USDA Northeast Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

2018 Partners Meeting Program

Building Agricultural Resiliency Through Adaptation

Rutgers University | New Brunswick, NJ

MARCH 14 - 15, 2018

Hosted by Delaware State University and Rutgers University

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Overview and Goals

Hosted by the USDA Northeast Climate Hub and partners, the intent of this meeting is for us to examine the state of our knowledge on climate adaptation and promote actions to support agriculture in our region. We will target our unique challenges and opportunities based on the climate science most relevant to the agricultural context of our region. The NE Hub and partners invited participants to include Extension specialists from Universities, federal and state agencies, and private sector. We also invited researchers, farmers, and others to provide critical context and information. Building upon the foundational understanding of the climate trends and impacts, participants will investigate the solutions—by sharing adaptation experiences and discussing feasibility, cost-effectiveness and tradeoffs. Altogether, this meeting will aid the Northeast community in an exchange of information that will drive continued collaboration and advancement of climate adaptation in agriculture. This initial workshop will focus on sharing adaptation experiences in agriculture, discussing outreach strategies and developing a community of practice.

Background

In 2015, we assessed the current and future capacity of research and Extension faculty and staff at land-grant universities across the Northeast to address climate change issues in the agricultural, natural resource, and forestry sectors. Through this effort, we determined the need for bringing together Extension professionals within the region to share and closely examine the details of available climate information and the feasibility of concrete adaptation strategies.

Objectives

- To share experiences in adapting to climate impacts and foster peer-to-peer learning through the multi-directional exchange of information among Research, Extension, and farmers in the Northeast.
- To collaboratively strategize on how to best support adoption of science-based and cost-effective adaptation in the context of the most current climate science.
- To support and formalize the growing Community of Practice around climate adaptation in agriculture in the Northeast.

Keynote Speaker

Randi Johnson, USDA NIFA Director of Global Climate Change

Bio: Dr. Johnson is the director of the Global Climate Change Division at the National Institute of Food and Agriculture (USDA NIFA). In this position she oversees NIFA's research, extension and education efforts that deal with climate change; projects that range from genes to landscapes. Previous to coming to NIFA in November of 2016 she was the first National Lead of the USDA Climate Hubs for its first 3 years. In 2007 she took on the role of national program leader for genetics, and later climate change (2009), for the USDA Forest Service. Before coming to DC she was a research geneticist for the Forest Service in Corvallis OR (1994-2007) and ARS at the US National Arboretum (1991-1994). Most of her active research career was working with research cooperatives at Oregon State University, North Carolina State University and in New Zealand. She received her BS from the University of Illinois (forestry), and MS (forest soils) and PhD (forest genetics) from NCSU.

Climate Trends and Related Risks in the Northeast

Art DeGaetano, Northeast Regional Climate Center

Bio: Art DeGaetano is a Professor in the Department of Earth and Atmospheric Sciences at Cornell. He is also the director of the NOAA Northeast Regional Climate Center (NRCC). Art serves as a climate editor for the Bulletin of the American Meteorological Society. The NRCCs climate data management tool ACIS is the source of both observed and projected in NOAA's Climate Explorer. He also was a Principal Investigator on The ClimAID Integrated Assessment for Effective Climate Change Adaptation Strategies in New York. He received an interdisciplinary Ph.D. focusing on Climatology and Horticulture from Rutgers University in 1989.

Title: Change is in the Air: Northeast U.S. Agriculture in a Changing Climate

Abstract: The effects of climate change are already being felt across the northeastern U.S. and will continue to be felt in the future. The most recent observed climate trends will be examined. Future projections based on the latest set of global climate model simulations and the downscaling technique that will be adopted in the next U.S. national climate assessment will also be presented. Changes will include increases in winter temperatures, a lengthening of the frost- free season and changes in the character of rainfall throughout the year. Special attention will be directed to trends in climate variables that are likely to have the greatest impact on Northeast agriculture. These include an examination of spring freeze risk in fruit crops, the impact of summer heat stress on dairy production, and potential changes in spring fieldwork conditions.

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Alex N. Hristov, Pennsylvania State University

Bio: Dr. Alex Hristov is a Professor of Dairy Nutrition in the Department of Animal Science at The Pennsylvania State University. He has a Ph.D. in Animal Nutrition from the Bulgarian Academy of Agricultural Sciences. His main research interests are in the area of protein/amino acid nutrition of dairy cows and mitigation of nutrient losses and gaseous emissions from dairy operations.

Title: Climate Change Effects on Livestock in the Northeast U.S. and Strategies for Adaptation

Abstract: The livestock industries are a major contributor to the economy of the northeastern United States. Climate models predict increased average maximum temperatures, days with temperatures exceeding 25°C, and higher annual precipitation in the Northeast. These environmental changes combined with increased atmospheric CO2 concentration are expected to either increase or decrease forage productivity depending on the crop, and may decrease protein content and forage digestibility. Winter damage to sensitive forage species may also increase. Predicted temperature increases are expected to reduce fertility in dairy cattle and heat stress-induced inflammation may limit energy available for productive functions. Additional loss in milk production due to decreased feed intake is estimated to be up to 1% of the projected annual milk production through 2100. The effects of climate change on the beef industry in the Northeast are expected to be minimal. Broiler production in the region may benefit from warmer winter and summer temperatures, but future housing will require greater insulation and ventilation fan capacity. Providing adequate housing and ventilation to offset climate changes will also be important for the layer industry and will likely increase the price of eggs. Climate change is expected to have an economic impact on the horse industry in the region through additional management of land and forage resources, building of shelters, and heat abatement at equine events. Increased temperatures and more intense storms will increase nutrient losses and gaseous emissions from animal manure. Uncertainties about how host animals, pathogens, and disease vectors will respond to climate change highlight the need for continued animal health monitoring.

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David Hollinger, USDA Northeast Climate Hub

Bio: Dr. Hollinger is Director of the USDA Northeast Climate Hub, leader of the “Climate, Fire, and Carbon Cycle Sciences Group” of the USDA Forest Service Northern Research Station, and an Adjunct Professor in the Department of Natural Resources at the University of New Hampshire. His present research and outreach efforts focus mainly on climate change adaptation in agriculture and forestry. Other work centers on understanding how climate impacts forest growth and carbon storage. He has contributed to past IPCC and National Climate Assessments and is a co-author of the Northeast Chapter in the current (NCA4) assessment. Dr. Hollinger received a PhD. In ecophysiology from Stanford University in 1984.

Title: Preparing to Adapt

Abstract: The Director of the Northeast Hub will provide an introduction and overview of cost-effective adaptation practices to climate change. He will also review the Northeast Climate Hub’s priorities for FY18.

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David Wolfe, School of Integrative Plant Science, Cornell University

Bio: Dr. David Wolfe is Professor in the School of Integrative Plant Science at Cornell University. His research and outreach efforts focus primarily on agricultural climate change adaptation and mitigation, and soil health and water management. In addition to peer-reviewed research publications, science communication efforts include writing commentary for the popular press and analyses for policy-makers, such as co-authoring the 2008 and 2014

National Climate Assessments sponsored by the U.S. Global Change Research Program. At Cornell, he teaches courses on climate change and environmental science writing, and is on the Advisory Boards for the Cornell Institute for Climate Smart Solutions, and the Atkinson Center for a Sustainable Future

Title: Climate Change Vulnerabilities, Opportunities, and Adaptation Strategies for Northeast Crops

Abstract: Climate change may both exacerbate the vulnerabilities and open up new opportunities for farming in the Northeastern United States. Among the opportunities are double-cropping and new crop options that may come with warmer temperatures and a longer frost-free period. However, prolonged periods of spring rains in recent years have delayed planting and offset the potentially beneficial longer frost-free period. Water management will be a serious challenge for Northeast farmers in the future, with projections for increased frequency of heavy rainfall events, as well as projections for more frequent summer water deficits than this historically humid region has experienced in the past. Adaptations to increase resilience to such changes include: expanded irrigation capacity; new water monitoring and irrigation scheduling tools; farm drainage systems that collect excess rain into ponds for use as a water source during dry periods; and soil health management for improved water holding capacity and drainage. A major concern for the economically important perennial fruit crop industry over the next several decades is increased risk of spring frost damage associated with warmer and variable winter and early spring temperatures. New bloom date prediction tools, improved real-time frost warning systems, and use of misting, wind machine, or other frost protection measures will be important adaptation strategies. Increased weed and pest pressure associated with longer growing seasons and warmer winters is another increasingly important challenge. Pro-active development of non-chemical control strategies, improved regional monitoring, and rapid-response plans for targeted control of invasive weeds and pests will be necessary.

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Adaptation/Identifying Impacts in the Northeast

Sonja Birthisel and **Dr. Ellen Mallory**, Maine Climate and Agriculture Network, University of Maine, Orono

Bio: Sonja Birthisel is a Ph.D. candidate in the Ecology and Environmental Sciences at the University of Maine. Her research focuses on climate change impacts on agronomic weeds and ecological weed management.

Bio: Ellen Mallory is an Associate Professor and Extension Sustainable Agriculture Specialist and past coordinator of the Maine Climate and Agriculture Network at the University of Maine. Her research and extension programs focus on value-added small grain production, biological nitrogen fertility systems, and soil health.

Bio: Erin Roche is Program Manager of the Maine Risk Management and Crop Insurance Education Program and the new coordinator of the Maine Climate and Agriculture Network at the University of Maine.

Title: Farming in a New Weather Reality: Farmer Stories from Maine

Abstract: Stories are a powerful tool to communicate the current impacts and significance of climate change at the individual level while avoiding disagreements over causes and future projections. The Maine Climate and Agriculture Network used a storytelling approach to raise awareness of climate and agriculture issues among farmers and agricultural service providers attending the 2018 Maine Agricultural Trades Show. Five experienced farmers representing different agricultural sectors (turf, sheep, honeybees, apples, and vegetables) were asked to tell one story each of how a shift in weather patterns or extremes had affected their farm and how they adapted. We noted that it was difficult for the farmers to tell one linear story because of the interconnectedness of the various components of their farming systems. While there were some shared weather changes observed (e.g., more frequent heavy precipitation events, longer drought periods, and longer growing season) and adaptation strategies (e.g., crop and species changes and infrastructure improvements), site and system-specific conditions, along with farmer's individual skill-sets, made much of each farmer's experiences and adaptation strategies

unique. The farmers agreed that access to resources such as cost-sharing through NRCS and crop insurance are important as they adapt, and that these resources need to be administered in a timely manner to be effective. Overall, the panel demonstrated that, while uncertainties exist about what to expect in the future from climate change, farmers already are making investments and altering production practices to make their farms more resilent to the changes in weather patterns they are experiencing today.

Collaborator: Erin Roche, Maine Climate and Agriculture Network, University of Maine, Orono

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Angelica Carey, Master of Regional Planning and Sustainability Sciences, University of Massachusetts Amherst and **Elisabeth Hamin**, Ph.D. in City and Regional Planning, University of Pennsylvania

Bio: Angelica Carey is a native from Lynn, Massachusetts and attended UMass Amherst for her undergraduate degree in Anthropology and Civic Environmentalism, a self-designed major from the BDIC program. After graduating in 2012, she taught K-5 General Music and 6-8 Choir with Teach for America, in the small town of Palestine, Arkansas. Following my two years there I applied and was accepted into the 2014 Dual Degree program of Regional Planning and Sustainability Sciences at UMass Amherst. My upbringing in Massachusetts, as well as my time in the South, have provided me great experiences to see firsthand public health, environment, planning and policy issues along with different methods of addressing them successfully. After the completion of her dual Master's degrees, Angelica accepted a Municipal Planner position with the city of Memphis and is currently leading the community engagement and outreach work in the Memphis 3.0 comprehensive plan development.

Title: Assessing Adaptive Capacity of Pioneer Valley Farmers

Abstract: Angelica Carey explores Pioneer Valley farmers and their agricultural practices, knowledge and resources as they relate to climate change. Adaptive capacity is used throughout scientific literature, and often includes numerous components; for this thesis the measurement of farmers' adaptive capacity would be assessed according to only three components: knowledge, past experiences and use of resources. Climate change and its impacts on agriculture have been studied but what is unclear is how prepared farmers are to deal with these impacts. This research developed a resiliency index for farmers and explores where they are most likely to get information that they use to prepare their agricultural practices for climate change, along with the adaptive practices they adopt over time. Through literature review, survey development and recorded interviews, data was then analyzed both for quantitative and qualitative results to understand farmer's adaptive capacity. Most Pioneer Valley farmers realized changes to their farming practices over 5 to 10 years but were not in consensus of the cause and if this could just be due to climate change. Despite mixed beliefs in climate change, most were willing to accept assistance to climate change adaptation, even if unaware what adaptation strategies would include. As a pilot study, numerous considerations have been included for future work on this topic to reduce assumptions and improve results accuracy. The research has implications for Extension as well others seeking to address information and knowledge gaps with farmers around climate change.

Jennifer de Mooy, Climate Adaptation Project Manager, Delaware Division of Energy and Climate

Bio: Jennifer de Mooy is the Climate Adaptation Project Manager for the state of Delaware in the Department of Natural Resources and Environmental Control, Division of Energy and Climate. Jennifer's current work includes leading inter-agency pilot projects on workforce safety and asset management. She also manages a state-funded competitive grant program to advance climate adaptation projects. Jennifer has a Master's in Energy and Environmental Policy from the University of Delaware. Prior to her current position, Jennifer worked in the private, nonprofit sector on environmental conservation planning and project management.

Title: Assessing climate change impacts to agriculture in Delaware

Abstract: Delaware's statewide climate change impact assessment included a focus on agriculture as one of five key sectors affected by changing temperature, rainfall, extreme weather, and sea level rise. The assessment

includes both quantitative and qualitative results to help understand potential risks to the state's agriculture and forestry resources. The presentation will describe the methods and resources used in the assessment, and how the project incorporated national and regional sources as well as local subject matter experts to form a Delaware-specific assessment. The report highlights vulnerabilities but also provides examples of adaptation strategies.

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Pam Mount, Terhune Orchards

Bio: Since 1975. Pam and her husband, Gary Mount own and operate Terhune Orchards in Lawrence Township, The Mounts have built Terhune Orchards into a prosperous business and a community treasure that welcomes more than half a million visitors each year. Starting with 55 acres, the farm now cultivates more than 200 acres of preserved farmland , growing 40 different types of fruits and vegetables both conventionally and organically. Including 14 acres of vineyards producing a dozen wines in a new sustainable, solar powered wine barn. Visitors are welcome in the winery tasting room and farm store year round. The farm is on the New Jersey Sustainable Business registry. Elected to the Lawrence Town Council for 12 years, she also served as mayor for three years. Pam and Gary served in the Peace Corps in Micronesia from 1967-1970. They lived on a small island in the Pacific Ocean called Satawal, Because of that experience, they became committed to empowering local efforts to strengthen the community. Once they owned the farm, it seemed natural to include the broader community with a year round farm store, pick your own, numerous festivals and educational activities. As mayor she founded the local nonprofit "Sustainable Lawrence", an organization that has successfully brought together local nonprofits, civic organizations, businesses, schools and government leaders to work toward creating a more sustainable community. Pam was a founding member and later chair of the board of Sustainable Jersey She is one of the founding board members of several nonprofits, including the Lawrence Community Foundation, Lawrence Hopewell Trail, Farmers Against Hunger, Lawrence Nature Center. In 2015, she became a founding member of C-Change Conversation, a group dedicated to promoting climate change awareness. She has three children and nine grandchildren. Daughters, Reuwat and Tannwen are now partners in the farm.

Title: Addressing Climate Change: On Farm Lessons and Practices

Abstract: Pam Mount, owner of Terhune Orchards will provide brief remarks on what she has been experiencing on her farm with respect to climate change, approaches to address climate change on her farm, and why it is so important to address these issues.

How Do We Adapt | Concurrent Session 1

Kevin R. Brinson, Associate State Climatologist and Director of DEOS, University of Delaware

Bio: Kevin Brinson is the Associate State Climatologist for Delaware and Director of the Delaware Environmental Observing System (DEOS) network within the Center for Environmental Monitoring and Analysis (CEMA) at the University of Delaware. Kevin received a B.S. in Atmospheric Science from the University of North Carolina at Asheville and has an M.S. in Geography from the University of Delaware where he conducted research on precipitation variability. In his regular duties for DEOS, Kevin oversees the operation of a network of meteorological stations, data systems, and development of data applications. In his capacity as Associate State Climatologist, Kevin processes and disseminates climate data and information to the businesses and citizens of Delaware and provides support and meteorological expertise to state public officials.

Title: Supporting Ag-Weather Decisions in Delaware

Abstract: Delaware's humid, sub-tropical summertime precipitation is highly variable within growing seasons and from one growing season to the next. This variability results is large swings in rain-fed crop production from year-to-year. As a result, growers in Delaware have adopted irrigation technology to adapt and reduce their vulnerability to potential short and long-term droughts. To aid growers with irrigated farm fields, the Univeristy of Delaware Center for Environmental Monitoring and Analysis (CEMA) collaborated with University of Delaware Cooperative Extension to develop the Delaware Irrigation Management System (DIMS) in 2010 (http://dims.deos.udel.edu). Each year, 100-125 irrigated fields are managed through DIMS at the Univerity of Delaware. DIMS uses the FAO 56 method for determining crop water demand for eight different crop types, with automated inputs of weather data from DEOS and dominant soil texture class data from the USDA soils database. Another important agricultural commodity in Delaware is lima beans. Downy mildew (*P. Phaseoli)* is a fairly common fungal disease that negatively affects mid-Atlantic lima production annually. To aid Delaware's lima bean growers in prediction the presence of downy mildew in their fields, researchers at the University of Delaware developed a risk model based on previous work done by R.A. Hyre in 1952 and L.C. Raniere in 1964. This risk model has been integrated into a web application (http://dims.deos.udel.edu/limabeanrisk) that automatically integrates weather data from DEOS to provide daily estimates of downy mildew risk for any lima bean field in Delaware.

Collaborators: James R. Adkins[3], Thomas A. Evans[2], Christopher P. Hughes[1], Gordon C. Johnson[3], Daniel J. Leathers[1], Matthew Shatley[1] ,

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Allison M. Chatrchyan, Director of the Cornell Institute for Climate Smart Solutions

Bio: Allison M. Chatrchyan - Director of the Cornell Institute for Climate Smart Solutions, and a Senior Research Associate in the departments of Development Sociology and Earth and Atmospheric Sciences at Cornell University. As a social scientist, her work focuses on the interactions between social, environmental, and agricultural systems. With the Institute, Dr. Chatrchyan facilitates interdisciplinary research and extension teams and helps develop resources and tools for climate change adaptation and mitigation. Her research focus is on assessing views and actions on climate change, multi-level climate change governance mechanisms, and climate change policies and institutions. She is co-developing a plan for a new Climate Master Extension Volunteer Program for Climate Smart Communities with NIFA funds. Dr. Chatrchyan helped establish the Cornell Climate Smart Farming program, the University Climate Change Seminar series, and has led the Cornell Delegations to COP21, COP22, and COP23. Dr. Chatrchyan previously worked for Cornell Cooperative Extension, the Bard Center for Environmental Policy, University of Maryland, United Nations Environment Programme in Paris, France, and the Environmental Policy Center in Washington, DC. A native of Hamilton, NY, she received her Ph.D. and M.A. from the University of Maryland in College Park, and her B.A. from Colby College in Waterville, ME.

Title: Cornell's Climate Smart Farming Program – resources, training and tools to help farmers adapt to more extreme and variable weather"

Abstract: Cornell established the Climate Smart Farming (CSF) Program and CSF Extension Team in 2015 to help farmers in the Northeast to make more informed decisions and increase adaptation and mitigation to climate change. Through a partnership with the Northeast Regional Climate Center at Cornell, the CSF program has developed agricultural decision support tools (DSTs) to provide farmers with accurate, real-time data about their farm to better manage the risks of climate change. The decision tool website serves as an interactive platform that integrates climate data with agricultural models, and provides free and easy-to-use tools for any farmer in the Northeastern US. Several tools have been built based on input on needs and input from farmers and Extension,

include a Growing Degree Day Calculator, Freeze Risk Tools, a Water Deficit Calculator, Cover Crop Calendar developed, and a new NE Drought Atlas and Seasonal Forecasts developed by Dr. Toby Ault.

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Brett Chedzoy, Sr. Resource Educator, Cornell Cooperative Extension of Schuyler County

Bio: Brett Chedzoy is a regional extension forester with Cornell Cooperative Extension of Schuyler County; Manager for Cornell's 4200-acre Arnot Teaching and Research Forest; and in his "spare" time owns and operates Angus Glen Farms, LLC with his family – a 450-acre grazing operation in Watkins Glen, NY.

Title: Why Silvopasturing Ranks In the Top Ten Solutions for Climate Change

Abstract: Silvopasturing (the integrated production of trees, forages and livestock) and other agroforestry systems have been recognized as major potential solutions for addressing climate change. This session will give an overview of these agroforestry systems, their potential, and the challenges & solutions for broader implementation in the Northeast.

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John S. Gunn, Ph.D.Research Assistant Professor of Forest Management, NH Agricultural Experiment Station and UNH Cooperative Extension

Bio: John S. Gunn is a research assistant professor of forest management with the New Hampshire Agricultural Experiment Station and UNH Cooperative Extension at the University of New Hampshire in Durham, New Hampshire. John has a B.S. in wildlife management from the University of Maine, an M.F.S. from the Yale School of Forestry and Environmental Studies, and a Ph.D. in biology from the University of New Brunswick studying the landscape ecology of forest songbirds. His current research interests include greenhouse gas accounting of the forest products sector and invasive plant impacts on forests

Title: Forest Degradation: Implications for the climate resilience of forests in northern New England

Abstract: A review of the most recent US Forest Service Forest Inventory and Analysis (FIA) data shows that 40% of the forestland in northern New England (Maine, New Hampshire, and Vermont) is in an understocked condition. That is, a significant acreage of forest does not contain sufficient stocking of current or potential future sawlog trees, of preferred or secondary commercial species, to be able to fully utilize the growing space of the site even following 10 years' growth (i.e., they are below the "C-line" in a stand stocking guide when desirable trees are considered). This degraded condition is likely the result of past management activities that have not considered long-term silvicultural objectives. In addition to degraded productivity, other recent research has documented the increased dominance of American beech in the region leading to a less diverse forest. Forest degradation could mean reduced resilience to many climate-related risks for forests and the ecosystem services they provide. Forest management pathways must be designed and incentivized to restore forest productivity and diversity to increase climate resilience of the forests in northern New England

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Dr. John D. Lea-Cox, Professor, Nursery, Greenhouse Research and Extension Specialist, Department of Plant Science and Landscape Architecture, University of Maryland

Bio: John Lea-Cox is a Professor and Research and Extension Specialist at the University of Maryland, College Park. He teaches courses in Principles of Water and Nutrient Management, Greenhouse Crop Production and co-teaches Sustainable Seminar courses. His research and extension programs are focused primarily on providing

people with real-time information from their farming operations, so they can make more rational, economic decisions about their everyday production practices.

Title: Sensing strategies and software tools to help farmers adapt to climate change

Abstract: We are using a variety of cost-effective sensor-based strategies to help farmers adapt to a changing climate, and increase the efficiency of their crop production. This talk will highlight the hardware and software tools that are now available, and some case-studies to illustrate the potential for mitigating the effects of drought with sensor-based irrigation scheduling, other risks (e.g. frost monitoring), and predicting the incidence of pests and diseases with models, for more effective integrated pest management decisions.

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Ellen Mecray, NOAA Regional Climate Services Director - Eastern Region

Bio: Ellen Mecray is the NOAA Regional Climate Services Director for the Eastern Region, based in Taunton, Massachusetts. In this role, Mecray helps bring NOAA's climate information to other federal agencies as well as regional, state, and local geographies and specific sectors of importance to the eastern region. She currently works with the transportation, coastal, public health, marine fisheries, and energy sectors. Mecray is currently serving as the Federal Convening Lead Author for the Fourth National Climate Assessment, Northeast Chapter and an author on the Energy national chapter. For almost 20 years, Mecray's teaching, research, and leadership have focused on efficient, cross-sectoral collaboration among inter-and intra-agency partners. With that interest, Mecray co-chairs 2 federal partners groups in the mid-Atlantic and New England. Prior to joining NOAA, Mecray was an oceanographer with the US Geological Survey's Coastal and Marine Geology program. Her work is published in a number of research journals. Mecray holds a bachelor's degree in geology from Colgate University and a master's degree in geological oceanography from the University of Rhode Island. She lives on Cape Cod with her husband, daughter, and two golden retrievers.

Title: NOAA's Weather and Climate Information for Ag Producers and Land Managers

Abstract: The National Oceanic and Atmospheric Administration (NOAA) and our core partners offer a variety of information and resources that apply to some of the key challenges farmers and land managers face in working under changing climate conditions. Over years of working with the US Department of Agriculture, and identifying some of these challenges, this presentation will showcase information from the National Integrated Drought Information System, the NOAA National Centers for Environmental Information, and the Climate Resilience Toolkit. We will show how to find resources on drought, flooding, extreme temperatures, these variables in historical context, and work NOAA and partners are doing to improve the forecasts into the monthly and seasonal timescales.

Pam Mount, Terhune Orchards

Bio: Since 1975. Pam and her husband, Gary Mount own and operate Terhune Orchards in Lawrence Township, The Mounts have built Terhune Orchards into a prosperous business and a community treasure that welcomes more than half a million visitors each year. Starting with 55 acres, the farm now cultivates more than 200 acres of preserved farmland , growing 40 different types of fruits and vegetables both conventionally and organically. Including 14 acres of vineyards producing a dozen wines in a new sustainable, solar powered wine barn. Visitors are welcome in the winery tasting room and farm store year round. The farm is on the New Jersey Sustainable Business registry. Elected to the Lawrence Town Council for 12 years, she also served as mayor for three years. Pam and Gary served in the Peace Corps in Micronesia from 1967-1970. They lived on a small island in the

Pacific Ocean called Satawal, Because of that experience, they became committed to empowering local efforts to strengthen the community. Once they owned the farm, it seemed natural to include the broader community with a year round farm store, pick your own, numerous festivals and educational activities. As mayor she founded the local nonprofit “Sustainable Lawrence”, an organization that has successfully brought together local nonprofits, civic organizations, businesses, schools and government leaders to work toward creating a more sustainable community. Pam was a founding member and later chair of the board of Sustainable Jersey She is one of the founding board members of several nonprofits, including the Lawrence Community Foundation, Lawrence Hopewell Trail, Farmers Against Hunger, Lawrence Nature Center. In 2015, she became a founding member of C-Change Conversation, a group dedicated to promoting climate change awareness. She has three children and nine grandchildren. Daughters, Reuwat and Tannwen are now partners in the farm.

Title: How sensors and weather information help us adapt to climate change and weather extremes.

Abstract: How climate and weather monitoring and sensor data are being used on a central New Jersey farm will be discussed including the value these data have brought to addressing climate variability and extreme weather.

Maggie Ng, Hampshire College

Bio: I am an undergraduate student at Hampshire College studying ecology and agriculture. My undergraduate work focuses on the way small-scale farmers in Western Massachusetts are perceiving and reacting to environmental change. Through conducting in-person interviews, I have been gaining insight into what it means to be a farmer in this day and age, as rapid change becomes the new normal. I love farming and being outside, and aspire to work closely with farmers in the future (and maybe even become one myself!).

Title: Climate Change and Agriculture: How Small-Scale Farmers in New England are Interpreting and Reacting to Environmental Changes

Abstract: Currently, farmers all over the world are facing unprecedented changes in agricultural ecosystems brought on by climate change and subsequent environmental changes. This research focuses on farms within Western Massachusetts, an area which has already experienced certain environmental changes. Through in-person interviews with local farmers and agricultural educators, three important concepts are explored: 1) farmer perception and experience of environmental change, including changing weather patterns and climate change, 2) its impacts on the productivity of their farm, and 3) the implementation of adaptations and solutions to combat these impacts. Agricultural educators are also included in this study in order to investigate the perception of people who work closely with farmers, but are not farmers themselves. Similar information is explored, including perceptions of climate change, its impact on local agriculture, and direct farm involvement in adaptive solutions. Adapting to environmental changes is an essential part of maintaining local food systems and livelihoods in the context of climate change. In addition to the interviews, this work is supplemented with current agricultural research. However, working from the perspective of farmers themselves and those who work closely with them allows for a deeper exploration of this knowledge as it exists in the lives of real people.

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Dr. Lindsey Rustad, USDA Forest Service Center for Research on Ecosystem Change

Bio: Dr. Lindsey Rustad is a Research Ecologist for the USDA Forest Service Center for Research on Ecosystem Change in Durham, NH, co-Director of the USDA Northeastern Hub for Risk Adaptation and Mitigation to Climate Change, a Team Leader for the Hubbard Brook Experimental Forest in NH, and a Fellow of the Soil Science Society of America. She received a B.A. in Philosophy at Cornell University in 1980, a M.S. in Forest Science at the Yale School of Forestry and Environmental Sciences in 1983, and a Ph.D in Plant Science in 1988 at the University of Maine. Her areas of expertise include biogeochemistry, climate change impacts, and advanced environmental sensor systems.

Title: Adaptive Silviculture for Climate Change: A Demonstration Project in the Northeastern United States

Abstract: Given the long life spans of forest tree species and decadal-scale rotations of forest harvest, developing appropriate tools to integrate climate change into silvicultural planning is challenging. To address this, the USDA Forest Service, in collaboration with state and private organizations, has initiated a nation-wide program of replicated silvicutural trials on Adaptive Silviculture for Climate Change (ASCC). The overarching goals of this program are to: (i) identify and deploy locally-relevant climate change adaptation treatments to create resistant, resilient, transitional and "no action" forests of the future, and (ii) introduce forest managers to concepts, approaches, and tools that help integrate climate change considerations into silvicultural decision making. Five ASCC sites are being established cross the country. One of these is at the Second College Grant, which is located in the Northern Forest region of New Hampshire and owned and managed by Dartmouth College. The project was initiated in summer 2016 with a meeting of forest managers and scientists to identify the locally relevant adaptation options. This is followed by a year of pretreatment data collection, forest harvest and planting to meet the three adaptation options of resistance, resilience, and transition. The regrowth of these trial forests will be followed for decades to come. It is expected the this two tiered approach will allow researchers to ask broad questions about climate change adaptation across all study sites, while addressing on-the-ground management application specific to individual sites.

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How Do We Adapt | Concurrent Session 2

Jenny Carleo, County Agent II, Department of Agriculture and Natural Resources, Rutgers NJAES Cooperative Extension of Cape May County

Bio: Jenny Carleo, M. S., County Agent II (Equivalent to Associate Professor), Department of Agriculture and Natural Resources, Rutgers NJAES Cooperative Extension of Cape May County. Jenny began working for Rutgers Cooperative Extension in 2003 and has served as the ANR faculty member for Cape May County since 2006. She is the Project Director for "Ultra-Niche Crops for the Progressive, New Farmer" a USDA funded Beginning Farmer and Rancher Development Program project which prepares new and beginning farmers for financial and crop success. As a County Agent, Jenny assists local farmers who often are concerned about sea-level rise, climate change, salt-water inundation and salt-water intrusion in fields and irrigation water sources.

Title: In the Trenches: Farmer Concerns and Observations on the Impacts of Climate Change on Arable Land in Coastal New Jersey

Abstract: Cape May County is a peninsula located in southern New Jersey between the Delaware Bay and the Atlantic Ocean. The eastern side of the County is home to a thriving tourism industry centered around the coastal environment. The western side of the county is dominated by public lands, family farms and recreational campgrounds. Private landowners on the bay are in the minority and slow to make public the dramatic erosion, storm surges and flooding that occur on their properties. Most vulnerable of this population are the farmers who depend on the health of their land to provide for their families. The realities of the gradual but impactful stressors this has on the agricultural community will be discussed. The presentation will reveal the ongoing and complex interactions between environmentalists, farmers and governmental agencies that all stand to lose without practical implementations of climate change mitigation tactics in the near future.

Collaborators: Dr. Gordon Johnson, University of Delaware, Department of Plant and Soil Sciences, and Elbert N. & Ann V. Carvel Research and Education Center

Emmalea G. Ernest, University of Delaware Cooperative Extension

Bio: Emmalea Ernest is an associate scientist working with the University of Delaware Cooperative Extension Vegetable and Fruit Program. She conducts variety trials and applied research with vegetable and small fruit crops and leads the UD lima bean breeding program.

Title: Addressing Lima Bean Yield Loss to Heat Stress through Breeding

Abstract: Heat stress reduces yields of May and early June-planted lima bean (Phaseolus lunatus) in the Mid-Atlantic Region of the US. High night temperatures during flowering and seed development can reduce or delay pod set, resulting in delayed harvest, lower yield and split pod sets. Breeding heat tolerant baby and Fordhook type lima beans is one goal of the University of Delaware lima bean breeding program. Greenhouse experiments were used to characterize the response of several lima bean genotypes to high versus ideal nighttime temperatures in order to better understand the mechanism by which high night temperatures reduce yield. In greenhouse experiments, heat sensitive genotypes exhibit a number of physiological changes while under heat stress, some of which may interfere with reproduction and affect yield: lower amounts of pollen deposited on the pistil; lower in vitro germination of pollen collected from the pistil; extrusion of the stigmatic pad from the keel; and anther indehiscence. Other aspects of reproduction, such as stigma receptivity, may be problematic in some heat sensitive genotypes, but not others. Vegetative growth is not reduced by high night temperatures. Plants grown under stressed and unstressed conditions produced similar shoot dry weights. Heat sensitive plants produce more leaves and stems under high temperature conditions, compensating for the reduction in seed weight. In the University of Delaware lima breeding program, characterization of some of the physiological changes associated with heat sensitivity is being used to screen diverse germplasm and breeding lines in order to select for heat tolerance.

Collaborator: Dr. Gordon Johnson, University of Delaware - Department of Plant and Soil Sciences, gcjohn@udel.edu
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Kaitlin Farbotnik, Conservation Agronomist with the New Jersey Natural Resources Conservation Service

Bio: Kaitlin is currently the Conservation Agronomist in for the Natural Resources Conservation Service. She works with producers across the state to solve resource concerns on their farms. One of her main duties is to provide training in conservation planning and implementation as well as plan outreach and educational events for local producers. Kaitlin attended the University of Wyoming and majored in Agroecology and minored in Soil Science and in Agricultural Entomology. She is a fourth generation farmer and lives with her husband on their family farm in Doylestown, PA where they raise grass fed beef and pastured pork and poultry. Since she has a farm, she has no hobbies.

Title: How to Increase Crop Resiliency in Climate Extremes

Abstract: Weather patterns have no doubt been changing over the past decades. In the last few years alone, summers either been excessively droughty or excessively wet. Winters have been either unusually warm or brutally cold. Unfortunately, typical crops have not been able to adapt at the rate of these weather changes. Crops become stressed from lack of resources and negative changes in pest populations. The adaptation of conservation practices that have been used for generations are becoming more and more important to make soils and crops resilient to weather extremes. Though these conservation practices have been used for decades, and some centuries, practices used in combinations with one another yield the greatest defense against weather and pest challenges. We will discuss which conservation practices are most effective at increasing soil and crop resiliency, how to transition into using those practices, and how to combat the potential negative effects of the practices.

Sarah Ficken, New Moon Farms, Munnsville, NY

Bio: Sarah Ficken is the co-owner, with her husband Chris, of New Moon Farms, a small family dairy and CSA in Munnsville, NY (http://www.newmoondairy.com). She is also an Agriculture Subject Educator for Cornell Cooperative Extension of Madison County, and a member of the Climate Smart Farming Extension Team in NYS

(http://climatesmartfarming.org/climate-smart-farming-extension-team/). Sarah focuses primarily on working with farmers to design whole farm plans, mitigate risks related to climate change, and improve record keeping practices. She earned a B.S. in Natural Resources from Cornell University and a M.S. in Agriculture from Washington State University.

Elizabeth Fiedler, Delaware State University

Bio: Elizabeth Fiedler is a graduate student at Delaware State University working on a degree in plant science. She received her associate's degree in Biotechnology from Delaware Technical and Community College in 2011 and her bachelor's degree in Biology in 2014. She took a year off, working as a research tech in the Molecular Genetics and Epigenomics Laboratory at Delaware State before beginning her current work for her M.S.

Title: Comparing the Transcriptomes of Three Phenotypically Different Sweetpotato Cultivars

Abstract: The sweetpotato (Ipomoea batatas) is the third most consumed root crop in the world and the seventh most important crop overall. Sweetpotato is a strategic crop in combating the effects caused by climate change. On a relatively small scale, as in a subsistence farming situation, sweetpotato can be grown under no-tillage conditions. Crops that can be grown this way typically don't require the fossil fuel-powered machinery typically seen on large-scale farming operations. This no-till option also has the potential to reduce soil erosion of fertile growth media. In addition to avoiding soil erosion due to mechanical farming, the sweetpotato, with its extensive root system may also be important in the avoidance of water erosion, if planted in and around a wetland area. Sweetpotatoes are usually sterile and grown from cuttings, and therefore there are challenges to producing a genetically superior crop. Additionally, viral infections are known to cause a loss of yield in subsequent generations. Our research can illuminate important genes including those that are related to disease resistance, biomass accumulation, sugar and starch accumulation, and root differentiation. This involves conducting RNA-sequencing on Illumina HiSeq2500 platform followed by bioinformatics for three phenotypically diverse sweetpotato genotypes (white-fleshed, orange-fleshed, and purple-fleshed). We also hope these transcriptomes will serve as good references for future projects including ChIP-seq analysis, and investigating viral resistance factors between genotypes.

Collaborators: Elizabeth Fiedler[1], Vasudevan Ayyappan[1], Lekha Paudel[2], Marikis Alvarez[2], Muthusamy Manoharan[3], Sathish K. Ponniah[3], Conrad Bonsi[4], and Venu (Kal) Kalavacharla[1,5]

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Isaac Fisher, Delaware State University, College of Agriculture

Bio: I am a second year graduate student at Delaware State University studying plant science. I work in the MGE (molecular genetics/Epigenomics) Lab, and my M.S project is studying gene expression of common bean grown in two different areas under drought stress.

Title: Genetic and Epigenetic responses to environmental stress in Common Bean

Abstract: Common bean (*Phaseolus vulgaris* L.) is one of the most important legumes produced worldwide. It is cultivated for its high dietary fiber, protein, and micronutrient content. Abiotic stresses such as drought, heat, cold, and salinity have the potential to limit or completely destroy a crop depending on the severity of the conditions. Plants have adapted means to defend against these different stresses by altering their gene expression patterns,

and plant breeders have learned to exploit these differences to develop new cultivars to be grown. Breeders have yet to tap into epigenomic/epigenetic resources for plant improvement though, and it could potentially be a new avenue for developing lines that can help combat climate change. Our lab focuses on gathering a deeper understanding of how epigenomic marks change under unfavorable conditions, and the role of these marks on the regulation and alteration of gene expression. With an increasingly changing climate, the occurrence of drought or other extreme conditions are much more likely, and we will have to adapt our domesticated plants accordingly. We have looked at how a single genotype will have varying levels of gene expression when grown in two different locations under both fully irrigated and terminal drought conditions. We have also examined how nucleosome occupancy can change under drought stress thus altering expression levels of drought-responsive genes.

Collaborators: Isaac Fisher[1], Venu (Kal) Kalavacharla[1], Mayavan Subramani[1], Rita Hayford[2]

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Christine E. Hatch, Extension Associate Professor, Department of Geosciences, University of Massachusetts

Bio: Dr. Christine Hatch is Research-Extension Liaison for the Center for Agriculture, Food and the Environment (CAFÉ), and Extension Associate Professor of Water Resources and Climate Change in the Department of Geosciences at the University of Massachusetts, Amherst. No stranger to extreme events, Christine moved to Amherst the day after Hurricane Irene in 2011, an event that inspired two research projects: RiverSmart Communities, a project dedicated to supporting ecologically restorative flood prevention and remediation in New England and "Farms, Floods and Fluvial Geomorphology: Making the most of our natural resources." Her research and extension work ranges from investigating the broader impacts of stream temperatures, surface water – groundwater interactions, floods, droughts and other water resources issues under changing climate conditions.

Title: Smart solutions to climate change: weathering floods and droughts in New England

Abstract: Do droughts and floods happen in New England? How often? And what can farmers do to adapt when they do? Regional-scale climate models for the northeastern United States predict changes in precipitation patterns, quantities, and intensity in the coming decades, including increased frequency of both floods and droughts. Here we explore the effects climate change may have on water resources, rivers and our ability to produce food. While very large flood events may recur in a single location every 60-100 years, there is a high likelihood of an event of this magnitude occurring somewhere in New England every year. Like many states in the region, we have many of rivers, and our farms are often located in the floodplains, making them more vulnerable to the impacts of flooding. New England communities can be more resilient to river floods, becoming river-smart , by (1) Understanding and applying the science of river dynamics and its key insights on river floods– both in general, and in relation to specific locations of concern and opportunity, (2) as much as possible, finding ways to give rivers room to move and be rivers– to carry and deposit water, sediment and debris, to flood floodplains, and to meander and braid, and (3) when armoring stream banks or deepening channels is unavoidable, mitigate these actions so as to reduce unintended consequences of erosion and deposition that will be displaced elsewhere. We also expect increasingly dry summers, and droughts. Innovative water saving practices can help weather these storms too.

Collaborators: Eve Vogel, Dan Cooley of UMass Amherst, and Dan Kaplan of Brookfield Farm, Amherst, MA

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Chris Miller, Manager and Plant Materials Specialist, USDA-NRCS, Cape May Plant Materials Center

Bio: Chris currently serves as Manager of the USDA-NRCS Cape May Plant Materials Center. He has been the Center Manager for 10 years. Prior to this, he served for 18 years as a plant science consultant to NRCS state and field offices in the Northeastern and Mid-Atlantic states providing vegetative recommendations for many NRCS conservation practices, including critical area stabilization, conservation cover and pollinator habitat, filter

strips and riparian areas, and wetland restoration. He also provided guidance on techniques and plant selection for stabilizing disturbed and eroding areas such as dunes, tidal shorelines, streambanks, and mined areas. Chris has a B.S Degree in Agronomy (soil science emphasis) from Penn State and an M.S. in Plant Science from the South Dakota State University.

Title: Selection and Use of Conservation Plants to Ameliorate the Impacts of Saltwater Inundation on Cropland.

Abstract: Sea level continues to rise at an increasing rate due to climate change. This is especially noticeable in the Mid-Atlantic States where agricultural producers in near coastal areas are more frequently dealing with salt water flooding from coastal storms. This presentation will expose participants to several short term and viable longer term practices to deal with this issue. Some methods to be discussed include adding appropriate soil amendments, implementing possible cultivation techniques, establishing riparian buffers, and selecting alternative salt-adapted crops and conservation plantings. Participates will learn about potential planting and field management options for agricultural producers impacted by salt water flooding and the possible value-added income opportunities that may result in these conservation plantings.

Hubert J. Montas, Ph.D. Associate Professor ,Fischell Department of Bioengineering, University of Maryland

Bio: Dr. Montas obtained his BS and MS in Agricultural Engineering at McGill University, in Canada, and his PhD in Agricultural and Biological Engineering at Purdue University, in Indiana. He joined the faculty of the Biological Resources Engineering Department at the University of Maryland, College Park, 20 years ago, and is now Associate Professor in the Fischell Department of Bioengineering at the same university. He is specialized in the computational analysis of heterogeneous bioenvironments, and in particular, in the combination of numerical methods and artificial intelligence.

Title: Diagnostic Decision Support and BMP effectiveness for water quality gains

Abstract: [not provided]

Gulnihal Ozbay, Ph.D., Professor and Extension Specialist in Natural Resources, Department of Agriculture and Natural Resources

Bio: Dr. Ozbay is a Professor and Extension Specialist of Natural Resources in the Department of Agriculture and Natural Resources at Delaware State University. Her research interests include water quality and resources, habitat restoration, aquatic ecology and health, sustainable marine aquaculture and fisheries, seafood safety, private wells water quality assessment, and climate change. She received her Ph.D. in Fisheries and Allied Aquacultures from Auburn University, Auburn, Alabama in 2002 on research leading to the development of aquaculture effluent water quality standards for the U.S. Environmental Protection Agency. She earned an M.S. degree in Marine Bio-resources from the University of Maine in 1996. Her undergraduate education was in Fisheries and Aquaculture Engineering in Turkey in 1991. She has served in the Research Advisory Committee for NOAA Living Marine Resource Cooperative Science Center and Technical Advisory Committee for the Northeast Aquaculture Center and Mid-Atlantic Climate Change Advisory Committee and was appointed by the Secretary of the Delaware Department of Natural Resources and Environmental Control as a member of the Delaware Climate Change Vulnerability Assessment Steering Committee for the State of Delaware. She has been the institutional lead person for the various climate change education grants and programs funded by NSF, USDA-NIFA, and NOAA and one of the team member for the Northeast Climate HUB Program. She is a member of the NSF funded Maryland and Delaware Climate Change Education Assessment and Research (MADE-CLEAR) Program.

Title: Efforts to Mitigate Climate Change Repercussions on Oyster Populations and Natural Oyster Recruitment via Aquaculture Practices in Delaware

Abstract: Oyster restoration efforts are increasingly challenged by anthropogenic influences such as run-off, sedimentation, sea level rise, decreased salinity and pH, and other factors. Populations of Eastern oysters, *Crassostrea virginica*, along the Atlantic coast of US are only 1-3% of historic population levels and further declines would be catastrophic. Oysters are essential as a keystone species that provides habitat and spawning

substrate, stabilize sediments, and a natural filtration system to clarify waters. Depth, salinity, and turbidity greatly affect oyster populations and their associated fauna and frequent flooding and coastal storms disturb their habitat and make them vulnerable to those changes (sedimentation, freshwater runoff etc.). Last few decades, ecological effects of Eastern oysters raised with commercial aquaculture gears have been research focus to move the oyster aquaculture where it deserves and allow industry to move away from a wild fishery harvest in order to meet consumer demands. Years of research efforts to measure biodiversity in and around the oyster gears is one of the significant ways to evaluate the impact of these culture operations on the ecosystem fully. In an attempt to enhance oyster populations and improve water quality conditions in Delaware, an oyster gardening restoration program initiated in 2003. Similar to other shellfish culturing efforts, aquaculture equipment used by the volunteer oyster gardeners in Delaware Inland Bays has provided venue to educate the public and increase public awareness for water quality and estuarine health. Shellfish aquaculture has become a new hope for the coastal community in Delaware, with the approval of new regulation allowing commercial oyster aquaculture practices in the Delaware Inland Bays. The use of cost-effective culture techniques to culture oysters for restoration has developed into an integral part of the ecological restoration efforts for the bays. A variety of culturing techniques including subtidal modified rack and bag aquaculture, oyster cages with stocked up trays, Taylor floats with two baskets enclosures, and created oyster reefs have been used, considering sedimentation issue, to investigate ecological and biological impacts of these efforts. Oyster survival looked promising, ranging from 70% to 99% survival. Natural recruitment of oysters have been observed on oysters in floats and nearby riprap, which may be a promising sign that oysters in the gardening program are reproducing within the Delaware Inland Bays. Alike oyster gardening practices, commercial aquaculture practices are expected to bring further viability and stability to the bays by allowing oysters to contribute ecosystem health.

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Jenny Paterno Shinn

Bio(s): JENNY PATERNO SHINN is a Program Coordinator at the Haskin Shellfish Research Laboratory, Rutgers University. Her work includes coordinating K-12 school programs as a part of Project PORTS (*Promoting Oyster Restoration Through Schools*) as well as monitoring faunal utilization of oyster reefs and living shoreline projects along the Delaware Bay. Jenny has a B.S. in Marine Science from Stockton University and an M.S. in Ecology and Evolution from Rutgers University.

DAVID BUSHEK, PH.D., is the director of the Haskin Shellfish Research Laboratory and associate professor at Rutgers University. The predominant focus of his research concerns host-parasite interactions in bivalve mollusks. A second focus aims to enhance understanding of the ecological impact of bivalves, particularly the eastern oyster, at the population, community, and ecosystem levels. Additionally, Dr. Bushek co-developed the Delaware Estuary Living Shoreline Initiative (DELSI) and continues to evaluate how living shoreline tactics and shellfish restoration interact to support resilient coastlines.

Title: Living Shorelines as a Potential Method to Reduce Impacts of Sea Level Rise on Coastal Farms

Abstract: As sea levels rise and storms build in frequency, low-lying farms in the mid-Atlantic and in coastal areas around the world will be increasingly vulnerable to the damaging effects of saltwater flooding. Along the eastern seaboard of North America, geological changes are also causing land to sink, intensifying the flood-inducing effects of the rising ocean. Farmers in these coastal areas need solutions to prevent saltwater intrusion into irrigation systems where it can cause crop mortality and soil damage. One potential solution is the installation of “living shorelines”. In contrast with traditional shoreline stabilization measures, such as seawalls, new approaches have been developed that incorporate natural features to reduce erosion and create habitat; these methods are known as living shorelines and incorporate ecological principles into engineering design. Projects are

usually implemented at the water-land interface with two complementary goals. The first is to stem erosion that can lead to a rapid loss of the marsh surface bringing salt water back to farms and forests. The second is to accelerate sediment accretion to assist the marsh in keeping pace with sea level rise and thus reduce flooding. Construction materials are usually biodegradable, such as coir and native plants. Implementation costs are comparable or less than hard structures and require annual maintenance as one might need to maintain any other living landscape. Researchers are actively validating how and where living shorelines may be effective alternatives.

Collaborators: David Bushek, Ph.D.

How Do We Adapt | Concurrent Session 3

John Bombardiere, West Virginia State University Extension Institute, WV and New Jersey Agricultural Experiment Station New Brunswick, NJ

Bio: From 2015 – 2017 I was a horticulture extension agent with WVSU. Work included high tunnel and field vegetable production systems and variety trials. I am currently the Farm Supervisor at Rutgers University's Hort Farm 3 in New Brunswick, New Jersey.

Title: High Tunnel Vegetable Trials

Abstract: In WV, the warmer average temperatures in late winter and late autumn as a result of climate change offer both challenges and opportunities for vegetable growers. The emergence of farm to school programs and increased demand for local produce has expanded markets for growers beyond traditional wholesale and retail outlets. As crops such as tomatoes and peppers continue to be harvested up to and beyond Thanksgiving in high tunnels, traditional planting schedules for fall/winter crops are disrupted. As growers plant crops sooner in the spring to take advantage of warmer temperatures and to supply more lucrative early markets, lack of pollinating insects can be a problem. The goals of the high tunnel trials at WVSU are to evaluate varieties better suited to early season high tunnel production, test alternative crop planting schedules for niche and farm to school markets, and evaluate yields for early and late season harvests. Specific crops evaluated are fall harvested trellised cantaloupe, spring harvested parthenocarpic zucchini, and winter planted garlic.

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Collaborators: Dr. Annette Eriksen WVSU Extension and Dr. Lewis Jett WVU Extension Specialist WV Dept. of Agriculture

Rakesh S. Chandran, Professor and Extension Specialist, Weed Science & IPM Coordinator, West Virginia University

Bio: Rakesh Chandran is a Professor and Extension Specialist in Weed Science & IPM Coordinator at West Virginia University He received his Ph.D. from Virginia Tech and M.S. from the University of Florida. He served as the President of the Northeastern Weed Science Society and is currently the Assistant Director for Research and Outreach at Ag. & Natural Resources, West Virginia University Extension Service. He was recently awarded the Distinguished Service Award by the National Association of County Agricultural Agents in the United States.

Title: Determination of Growing Degree Days to Manage a Warm-Season Annual Weed in a Cool Season Pasture

Abstract: Field experiments were established to determine the Growing Degree Days (GDD_{10C}) required for the germination of *Arthraxon hispidus* (Thunb.) Makino (joint-head Arthraxon, small carpetgrass, joint-head grass), a warm-season C4 grass, considered to be an invasive weed in certain pastures of the Appalachian region. The experiments were conducted in an established permanent cool-season pasture near Lost Creek West Virginia. The pasture contained over 75% cover of well-established jointhead Arthtraxon. The forage species in the pasture included Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*), orchard grass (*Dactylis glomerata*), red clover (*Trifolium pretense*), and white clover (*Trifolium repens*). The first experiment was initiated on January 1,

2016 and the second experiment was initiated on January 1, 2017. Weather data were collected from a nearby meteorological station to calculate growing degree days. In 2016, based on the Julian calendar, two- to three-leaf seedlings of jointhead Arthtraxon gerimination were recorded when GDD_{28C} reached 207, and during the second year, the same stage of jointhead Arthtraxon seedlings were recorded when GDD_{10C} reached 217. The pre-emergence herbicide pendimethalin applied a week prior to germination of jointhead Arthtraxon provided effective control of this weed. Based on these observations, timing of pendimethalin application when GDD_{10C} approaches 200 is expected to control this weed successfully in a cool-season pasture.

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Alex DePillis, Senior Agricultural Development Coordinator, Vermont Agency of Agriculture, Food & Markets

Bio: Alex DePillis has diversified experience developing clean energy projects and policies in public service and in the private sector. He helps farmers in Vermont develop farm-integrated energy projects, especially manure digesters, and is a state partner to the EPA's AgSTAR, which promotes biogas recovery systems to reduce methane emissions from manure. He has been tapped to support Governor Phil Scott's Vermont Climate Action Commission, in the area of carbon sequestration.

Title: Biogas Systems, Carbon Sequestration, and Dairy Farm Viability

Abstract: While Vermont dairy farmers are mitigating greenhouse gas emissions with manure digesters, the main effect, both real and perceived, is to generate profit and to improve water quality. Farmers and dairy industry service professionals typically frame and name climate adaptions as side benefits rather than as anything related to climate, all the same digesters are helping dairy farmers adapt to changes in climate in subtle yet powerful ways. Meanwhile, dairy farmers face financial and regulatory pressure, and are aware they might be able get money from financial markets to destroy greenhouse gases and to sequester carbon in soils. However, the pressures are immediate and the markets nascent.

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Dr. Franklin Egan

Bio: Dr. Franklin Egan is the Education Director for the Pennsylvania Association for Sustainable Agriculture. Through PASA's SOIL Institute education programs, Franklin supports farmer-to-farmer learning, administers apprenticeships for beginning farmers, and coordinates on-farm research into soil health and other topics. Franklin holds a PhD in Ecology from Penn State University and has previously worked as a research ecologist with the USDA-ARS. He has contributed to research on a range of topics, including production efficiencies on grazing dairies, integrated weed management, and soil carbon storage.

Title A citizen-science model to build soil health and adapt to changing climates

Abstract: Healthy soils must be the foundation of any farm's strategy to adapt to a changing climate, and farmers need a clear understanding of the status of their soil resources to manage for the future. The Pennsylvania Association for Sustainable Agriculture (PASA) is working to document and improve soil health outcomes through a farmer-led, citizen science model. In 2017, we worked with 29 organic and no-till farms across Pennsylvania to quantify soil health using field samples and farm records for practices including cover cropping and reduced tillage. We found that these farmers increased organic matter an average of 1.9 times over NRCS ratings for their soil types, maintained living cover on their fields an average of 237 days, and obtained average soil health scores of 80, an "optimal" score in the Cornell Comprehensive Assessment of Soil Health. We also found that many farmers were able to maintain high soil health scores and organic matter levels while continuing to use intensive tillage practices, although aggregate stability levels were typically lower on these farms. Within this sample, we found several examples of very high performing farms, where soil health scores were above 80 and organic matter

was as much as 2.6 times higher than ratings for their soil types. We have been featuring these leading farmers in field days and workshops that use these data to guide discussions and collaboratively generate new ideas for improving soil health.

Collaborators: Franklin Egan[1], Dan Dalton[1], Kristy Borrelli[2]

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Lucia Huebner, Beechtree Farm, Hopewell, NJ

Bio: Lucia Huebner and her husband Charlie raise grass-fed beef and lamb on their 58 acre grass farm, Beechtree Farm, in Hopewell, New Jersey. The Huebners preserved their farm in 2006. They sell their pastured meat at four regular farm markets as well as from their farm store. Lucia is active in preserving farmland and working on local farm related issues. They both serve as members of the Mercer County Board of Agriculture, Lucia is chair of the Hopewell Township Agricultural Advisory Committee; is a District Supervisor of the Mercer County Soil Conservation District and serves on the Board of the Northeast Organic Farmers Association

Title: Raising Grass-fed Beef in a Changing Climate

Abstract: Since 1986, we have owned and raised cattle on our farm. In 2006, after we learned about the benefits of grass fed beef for human, animal and environmental wholeness we started farming full time and selling our meats directly to people from a farm store on our farm and at farm markets. We practice rotational grazing. As the cattle are rotated from field to field their manure decomposes and enriches the soil. Our animals have an unlimited supply of fresh water from well water and have access to minerals. Our fields are essentially large soil panels and act as carbon sinks. We have another 53 acre farm in a neighboring township where we raise hay to feed our animals in the winter. We have worked with the Natural Resource Conservation Service to employ best conservation practices such as controlling storm water runoff through animal paddocks, building a vernal pond for amphibious habitat and educational pasture walks.

Heather Karsten

Bio: Heather Karsten is an Associate Professor of Crop Production/ Ecology in the Dept. of Plant Science at Penn State University. With an interdisciplinary research and outreach team she studies conservation cropping systems for dairy and crop farms. She also teaches courses in Agronomy and Agroecology. Prior to joining the faculty at Penn State, she earned her MS and PhD at Cornell University in Agronomy with minors in Ecology and Soil Science; spent a Fulbright at Massey University in New Zealand; and conducted post-doctoral research at Utah State University.

Title: Climate change adaptation strategies for dairy cropping systems from an 8-year Pennsylvania dairy cropping system experiment

Abstract: For 8 years, we have been evaluating diversified, conservation dairy cropping systems designed to produce all of the forage, feed and some fuel for an averaged-sized PA dairy farm, while minimizing environmental impacts. The cropping systems management practices include no-till, manure injection, double-cropped winter and summer annual crops, perennials, cover crops, and IPM. Compared to typical PA dairy cropping systems, results thus far indicate that the conservation cropping systems can produce almost all of the feed and forage and reduce off-farm fertilizer, energy and pesticide inputs. In addition, given NE climate change projections, cropping systems that integrate winter annual and perennials crops take advantage of projected extended spring and fall growing seasons; increase land and seasonal manure application nutrient utilization; and distribute crop production risks over multiple seasons. Continuous crop coverage; and soil and nutrient conservation practices

can also reduce soil and nutrient losses associated with increased winter rain, snowmelt, and extreme precipitation events. As climate change progresses, new site-specific crops, hybrids and management practices can also provide additional strategies for resilience to climate change.

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Jim Kinsel, Honey Brook Organic Farm, Hopewell, NJ

Bio: Jim Kinsel is General Farm Manager of Honey Brook Organic Farm, one of the oldest operating organic farms in New Jersey and the oldest certified organic Community Supported Agriculture program in the Garden State. He had worked on several farms throughout New Jersey before striking out on his own in 1991 as a tenant farmer and is now the owner of two permanently preserved farms and farms two others as a tenant. Jim has a degree in mathematics, which he does have the opportunity to dust off now and then on the farm. In organic farming, Jim enjoys the challenge of working out solutions to the pressing problem of how we choose to interact with the natural world in our most fundamental relationship – through the food we eat and where it comes from.

Title: Observing Changes and Mitigating Their Impacts to Plants and Soils in Central New Jersey.

Abstract: Jim Kinsel, who has over 30 years experience farming organically in New Jersey (both as a tenant and farmland owner), will share his observations on the ways in which growing conditions have been changing during that time. He will share what he and his staff are doing to sequester carbon on his four farms now, the mitigation strategies both planned for and adopted and briefly touch on additional practices the farm could adopt if funds were not a limiting factor.

Glen Koehler, University of Maine

Bio: M.S. Entomology. I have worked as an Extension pest management advisor for Maine tree fruit growers for 30 years, along with other IPM outreach, and more recently climate change adaptation work. Tree fruit pest management led to using weather data for decision support through a system called Ag-Radar. Working closely with weather increased my awareness of the trends and importance of climate change, impacts on orchard management, and the need for proactive adaptation.

Title: Automated access to free NOAA hourly weather forecast and weather databases for input into agricultural decision support models.

Abstract: Weather-based decision support provides many benefits for agricultural producers. Those models require a source for weather data input. Operating on-farm weather stations incurs expenses to buying and maintain equipment as well as data transmission. It also requires management time and expertise which are often not available. As a result, data continuity and quality from on-farm weather stations can be inadequate or inefficient. NOAA has increased resolution, access and the quality of gridded weather data. These data are derived from input acquired from high quality, professionally maintained weather instruments to create virtual set of values for every other point between station locations. Those values are adjusted for topography and meteorological influences. With increased grid resolution, the distance between grid points is now down to 3 km, which is sufficient to accurately represent site-specific conditions for variable such as temperature, relative humidity, and solar radiation that tend to have high uniformity over the range of multiple grid cells. This also applies to precipitation from large scale fronts. More locally specific variables such as summer precipitation from

convective storms is less reliable from gridded vs. on-site station measurements. Anecdotal experience and formal evaluation have found that gridded data can replace site-specific station data without negatively affecting output from decision support analysis. The advantages of NOAA gridded weather data have been constrained by the technical expertise needed to create automated scripts to acquire them. With funding from the USDA Northeast Climate Hub, automated scripts to do that are now available.

Pam Mount, Terhune Orchards

Bio: Since 1975. Pam and her husband, Gary Mount own and operate Terhune Orchards in Lawrence Township, The Mounts have built Terhune Orchards into a prosperous business and a community treasure that welcomes more than half a million visitors each year. Starting with 55 acres, the farm now cultivates more than 200 acres of preserved farmland, growing 40 different types of fruits and vegetables both conventionally and organically. Including 14 acres of vineyards producing a dozen wines in a new sustainable, solar powered wine barn. Visitors are welcome in the winery tasting room and farm store year round. The farm is on the New Jersey Sustainable Business registry. Elected to the Lawrence Town Council for 12 years, she also served as mayor for three years. Pam and Gary served in the Peace Corps in Micronesia from 1967-1970. They lived on a small island in the Pacific Ocean called Satawal, Because of that experience; they became committed to empowering local efforts to strengthen the community. Once they owned the farm, it seemed natural to include the broader community with a year round farm store, pick your own, numerous festivals and educational activities. As mayor she founded the local nonprofit "Sustainable Lawrence", an organization that has successfully brought together local nonprofits, civic organizations, businesses, schools and government leaders to work toward creating a more sustainable community. Pam was a founding member and later chair of the board of Sustainable Jersey She is one of the founding board members of several nonprofits, including the Lawrence Community Foundation, Lawrence Hopewell Trail, Farmers Against Hunger, Lawrence Nature Center. In 2015, she became a founding member of C-Change Conversation, a group dedicated to promoting climate change awareness. She has three children and nine grandchildren. Daughters, Reuwat and Tannwen are now partners in the farm.

Title: How A Family Farmer is Raising Tree Fruit, Berries, and Grapes in a Changing Climate

Abstract: Our orchards produce apples, peaches, cherries, wine grapes, as well as many types of berries. This talk will provide some lessons about how we are addressing climate change on our family farm in the context of these fruits and vines.

Daniel Ward, Extension Specialist, Pomology, Rutgers/NJAES, Rutgers

Bio: As Associate Extension Specialist in Pomology Dr. Ward has state-wide extension responsibility for fruit crops including wine grapes, other small fruit, and tree fruit. Current viticultural research areas are canopy management, training systems, and cultivar evaluation. Dan also conducts fruit quality research on Peaches and other stone fruits, as well as vegetable production. He is the Director of Rutgers Agricultural Research and Extension Center, and the New Jersey Center for Wine Research and Education.

Title: Strategies and Tactics for Wine Grape Production in a Changing Environment

Abstract: Increasing average temperatures in various wine regions is much less of a factor in current practice than adaptation to increased climate variability, especially the frequency of extreme weather events. Important climate factors influencing grape quality (e.g. growing season heat accumulation, and pre-harvest precipitation) must be considered in contrast to climate factors that limit vine survival (e.g. fluctuating winter temperatures) and crop survival (e.g. extraordinary rainfalls). A general strategy for adaptation is to explore the cultural practices and grape cultivars being used in higher and lower latitudes. Typical warm-climate viticultural practices being adopted in more northerly regions include selective leaf pulling in the fruit zone and selection of high heat requiring cultivars. In the mid-Atlantic there has been increased planting of high quality and high value warm-climate grape cultivars, but these cultivars must possess the ability to withstand a wider range of climate fluctuations. Cool-climate viticultural practices which have been implemented farther south include the hilling-up of soil to protect graft

unions, and the retaining of excess fruiting wood and structural wood to compensate for losses from freeze injury. The planting of cool-climate cultivars in those climates capable of producing warm-climate cultivars is limited due to the higher prices commanded by most warm-climate cultivars.

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Jenifer Wightman, Cornell University

Bio: Jenifer Wightman holds a Masters in Environmental Toxicology from Cornell and works as a Research Specialist specializing in greenhouse gas inventories and life cycle analysis of agronomic systems. She teaches 'Sustainable Systems' and ‘BioDesign’ at The New School in NYC. She is also a science-based conceptual artist with a fondness for graphs, microbes, and mud. Fundamentally, she is interested in forming an ecological rationality by reflecting on the co-evolution of a culture and its supporting ecosystem.

Title: Dairy Manure Storage & Greenhouse Gas Mitigation & Adaptation Opportunities

Abstract: Society increasingly expects agriculture to produce food in a manner that maintains environmental quality. In the past, daily spreading of manure, with the potential to contaminate surface waters, was common particularly during fall or winter when crops are not growing and frozen ground increases surface runoff of nutrients to streams (Williams et al., 2011, Wightman & Woodbury 2016). To address water quality, manure is stored in a solid stack (less often) or in a liquid storage facility (more often) for many months so manure can be spread on dates closer to when crops can take up the nutrients, reducing the potential for pollution of surface and groundwater. However, liquid manure storage for water quality increases greenhouse gas (GHG) emissions from dairy farms. Climate change in the northeast includes extreme weather events that can cause these storages to overflow causing new water quality issues. This talk will provide insight in how manure management can adapt to changing conditions while maintaining water quality and mitigating climate change. We have developed a range of outreach materials based on our research on climate change mitigation and adaptation opportunities for farms and forests in general: http://blogs.cornell.edu/woodbury/resources/

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Collaborator: Peter Woodbury

USDA Northeast Climate Hub Partners

Erin Lane, USDA Forest Service Northern Research Station in Durham and USDA Northeast Climate Hub, Coordinator

Bio: Erin is a career employee of the US Forest Service since 1997 and joined Northern Research Station in 2014. She is the coordinator for the USDA Northeast Climate Hub. Her background and education are in fire ecology and she is one of the leaders of the North Atlantic Fire Science Exchange. Duties for both organizations include bringing people together, cultivating communications, and sharing experiences to improve efficiency and productivity. Erin has strong passion for collaboration and working together toward solutions to enhance lives.

Title: USDA Northeast Climate Hub Partners

Abstract: The USDA Northeast Climate Hub, as part of a national network of Hubs, is a partnership among the USDA agencies and other federal, state and private organizations. We are working to deliver science-based knowledge and practical information to farmers and resource managers to support decision-making related to climate and weather related risks, such as floods, droughts, extreme storms, and invasive pests. We are built on a collaborative model that engages a diversity of partners in order to meet our mission. The USDA NE Climate Hub works with the 16 land grant Universities in our region, both Agricultural Experiment Stations and Cooperative Extension, to develop and catalog information and materials for service providers, and share approaches through workbooks, decision support tools, and demonstration sites. Climate data, adaptation strategies and mitigation information is synthesized, translated, and delivered through existing networks, as new connections form. The Climate Hubs and our partners promote climate-informed decision-making for farms and forest lands.

Climate Learning Network Resources, Collaboration, and Climate Literacy Certification

Dan Geller, PhD, University of Georgia

Bio: Dr. Dan Geller is an Agricultural Engineer in The University of Georgia's College of Engineering and an Extension Associate at Southern Regional Extension Forestry. Dr. Geller works in Climate Change and Renewable Energy and is the coordinator of the eXtension Climate Learning Network.

Title: Climate Learning Network – CLN resources, collaboration, and Climate Literacy Certification

Abstract: The eXtension Climate Learning Network (CLN) is a USDA funded, national network of Extension Professionals who work together on climate issues. The goal of the CLN is to help facilitate connecting the resources of the Climate Hubs with Cooperative Extension programs throughout the country. The CLN develops electronic learning resources for Extension personnel focused on climate adaptation and resilience. The CLN also works with the Climate, Forests, Woodlands Community of Practice to provide climate adaptation resources to natural resource Extension agents and forestry professionals. The CLN works directly with USDA-NIFA Coordinated Agricultural Projects to connect Extension to the resources developed in these multi-institutional projects. The CLN has developed a Climate Literacy Certification program for Extension Professionals that is located at eXtension, Cooperative Extension's national online resource.

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Outreach Talks from Northeast Climate Hub Partners

Suzanne Baker, Acting Tribal Liaison, NRCS-NY, NE Regional Tribal Liaison and NRCS, Resource Conservationist, SE Area, NRCS-NY

Bio: Suzanne has just finished a yearlong detail with the NE Climate Hub as NRCS Project Liaison. She focused her efforts on tribal outreach, developing a workshop on declining habitat and species of cultural importance and developed a pilot project to deploy weather stations (TSCAN, Tribal Soil Climate Analysis Network units) on tribal lands across the United States. Prior to work with the Hubs she served a seven month detail to NHQ in the Ecological Science Division. During the 13 years with NRCS she has served as a Certified Conservation Planner, Civil Rights Advisory Committee Officer and Resource Conservationist for the Southeast Area. Pre-NRCS includes, engineering with Soil and Water Conservation District in NY, Environmental Analyst coordinating research efforts in the Sierra Nevada Mountains and Finite Element Analyst for SDRC in MI.

Title: Tools for Tribal Outreach

Abstract: Listening sessions provide a great deal of guidance on where to focus your efforts. Through these sessions it was determined that a workshop on declining species held at a NRCS Plant Material Center would highlight the support the PMC can provide and steps tribes can take to increase diminishing species of cultural importance. Access to technology and decision support tools also became an interest during a number of meetings that included participants from both tribes and US agencies. From this an application for funding was developed and granted to purchase and deploy units to monitor a number of weather parameters to support agriculture and STEM education for the k-12 youth of tribal communities. Networking, newsletters, workshops and projects are all components of a successful outreach plan.

Lori Brewer, Senior Extension Associate, Cornell University Garden-Based Learning, School of Integrative Plant Science, Horticulture Section

Bio: Lori Brewer, Senior Extension Associate, Cornell University Garden-Based Learning, School of Integrative Plant Science, Horticulture Section. Lori Brewer's effort focus on professional development that builds the capacity of the Cornell University Cooperative Extension county community horticulture educators and Master Gardener Volunteers to support successful gardening experiences in their local communities around state initiatives including Gardening in a Warming World, Vegetable Varieties for Gardeners Citizen Science, and Seed to Supper.

Title: Gardening in a Warming World: Strategies for Engaging Gardeners and Cooperative Extension Master Gardener Volunteers

Abstract: Working in a garden means dealing directly with drought conditions, flooding and water-logging; unseasonable cold and freezing conditions; increases in new pests; changes in plant diseases; variability in heat and hardiness zones; and extreme weather events. Cornell Cooperative Extension (CCE) Master Gardener Volunteers (MGV) in collaboration with Cornell Garden-Based Learning Program leadership have had several initiatives to enhance understanding of climate change among gardening audiences including the development of a curriculum. Gardening in a Warming World: A Climate Smart Gardening Course Book is a 36-page publication that describes the key concepts such as systems thinking that are fundamental to understanding the challenge of the changing climate and how it relates to gardening skills and techniques. Also available is related Facilitator's notebook and presentation. There is no national climate change curriculum for Extension Master Gardeners, so the development of materials for NYS can be adapted and utilized nationwide (potentially reaching 90,000 active Extension Master Gardeners in all US states and Canadian provinces). With an understanding of how and why their local climate is changing, and how it matters to them and their community, and what they can do to reduce carbon emissions and prepare for change; gardeners can be engaged as leaders and effectively mobilized for action.

Co-authors: Anne Christian-Reuter, Program Educator, Cornell University Garden-Based Learning, School of

Integrative Plant Science, Horticulture Section. Anne focuses on climate change literacy for gardening audiences including curriculum development, workshops and distance learning.

Kathy Bunting-Howarth and **Sara Via**, University of Maryland and **Allison Chatrchyan**, Cornell University

Bio: Katherine (Kathy) Bunting-Howarth is the Associate Director of New York Sea Grant and Chair of the Sea Grant Extension Assembly. She serves on multiple boards and committees including the Executive Council of the Science and Resilience Institute at Jamaica Bay, New York Water Resource Institute, Great Lakes Basin Advisory Council, Cornell Biological Field Station and the Chesapeake Bay Program Science and Technical Advisory Committee. She enjoys working with diverse groups of people to address wicked problems-from changing lake ecosystems to estuarine eutrophication to optimizing the transportation of crude oil. The former Director of Water Resources for the state of Delaware, Kathy served in leadership roles for the two National Estuary Programs, the Chesapeake Bay Program and the Delaware River Basin Program. Bunting-Howarth holds a Ph.D. in Marine Studies (concentration in Marine Policy) (University of Delaware, 2001) and a JD with a certificate in Environment and Natural Resource Law (University of Oregon, 1995).

Bio: Sara Via, Professor and Climate Extension Specialist at the University of Maryland, College Park. Sara Via designs and delivers programs that teach Marylanders about climate change: how it works, how it impacts us now and what we can do about it. Through talks and articles, Sara is introducing farmers to the issue of climate change, how it will affect their farms, and steps that they can take to minimize their risks. She leads the Climate Science for Farmers Extension Team, a group of faculty extension specialists and extension educators who work across the state. Sara also works with Master Gardeners on principles of climate-friendly gardening, and is currently training Master Gardeners to give talks on climate change and gardening in their communities.

Title: Climate Master Volunteers: Developing A New Extension Master Volunteer Program for Climate Smart Communities

Abstract: Many Americans remain confused about the science of climate change, and this has slowed meaningful action on both adaptation and mitigation. Not only have people been subject to widespread misinformation, but climate change is often seen as somebody else's problem, or an issue of the distant future rather than a problem that is already affecting most of us. Due to inaction at the federal level, there is now a movement to address climate change at the state and local level. But many communities, especially smaller, rural communities, or less wealthy urban communities, lack the knowledge, time, or resources to plan for climate change or reduce municipal emissions. Our team from Cornell, University of MD and 8 universities in the USDA NE Climate Hub Land Grant partnership is developing a plan for a new Extension Climate Master Volunteer Program, including holding focus groups in 9 states and the District of Columbia. Modeled after other Extension volunteer programs, such as the Master Gardener program, this program would produce a cadre of trained volunteers who could teach others about climate change and help their communities with planning and implementing local adaptation and mitigation projects. We will describe the work we are doing this year, and the goals of the program.

Dan Dostie, NRCS/Pennsylvania

Bio: Dan Dostie is a conservationist for USDA's Natural Resources Conservation Service in Pennsylvania. Dan has 20 years of experience in delivering conservation in the Northeast US. During calendar year 2016, Dan served as the NRCS liaison to the USDA Climate Hubs for the NE and MW co-authoring the Adaptation Resources for Agriculture and promoting the Adaptation Workbook. Presently he is serving as the Technical Service Provider and Agribusiness Partners program coordinator for PA NRCS focusing on engaging ag retailers in promoting 4R principles of nutrient stewardship.

Title: Adapting Farms to Weather Extremes and Climate Uncertainty

Abstract: This presentation will update partners on NRCS plans to transfer the Adaptation Workbook to other

regions of the country, develop more workbook examples and case studies, and integrate adaptation and resiliency concepts into NRCS training programs for improving soil health.

Co-authors: Maria Janowiak, Mike Wilson, Howard Skinner, Jerry Hatfield, Mike Kucera, Christopher Swanson

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Joshua Faulkner, PhD Farming and Climate Change Program Coordinator, UVM Extension Center for Sustainable Agriculture and **Hannah Aitken**, project coordinator for the Climate Masters Project, University of Vermont

Bio: Joshua Faulkner coordinates the climate change and farming program for UVM Extension. He is an agricultural engineer who works with all types of farms on improving resilience to climate change, primarily related to soil and water management. His program provides technical assistance and education to farmers and agricultural stakeholders, and performs applied research on promising adaptation solutions.

Bio: Hannah Aitken is the project coordinator for the Climate Masters Project and a research assistant at UVM. When not at UVM she works as a farmer in Huntington, Vermont.

Title: The Climate Masters Project: A farmer fellows program for peer-to-peer climate adaptation education

Abstract: The goal of this one-year USDA NIFA AFRI-funded project is to support managers of land-based businesses (farms and forests) in the Northeast to independently plan, initiate and complete climate change-focused outreach, adaptation strategies, and peer-to-peer learning. Through this project, we will (1) review, synthesize and share available knowledge related to climate resilience, climate adaptation outreach and education, and peer-to-peer learning; (2) collaboratively develop and design the Climate Adaptation Fellowship curriculum, consisting of in-person training, mentorships, and sector-specific training modules for vegetable/small fruit, tree fruit, and dairy farmers, foresters, and technical service providers; (3) design impact assessments to evaluate each component of the curriculum; and (4) validate the modules through a peer review process. We will work with project partners, including extension, researchers, agency and NGO representatives, farmers and foresters. We will present a 2-day workshop focused on the most current climate science information, made relevant to land managers and their service providers. Project subgroups will work remotely over a six-month period to create the overarching architecture of the curriculum (which will detail the peer-to-peer education process), four sector-specific modules, prototype evaluation tools for each curriculum module, and overall project evaluation. The final stage of the project, an independent peer-review process, will validate the curriculum through review by two farmers, one TSP, and one university-based researcher or NGO representative for each module. The final products of this project will be made open access. We will also seek to pilot the curriculum at the conclusion of this effort

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Christine E. Hatch, Extension Associate Professor, Department of Geosciences, University of Massachusetts, Amherst

Bio: Dr. Christine Hatch is Research-Extension Liaison for the Center for Agriculture, Food and the Environment (CAFÉ), and Extension Associate Professor of Water Resources and Climate Change in the Department of Geosciences at the University of Massachusetts, Amherst. No stranger to extreme events, Christine moved to Amherst the day after Hurricane Irene in 2011, an event that inspired two research projects: RiverSmart Communities, a project dedicated to supporting ecologically restorative flood prevention and remediation in New England and “Farms, Floods and Fluvial Geomorphology: Making the most of our natural resources.” Her research and extension work ranges from investigating the broader impacts of stream temperatures, surface water – groundwater interactions, floods, droughts and other water resources issues under changing climate conditions.

Title: Climate Around the Table: Farmers Talking to Farmers

Abstract: As part of a project investigating the unique and uniquely vulnerable role of floodplain farms in New England, we planned a climate change roundtable discussion with agricultural producers in the region. Who better to know how the land and weather patterns have changed than the people out farming in it for the last decades? How will we know when a farm has flooded so many times it would be better to abandon than lose money on again? And, if farmers are planning for next season's crops, how helpful are 30-year projections of climate change with broad error bars, really? Several Climate Hub studies have found that while many producers in the Northeast are interested in what scientists have to say, they don't get their most actionable information from them, nor are they as likely to go to them with questions as they are to other farmers. We tried two models for the roundtable. At the first meeting, producers came to a semi-formal forum where scientists presented climate and soil carbon information, asked questions, and filled out a survey. Interaction was somewhat limited, some voices were not heard at all, and most participants were already very knowledgeable about our changing climate. By contrast, scientists were invited to the second meeting, guests of a monthly young farmers' potluck where ongoing challenges were discussed, experiences and adaptations proposed and shared. This mutual trust opened the door for the scientists as well, building trust through mutual respect and dialog, rather than impressive graphics.

Collaborators: Ben Warner of University of New Mexico, and inspiration from Dan Cooley of UMass Amherst, Dan Kaplan of Brookfield Farm, Amherst, MA, and Joshua Faulkner and Rachael Schattman of University of Vermont)

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Suzy Hodgson, UVM Extension Center for Sustainable Agriculture

Bio: Suzy has worked at University of Vermont's Center for Sustainable Agriculture since 2013 in the new farmer and farming and climate change program areas. From 2009 to 2015, she started and ran *yourfarmstand*, a new web-based platform for helping farmers sell directly to consumers online and reduce food miles. Before moving to Vermont in 2008, she built her environmental career in the UK and mainland Europe over 16 years where she was a principal consultant with Carbon Clear; a senior lecturer, developing and teaching new courses in life cycle assessment, environmental management and environmental economics at the University of Sunderland and then program director at the Center for Environmental Strategy, University of Surrey, UK where she developed Surrey's first inter-disciplinary, inter-departmental environmental masters course. She currently writes for UVM Extension's New Farmer blog and the Farming and Climate Change Adaptation blog and in the past, wrote regular feature articles on energy and business for the Institute of Environmental Management and Assessment (IEMA). She has a MSc. Environmental Management from Yale's School of Forestry and Environmental Studies.

Title: Outreach and economics: From videos to case studies - framing and analyzing the costs and benefits of how farmers are adapting to climate change

Abstract: UVM Extension's Center for Sustainable Agriculture started its USDA NE Hub outreach with blogging and producing videos of farmers talking about climate impacts on their farms and their responses to these impacts. Research shows that farmers prefer to hear from fellow farmers.Farmers described in their own words the severe weather they were experiencing, such as too much water or too little water. Two practices were examined more closely, irrigation and gully repair. This was our second phase of work, assessing the costs and benefits of implementing specific practices. Considering irrigation, the question was, "does crop irrigation make sense as a climate adaption strategy given the overall increased precipitation trend in the Northeast"? Using 10+ years of data, we evaluated the costs and benefits of irrigation at the Intervale Community Farm, a diversified organic vegetable farm in Burlington, Vermont Reviewing equipment purchases and additional labor costs and the benefits of avoiding crop loss, we discovered that the benefits of avoided crop loss were greater than the costs of irrigation in all but one year. Looking at the numbers another way, if the farm can protect at least 3.5% of its crop revenues with irrigation, it will cover its costs of irrigation. Significantly, rainfall does not always coincide with critical crop growth. At Last Resort Farm, a diversified farm with sugarbush, vegetable, berries, and hayfields

in Monkton, Vermont, a number of gullies on a sloping sugarbush were eroding and sending soil to a nearby stream. The gullies had recently been repaired so cost data was available. However, if the costs of gully repair exceed the direct benefits to the farmer, of avoided soil loss should this adaptation practice be recommended? In this case, the improvements in water quality extend beyond the private property boundaries of the farm and benefit the wider community. Without gully repair, the problem of soil erosion from the farmer's fields would accelerate, resulting in more sediment in Lake Champlain. This evaluation showed that when the adaptation practice benefits reach beyond the farmer and are shared among the wider public, the burden of costs to the farmer should be alleviated by public entities as grants or assistance. It is here that NRCS fills the gap between the private costs to farmers and the benefits to the public. In this case, the approach to costs and benefits is to choose the method, which is the most "cost effective" or "least cost" which achieves the public conservation benefits. In summary, there are more adaptation practices to measure and evaluate, and beyond the specific practices, there's more to understand - how farmers' climate adaptation ties in with their communities and their relationships with customers, service providers, public entities, and other stakeholders.

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David Lane, Cornell University

Title: Climate Change and Agriculture in New York and Pennsylvania: Risk Perceptions, Vulnerability and Adaptation among Farmers"

Abstract: Climate change impacts on agriculture have been intensifying in the Northeastern United States. In order to encourage the adoption of climate change adaptation and mitigation practices by farmers, it is critical to understand their perspectives on the risks they face and actions they are taking. However, very few empirical studies have considered how farmers are interpreting and responding to climate impacts, risks and opportunities in the Northeast. This study investigates farmer views and decisions related to climate change using data from six farmer focus groups conducted across New York and Pennsylvania. The study examined how farmers perceived climate impacts on their farms, the practices they are willing to adopt, and how perceived risks and vulnerability affect farmers' decision-making related to adaptation and mitigation strategies. Although farmers articulated concern regarding climate impacts, they also made clear that other business pressures, such as profitability, market conditions, labor availability or government regulations were often more critical issues that affected their decision-making. Decisions about adopting climate change adaptation and mitigation practices vary widely, and personal experience with extreme weather and changing seasons affected decision-making. The findings from this study provide improved understanding of farmers' needs and priorities, which can help guide land-grant researchers, extension and policymakers in their efforts to develop and coordinate a comprehensive strategy to address climate change impacts on agriculture in the Northeast.

Co-authors: David Lane 1, Allison Chatrchyan 1, Daniel Tobin 2, Kaila Thorn 3, Shorna Allred 4 and Rama Radhakrishna 3

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Lekha Paudel, Delaware State University [lnpaudel@desu.edu]

Bio: Dr. Paudel has been at DSU as Farm Management Specialist since 2011. He received his PhD in plant and soil sciences from Alabama A&M University in 2009. Prior to moving to the US, he served as an extension agent in Nepal for 15 years. Currently at DSU, he is carrying out field research on vegetables and small fruits in addition to

reaching out the agricultural community to empower audiences on how they improve their farm profitability, specially limited resource farmers.

Title: Performance of Sweetpotato as an Alternative Agriculture Enterprise While Transitioning to Organic Farming

Abstract: Underserved farmers in Delaware are still facing challenges generating farm income adopting sweet potato [*Ipomoea batatas* L.] as an alternative agriculture enterprise during organic transitioning due to lack of knowledge and information. To determine if sweet potato could be successfully produced in Delaware climate with minimum inputs as organic transitioning crops, four accessions of sweet potato were evaluated during growing season of 2012, 2013 and 2014 at Smyrna Outreach and Research Center of Delaware State University. Field researches were conducted in the Randomized Complete Block Design with four accessions replicated three times on sandy loam soil pH with 6.8 and constant agronomic practices were maintained throughout the growing season. In comparing the ungraded storage root yield, Birmingham (T2) showed the highest yield (34833 kg ha-1) as control followed by TUI-001 (T6) (31847 kg ha-1), A-193-217 (T1) (28935 kg ha-1), and TI-6008 (T4) (26481 kg ha-1), respectively. The result suggested that these sweet potatoes accessions have shown great potential to be good crops for organic transition in Delaware climate without adding any chemicals. However, there is an impact of weather pattern (rainfall) that causes drastic yield variability among these accessions.

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Rachel E. Schattman, PhD USDA Northeast Climate Hub/University of Vermont Extension, Burlington, Vermont

Bio: Dr. Schattman serves as a Research Fellow with the USDA Northeast Climate Hub, and as a Research Specialist with the University of Vermont Extension Vegetable and Berry Program. Her research and outreach addresses climate change adaptation, produce safety, and behavior change. Her background is in Agroecology, with a focus on sociology, community food security, and farm-based adaptive practices to climate change. She also has 8-years of experience owning and managing a commercial vegetable farm, located in Monkton, Vermont.

Title: "What-do-ya-know? …about water accessibility for commercial vegetable farms in the Northeast"

Abstract: What are the current water-use practices of vegetable farmers in the Northeast? In 2017, collaborators at the USDA Northeast Climate Hub, the University of Vermont Extension, and the University of Massachusetts Amherst created a survey of vegetable growers to find out more about current practices related to irrigation, wash water, and water disposal. The survey was sent to subscribers to the Vermont Vegetable and Berry Growers Association (VVGBA) listserve and the UMass VegNotes newsletter. Results from the survey help describe the current practices of vegetable farmers. This information is necessary as we work to understand how changing water availability, access, and quality associated with climate change will affect the northeast vegetable industry.

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Kaila Thorn, Pennsylvania State University

Title: influences to farmers' climate change farm-management decisions: a Pennsylvania study

Abstract: Key Farmers in Pennsylvania have been feeling the impacts from climate change through increased pests, variability in precipitation, and more extreme storms. Determining who farmers turn to for information regarding farm management decisions can be an informative way for outreach organizations, such as Extension, to assist farmers in managing climate change impacts. In the spring of 2017 a comprehensive study was completed with Pennsylvania farmers regarding their perceived barriers to adaptations, key influencers, preferred delivery methods, and their beliefs regarding climate change. In total, 500 farmers were surveyed, with a response rate of 52%. This presentation will focus on the key influencers to Pennsylvania farmers' farm-management

decisions as they relate to climate change. Respondents selected from four categories of top influencers *business, community, online weather resources, and government.* Results indicated that the most influential group in farm-management decisions related to climate change was found within the *online weather resources* category, specifically 1-7 day forecasts. This was followed by 8-14 day forecasts from the *online weather resources* category, and crop/livestock consultants from the *business* category. These results inform research in where to turn to next to be most helpful to farmers, as well as informing outreach organizations in how to tailor educational programs to best include sources farmers are influenced by. Additionally, these findings encourage collaboration efforts between researchers, outreach, and the sources that farmers are influenced by to work together to meet the climate change needs of Pennsylvania farmers.

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Jennifer Volk, University of Delaware and **Karrah Kwasnik**, University of New Hampshire

Bio: Jennifer Volk joined the University of Delaware as an Extension Specialist in Environmental Quality and Management and now also directs the Kent County office and serves as the Associate Director. She continues to work on water quality issues in Delaware and the region and also serves as UD's liaison to the Northeast Climate Hub where she helps to share research and outreach initiatives on climate related topics.

Bio: In partnership with the University of New Hampshire, Karrah Kwasnik orchestrates digital media and communication efforts for the USDA Northeast Climate Hub. As Digital Content Manager, Karrah strives to make complex information more approachable through design and visual storytelling mediums. As of late, Karrah has helped spearhead the virtual climate adaptation demonstration project, 'As If You Were There,' where she championed multiple projects from camera to launch.

Title: 'As if You Were There' Virtual Climate Adaptation Demonstrations

Abstract: The USDA Northeast Climate Hub, in partnership with University of Delaware Cooperative Extension, recently developed an interactive virtual experience called, 'As If You Were There.' This online tool showcases adaptation strategies that can help producers and land owners deal with a changing climate, and features mitigation opportunities that can improve energy efficiency and sequester carbon. Many of the practices featured have immediate benefits and improve the overall sustainability of an operation.

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Alissa White, University of Vermont, Department of Plant & Soil Science

Bio: Alissa joined UVM's Department of Plant and Soil Science as a graduate student after a decade working for farms, nonprofit program development, and grassroots fundraising. Alissa was drawn to the University of Vermont as a place where she can deepen her understanding of comparative agricultural challenges, and engage with farmers and other stakeholders to shape research. Alissa's thesis combines research & outreach to understand the nature of change in agricultural communities, and how usable information on climate adaptation is created and communicated strategically.

Title: Bridging the Climate Information Usability Gap: Engaging Farmer Networks & Boundary Organizations

Abstract: Research from the University of Vermont explores best practices in communicating about climate change adaptation with agricultural communities of New England. This presentation will begin by sharing key themes and highlights which emerged in interviews with extension professionals about what works on the ground and what doesn't when it comes to communicating about climate change with farmers. Success stories from the region showcase the importance of established relationships extension programs have built with the agricultural community to produce actionable information. Co-produced information in these cases is reported as more

usable because it is tailored to specific agricultural operating contexts, tied to local climate impacts, and delivered strategically. Examples include translating weather data into growing degree days, linking weather data to nutrient availability in soils, and quantifying benefits of adaptation practices that promise more tangible advantages for farmers. Valuable trends from these interviews informed a two-year project called the New England Adaptation Survey. This project draws upon the expertise of vegetable and berry growers across New England to identify adaptive management practices already in use on farms, and innovative strategies that are emerging to manage for increased incidence of drought and extreme precipitation. In this first year of the project, 200 vegetable and berry farmers across New England have participated in the survey. In the second year, focus groups will ask farmers to identify the resources they need to support them in adapting. An integrated research and outreach design leverages collaborations with farmer networks and organizations to smooth the interface between scientific research and decision-makers.

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Sarah Wiener, USDA Southeast Climate Hub, Raleigh, NC

Bio: Sarah Wiener is a Fellow with the Southeast Regional Climate Hub (SERCH). She is in charge of researching how climate information is communicated to land managers and land management professionals in the southeastern United States, and developing tools and resources to meet those needs. Sarah came to the Climate Hubs after getting her Masters of Science in Forestry from North Carolina State University.

Title: Tools to Simplify Climate Adaptation

Abstract: Land managers, Extension agents, and USDA field staff have numerous and increasing demands on their time, making it difficult to constantly consider climate change adaptation. The Climate Hubs strive to simplify the use of climate and climate adaptation science in daily to long term decision making through tools, trainings, and other resources. In this session, we briefly showcase three tools that seamlessly integrate climate adaptation into existing workflows, or streamline dispersed and disparate products into a single easy to use platform. Tools covered include (1) SERCH LIGHTS, a climate threat email alert system; (2) the Climate Concerns and Adaptation Practices (CCAP) tool, a platform for integrating climate stressors with the Conservation Planning Process; and (3) the Tool Shed, a searchable database of climate adaptation tools for land managers and land management professionals.

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Perspectives from the Climate Change Program Office

William Hohenstein, Director, Climate Change Program Office, Office of the Chief Economist, Acting Director, Office of Environmental Markets, Office of the Chief Economist

Bio: William Hohenstein is the Director of USDA's Climate Change Program Office, within the Office of the Chief Economist. The Climate Change Program Office provides coordination and policy development support for the Department's climate change program. It serves as the focal point for the Secretary of Agriculture on the causes and consequences of climate change, as well as strategies for addressing them. Mr. Hohenstein also serves as the Acting Director of the USDA Office of Environmental Markets, also within the Office of the Chief Economist. The Office of Environmental Markets (OEM) was established to facilitate the participation of farmers, ranchers, and forest land owners in emerging environmental markets. Before arriving at USDA, Mr. Hohenstein served as a Division Director in EPA's National Center for Environmental Economics. Prior to that, Mr. Hohenstein served in the Climate Change Division of EPA's Office of Policy Planning and Evaluation. He represents the United States at international climate change negotiations and has served as a U.S. representative to the Intergovernmental Panel on Climate Change (IPCC). Mr. Hohenstein has a B.S. in Natural Resource Management from Cook College,

Rutgers University and a M.E.M. in Resource Economics and Policy from Duke University's School of Forestry and Environmental Studies.

Title: National Efforts to Address Adaptation and Resilience

Developing a Community of Practice

Larry Lenton, Knowledge and Technology Transfer Office Agriculture & Agri-Food Canada, Regina, SK, and **Mike Hoffmann**, Cornell Institute for Climate Smart Solutions, Cornell University, Ithaca, NY

Bio: Mike Hoffmann is the executive director of the Cornell Institute for Climate Smart Solutions, which was created to help raise the profile of the challenges posed by a rapidly warming climate and to help those who grow our food adapt to the changing conditions as well as reduce their carbon footprint. As executive director he provides visionary leadership, communicates to a wide range of audiences the challenges and opportunities that come with a changing climate, and builds partnerships among public and private organizations. Previous positions he has held at Cornell include Director of the Cornell University Agricultural Experiment Station, associate dean of the College of Agriculture and Life Sciences, associate director of Cornell Cooperative Extension, and director of the New York State Integrated Pest Management Program. He is a professor in the Department of Entomology. He received his Bachelor's Degree from the University Wisconsin, Masters from the University of Arizona and PhD from the University of California, Davis.

Bio: Larry Lenton, Director of Knowledge and Technology Transfer in the Prairie Region of Agriculture and Agri-Food Canada's Science and Technology Branch has participated in and led many collaborations and partnerships. With a focus on agri-enviromental issues as a main theme in the development and promotion of beneficial management practices (BMPs) on agricultural landscapes; Larry engages with federal and provincial government departments, universities, not-for-profit organizations, and Indigenous groups towards the goal of sustainable agriculture though BMP adoption. Using a community of practice approach to better understanding the development and implementation of BMPs helps to achieve this goal.

Title: A new model for building collaborations – What did we learn from 2017 US-Canada Climate Change Syracuse Workshop?

Abstract: On October 17, 2017, 47 invited individuals representing federal and local government, universities, non-government organizations and private sector interests gathered at the Cross-Border Syracuse Workshop on: *Adaptation to Climate Change; Information and Tools for Decision Making*. As we know climate impact affects similarly across geo-political borders and an information exchange on the subject matter among the two countries can prove to be beneficial. Planners from this workshop wanted more than information exchange from the participants; there was an additional commitment towards working on collaborative project ideas. We understood collaborations can reap greater rewards than working it alone and therefore the workshop proceedings captured not only the information, but also the collaboration activities among participants. The day and half event covered the following three themes: extreme weather events affecting soil erosion and nutrient loss; climate change impacts on increased pressures from pest and diseases; and a session on weather and climate decision support tools. Twelve on-line tools were presented in a tools café in support of farm manager's decisions. So how successful was the event? Of the 47 people attending, 33 completed a survey and 77% reported it was useful and 20% found the event extremely useful. In addition, 92% of the respondents indicated that they would use the information in their work. Important to note the planning committee's work was not done when the last person left the workshop, since we continue to follow up on those participants' commitments and by doing so continue to build upon our community of practice around the workshop's three session themes.

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