCH is one of three NIFA Climate Change and Variability Coordinated Agricultural Projects (CAPs). The CAPs are large efforts that integrate three or more of these dimensions into transdisciplinary efforts that span disciplines, regions, and institutions. They are breaking new ground for NIFA in terms of the scope of their long-term mission for science, education, and extension efforts. These projects represent examples of the new call for convergence of disciplines and sectors to address societal challenges (Figure 1). Each project is charged with initiating efforts that will lead to improved carbon sequestration, nitrogen use efficiency, and resilience to changing climates well into the 21st century. Project leaders and NIFA program leaders are working together to monitor project efforts to ensure that they are meeting these needs. NIFA is pleased with the accomplishments being made, and is encouraged that REACCH and the other CAPs will generate the envisioned information and impacts.

The larger context of the work by the CAPs is broad. Not only are these projects addressing diverse agricultural systems, from Pacific Northwest wheat production (REACCH) to Midwest corn (Sustainable Corn) and Southeast plantation pine (PINEMAP), they are also part of the necessary global response to the challenges of food and fiber production as climates change. Production systems are complex technologically, socially, and economically. Responding to changing climates involves addressing "wicked" problems in which diverse stakeholders, from farmers to national policy makers, must integrate different perspectives in order to delineate effective actions.

Climate change is just one specific global challenge. It is our hope that the efforts of NIFA-funded projects can help improve how production systems respond to the challenges ahead as populations grow, along with their per capita demands for more protein-rich animal foods, goods, and higher living standards. Contributing to solutions for these wicked problems will indirectly, but significantly, improve the well-being of U.S. farmers, their families, and their communities.

Figure 1. *Complex problems that negatively affect natural and managed systems are often transdisciplinary in nature, without a single solution. It is therefore necessary for state and federal governments, land managers, educators, and other decision makers to work together and consider each aspect that can improve the long-term sustainability of these systems.*

In the coming months and years, we anticipate that the good work ongoing in the U.S. Department of Agriculture NIFA CAPs and related projects will bear fruit in the form of better understanding of systems, better platforms for continued collaboration across institutions, and better approaches and technologies to address environmental and climatic challenges.

Sanford Eigenbrode (left) discusses Northwest agriculture with Sonny Ramaswamy, current director director of the USDA National Institute of Food and Agriculture during a visit to Moscow, ID, in July 2014. Photo by Joe Pallen.