ESCOP Science & Technology: http://escop.info/committee/scitech/

8/24/2020
4 pm ET, via Zoom (https://us02web.zoom.us/j/7318779678?pwd=SXBwMjVNeGplWExRVzhIQjF5ZytLZz09 or 1 669 900 9128 Meeting ID: 731 877 9678 Passcode: 222828)

Committee Members:

Chair: Jody Jellison (NERA) **Past Chair:** Laura Lavine (WAAESD) **Delegates:** Alton Thompson (ARD) John Yang (ARD) Joe Colletti (NCRA) Bill Barker (NCRA) Indrajeet Chaubey (NERA) Mark Hutton (NERA) Susan Duncan (SAAESD) Nathan McKinney (SAAESD) Gene Kelly (WAAESD) Chris Davies (WAAESD) **Executive Vice Chair:** Bret Hess (WAAESD ED) Saige Zespy (WAAESD Recorder)	**Liaisons:** Robert Matteri (ARS) Wendy Powers (ECOP) Tim Conner (NIFA) Danesha Carley (NIPMCC) Tim Killian (SSCC)

Agenda:

1. **Welcome**– Jellison
2. **Roll Call**– Hess
3. **Approval of meeting notes from 06/01/2020** – Jellison
4. **AIA Comments (Please review the attached pdf file "AIA Collective Input" prior to our discussion)**
    a. What resonates with you? Are there points STC would like to specifically endorse and/or add?
    b. Are there common threads STC should be exploring this next year and what would be the specific deliverables?
    c. Are there suggestions for how STC could add value?
    d. What should STC do to prepare for the next phase of AIA? (click here for the link to John Dyer's presentation as a reminder)
5. **Liaison Updates**, as needed
    a. ARS
    b. ECOP
    c. NIFA
    d. NIPMCC
    e. SSSC
6. **Next Scheduled Meeting(s)**
    a. 4-5 pm EDT September 28

b. Should we keep this schedule or attempt setting a new day and time each month?

7. **Unfinished Business for the Future**
    a. Breakthroughs 2030 – might this be part of the AIA effort since AIA utilized this report?
    b. Capacity Projects on Infectious Diseases – APLU request that will feed into the Capacity Funding Workgroup's efforts

August 1, 2020

Mr. Stephen Censky
Deputy Secretary
United States Department of Agriculture
1400 Independence Avenue, SW
Washington, DC 20250

Re: Solicitation of Input from Stakeholders
on Agricultural Innovations
Docket Number: USDA-2020-0003
Federal Register Effective Date: 04/01/2020
Federal Register Page Number: 18185

Dear Deputy Secretary Censky:

The Association of Public and Land-grant Universities' Board on Agriculture Assembly (APLU BAA) is a national organization representing land-grant universities that provide science-based solutions to the food, natural resource, health, economic, and environmental challenges facing the agricultural sector and our diverse communities in a rapidly changing world. We appreciate the leadership of the Secretary of Agriculture in putting forth a vision for an Agricultural Innovation Agenda (AIA).

In response to the request for public comment and written stakeholder input set forth in the Secretary of Agriculture's AIA request for Information (RFI), the APLU BAA, in partnership with the National Association of State Departments of Agriculture (NASDA) and with technical support from the eXtension Foundation, invited producers, Commissioners of Agriculture, and faculty, as well as Deans and Directors of Colleges of Agriculture, to participate in the USDA Agricultural Innovation Agenda Deep Dive Sessions in July 2020. Our goal was to gather a combination of farmer, forester, and rancher stakeholder input as well as advice from LGU scientists who work with these practitioners daily.

The discussions centered on how the United States can achieve greater agricultural productivity, while experiencing less waste, decreased greenhouse gas emissions, higher water quality, and while capitalizing on bioenergy production and other value-added opportunities. The sessions focused on two themes:

- Driving Innovation Through Breeding Technologies in Livestock and Dairy Production
- Conservation Data to Improve Environmental Outcomes/Productivity in Farming Systems

The two areas we selected to discuss represent important areas at the intersection of agricultural science and sustainability. The work that our 112 land-grant universities undertake is carried out in partnership with producers of all sizes and stakeholders along the supply chain. APLU is grateful to Dr. John Dyer, Research Leader of the Plant Physiology and Genetics Research Unit at USDA-ARS and Innovation Strategy Coordinator for the Agriculture Innovation Agenda, who provided context presentations for all the sessions.

There are a vast number of research and extension innovation areas that APLU BAA member institutions undertake in partnership with producers. Unfortunately, we could not cover all the areas we work in. Still, this process provided an invaluable contribution to the development of future approaches for meeting the needs of the agricultural sector through research, education, and extension. It is a process we aim to engage in more regularly with our partner organizations. To that end, the APLU BAA would welcome additional opportunities to provide continued feedback on the

many other critical topics affiliated with the Agricultural Innovation Agenda. Furthermore, we would like to invite a series of dialogues with USDA REE around three key areas:

1) maintenance[1] and renewal of research and Extension facilities, allowing for a new era of innovation supported by advanced research, education, and Extension programs;
2) skill development[2] for the future workforce to lead the United States' competitive excellence in global agricultural and natural resource economies; and
3) visionary research and Extension programs[3] that address the productivity and sustainability benchmarks outlined in the Agriculture Innovation Agenda.

Such dialogues will provide insights into the tactical actions that can be included in a United States' agricultural innovation strategy.

Meanwhile, in the following submission, we've provided specific thematic answers to the questions posed in the RFI, followed by some overarching national themes that we encourage the USDA to consider for the AIA. This submission is only the first contribution; we are committed to remaining engaged throughout the AIA development process.

APLU/NASDA AIA Deep Dive Sessions

Driving Innovation Through Breeding Technologies in Livestock and Dairy Production[4]

Deep dive session to shed light on livestock and dairy producer-oriented solutions. This section includes advancements for cow/calf operations, especially for those receiving calves into grazing and feeding operations. We've also included perspectives from grass-fed operations, general dairy producers, swine-breeding companies, and many other animal-based operations.

Discussion Group on Genome Design

Utilization of genomics and precision breeding to explore, control, and improve traits of agriculturally important organisms.

Genome design science and infrastructure challenges: Areas of focus to enable livestock producers to increase productivity and limit environmental impact over the next 10-30 years.

- **Livestock and herd genetics.** Advancing livestock breeds can have an immense impact on greenhouse gas emissions, waste efficiencies, and nutrient management. There is a great opportunity to develop livestock and herd genetics—disease resistance will help increase animal welfare and produce products that will have a return for farmer and consumer alike.
- **Developments in fundamental animal biology.** There is a need for fundamental biology of animal production systems and associated research equipment and facilities to study fundamental mechanisms that control animal

[1] A National Study of Capital Infrastructure & Deferred Maintenance at Schools of Agriculture

[2] Crawford, P. & Fink, W. (2020). From Academia to the Workforce: Critical Growth Areas for Students Today. Washington, DC: APLU

[3] The Challenge of Change: Harnessing University Discovery, Engagement, and Learning to Achieve Food and Nutrition Security

[4] Many of these recommendations could be applied to specialty crop and field crop applications as well. A few apply only to livestock/dairy production.

growth/fertility/etc. Researchers will need to collect a large amount of coordinated data about these important traits. We will need supportive data-management systems to allow for the best science.

- **Feed, management, and fertility efficiencies.** Many challenges can be addressed through advances in genetics, humane handling and slaughter, and improved feed efficiency and fertility.
- **Developing technology in tandem with market opportunities.** While technologies will bring great efficiencies for the production system, they do not always enable greater producer viability. Producer viability is also affected by a dynamic economic and market environment. Because there is immense pressure on producers, considering how to develop technology in tandem with market demand is imperative. As a result, technology/new breeds need to address production and consumer preferences to ensure that innovations are valuable to producers.

Genome design tactical opportunities: Actions that can be taken to enable livestock producers to increase productivity while limiting environmental impact.

- **Advances and upgrades in research facilities.** The State Agricultural Experiment Station (SAES)[i] system is invaluable in that it allows for testing of locally relevant environmental stress factors that affect livestock and dairy production. SAES facilities can be improved to ensure cutting-edge research that evaluates animal genetics, breeding, herd management, and other production factors critical to achieving the AIA goals. Integrated data-sharing systems combined with improved monitoring technologies will allow for evaluation of emissions due to breeding or management technologies. In concert with producers, the LGU system can design facilities to optimize development of new livestock breeding and management research approaches.
- **Multidisciplinary programs between veterinarians, microbiologists, animal nutritionists, and breeders.** As mentioned in the facilities note above, collaborative work environments that contribute to effective cross-disciplinary research are needed. These can be developed, both at main campuses and outlying research stations. The Cooperative Extension (CE) system may also be engaged as a key component for on-farm research and the study of applied management solutions to key sustainability challenges. The combination of effective programming and facilities/data management will allow for collaboration that will lead to more rapid discovery and application.
- **Addressing regulatory and data-related barriers to discovery and application.** As advanced technologies become available to speed the development of genetic traits, federal regulations and policies related to animal science should be reviewed by a task force of producers, agribusinesses, institutions, and agricultural sector policy experts.

Discussion Group on Prescriptive Intervention

Application and integration of data sciences, software tools, and systems models to enable advanced analytics for managing the food and agricultural system.

Prescriptive intervention science and infrastructure challenges: Focus areas to enable livestock producers to increase productivity and limit environmental impact over the next 10-30 years.

- **Prescriptive interventions can be used to solve problems associated with animal nutrition, manure management (regarding the circular economy), farm labor, and nutrient management.** Using a mixture of on-farm and experiment station-based approaches to research will allow for decision-making tools to have not only an environmentally relevant but also an economically relevant context, making the transition from university to farm more efficient. Such approaches to research and technology transfer already exist across the LGU research-extension system and would be easy to ramp up with additional strategic direction.
- **Prescriptive interventions can be useful for farms of all sizes, economies, and types.** Advancing prescriptive interventions only for producers who already use precision monitoring limits the range of opportunity that we can realize from these modalities. Providing demonstrations of interventions will allow producers of all types to see

value in new prescriptive approaches to livestock and dairy management. SAES scientists and CE educators can support this through the LGU system.

- **Advances in genetic technologies and monitoring, along with the monitoring of nutrients, herd health, microbial/gut health, forage and feed quality, and behavioral indicators of health would significantly advance the capability to achieve the sustainability goals of the USDA AIA.** However, significant facility investments need to be made to enable monitoring of these herd, feed, and environmental characteristics—both sensors-based and on-farm testing-based approaches will be needed.
- **Circular economic approaches to limiting on-farm waste, developing new waste markets, and considering other production efficiencies will benefit USDA's approach to addressing sustainability and production efficiencies.** For this purpose, it is important to not only include multiple disciplines in projects, but multiple sectors, so that the design of production systems can consider all the possible uses of animal production byproducts. Multidisciplinary approaches are only a formative step in the innovation cycle—we must think bigger and train our future innovators to do so as well.
- **Big data resources and blockchain technologies have implications for traceability throughout and sustainability within production systems.** The challenge remains as to how effectively producers can use data and information to inform their enterprises. NIFA has demonstrated excellence in its capability to adapt to new challenges and provide opportunities for new training, innovations, and research and Extension programming associated with addressing these new challenges.

Prescriptive intervention tactical opportunities: Actions that can be taken to enable livestock producers to increase productivity while limiting environmental impact.

- **A wide spectrum of producers can benefit from prescriptive intervention if there is a strategic approach underpinning program design that focuses on equity across operation types and a combination of open-access and data secure environments.** Innovators can undertake training across the research system, in concert with key early adopters, via campus/on-farm research and through public-private partnerships. Researchable questions can inform data collection from production and management systems relating to operations of all sizes and types with smart use of monitoring, artificial intelligence, and environmental control systems.
- **Prescriptive intervention requires knowledge of computers, coding, and scanning technologies as well as fundamental knowledge of animal, crop, soil, and agronomic sciences.** Sensor technologies are prolific and relatively inexpensive but require training if they are to be used to their full innovative capacity. Advances in informal education, higher education, and professional development learning environments are possible. Animal scientists of the future will be more interdisciplinary. Training these students will require interdisciplinary instruction, and it will be necessary to capitalize on intra-institution (across departments) collaboration. Engagement of SAES[i], CE (especially related to 4-H and STEM) programs, and academic programs can result in a plan to develop a new generation of technically skilled agricultural and innovators.
- **Data sources can be proprietary, so collecting all the information in one place that also respects producer privacy is a challenge.** A facilitated public-private planning effort that also includes LGUs and stakeholders could help to overcome these challenges. The sources of data that are needed to address sustainability issues are also not connected by similar identifiers or loosely linked by geographic or temporal attributes. Even across the U.S. government, the interoperability of data systems for sustainability monitoring purposes is limited. Through a facilitated process, incentives for data-sharing can identify standards, practices, or best approaches.
- **Addressing broadband limitations will allow for prescriptive intervention across all geographies.** Limited upload capabilities in rural areas make data sharing and storage inefficient or unreliable. Adoption of prescriptive intervention approaches is not possible for producers who do not have access to proper broadband or wireless connections.

- **CE can be instrumental in facilitating producer-to-producer dialogues about the adoption of prescriptive intervention approaches or technologies.** Early adopters or those who co-create technological methods can be ambassadors for new technologies and approaches. Some communities will not address advanced technology due to religious or other considerations. These communities may be more open to farming-system based, animal behavior, and other management approaches that will help them overcome livestock and dairy production challenges. Such approaches can be developed through the application of prescriptive intervention monitoring and measuring through LGU-led research.

Conservation Data to Improve Environmental Outcomes/Productivity in Farming Systems

Deep dive session to shed light on agricultural conservation data solutions. Our responses pertain to dairy, integrated livestock systems, agricultural input/pest managers, the conservation sector, beef-cattle production, specialty crops, row crops, and those concerned with sustainability.

Discussion Group on Digital Automation

Deployment of precise, accurate, field-based sensors to collect information in real time in order to visualize changing conditions and respond automatically with interventions that reduce the risk of losses and maximize productivity.

Digital automation science and infrastructure challenges: Actions that can be taken to enable producers to increase productivity and limit environmental impact over the next 10-30 years.

- **Public-private partnerships with local, regional, and national agribusiness organizations can be constructed to collaborate on research that develops innovations relating to carbon neutral operations and reduced agricultural greenhouse gas emissions.** Financial constraints related to collaboration should be outlined and collaborative opportunities should be identified and developed. Public-private partnerships should also have an Extension component to them appropriate to the local and state system. This will allow increased access to essential services and information for operations of all sizes.
- **For specialty crops, a greater focus on automation and AI can mechanize harvesting methods and improve input and equipment efficiencies.** Digital automation needs to address the labor challenges of small, medium, and large operators alike.
- **Digital automation can increase knowledge and application of system efficiencies across the agricultural and broader product economies.** While we typically consider agricultural production to be field level, value-added product capabilities can create new market opportunities while also advancing sustainability. Bio-based products can use biomaterials, contribute to sustainable energy, meat, and dairy production, and contribute to microbial health in humans and animals, while also reducing greenhouse gas production.

Digital automation tactical opportunities: Actions can be taken to enable producers to increase productivity while limiting environmental impact.

- **Develop collaborative Agricultural Innovation workgroups for key sectors—specialty crops, bioenergy, value-added products, commodities, processors, aquaculture, forest products, livestock and dairy.** LGU scientists, administrators, and stakeholder groups would welcome participation.
- **Map out intersecting sustainability needs, product development opportunities, possible efficiency gains, facility challenges, and science policy incentives that can create an environment that supports innovation.** Determine what will also encourage the entry of new innovators.
- **Increase rural broadband in areas with poor connectivity and upload capabilities.**

Discussion Group on Systems-based Farm Management

Leverage a systems approach in order to understand the nature of interactions among different elements of the food and agricultural system to increase the overall efficiency, resilience, and sustainability of farm enterprises.

Systems-based farm management science and infrastructure challenges: Actions that can be taken to enable producers to increase productivity and limit environmental impact over the next 10-30 years.

- **Advances and upgrades in research facilities.** Both SAES and on-farm experiments can focus on how to create systems-based farm management processes that maximize yield and economic value. Detection and imaging technologies can be used to identify weeds, pests, and nutrient deficiencies so that amendments and pest technologies can be used only when required. These applications can be developed in partnership with small, medium, and large-scale producers so that constraints to the use of monitoring technologies can be overcome. To make this a reality, we need to invest in our SAES and CE capacity funds as well as in competitive research facilities grants.
- **Drone technologies can be developed to provide producers who have multisite operations with reliable information.**
- **Remote sensing equipment can be used but privacy issues need to be considered.** It is a powerful technology that can determine nutrient hue of plants, precision farming needs, soil quality. Remote sensing can also measure the organic content of soils, which is related to flood and fire resilience.
- **Specialty crops have a short window for harvest.** System-based farm management can provide specialty crops harvest strategies that will not impact the integrity of the marketable product. To determine the applications and adaptability of innovations in specialty crops, an online location could be constructed where farmers and researchers can share resources.

Digital automation tactical opportunities: Actions that can be taken to enable producers to increase productivity while limiting environmental impact.

- **Explore the potential for a community-based management system for weeds, pests, and other production challenges in coordination with CE.**
- **Develop appropriate regulatory/ethical guideposts for drone utilization.**
- **Develop a cybersecurity plan.** Through a facilitated process, incentives for data-sharing can identify standards, practices, or best approaches. How do we manage "multi-modal" data—a lot of different types of data? How can data best be organized to capitalize on the information it provides? How can this be done in a way that is easily accessible to the farmer while also remaining sensitive to privacy concerns?
- **Communication is key to bridging misconceptions and advancing us into an equitable and sustainable agricultural innovation-based future.** A promotional campaign designed around public benefits related to USDA-sponsored solutions could help improve public awareness of the value of the USDA and how agricultural research positively affects communities, both urban and rural. A coordinated agritourism effort could shed light on how science and technology can help tell the story of sustainability in the context of food, fuel, and natural resource management. This effort can not only provide our nation's producers with the capability to share stories but also reinvigorate the capability for CE and the SAES to narrate their history to an interested public while providing a vision for the future that is aspirational. A nationwide "America's Fair," celebrating agricultural innovation across these local and state entities, could provide a unifying event celebrating the dynamic and evolving history of agriculture in our country in a way that reflects and looks forward with possibility.

Overarching Themes

These overarching themes have been influenced by the regions that engaged in the AIA RFI response development process. These regions vary in the types of producers that they have and the types of agriculture that they represent.

- We hope that the USDA will leverage the relationships and infrastructure already available through the SAES and CE services. We are an eager partner.
- We can redesign/renew facilities to undertake the inquiries necessary to develop research approaches and support outreach and engagement with producer groups.
- In concert with LGUs, we can create a clearinghouse of agricultural data and information that is secure and protected.
- APLU BAA would welcome additional opportunities to provide continued feedback on the many other critical topics affiliated with the Agricultural Innovation Agenda, specifically, to build out a programmatic approach to achieving its goals.

[i] The mission of the State Agricultural Experiment Stations is to perform basic and applied research on agricultural, environmental, natural, and community resource issues related to the future needs of the state, the region, the nation, and the world. Research is designed to provide knowledge that will enhance the quality of individual and family life and the social and economic vigor a state. Researchers utilize the best techniques of qualitative and quantitative research to form the knowledge base for instruction of and application to the broader mission of the land-grant university. An example of an SAES can be viewed here.

Ag Innovation Agenda: Comments from the Northeast (July 14, 2020)

Background:
The Association of Northeast Extension Directors (NEED) and the Northeastern Association of State Agricultural Experiment Station Directors (NERA), with technical support from eXtension, hosted a virtual listening session on July 14, 2020 from 10:00am - 12:00pm. Invited to attend were college deans, Cooperative Extension and AES directors, or associate directors, and institutional scientists. Eighteen attendees joined the session.

The attached document describes the output of the Northeast conversation on the challenges and opportunities associated with increasing agricultural productivity and decreasing the environmental footprint and their connections to the USDA's pre-defined innovation clusters:

- Genome Design
- Digital/Automation
- Prescriptive Intervention
- Systems Based Farm Management

Importantly, these reflections feature a Northeast perspective and incorporate the unique agricultural, environmental, natural resource, social and community attributes of the region.

PRODUCTIVITY
General Comments. Northeast participants voiced a concern about posing a goal of increasing agricultural productivity by 40% without defining the dimensions of productivity. Agricultural productivity could be increased through crop monoculture; heavy water, fertilizer and herbicide use; and diminution of biological diversity. We're confident that's not the strategy to meet the productivity goal. As the Northeast refers to increasing productivity, we do this in the context of developing, growing, and distributing plant and animal-based food that have healthy nutritional profiles, is accessible to and affordable for consumers, and is sustainable. As colleagues have challenged us in the agricultural community, how do we feed the world without wrecking the planet? We recommend that the USDA closely consider what it means by "productivity" and design opportunities in research, outreach, and engagement with private industry, producers, and universities in a way that does not encourage the elevation of monoculture production, the consolidation of land ownership, nor volume over quality, and socio-ecological factors. We hope that the USDA will leverage the relationships and infrastructure already available through the agricultural experiment stations and cooperative extension services to this end.

We also reflect that there is great intersectionality across the grand agriculture challenge domains. We strongly urge the USDA to avoid creating research RFPs, outreach education endeavors or program incentives based exclusively on a single innovation cluster. Further, the human dimension of all future programs must be elevated and respected. Last, your colleagues at the Northeast Land-grant institutions look forward to employing our highly effective R&D strategy using a bench research – extension feedback loop.

Challenges

Natural disasters, pandemics, and climate variability. The Northeast climate is changing. Wetter springs, cold snaps, drier summers, warmer winters, and more frequent severe storms is challenging regional agriculture. Then superimpose a pandemic that challenges our healthcare system and labor force. From a plant perspective, frost-, drought- and heat-protection constitute addressable challenges. Likewise, environmentally-friendly technological approaches to pest and weed control are needed to offset the impacts of climate change. Development and identification of regionally suitable plant ecotypes would assist in ensuring healthy and relevant regional food systems. Likewise, development of plants that could be left alone during periods of disaster and saltwater intrusion would assist in mitigating the detrimental effects of natural disasters.

The warming environment also affects animal production. In the Northeast, dairy and poultry production are the region's two largest animal agricultural enterprises. Developing farm-building strategies that provide protection from heat-stress and developing strains of animals that are heat-stress tolerant are essential for animal welfare and productivity. Sea-level rise caused by global warming is affecting commercial fisheries, an important economic driver in the many coastal Northeastern states. For these challenges, the innovation clusters that could be deployed include genome design (genetically modifying plants and animals to provide traits that allow adaptability to the agricultural ecosystem) and prescriptive intervention. How might we use big data to model disruption and develop solutions?

Healthy soil, healthy food, healthy people. While this challenge in not uniquely Northeastern, it's a challenge that Northeastern food systems face and encompass the complexities of diverse sources of food and large urban hubs. For our regional producers, building and maintaining healthy soils (later we cite carbon sequestration as a decreasing environmental footprint opportunity) is essential. How might our healthy soils be monetized and marketed? How can farmers, ranchers, and foresters be incentivized to incorporate best practices to continually improve soils for productivity and carbon sequestration? The USDA should use its position to stand up, test, and support new markets for farmer collectives to support themselves and their communities and earn a profit from these non-product benefits they produce.

Likewise, the nutritional profiles of our food must match our needs. We can build healthy foods through precision nutrition. And we need to cultivate healthy people. Later, we cite the proximity of urban hubs with Northeastern agriculture as an opportunity. Here, we pose food access in urban areas as a challenge.

Building healthy soils and foods could be accomplished by utilizing genome design and systems-based management. Likewise, healthy people, are dependent on food systems-based management. How do we ensure access to healthy and affordable food to those in most need?

The economics of agriculture in the Northeast. The Northeast is the home to large urban centers and highly populated areas. Northeastern land prices are among the most expensive

agricultural lands in the country. Access to capital and to profitable regional markets are two clear challenges that must be addressed. Hence, the region would benefit greatly from the development of science-based policies to address the complex of Northeastern food system issues including farm labor and labor management, capital access, market development, population demographics, access to farm subsidies spanning the breadth of small to large operations, social justice and equity. What strategies could be employed to provide access by producers to high income consumers? Application of prescriptive interventions and systems-based management are essential strategies to address the complexity of the economics of Northeastern agriculture.

Opportunities

Production systems that are uniquely suited for the Northeast. The Northeast is uniquely situated to support wide ranges of agricultural enterprises including field agriculture and controlled environment agriculture, an enterprise cluster suited for urban settings. The Northeast today is also a barometer of a more densely populated United States of the future: areas that have large rural-suburban-urban interfaces. Importantly, the Northeast has had a tradition of direct farm sales, niche agricultural enterprises as well as traditional commodity agriculture. The high concentration of Land-grant universities make this region a unique test bed for innovation in food system research and outreach. The access by agricultural producers to university-based, intellectual property and technologies should be widely exploited and employed. The other resource that is abundant in the Northeast is water. Hence, the access to an educated labor force, intellectual hubs, urban areas suitable for controlled agriculture (e.g., brownfields, industrial parks, rooftops, etc.), short distances between urban hubs and ag producing areas (minimize food miles, long storage needs, and related waste), and the natural resource base is encouraging for the development and expansion of regional food systems. Employing big data and systems-based management will accelerate Northeast agriculture as an economic force and food dynamo.

Northeastern diversified farming. The Northeast is home to a diverse set of agricultural enterprises and food systems. These encompass coastal saltwater aquaculture, poultry production, dairy farming, fruits and berries, and a strong green industry (e.g., turfgrass and ornamentals.) Thus, consumers have access to a wide variety of agricultural products. Research and extension is needed to develop strategies to decrease energy use, increase water and nutrient use efficiency for production of high-value and high-demand niche crops selected with short growth period in small spaces to enhance economic profitability. Further, increasing profitability will improve farming community resilience by building prosperity.

The shifting consumer mindset on agriculture. Access to healthy food is a challenge throughout the U.S. and the Northeast is no exception. With a large human population and relatively small land mass, the Northeast is well-positioned to further develop local food systems. Direct sales through farmer's markets, CSAs, and farm stands and institutional sales (e.g., schools, hospital) are prime venues for improving access to healthy food. Direct markets are especially effective for developing producer-consumer relationships and promoting

agricultural literacy by providing consumers with farm experiences and education. Extension is poised to develop and implement effective educational programs to assist the development of a mindset towards healthy, nutritionally and culturally relevant, regional, sustainable, foods. In viewing agriculture innovation, the Northeast strongly encourages the USDA to consider the breadth of the food system: producer to consumer.

DECREASE ENVIRONMENTAL FOOTPRINT

Challenges

Reduce physical distance between producers and consumers. The supply chain accounts for approximately 20% of the food system's greenhouse gas emissions. Identifying appropriate (environmentally suitable, culturally respectful, accessible, financially viable) spaces in an urban environment is challenging. In circumstances where the distance between the consumer and producer cannot be reduced, we suggest modifying supply chains and utilizing modern intermodal/multimodal transportation systems that incorporate cutting-edge, technological innovations including robotics, automation, and artificial intelligence. New strategies that increase: productivity in novel bio-intensive systems; value-added chain processing and packaging; and building bio-energy and healthy composted soil from food waste are necessary.

Northeastern milk production/dairy production. Across the globe, animal production contributes approximately 30% of the greenhouse gas emissions associated with food production. How might the microbiome of agriculturally important ruminants be altered to decrease the carbon output while ensuring animal productivity and animal product quality? Using genome design to shift carbon output of ruminants and/or the utilization of carbon-capture farm system infrastructure should be employed to make progress in this area.

Eliminate waste; change views on what is "waste." In the United States, 40% of food produced ends up unconsumed and in a waste stream. This problem is magnified in the Northeast where large hubs of populations reside. What strategies could be used to reduce "nonconsumption". Relevant consumer education programs that target changing consumer behavior are needed. Further, how could the unconsumed food products be repurposed for human or animal consumption or energy production? There are needs for technologically advanced storage capabilities of unconsumed food. (Can unconsumed food be stored for later use?) Transportation (using modern intermodal/multimodal strategies) of unconsumed food to repurposing sites (consumption or energy) and utilizing modern technology to turn the unconsumed food into usable products is needed.

Several final observations: decreasing the environmental footprint must be done collaboratively with increasing productivity. This not an exclusive U.S. challenge, it's a global challenge. How do we reduce the barriers to work across international boundaries in global collaboration and cooperation?

Opportunities

Create animals and plants with smaller environmental impact. Earlier we cite the environmental impact of animals (specifically diary animals) as a challenge. We also believe that there are opportunities as well. Intentional design of plants and animals has the potential to improve environmental quality, agricultural productivity, nutrient utilization (by plants and animals) and economic opportunity. Modern farms are carbon sinks and have the potential to be market-makers. Development of markets that ensure farm prosperity are needed as are the policies that will serve to support the markets. Genome design, prescriptive intervention, and systems-based management will all be important innovation clusters to address these opportunities.

Promote soil health in the face of a changing climate. Land use intensity modifies soil services. 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. All of this must be accomplished in an era of a changing environment.

Incentive compatible public policy - incentivize to decrease environmental footprint. We suggest focusing strategies on a regional/sub-regional basis to identify investment opportunities that incentivize decreasing the environmental footprint while ensuring farm viability. Identification of food production that reward environmental stewardship is essential. All members of the Northeast food systems 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.

Agriculture Innovation Agenda: Comments from the Western Region

Background:

The Western Extension Directors Association (WEDA) and the Western Association of Agricultural Experiment Station Directors (WAAESD), with technical support from eXtension, hosted a virtual listening session on July 9, 2020 from 3:00 to 5:00 pm PDT. Invited to attend were Western Region Cooperative Extension Service (CES) and Agricultural Experiment Station (AES) directors and associate directors, CES specialists, AES scientists, and leaders of state-based stakeholder organizations. Sixty-one attendees joined the session, including three members of eXtension, the executive directors of WEDA and WAAESD, and 5 CES directors and 5 AES directors who facilitated breakout sessions.

Attendees were assigned to one of five self-selected breakout sessions. The breakout sessions included the USDA pre-defined innovation clusters:

- Genome Design
- Digital/Automation
- Prescriptive Intervention
- Systems Based Farm Management

A second breakout session on systems-based farm management was arranged to limit the number of attendees to no more than 10 per breakout session.

The attached document outlines the Western Region's breadth of participants, output of conversations on the challenges and opportunities associated with increasing agricultural productivity and decreasing the environmental footprint, and additional items for USDA to consider in the development of a national agriculture innovation agenda.

It is important to stress here that the input provided in the attachment features a unique Western Region perspective. The broad representation of participants in the Western Region's listening session highlights the region's extremely complex and vastly diverse agricultural, environmental, natural resource, social, and community attributes of the region.

The Western Region in this case is comprised of 11 states in the continental U.S. (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming), Alaska, Hawaii and the Pacific Islands and Territories (American Samoa, Guam, Micronesia and the Northern Marianas). This vast geographical area covers one quarter of the earth. The region stretches 7,700 miles from the western most island of Palau in the Pacific Ocean to the eastern most state of Colorado; more than 3,300 miles from Fairbanks, AK at its northern end to American Samoa in the south; and more than 1,350 miles from the U.S.-Mexico border in California to the U.S.-Canada border.

The expansive area covered by the Western Region includes a diverse demographic distribution and extremes in climate. The Western Region contains the highest elevation mountain peaks, in the highest mountain ranges in the United States and has the lowest locale in North America: Death Valley. The West is home to the coldest (Barrow, AK) and hottest (Lake Havasu City, AZ) environments in the United States.

The Western Region is a unique amalgamation of densely populated cities juxtaposed by large expanses of sparsely populated countryside. The public owns 47 percent of the land in the Western Region. Many Western Region's participants are located in high desert semi-arid

(Great Basin) and arid desert (Mojave/Sonoran) environments while others either serve as the gateway to the Pacific, serving tropical agriculture, or extend to the arctic with agriculture/natural resources in sub-zero climates. The breadbasket state of California has rich soil and optimal growing conditions and produces a wide spectrum of agricultural products, while the states in the Pacific Northwest are characterized by abundant rainfall, producing a rich diversity of agricultural and forest products. Rangelands of the interior states support livestock while the Pacific Ocean supports a variety of fish industries. In total, Western agriculture production accounts for roughly 25 percent of the total U.S. farm gate value.

The point of briefly describing the Western Region was to illustrate the region's tremendous diversity. Such diversity becomes a challenge when developing broad-scale national agendas. Therefore, the Western Region respectfully requests serious consideration be given to unique regional characteristics as USDA develops a national agriculture innovation agenda.

Thank you for the opportunity to comment.

Innovation Cluster: Systems-based Farm Management

Agricultural commodity, group of commodities, or customer base represented.

- Controlled Environment Agriculture
- Small and beginning farmers
- Dryland farming
- Livestock production
- Grazing in western states
- Aquaculture and fisheries
- Commercial fishing
- Dairy Farmer, Idaho Dairy Association
- Small-scale farmer - diversified organic farming of hemp, avocado, cover crops
- Animal & Dairy Science, Department Head at the University of Idaho
- Dairy Extension, University of Idaho
- Animal & Range Sciences, Department Head & Extension, New Mexico State University
- Aquaculture & fisheries, Agricultural Experiment Station at Oregon State University
- American Samoa - Director of Cooperative Extension, research & instruction: traditional crops such as taro (colocasia), ta'amu (alocasia), banana, breadfruit, coconut, cassava, yam, etc

Challenges and opportunities to increase productivity and/or decrease environmental footprint.

- Water quality and quantity
    - Water management and environmental impact issues
    - Availability for livestock and agriculture in general
    - De-salinization
    - Wastewater management and utilization
    - Data driven management tools
    - Forest health and watershed management
    - Ecosystem services identification and marketing
        - Platforms to trade water quality credits to enhance farm income
    - Low water use crops
    - Groundwater recharge (e.g. mapping areas to optimize recharge)
- Urbanization
    - Controlled Environment Agriculture
    - Urban Agriculture
    - Architecture
    - Engineering
    - Green roofs
    - Vertical Agriculture
- Soil health, salinity….
    - Soil Health, management of microbiomes
    - Cover crops
    - Tillage practices (reduced, carbon sequestration)
    - Nutrient management and efficiency
    - Soil restoration - amendments
- Linkages between sea grant and land grant …
    - Agricultural management and fisheries
    - Aquaculture…. (related to Aquaponics)

    - Dam removal, siltation
    - Climate change
    - By-products of fisheries for fertilization
    - Supply chain issues…. (plant vs fish)
- Marketing….
    - Marketing new crops….
    - Local production – eco-friendly - sustainably sourced
    - New uses of crops or products
    - Consumer perceptions in terms of food safety and sustainability
    - Phytosanitary
    - Adaptable Artificial Intelligence - machine learning, for supply chain
- Lack understanding of the science (e.g. boundaries of systems, systems approach)
    - Increase citizen science
    - Farm to table options
    - More 4H programing
    - Hands on - experiential learning
    - Educational - museums
- Consumer demand
    - Farmer markets - possible test beds…
    - Big data - tracing sources of food
    - Clear labels
    - Food hubs
    - School programs - directly related to Ag structured demand
    - Food waste
    - Platforms to trade air quality credits
- Human health.
    - Food, nutrition and health - synergies….
    - Shelf life and nutrition
    - Microbiome
    - Malnutrition
    - Diet and health
    - Produce safety
- Policy (e.g. water)
    - Encourage science-based information
    - Educate legislators
    - Evidence based approach -
    - Cooperative Extension – need more of it!!!
    - Policy and economics - triple bottom line
- GMO, genomics
    - Gene editing vs classical GMO
    - Social equity
    - Impossible burgers
    - Lack of education
    - Misinformation
    - Public vs private breeding programs and research line
- Manure management
    - Air/water quality
    - Technology for better profitability

Farm Management
    - Transplanters for cover crops in no-till systems
    - Automated systems for farm management
    - Automated systems for organic certification
    - Strategies for beef & dairy cattle production on extensive landscapes
    - Scaling up solvent extraction in aquaponics
- Hemp Farming
    - More efficient systems for production and processing that would allow utilization of unskilled labor for operation.
- Environmental monitoring in animal production systems
    - Better and advanced for maximizing animal productivity
        - Concentrated Animal Feeding Operations
        - Grazing field conditions
- Subsistence farming on the Pacific Islands
    - Environmental impact of pesticides and other chemicals on terrains from mountains to reef & water quality
    - Animal waste management
    - Pests and diseases
        - Traditional crops and small-scale farming

<u>Research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application, of innovations.</u>

REGIONAL CONSIDERATIONS

- Regional differences in livestock management require research done in different regions addressing unique systems and challenges
- Research is lacking on management strategies for production systems in extensive landscapes. These systems require long-term research to develop.
- Some balanced funding across the regions of the country to address the unique research needs in every region. Funding is disproportionately low for the western region.
- Small operations in aquaculture industry need support
- Distance from islands to sources of ag inputs (fertilizers)
    - National Ag program in dairy addresses transportation issues

WORKFORCE CONSIDERATIONS

- Workforce development and retention challenges
    - There is a lack of adequate agricultural workforce
    - Attracting employees to work in ag industry is difficult
    - Ag jobs are unattractive to domestic workers because of a stigma and work being hard, salary is not always the issue
    - Shift from family labor to immigrant labor
        - Access to H2A visa program - currently year around ag producers do not have access to bring in migrant labor
        - Farm labor dwelling (USDA program) - local barrier in implementing the program
        - Language can be a challenge with migrant labor

- Trained labor is a challenge
    - Major need for workforce & safety training
        - Body type challenges that can lead to occupational injuries
- Improve disability programs to help disabled farmers work and be more productive
- Attracting qualified researchers is a challenge

TECHNOLOGY CONSIDERATIONS

- Innovation and automation are needed but not affordable to develop
- Affordability of technology for small scale farms is a challenge
    - Needs affordable technologies for small scale operations
- Connectivity because of limited to no bandwidth is a major challenge
    - Artificial intelligence, remote monitoring of livestock, etc are difficult because of lack of connectivity

AGENCY BARRIERS

- Responsibility for aquatic food is divided between different agencies making it difficult to take a system-based approach to improve systems
    - Difficulty identifying the agency responsible for aquatic food that are grown in water, on land, and in the sea
- Different agencies addressing different parts of the system
    - New crops for aquatic food (e.g., seaweed)

Innovation Cluster: Digital/Automation

<u>Agricultural commodity, group of commodities, or customer base represented.</u>

- Cooperative Extension
- Agricultural Experiment Station serving as convenors to promote new approaches
- Tree fruits and variabilities in soils - precision management to address inefficiencies
- Wildlife data science - monitoring of pollinators and other wildlife
- Alaska seafood - technology and data sharing opportunities for seafood production and processing
- Wine and vineyards - improve grape production through better monitoring of water, soils, climatic data, and digital devices for real time monitoring of conditions to improve yields, and reduce water use

<u>Challenges and opportunities to increase productivity and/or decrease environmental footprint.</u>

- Connectivity and deployment of technology in the absence of access to the internet.
    - Consider things such as the High-Altitude Platform Station. Company name is HAPS Mobile App.
- Microclimates and variable soils lead us to manage fruit crops for the weakest plant.
    - Larger scale sensory deployment and management of implements that can address variability and improve management.
- Better ways to interpret large data sets quickly enough to inform management decisions.
    - Need for additional sensors - across the board. For example, water, pests, water status of the plant, fungal diseases, insect damage, and better estimates of yield.
    - In the absence of automation, creations of harvest aids to improve efficiency of harvesting fruit crops.

- Labor issues. Availability and cost of labor demands more automation and technology development for all types of production and processing.
    - Advancing technologies for automating wild fisheries production and processing.
    - Increased automation at seafood processing facilities.
        - Diversity of species and location of processing facilities requires more automation.
- Fuel consumption for fisheries production, particularly smaller producers to make their production more sustainable.

Novel approaches, research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application.

BROADBAND SOLUTIONS

- There may be solutions short of large federal efforts - efforts that can do the heavy lifting, locally.
- Deploy a Rural Electric Association-type approach to expand broadband availability to rural areas across the US.
- Investigate localized wireless networks that utilize independent computational capabilities and then only the results and not all the data need be exported.

PARTNERSHIPS

- Microsoft Artificial Intelligence (AI) for Earth and the 'Planetary Computer'
    - For example, grants for innovative tech for agriculture https://www.microsoft.com/en-us/ai/ai-for-earth.
- Utilize Hackathons to put producers and technology developers together to produce new technologies.

GAP

- Full utilization of all seafood products and remaining protein.
    - More research on utilizing processing waste as a source of protein.

BARRIER

- Concerns around data privacy and sharing of information from individual producers.

Innovation Cluster: Prescriptive Intervention

Agricultural commodity, group of commodities, or customer base represented.

- Seafood and processing - food related research opportunities in tuna, crab, etc.
- Seafood and processing - member based - salmon (AK area)
- Dryland small grains - all commodities need a nutritional focus
- General public, gardening, ag literacy, public education with local agriculture
- Broad interest in agriculture and natural resources
- Dryland farming in alternative crops, Weeds--enemy to friends. Companion weeds. Using weeds to enhance production/decrease footprint. Wild foods, native or introduced. Hybrids of native plants.

Challenges and opportunities to increase productivity and/or decrease environmental footprint.

- Challenge - Productivity versus nutrient density
    - Agriculture incentives focus on volume, but what is the relationship to health care cost. Health care needs more consideration.
    - Opportunity to work with younger populations as they might be more interested in reducing footprint.
- Challenges - Seafood –
    - AK issue increase in bio-toxins. Fisheries measuring stress in seafood. Parasites in fresh catch.
    - Opportunity to increase efficiency and environmental beneficial methods.
- Opportunities in productivity and decrease in footprint.
    - There are healthy natural plants not being used for food. If you cannot beat them then eat them.
- Challenge and Opportunity --- PPP - pandemic proof productivity!!!

Solutions, research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application.

- Solutions
    - DATA - Better tap data flow for decision support. Example---on-farm demo used for better decisions. Need coordinated/synthesize data systems. Data analytics. Link from one data set to another.
        - Courses/training in data mining.
        - Tracking of data related to food safety - farm to table. And also in sustainability of food production.
    - Reduce food waste to increase production and decrease footprint.
    - Bio-toxins - what if we had ocean **censors**, data collected to ID not only harvest and quality. Real time vs delayed.
    - Nutrition over Volume
- Barriers, Hurdles
    - Long term funding for research.
        - Multiple agency overlap.
        - Lack of clarity to potential research.
    - How do we think about the data that's coming at us?
        - To get us to learning.
        - Need useable information.
        - Evaluation as a mid-course correction and implementation support tools.
    - Need quality over quantity of data
    - Rural broadband limitations
    - End game in a fully automated system---Human side??

Innovation Cluster: Genome Design

Agricultural commodity, group of commodities, or customer base represented.

- Most crop plants; including specialty crops
- Gene editing for crops that are transformable
- Farm animals

Challenges and opportunities to increase productivity and/or decrease environmental footprint.

Challenges:

- Some plants are difficult to transform
- Gene identification is difficult in some plants
- Genes controlling complex traits are very difficult to identify
- Regulatory hurdles for engineering animals
- Consumer acceptance (plants and animals)
- G x E complexities
- Understanding microbiome management (animals and plants)
- Farming system adoption

Opportunities:

- Disease resistance (genetics and microbiome manipulation)
- Engineered vaccines
- One Health: Animals-Humans-Environment
- Engineering microbiomes with stable phenotypes
- Efficiencies (profitability) in animal and plant production
- Environmentally Resilient Crops and Animals
- Crops that need fewer inputs
- Climate resilient crops (and microbiomes)
- More nutritious plants for humans and animals
- Higher quality animals and plants
- Plants with less spoilage and better storage (post-harvest disease and oxidation)
- Profitable bioenergy/bioproducts
- Dual purpose cattle
- Dual purpose crops

Outcomes, research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application.

Outcomes:

- Disease resistant plants and animals
- Crops that need less inputs
- Increased water use efficiency
- More nutritious/higher quality crops
- Environmental resilient plants and animals
- Affordable biofuels and bioproducts
- Lower environmental impacts
- More sustainable production systems
- Cleaner water
- Epigenetic and genetic adaptation to specific environments
- Increased profitability

Gaps and Barriers:

- Consumer acceptance
- Regulatory barriers
- Annotated genome sequences available for different genotypes reference and different accessions
- We do not know the genes for most quantitative traits: Genotype to Phenotype
- Off-target effects of gene editing can be improved: gene redundancy problems; genes with multiple effects
- Identity preservation for safety and profitability