Northeast Food Systems: Grand Challenges 2040

Executive Summary:
The Northeast[1] has the research and outreach capacities to provide solutions and models for a growing regional, national and global demand for food. While the Northeast has a modest land mass (~6% of the US) and large population (~17% of US) that generates 20% of the national GDP, the complex food systems of the Northeast constitute useful models for innovative agricultural enterprises and markets and agricultural literacy among the non-farming public. Further, the large concentration of Land grant universities make this region a unique test bed for food systems research and extension.

We envision this whitepaper assisting prospective funding agencies (e.g., NIFA, NSF, EPA) in defining problem statements in current agricultural and natural resource requests for proposals. Importantly, we advocate for the investment in large, cross-disciplinary, funding opportunities that address the complex issues of food systems development as a means to ensure U.S. agricultural vitality, sustainability and resilience.

Background:
The Northeast Regional Association of State Agricultural Experiment Station Directors (NERA) is composed of 13 land-grant universities and 15 experiment stations. An essential mission of all NERA members is to provide cutting edge research that addresses regional challenges in agriculture, the environment and natural resources. While food systems are large and complicated entities, they can be systematically evaluated as a means to identify strategies that ensure economic vitality, human health, environmental health and social well-being. The Northeast has the research and outreach capacities to provide solutions for a growing regional, national and global demand for food. While the Northeast has a small land mass (~6% of the US) and large population (~17% of US) that generates 20% of the national GDP. Importantly the Northeast today reflects the more densely populated United States of the future: areas that have large rural-suburban-urban interfaces, communities that have had a tradition of direct farm sales, niche agricultural enterprises as well as traditional commodity agriculture. Further, the large concentration of Land grant universities make this region a unique test bed for food system research and outreach.

Development of this whitepaper:
The recommendations made in this whitepaper were made by a team composed of Dr. Lisa Chase (Extension Professor: Natural Resources Specialist, University of Vermont and Director of the Vermont Tourism Research Center), Dr. Stephan Goetz (Professor of Agricultural and Regional Economics, Pennsylvania State University and Director of The Northeast Regional Center for Rural Development), Dr. William Hare (Associate Dean/Director for Land-grant Programs, College of Agriculture, Urban Sustainability, and Environmental Science, University of the District of Columbia), and Dr. Rick Rhodes (Executive Director, Northeastern Regional Association of State Agricultural Experiment Station Directors [NERA]). The document was peer-reviewed and endorsed by the members of NERA.

[1] Defined as Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia

Issue areas and research needs

1. The business of farming and agriculture

A key issue in US agriculture is that the number of farms continues to dwindle, although at a slowing rate compared to historical averages, while the average age of farmers continues to rise, from 50.5 years in 1982 to 58.3 in 2012.[2] Not enough new young farmers are entering agriculture (or remaining on the farm) to offset the number retiring. Individuals are making career choices about entering into farming or pursuing other job opportunities based on the information available to them (including public media, high school guidance counselors, etc.) In comparison with other parts of the U.S., in the Northeast there are more new and beginning farmers, as well as more female- and minority-owned operations. Labor saving technological change, including artificial intelligence (AI), robots and drones, will continue to have the effect of reducing the numbers of farmers and farm workers needed to grow the nation's food supply, but there are limits to such automation (e.g., Autor, 2015). What is the minimum number of farmers (or tipping point) required to ensure long-term food system sustainability? What factors determine farm profitability and resilience? Recent research suggests that educational programs delivered by Cooperative Extension are more effective than farm subsidies in raising farm profits and keeping farmers in business (Goetz and Davlasheridze, 2017). An emerging research area in rural development revolves around the concept of rural wealth creation as a means for assessing the impact of localized food systems (Jablonski et. al, 2016.)

Research needs:

- *Barriers to entry:*
  A variety of barriers prevent individuals from entering into farming, ranging from high cost of land (resulting in part from purchases by foreign nationals) to difficulty borrowing capital, lack of tacit and codified knowledge about farming, quality of life concerns, and challenges accessing profitable markets. Yet systematic, survey-based information on the relative importance of these factors, especially in the Northeast, and how they could be addressed through policy, does not exist. What can we learn from land-link or farm-link programs that have sought to increase the number of individuals who enter into farming (e.g., Chase and Grubinger, 2014)? Also needed is research on the determinants of farm entry/exit, the supply of farm labor, especially in the context of changing immigration policies, and the cost and availability of farmland, both to own and to rent, in a region in which, evolving versions of traditional sprawl are still relevant. What is the value of other uses of rural land (as rural landscapes; in producing energy from wind and solar to fossil fuels; etc. are far from static).

- *Social and economic forces:*
  To elucidate issues related to increasing numbers of females, minorities and new farmers, are the research and information needs of minority farmers different from those of traditional farmers in the Northeast and elsewhere? What is the optimal size distribution of farms (small-medium-large) in the Northeast and what are the implications for the food distribution system (one large buyer vs. many smaller, distributed ones)? With dairy farming playing a more dominant role in the Northeast (USDA Census), off-farm employment is less common; as a result, dairy farmers are also less likely to have health insurance through an off-farm job, and may be more vulnerable to high medical expenses; to what extent does this affect their long-term survival? How does access to healthcare, childcare and other social

[2] https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Highlights/Farm_Demographics/#average_age

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programs influence farmer entry and retention? What are the roles of collaborative networks and cooperatives in helping smaller farmers gain scale economies in production and marketing? Are social factors discouraging new entry?

- *Business planning:*
  How common and effective are intergenerational transfers of farms? What is the role, if any, of inheritance taxes in reducing such transfers? What are sources of information for developing new value added products that may potentially enhance farm profits; for example, the production of high-end cheeses or wines, or clusters related to wood products processing and manufacturing in the forestry sector? How can farms benefit from localization in the Northeast, including institutional and direct markets? What are effective strategies for creating and building rural wealth?

- *Infrastructure and markets*:
  With the consolidation of agricultural industries, farmers are finding it increasingly difficult to find enough buyers for their products. In some cases, the processing infrastructure is also disappearing making it impossible for producers to sell their products. While market forces appear to be driving these changes, it is less well understood what role regulations and barriers to trade may play in developing and scaling up food systems. An example worth further study is the Green Markets program in New York City, which is set up to better connect farmers, wholesalers and consumers in the nation's largest city.[3] What are the barriers to infrastructure and market development?

- *Barriers to production:*
  As farm numbers dwindle, many communities are seeing the disappearance of agricultural support industries. In some cases, this may make it difficult for farmers to access inputs, business advice, and output markets. It is not clear, however, to what extent farmers are increasingly purchasing inputs and other supplies on the internet, following general trends in the populations. While farmers can also increasingly access production information and advice on the internet, it is not clear that the knowledge also applies specifically to their particular operation or land. Barriers on the harvesting side (e.g., flash freezing of products in the field immediately after harvest) may not only prevent farmers from entering, but also reduce potential food nutritional quality. What is the effect of productivity growth and supply vs. demand balances for food, as well as the relative effects of extension and farm subsidies?

2. Workforce development that supports food systems

Even as the size of the agricultural (on-farm) labor force is forecast to shrink,[4] the number of workers needed in the food system is forecast to grow by 5% annually between 2015 and 2025.[5] However, as Goecker et al. (2015) point out, the annual number of new university graduates (35,400) is not sufficient to fill the anticipated number of new job openings in the food system (57,900). Although graduates from other, non-agricultural programs often can fill the gaps (e.g., general business students), this raises basic questions about the future workforce needed to ensure

[3] https://www.grownyc.org/greenmarket
[4] https://www.bls.gov/ooh/farming-fishing-and-forestry/agricultural-workers.htm
[5] Forecasts for a subset of these, food scientists, are available here: https://www.bls.gov/ooh/life-physical-and-social-science/agricultural-and-food-scientists.htm

that the food system continues to operate sustainably and efficiently. About 15 cents out of every dollar spent by food consumers goes to post-farmgate businesses, making this an essential sector. There is also a perception that foreign workers fill many of the jobs that Americans find undesirable (e.g., chicken processing, fruit and vegetable harvesting). Are there ways of making these routine, manual positions more appealing to U.S. nationals, for example, through automation? How do young workers make their decisions about their career choices; where do they get the information about opportunities in agriculture and the food system? Answering this question may be especially critical given the projected gaps in supply.

Research needs:

- *Educational needs to meet food system sustainability:*
  What training is needed, beyond the nuts and bolts of food production, processing and manufacturing, to ensure food system sustainability over the long-term? Are business training programs available that encourage the system-wide thinking that would allow entrepreneurs to play roles throughout the food system?

- *Well-trained workforce:*
  How do current workforce skills match up with what employers are demanding in the different sub-industries of the food system? Which universities are leaders in meeting the demands of employers now and into the future, and optimally placing their graduates in private firms and encouraging entrepreneurship?

- *Access to work opportunities:*
  For individuals not raised on farms, or otherwise exposed to the food industry, where do they get information about these careers? Is there a need for an apprentice-style system?

- *Labor needs beyond the farmgate:*
  As consumer demand changes for particular foods, and consumers want to know specifically how and where their food is grown, what additional skills do workers need to have to ensure traceability of products, including in cases of diseases and product contamination? What are the skills sets needed for entrepreneurs who can identify market opportunities to connect farmers and consumers, and also have the interpersonal skills to organize farmers efficiently?

3. The environment and food systems

Food systems are complex, and the production, processing, distribution and consumption of food has an impact on the environment. Clearly, a balance between agricultural yield and environmental quality must be achieved. Conversely, climate disruptions to agriculture have increased and pose a challenge of adaptation of production strategies that includes planting times, crop rotations, plant/animal selection, IPM, and water management. The Northeast is the most densely populated region in the United States (342 people/sq. mile; U.S. Census Bureau [2012]); agricultural issues associated with water, soil, and variable weather patterns are magnified in the region. Indeed, the interface between urban areas and agricultural lands poses unique challenges to producers, planners and policy-makers (d'Amour et al., 2016). If the U.S. is to develop sustainable and resilient regional and national food systems to meet our food needs by mid-century, producers and all members of the food system chain must have access to science-based, data-driven information on innovations that preserve the quality and quantity of water, maintain soil quality and health, preserve air quality, sustain biodiversity and reduce agricultural pollution.

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Research needs:

- *Water quality:*
  Research and extension are needed to develop and implement cost-effective methods for reducing agricultural runoff/drainage, understand the transport fate of agricultural chemicals (e.g., endocrine disrupting chemicals, antibiotics, pesticides, and fertilizers), assess and utilize the positive characteristics of watersheds to preserve environmental quality and maintain agricultural yield. If agricultural contamination occurs, technological methods are needed for rapid assessment and containment. Northeastern farming practices that can withstand climate variability (e.g., high rainfall, drought, extreme weather events) are needed to ensure farming community resilience and environmental quality.

- *Integrated pest management:*
  Reducing the dependence of agriculture on application of field chemicals and identifying alternative, pest-reducing strategies will reduce input costs, preserve environmental quality, and protect human health. Innovative strategies for pest management are especially needed in densely populated areas like the Northeast.

- *Soil health:*
  Land use intensity modifies soil services. Globally, levels of atmospheric carbon dioxide have risen above 400 PPM for the first time in the industrial age[6]. Plant agriculture provides a means to reduce atmospheric carbon dioxide through sequestration. To ensure soil health, research is needed to identify approaches for building the soil environment. This includes identification of rotational grazing strategies for cool season grasses, sustainable means for enhancing soil organic matter through food waste to compost, and schemes to assess and monetize soil and plant ecosystem services. Erosion control at the urban-rural interface will require the development of novel approaches to ensuring environmental quality.

- *Biodiversity*:
  Agricultural biodiversity is shaped by producers and is essential for the agricultural ecosystem. Producers need access to science-driven data to implement growing strategies that promote nutrient cycling, pollination, maintenance of the hydrological cycle and carbon sequestration. Biodiversity is threatened in the Northeast by land use patterns and habitat fragmentation. Research is needed to assess the relative costs and benefits of fragmentation to build an information base that allows data-driven, environmental policy development and decision making.

4. Access to healthy food

Access to healthy food is a challenge throughout the U.S. and the Northeast is no exception. Although food insecurity is slightly lower in the Northeast than the national average of 13 percent of the population, it is a concern in every county in every state (Coleman-Jensen et al. 2016). Research and extension are needed to develop strategies for addressing limited access to healthy food including fresh vegetables and fruit, grains, milk, cheese, eggs, and meats. The Northeast is ideally situated for localization of production, distribution, and consumption with the goal of improving human health while also creating jobs and contributing to community vitality. More research is needed, however, to assess which products can be grown competitively in the region (for example

[6] NOAA, https://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html.

through season extensions) and which cannot. Research is also needed to assess and improve crops' nutrient density, distribution methods, markets, and educational programs for consumers of all ages.

Research needs:

- *Food production:*
  Research and extension are needed to develop and implement cost-effective methods for expanding yields, increasing crops' nutrient density and extending the season for year-round production in the Northeast. Especially relevant are cold climate crops including winter greens and storage crops, and novel production systems for urban agriculture.

- *Distribution and markets*:
  The Northeast is characterized by densely-populated urban areas surrounded by extensive urban-rural interfaces that transition into sparsely-populated rural areas. With a large human population and relatively little land mass, the Northeast is well-positioned to further develop localization of distribution and markets. Direct sales (e.g., farmers' markets, CSAs, farm stands) and institutional sales (e.g., schools, hospital) are prime venues for improving access to healthy food. Direct markets are especially important for developing producer-consumer relationships and promoting agricultural literacy by providing consumers with farm experiences and education.

- *Social equity and education*:
  Research and extension are needed to improve programs that serve low-income households, such as the Supplemental Nutrition Assistance Program (SNAP). But not only low-income households are at risk of diseases related to unhealthy eating habits, such as obesity and diabetes (Ogden 2015). Access to healthy food is necessary but not sufficient. Research is needed to better understand how households and individuals at all income levels make decisions about food purchases, preparation, and consumption. Research findings can be integrated with extension to develop innovative distribution channels and markets as well as effective educational programs.

- *Traceability of food*:
  As the global food system has become a complicated web, traceability has become increasingly important for food safety. When an outbreak of a foodborne illness occurs, rapid identification of the source and engagement with producers, processors, distributors and consumers is critical for containing and minimizing consequences. Beyond food safety, traceability provides consumers with the ability to make informed choices about geographic distribution and potentially other characteristics such as production methods, labor practices, and environmental impacts. The Northeast is well-positioned to serve as a test case for research and extension regarding traceability because of its relatively small area and emphasis on localization.

5. Improving food systems through innovation

Utilizing emerging technologies to increase the availability, affordability and accessibility of healthy foods requires innovation. Developing a vibrant food system in the culturally diverse, densely populated Northeast Region with minimum agronomic production land demands an interdisciplinary research and extension effort to address community-specific problems and to train the next generation of entrepreneurs. Research to determine appropriate cyber physical systems

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(CPS) for automation and artificial intelligence will then drive competition and innovation to minimize labor demand and costs of food production, processing, packaging and waste management. Disruptive local direct market distributors such as the Uber in smart agricultural communities are essential marketing strategies to reduce food footprints and carbon emission in highly urbanized areas. Sustainable and resilient food systems must be driven to achieve a net positive energy balance where total food production in kilocalories exceeds the combined energy needs of the production inputs and processes (O'Hara, 2015). Improvement through innovation ultimately results in food systems that are economically profitable, socially responsible and environmentally friendly.

Research needs:

- *Urban agriculture*:
  Rural migration to the urban sector has increased significantly over the past years, with 80% of the U.S. population and over 50% of the world's population now living in urban areas. Innovation in research and extension addressing food security holistically must include urban solutions. Social and workforce stigma in urban food desert areas related to past historical injustices in food systems must be improved. Research and extension improving energy, water and nutrient use efficiency for production of high-value and high-demand niche crops selected with short growth period in small spaces can enhance economic profitability.

- *Food waste*
  Food waste in the US is estimated at 40 percent of the food supply, with the largest loss occurring at the retail and consumer levels[7]. Reducing the loss of edible food mass along the food system will require research and outreach on harvesting, shipping, storing, marketing, and distributing agricultural products. Likewise, innovative strategies that address recycling of excess food and food waste are needed and represent significant cross-agency opportunities (e.g., USDA/NIFA-EPA) for supporting new research and extension initiatives.

- *Robotics, automation and artificial intelligence*:
  Multi-disciplinary integration of science, technology, engineering and math (STEM) as an innovative mechanism to solve problems with cyber physical systems such as robots and drones for automation to reduce labor is essential for the next generation of food system entrepreneurs. New strategies that increase productivity in novel bio-intensive, aquaponics, and hydroponics crop production; value added chain processing and packaging; and building bio-energy and healthy composted soil from food waste are necessary. Wireless sensors and smart phones are increasingly used to monitor, evaluate and improve production, processing and marketing in food systems.

- *Big data applications:*
  Informatics or big data mining to build smart agricultural communities for new local distribution and market networks between producers and consumers will reduce food footprints, maintain high nutrient density and minimize carbon emission. GIS application

[7] USDA, Economic Research Service estimates that 31% of food loss in 2010 corresponded to 133 billion pounds of food worth $161 billion.

and analytics that links production supply and consumption demand support efficiency in market planning and sales. Creation of new jobs and small businesses through innovation by trained entrepreneurs will improve our regional and national food systems.

Recommendations:

The need for the development of sustainable food systems is clear. However, to reach a goal of meeting future regional, national and global food demands, critical knowledge and outreach gaps must be bridged. We recommend the investment in research funding that supports broad, multidisciplinary approaches to understand the breadth and depth of the dimensions of food systems. Herein we describe five areas for strategic funding investment including: the business of farming and agriculture; workforce development that supports food systems; the environment and food systems; access to healthy food; and improving food systems through innovation. We appreciate the grant funding opportunities extended by the National Institute of Food and Agriculture (a list of recent NIFA funding opportunities follows the References) and advocate for extending the large multidisciplinary RFPs. Last, we believe that the Northeast is in a unique position to address the critical issues associated with building resilient, sustainable food systems.

References

d'Amour, C. B., F. Reitsma, G. Baiocchi, S. Barthel, B. Güneralp, K.-H. Erb, H. Haberl, F. Creutzig, and Seto, K. C. (2016). Future Urban land Expansion and Implicaitons for Global Croplands. PNAS, December 27, doi/10.1073/pnas.1606036114.

Autor, D.H. (2015). Why Are There Still so Many Jobs? The History and Future of Workplace Automation. The Journal of Economic Perspectives 29 (3), 3-30.

Coleman-Jensen, A., Rabbitt, M. P., Gregory, C., and Singh, A. (2016). Household Food Security in the United States in 2015. U.S. Department of Agriculture Economic Research Service.

Chase, L. and Grubinger, V. (2014). Food, Farms, and Community: Exploring Food Systems. University of New Hampshire Press, Durham, New Hampshire.

Goecker, A.D., E. Smith, J.M. Fernandez, R. Ali, and Theller, R.G. (2015). Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment, United States, 2015-2020. Purdue Univ., West Lafayette, IN. *https://www.purdue.edu/usda/employment/*

Goetz, S.J. and M. Davlasheridze (2017). State Cooperative Extension Spending and Farmer Exits. Applied Economic Perspectives and Policy. doi:10.1093/aepp/ppw007

Jablonski, B., T. Schmit, J. Minner, D. Kay and Jensen, J. (2016). Defining the Rural Wealth Impacts of Regional Food Systems. Research and Policy Brief Series, Community and Regional Development Institute, Cornell University. Issue 75, 4 pp.

Ogden, C. L., Carroll, M. D., Fryar, C. D., and Flegal, K. M. (2015). Prevalence of Obesity Among Adults and Youth: United States, 2011–2014. U.S. Department of Health and Human Services Centers for Disease Control and Prevention, National Center for Health Statistics Data Brief No. 219.

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O'Hara, S. (2015). Food Security: The Urban Food Hubs Solution. *www.thesolutionsjournal.org*, pp. 42-53.

U.S. Census Bureau. (2012). 2010 Census of Population and Housing, Population and Housing Unit Counts, CPH-2-1, United States Summary. U.S. Government Printing Office, Washington, DC.

NIFA Funding opportunities (recent/current[8])

Community Food Projects Competitive Grants Program ($8.6M)
Innovations at the Nexus of Food, Energy, and Water ($40M)
Beginning Farmer and Rancher Development Program (BFRDP, $17.7M)
Agriculture and Food Research Initiative - Food Security Challenge Area ($16.8M)
Farm Business Management and Benchmarking (FBMB) Competitive Grants Program ($1.4M)
Agriculture Risk Management Education Partnerships (ARME) Competitive Grants Program ($4.5M)
AgrAbility- Assistive Technology Program for Farmers with Disabilities ($4M)
Organic Transitions (ORG, $3.8M)
Agriculture and Food Research Initiative - Childhood Obesity Prevention Challenge Area ($7M)
AFRI Foundational: Critical Agricultural Research and Extension (CARE, $3M)
Agriculture and Food Research Initiative - Foundational Program ($130M)
Agriculture and Food Research Initiative - Water for Agriculture Challenge Area ($10.7M)
AFRI Foundational: Agriculture Systems and Technology ($11M)
AFRI Foundational: Plant Health and Production and Plant Products ($33M)
AFRI Foundational: Bioenergy, Natural Resources, and Environment ($15M)
AFRI Foundational: Exploratory Research ($2M)
Specialty Crop Research Initiative (SCRI, $48.1M)
Crop Protection and Pest Management ($4M)
Organic Agriculture Research and Extension Initiative ($17.6M)
Agriculture and Food Research Initiative - Agriculture and Natural Resources Science for Climate Variability and Change Challenge Area ($8.4M)
Agriculture and Food Research Initiative - Food Safety Challenge Area ($6M)
AFRI Foundational: Animal Health and Production and Animal Products ($31M)
AFRI Foundational: Food Safety, Nutrition, and Health ($19M)
AFRI Foundational: Agriculture Economics and Rural Communities ($17M)

[8] See https://nifa.usda.gov/search/type/grant?keyword=grant%20opportunities&sort_by=search_api_relevance

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