Food Security in Extreme Environments and Food Deserts

ACCELERATING SUSTAINABLE SYSTEMS

NSF Convergence Accelerator: Sustainable Systems Enabling Food Security in Extreme Environments and Food Deserts employing a Convergence of Food, Energy, Water and Systems for Societal Impact

Final Workshop Report

ConvergentFoodSystems.org

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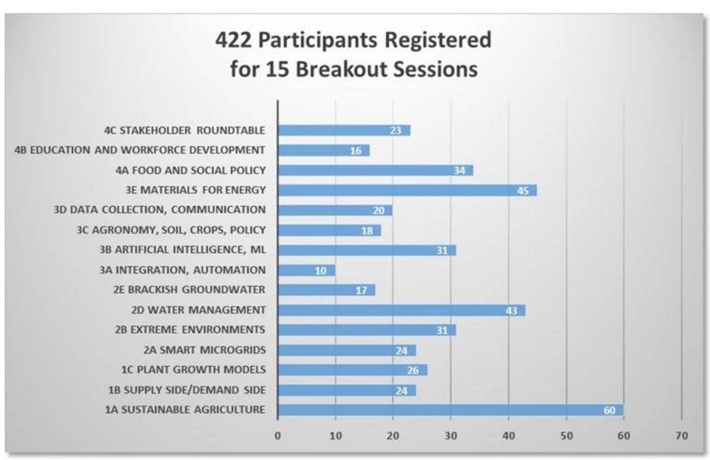
EXECUTIVE SUMMARY

Deserts cover about 33 percent of the world's land area, and are living environments challenged with resource degradation and desertification. The increasing demand for water, food and energy resources in the face of a changing climate and continued population growth, make these vital resources increasingly scarce. Moreover, changes in climate, land use, resource consumption, and population growth are pushing some regions to no longer be able to support regional food requirements, contributing to large-scale human migration in parts of the world. Food deserts, in a parallel concept to physical deserts, are areas with limited access to nutritious and affordable food. The U.S. Department of Agriculture reported in 2010 that 23.5 million people in the U.S. live in food deserts. The United Nation's Sustainable Development Goal (SDG) of Zero Hunger is to "end hunger, achieve food security, improve nutrition and promote sustainable agriculture". By 2050, a global population of 9 billion will increase water demands by 55%, energy needs by 80%, and food demands by 60%. The world's population is expected to increase from 3 billion in the late 1960's to almost 11 billion by 2050, representing an increase in agricultural demand representing an urgency in the need to produce more food to enable food security. Total food consumption globally, is projected to increase.

Challenges contributing to a slowdown in agricultural yield growth, include increased water use for irrigation due to rising temperatures, soil degradation, chemical runoff and climate change. Hot weather combined with dry conditions can hinder agricultural yield. Ongoing and persistent drought results in increased prices of food costs, electricity, and water, and large agricultural production declines in crops. Water scarcity impacts irrigation for agriculture and the capacity to generate hydroelectricity. Higher temperatures, impact water scarcity and increases the energy demand with cooling and air-conditioning.

We propose NSF Convergence Accelerator tracks that are ready for accelerated convergence, and scalable solutions for sustainable systems development enabling food security in extreme environments and food deserts, including arid regions, for societal impact, employing a convergence of food, energy, water and systems. This recommendation for NSF Convergence Accelerator tracks comes out of this NSF C-Accel workshop, "Sustainable Systems Enabling Food Security in Extreme Environments and Food Deserts employing a Convergence of Food, Energy, Water and Systems for Societal Impact", addressing key questions including: How can we realize a sustainable, food secure society, in extreme environments and food deserts, employing an accelerated convergence of food, energy, water and systems technologies? How do we collaborate with policy makers and other leaders to identify politically viable and socially acceptable solutions? How can we incorporate education, re-education and workforce development for jobs creation? How do we converge at an accelerated pace to accomplish the ideas, suggestions and recommendation?

The workshop occurred virtually, May 19-21, 2021 and featured 24 world-renowned expert speakers, 15^{+} organizing committee members, 1,060 participant registrations from academia, industry, government, NGOs, foundations and others, 422 registrations in 15 different breakout sessions, interactive and integration sessions, and 83 lightning talks. Registrations were closed early due to the large demand, and many requests



to register and participate continued after the closed registration. Interest was also indicated by the website's Google analytics showing almost 6,000 website users worldwide. A word cloud highlights the workshop's participants' disciplines, showing both representative multiple disciplines and different stakeholders. A slack community was created with 183 active members who exchanged 1,560 messages.

In this workshop, we identified tracks that are ready for accelerated convergence, and scalable solutions for sustainable systems development enabling food security in extreme environments and food deserts, including arid regions, for societal impact, employing a convergence of food, energy, water and systems. Also, members in the Slack community formed as a part of this workshop were asked to identify track topics and consider teaming arrangements. The following tracks and sub-tracks were identified in this workshop.

Track #1 – Assessing, Modeling and Prediction of Food Deserts, Systems and Security in Extreme Environments and Food Deserts:

Sub-track #1: Predicting Future Deserts – Climate, Population Growth, Regional Resource Diminishment

Convergent teams will assess, model and predict food systems and security in extreme environments and food deserts using climate data, population growth and regional resource diminishment. Teams will use existing datasets to build upon, and using Big Data Analytics, Machine Learning and Artificial Intelligence to build predictive models and forecasting algorithms, to forecast future food deserts and sustainable systems that will enable food security in different food insecure extreme regions.

Sub-track #2: Workforce Development, Training, Re-training, and Integrated Education:

Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy. Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Track #2 – Sustainable Food Production Systems at the Intersection of Food, Energy, Water, and Systems for Societal Impact:

Convergent teams will develop a plan for sustainable food production systems at the intersection of food, energy, water and systems, including models and prototypes. Teams will use a systems-of-systems approach in the development of sustainable food systems that can be employed in extreme environments and food deserts.

Sub-track #1: Closed Loop Agriculture Systems:

Convergent teams will develop a plan, prototype or model for loop agriculture systems that can be employed in extreme environments and food deserts. Closed loop agriculture systems include precision agriculture systems, controlled environment agriculture, alternative, Next Generation, Smart Farming, robotic and Artificial Intelligence solutions.

Sub-track #2: New Materials for Power/Energy Management:

Convergent teams will develop a plan, prototype or model for the emergence of new materials, approaches and applications for controlling environmental parameters, light systems, light transmission, and power/energy management.

Sub-track #3: Non-traditional Water Sources:

Convergent teams will develop a plan, prototype or model for non-traditional water sources, including brackish groundwater, reclamation and desalination systems for sustainable agriculture in extreme and arid environments.

Sub-track #4: Workforce Development, Training, Re-training, and Integrated Education:

Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy.

Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Sub-track #5: Socially, Politically, Economically, and Culturally Acceptable Solutions:

Convergent teams will develop a plan for socially, politically, economically, and culturally acceptable solutions for the development of sustainable systems enabling food security in extreme environments and food deserts.

Track #3 – Food Optimization and Minimization of Waste:

Convergent teams will plan, prototype or model for food optimization and minimization of waste, including the utilization of sensors, data and networks, and addressing policy, food labels and discard behaviors.

Sub-track #1: Utilization of Sensors, Data and Networks:

Convergent teams will develop a plan for utilization of sensors, data, and networks for tracking plant growth, food safety, and transport, and the reduction of food waste.

Sub-track #2: Policy, Food Labels, and Discard Behaviors:

Convergent teams will develop a plan for policy, food labels and discard behaviors including supply side – food production and distribution systems, and demand side – society, consumers, food preference and access.

Sub-track #3 Workforce Development, Training, Re-training, and Integrated Education:

Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy. Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Sub-track #4: Socially, Politically, Economically, and Culturally Acceptable Solutions:

Convergent teams will develop a plan for socially, politically, economically, and culturally acceptable solutions for the development of sustainable systems enabling food security in extreme environments and food deserts.

1. INTRODUCTION

Arid and semi-arid regions including deserts, exhibit harsh climates, salt-affected soils and often lack fresh water. Additional characteristics can include very low precipitation rates relative to evaporation, extreme temperatures, strong winds, and conditions that are frequently hostile to abundant plant growth. Deserts cover about 33 percent of the world's land area, and are living environments challenged with resource degradation and desertification (the transformation of habitable land to desert), where socio-economic conditions play a vital role [1-5]. NSF Convergence Accelerator Track D America's Water Risk: Water System Data Pooling for Climate Vulnerability Assessment and Warning System PI, Dr. Upmanu Lall, has shared results from analysis on the onset and severity of the worst drought shown in Figure 1 [6]. Within the United States, recent population growth is greatest in the southwestern US, according to the U.S. Census Bureau 2020 Census. Much of this region is dominated by desert environments. The increasing demand for water, food and energy resources in the face of a changing climate and continued population growth, make these vital resources increasingly scarce [7-10]. Moreover, changes in climate, land use, resource consumption, and population growth are pushing some regions to no longer be able to support regional food requirements, contributing to large-scale human migration in parts of the world. Extreme environments include scenarios beyond arid and semi-arid regions, including attempts to grow food in food deserts, polar deserts and in space. Food deserts, in a parallel concept to physical deserts, are areas with limited access to nutritious and affordable food. The U.S. Department of Agriculture reported in 2010 that 23.5 million people in the U.S. live in food deserts, shown in Figure 2 [11]. In the same way that physical and environmental constraints define deserts, social, political and economic conditions have led to food deserts in many areas of the world.

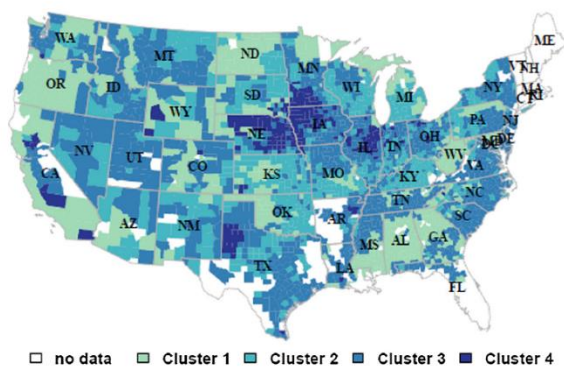


Figure 1. Results from the K-means clustering analysis on the onset of and severity of the worst drought. [6]

The United Nation's Sustainable Development Goal (SDG) of Zero Hunger is to "end hunger, achieve food security, improve nutrition and promote sustainable agriculture". This can be accomplished by doubling agricultural productivity and incomes of small-scale food producers, and by ensuring sustainable agriculture and food production systems. Agriculture is the single largest employer in the world, providing livelihoods for 40% of the global population [12]. The National Academy of Engineering (NAE) has identified 14 "Grand Challenges for Engineering"[13]. The committee suggested these Grand Challenges fall into four cross-cutting themes: Sustainability, Health, Security and the Joy of Living. One grand challenge is to make solar energy economical through the use of new materials which can help reduce the fabrication costs [14]. NAE documents, for a long-term, sustainable energy source, solar power far exceeds and conceivable future energy demands. Another grand challenge is

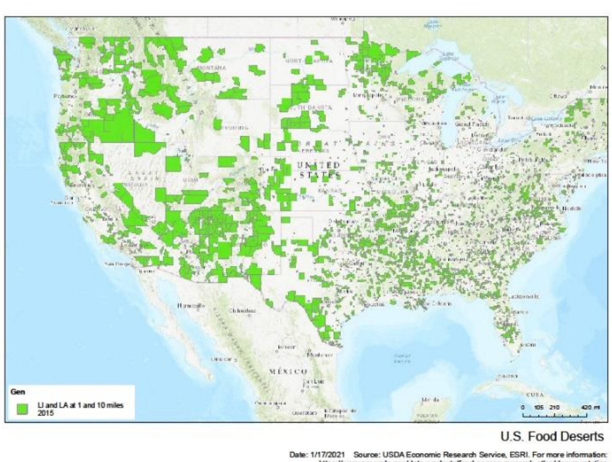


Figure 2. U.S. food deserts where 23.5 million people live.

to provide access to clean water [13]. About 1 out of 6 people today do not have access to water [15]. In some countries, half the population does not have access to safe drinking water, and results in poor health [13]. Household water usually accounts for less than 5% of total water use [16]. Most of the water we use is for agriculture and industry. Most of the world's water is in the oceans, salty and require desalination. The rate of use of water in groundwater aquifers exceeds the rate of its replenishment. Overcoming the crisis in water is one of the greatest human development challenges of the early 21st century [17]. Managing the nitrogen cycle is an identified grand challenge that has a key role in the production of food. The global cycle of nitrogen is a growing challenge for sustainable development.

2. SUSTAINABLE SYSTEMS ENABLING FOOD SECURITY WORKSHOP

Launched in 2019, the NSF Convergence Accelerator builds upon basic research and discovery to accelerate solutions toward societal impact. This workshop is a product of the Convergence Accelerator (C-Accel), within the Office of Integrative Activities at the National Science Foundation, a brand-new initiative designed to accelerate use-inspired convergence research through partnerships between academia, industry, non-profits, government, and other sectors. The NSF Convergence Accelerator's mission is to address national-scale societal challenges through use-inspired convergence research. Using a convergence approach, the Accelerator integrates multidisciplinary research and innovation processes to transition basic research and discovery toward impactful solutions. This National Science Foundation-sponsored workshop aimed to accelerate convergence to merge ideas, approaches, and technologies from a wide range of diverse sectors, disciplines, and experts. The workshop involved diverse stakeholders, including academia, government, industry, non-profits, community-based organization, and others. The success of this Convergence Accelerator workshop will inform future investments from the National Science Foundation for accelerating sustainable systems for food security in extreme environments and food deserts at the intersection of food, energy, water, and systems for societal impact.

This NSF C-Accel workshop, "NSF Convergence Accelerator: Sustainable Systems Enabling Food Security in Extreme Environments and Food Deserts employing a Convergence of Food, Energy, Water and Systems", aimed to address key questions including:

1) How can we realize a sustainable, food secure society, in extreme environments and food deserts, employing an accelerated convergence of food, energy, water and systems technologies?
2) How do we collaborate with policy makers and other leaders to identify politically viable and socially acceptable solutions?
3) How can we incorporate education, re-education and workforce development for jobs creation?
4) How do we converge at an accelerated pace to accomplish the ideas, suggestions and recommendation?

The workshop engaged participants' expertise, creativity and ideas from researchers, innovators, experts, stakeholders and other partners from a multiple disciplines, expertise and organizations from academia, industry, non-profit organizations, government and other sectors, including underrepresented groups who all converged to identify innovative tools, techniques, prototypes and methods, solutions that improve human well-being, the environment and natural resources, and can yield high-impact results in three years. Figure 3 illustrates the disciplines and organizations engaged in this workshop.

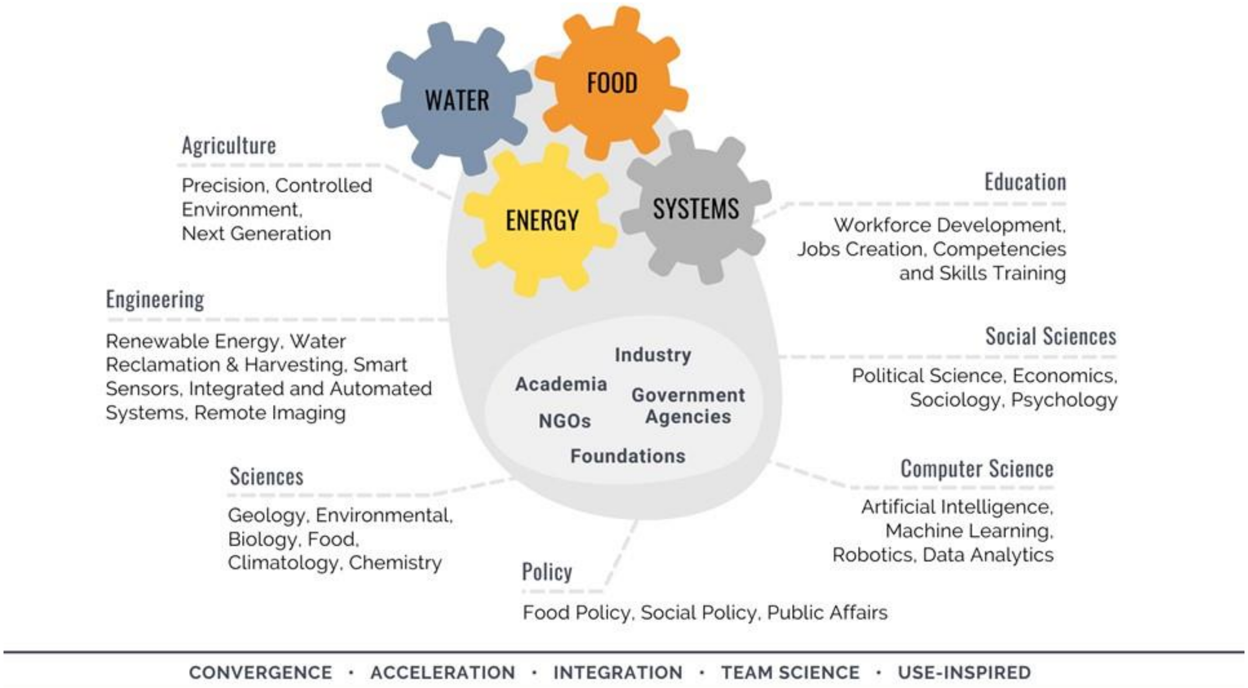


Figure 3. Accelerating sustainable systems for food security in extreme environments and food deserts disciplines, expertise and organizations required and engaged in the workshop.

3. MAJOR CROSS-CUTTING THEMES

The workshop occurred virtually, May 19-21, 2021 and featured 24 world-renowned expert speakers, 15+ organizing committee members, 1,060 participant registrations (before closing registration) from academia, industry, government, NGOs, foundations and others, 422 registrations in 15 different breakout sessions, interactive and integration sessions, and 83 lightning talks. Figure 4 is a word cloud of the workshop's participants' disciplines, showing both representative multiple disciplines and different stakeholders. Registrations were closed early due to the large demand, and many requests to register and participate continued after the closed registration. Additional details on this information can be found in the report's appendices and on the workshop's website. Recordings of plenary, convergence sessions, and lightning talks are available on the website. The workshop spanned three days, included daily talks from expert speakers, concurrent workshops with parallel breakout sessions, integration converging sessions, an open-mic Innovation, Convergence and Acceleration session, and a Teaming, Collaboration and Community session. The cross-cutting themes and workshop topics addressing the key question, "How can we realize a sustainable, food secure society, in extreme environments and food deserts, employing an accelerated convergence of food, energy, water and systems technologies?" In addition to the workshops and breakout sessions, the conference included:

- 1,060 registered participants
- 541 institutions and organizations
- Plenary speakers: 4
- Convergence session speakers: 19
- Lightning talks: 83 presenters
- Open-Mic: Innovation, Convergence and Acceleration: over 100 participants
- Teaming, Collaboration and Community session: with an NSF-CA PI speaker
- Four cross-cutting workshops with 15 breakout sessions

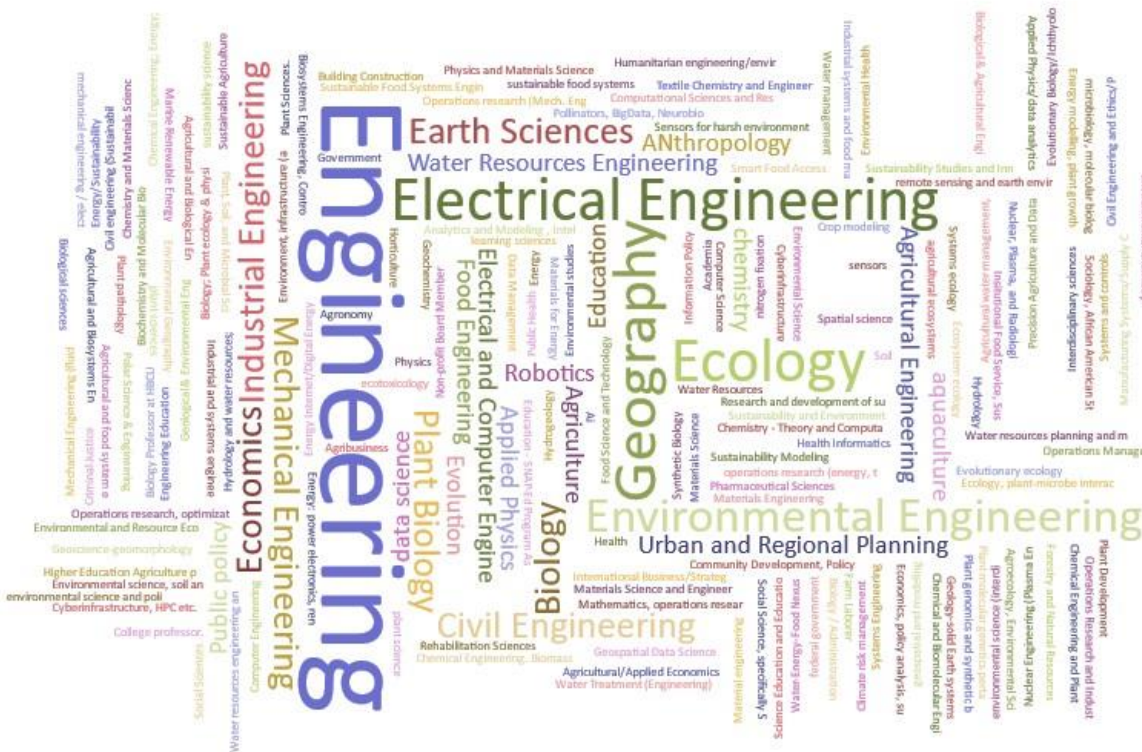


Figure 4. Word cloud showing the workshop participants' disciplines, showing both representative multiple disciplines and different stakeholders.

Listed below and shown in Figure 5, are the four workshops that consisted of cross-cutting themes with 15 breakout sessions, and 422 registered participants. Breakout sessions were limited to 20 participants. Breakouts with a large number of registered participants were split into smaller breakouts, and experts were recruited to lead those breakouts.

Workshop #1: Food Security and Sustainable Food Systems

- 1A: Sustainable Agriculture: Precision, Controlled Environment, Alternative, Next Generation and other Smart Farming and Artificial Intelligence Solutions
- 1B: Supply Side: Food Production and Distribution, Demand Side: Society, Consumers, Food Preference and Access
- 1C: Plant Growth Models, Selection and Pathology, Plant Science, Physiology, Agroecology, Biology, Genomics and Breeding

Workshop #2: Renewable Energy and Sustainable Water Resources

- 2A: Smart Microgrids, Photovoltaics, Wind and Battery Storage
- 2B: Pushing the Bounds: Finding Food Solutions in Extreme Environments
- 2D: Transdisciplinary Water Management – Opportunity for Food Security
- 2E: Brackish Groundwater, Reclamation and Desalination

Workshop #3: Sustainable, Integrated and Smart Systems

- 3A: Hands-off intensive Agriculture: Automation, Robotics, and Sensors
- 3B: Artificial Intelligence, Machine Learning, Big Data and Analytics
- 3C: Agronomy, Soil, Crops, and Policy
- 3D: Data Collection, Communication, Systems, and Controls
- 3E: Materials for Energy and Sustainable Systems

Workshop #4: Social Engagement, Policy, Education and Workforce Development

- 4A: Food and Social Policy, Ethics, Engagement and Economics
- 4B: Education and Workforce Development, and Jobs Creation
- 4C: Stakeholder Roundtable: Academia, Industry, Government, NGOs, Foundations and Others

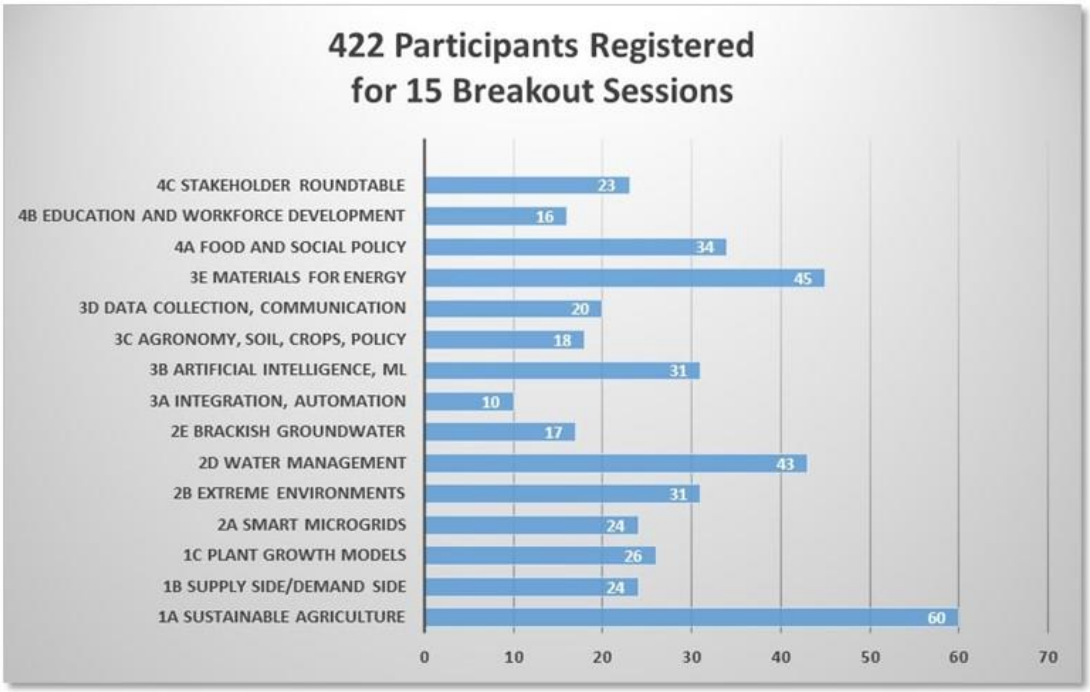


Figure 5. 15 breakout sessions in four cross-cutting themes workshops, with 422 participants registered. Large sessions were split into smaller sessions and lead by experts in the field.

4. OVERVIEW AND FINDINGS

Workshop #1: Food Security and Sustainable Food Systems

By 2050, a global population of 9 billion will increase water demands by 55%, energy needs by 80%, and food demands by 60% [18]. The world's population is expected to increase from 3 billion in the late 1960's to almost 11 billion by 2050, representing an increase in agricultural demand [19], representing an urgency in the need to produce more food to enable food security. Total food consumption globally, is projected to increase from 2,373 kcal/person/day in about 1970 to 3,070 by 2050 [20]. Challenges contributing to a slowdown in agricultural yield growth include increased water use for irrigation due to rising temperatures, soil degradation, chemical runoff and climate change. Hot weather combined with dry conditions can hinder pollination and agricultural yield. Ongoing and persistent drought results in increased prices of food costs, electricity, and water, and large agricultural production declines in crops. Water scarcity impacts irrigation for agriculture and the capacity to generate hydroelectricity. Higher temperatures, impact water scarcity and increases the energy demand with cooling and air-conditioning. The cross-cutting themes of the four workshops and 15 breakout sessions convened to address "Sustainable Systems Enabling Food Security in Extreme Environments and Food Deserts employing a

Convergence of Food, Energy, Water and Systems for Societal Impact" as an NSF Convergence Accelerator workshop. The findings of the breakout sessions are highlighted below.

1A: Sustainable Agriculture: Precision, Controlled Environment, Alternative, Next Generation and other Smart Farming and Artificial Intelligence Solutions

This group identified energy, water scarcity, drought, production of nitrogen, inhibition of plant growth by saline soils, and rural internet infrastructure as some of the major challenges or barriers to ensuring food security. Big ideas suggested include fertigation on demand, plant-based transgenic sensors of nutrition status and stress, satellite monitoring, big data-drive precision agriculture, real-time data, useful data for communicating to policy makers, prediction of near food water availability, remote sensors, cell phone sensors, food waste to value added products, materials and energy input and output for climate, biodiversity and pollution, hydroponics for real-estate challenged locations, ML and life cycle analysis. Goals and impacts identified include government policies for subsidies to alternative production, improved efficiency of nutrient use, reduced chemical residues, advanced food safety, enhanced hydroponic farming in food deserts, engagement and focus on the people, incentives, and interoperability of sensors and data science technology. High-impact deliverables in a three-year time-frame identified include remote and local sensing technology for what farmers need, pilot manufacturing and food processing facilities, pilot scale demonstration environments and potential demonstration/deliverable living solar panels generating electricity from living, green plants growing in the ground. This was identified being convergent ready because single technologies are existing, but expertise from multiple fields and various experts is required to move forward. Weather data, soil scientists, microbiome, plant experts, experts in new technologies (drones, non-thermal plasmas, sensor technology, etc.) Barriers to implementation identified include interoperability of sensor and data systems, motivating farmers to try new approaches, economics and lack of a well-trained workforce for implementation.

1B: Supply Side: Food Production and Distribution, Demand Side: Society, Consumers, Food Preference and Access

This group identified the following as challenges and barriers to ensuring food security: lack of a consorted effort to address food waste, food production materials and mechanics, preservation of food for later consumption, knowledge transfer, lack of policies against food waster, high rates of food spoilage/contamination between supply side and demand side, acceptance of new technologies, lack of resilience in the supply chain, high food prices, lack of access, poor supply chains for fresh food, challenges in our political system, and the food and agriculture system. Big ideas identified by this group include tools for mitigating spoilage and food waste with the use of electric fields, electrothermal processing, and high pressure to inactivate pathogens, spoilage organisms, and enzymes with reduced application of heat, use of the Internet of Things to monitor and control food quality, data modeling and workforce development, integrating culturally-relevant food venues, increasing acceptance among the public, anti-poverty programs/policy, connecting and incentivizing local and sustainable supply chains, use of big data and use of technologies that improve food shelf-life, and transportability. Goals and positive societal impacts identified include reducing food waste and resource utilization through technological solutions, and low-cost, high-throughput manufacturing of protein-rich food that decreases the environmental footprint of traditional animal agriculture and increases accessibility for populations facing insecurity. High-impact deliverables in three-year time frame identified include model-based optimization tools supported by data analytics to help make the food distribution and delivery systems more efficient, an early warning system, a mobile phone app and social messaging informed from data, regulatory approval of food spoilage mitigation technologies, labeling consistency technology, support for advertising campaigns, transdisciplinary food councils, refrigerated distributed networks and mobile markets. A food production manufacturing and mechanics and reducing food waste was identified as convergence ready. Barriers to implementation identified include the additional expertise required in medical sciences and the challenges to changing consumers behavior.

1C: Plant Growth Models, Selection and Pathology, Plant Science, Physiology, Agroecology, Biology, Genomics and Breeding

Challenges identified by this group include plant yield that is negatively affected by global warming, drought, rising temperatures, crop losses due to pathogens/disease or abiotic stress, general public buy-in, finding ways to improve plant water-use-efficiency in the future water deficit conditions, diversity highly-qualified scientific workplace for greater equity, inclusion and idea generation, better genomic/phenomics characterization of germplasm held in the National Plant Germplasm system, language barrier between people in different disciplines and sectors, lack of experimental tools that can be applied across species for high-throughput and rapid testing of plant gene functions, understanding what's happening below ground and the ability of households/communities to produce food locally, under challenging conditions. Big ideas identified by this group include breeding horticultural crops for resilience to pre- and post-harvest stress, and optimal integration of traits into the supply chain for better quality and shelf life; combine sensors, robotics, machine learning to understand soil dynamics, root growth and the microbiome; build a synthetic plant; domesticate plants that are already adapted to extreme environments; improve plant water-use efficiency to help tolerate drought stress; develop technologies that allow for the transformation and hybridization of any plant species; improve plant transformation (tissue culture) systems to better enable the utilization of genome editing and novel breeding tools; and maximize crop productivity and nutrition through breeding/editing for vertical ag. Goals and impacts identified include the development of more efficient horticultural systems. High impact deliverables identified include development of vertical farming systems; open source, high quality germplasm/seed varieties for indoor growth of high-quality, nutritious, low-input plants and microbial treatments for crop resilience in controlled environments. The group identified this as convergent ready because the nanotechnology and gene editing revolutions make rapid breeding more feasible, especially in the context of vertical farming, where LED lighting, smart monitoring, and nutrient/water recycling could facilitate several generations per year and would allow for breeding for nutrition, and public/consumer buy-in and interest would be high. Barriers to implementation identified include a stable power infrastructure that is not available in developing countries, an incomplete understanding of plant gene function, regulatory hurdles, communication tools and cost.

Workshop #2: Renewable Energy and Sustainable Water Resources

Extreme and isolated areas face challenges due to lack of necessary infrastructure and adverse weather conditions to produce cost-effective and scalable energy sources, locally. Contrary to the general perception that agriculture is a low energy consumption domain, abundant energy is necessary for food production and water management. Identifying the relationship between energy needs and causes of food deserts is required to devise strategies targeted on these food deserts. There exist several challenges to study the role of automation and systems, coordination of energy generating resources with water generating resources, modular energy systems, and efficient storage, management and transportation of these resources to right location and right time.

Efficient energy utilization for generating usable water (even in humid areas) is critical for cost-effective sustainable agriculture. Transition from traditional irrigation system to pressurized irrigation system has impact on energy consumption. Tools, models, and technology needed to address scalability, resilience, and faster deployment requires integration of multiple disciplines. Integrating engineering solutions with Socially responsible solutions are also crucial to address these challenges.

Faced with water scarcity and groundwater depletion within a few decades at current use rates, the sustainability of irrigated agriculture is threatened in many areas of the world. Developing alternative water sources is one element of a long-term strategy for sustaining irrigated agriculture. Non-traditional water sources need to be developed and utilized, focusing on low energy or off-the-grid approaches.

In some environments, rainfall or precipitation harvesting and storage represents a underutilized resource that may be of sufficient quality and quantity for high efficiency agricultural systems. For example, El Paso, Texas receives only 246 mm of average annual rainfall, primarily in the monsoon months (late summer). Assuming a relatively modest draw of 10 liters per day, and a rainfall capture efficient of 50%, a capture area of roughly 30 m^2 may be sufficient for some closed-loop systems. However, given the predictions of increased drought as a resulting of changing climate combined with long, dry winters exacerbated during La Nina conditions, humidity extraction and harvesting may be another alternative approach to provide low-quantity baseline water source, throughout the year. In addition, water collection from air conditioners or other condenser-based methods to regulate temperatures in controlled agricultural systems can also be considered.

Alternatively, brackish groundwater is present at shallow depths in most arid and semi-arid regions. Affordable desalination systems may represent part of the solution to the challenge of groundwater depletion, which is one of the largest sources of consumptive water use in the country. Successful implementation of desalination for agriculture will reduce freshwater demand for irrigation by providing a non-traditional source of water (desalinated brackish water).

2A: Smart Microgrids, Photovoltaics, Wind and Battery Storage

Challenges identified by this group include matching agricultural energy demand to renewable energy grid production, local supply vs. energy efficient cost-effective transportation methods, conversion of agricultural industry to a flexible demand load, diverse sources of uncertainty across geographical areas and locality of severity of conditions, and the inability to properly store and refrigerate produce that could lead to its limited availability and rapid spoilage. Big ideas identified include risk pooling to counter uncertainty by aggregation using communication technology, dispatchable modular applications, net-resource management systems, transpiration only irrigation, thermal energy storage systems and phase change materials, and human capital and workforce development. Goals and impacts identified include job creation and economic development, deployable, and scalable and variable turn-key solutions. Convergent readiness is identified because there are concrete frameworks on the energy side, physical layer readiness is possible and partnerships to harness engineering innovations with indigenous communities. High impact deliverables include physical, management and coordination, financial, and societal layers deliverables, and creating a framework for food-grid similar to the energy-gride. Barriers to implementation identified include cost, time, lack of social capital and change of thought paths.

2B: Pushing the Bounds: Finding Food Solutions in Extreme Environments

This group defined extreme food environments by considering social factors, and extreme poverty, connectivity to transport infrastructure and access to resources, limitations to plant growth from temperature extremes and moisture extremes, and problems with salinity, post disaster regions and conflict ridden and war-torn regions. Challenges identified by this group include energy, poverty, and environmental change across the artic, rural community engagement and cost. Big ideas identified by this group include regulations, modeling tools, remote sensing, AI to look at the ecosystems and optimize water/food/energy systems, compilation of case studies, and artificial photosynthesis used in food production decoupled from land and water usage. Goals and impacts identified include a true implementation plan for affordable, reliable energy-food-water system for remote and rural small communities, and coordination and early engagement of social groups, government/private organizations for informed and adaptive technology understanding, and policy. High-impact deliverable identified include implementation plans for several protype communities in different areas, smaller impactful testbeds, a shared resource of ecosystem models and educational tools. This is identified as convergent readiness because there has been significant fundamental research of various components in various disciplines, but has not been synthesized in a whole system, and not including the underserved community. Barriers to implementation identified by this group include lack of internet access, Covid-19, education, lack of trust between different sectors, and timely and effective communication with stakeholders.

2D: Transdisciplinary Water Management – Opportunity for Food Security

This group split into 5 subgroups. Here we highlight some of their combined input. Challenges identified include adaptation by and cost to farmers, water law, policy, rights, water transport cost, quality, and trade-offs of water conservation and energy cost, and brine discharge, climate change, irrigation, and overextraction. Big ideas identified include the use of AI/ML, risk mitigation, long term planning, reservoirs dead and active storage, water rights and resources, couple interconnection between human behaviors, capital and legal, socio-economic accounting, virtual water, sensors and incubation for convergence. Goals identified include sustaining and enhancing crop production while saving 10% of irrigation water and energy by providing field-level optimal irrigation decision making information to farmers. High-impact deliverables identified include strategies for prioritizing demand curtailment while minimizing adverse financial consequences.

2E: Brackish Groundwater, Reclamation and Desalination

Goals and impacts identified by this group include technology for water reuse, centralized and decentralized desalination/reclamation systems, rules and regulations, industry involvement, provisioning, water treatment technology with minimum energy use and integration of technologies. Challenges identified by this group include cost, sustainability and global application, competition between agriculture industry and municipalities, a variety of contaminants, microorganisms requiring removal, public concern regard water safety and liability. Big ideas identified include circular economy, water reuse, beneficial discharge, exploring more salt resilient crops and incentives. Barriers to implementation include cost, public acceptance and education, farmers buy-in, energy cost, regulations, optimization of multi-tech solutions and stakeholders agreement. High-impact deliverables identified include point-of-use treatment unit, comprehensive accounting of costs and benefits, controlled environment testing, studies, collaborations and new systems. Convergent-ready ideas include collaboration at pilot level, economic analysis of costs and benefits, advance materials for water treatment, membrane technology, educational campaigns and decentralization.

Workshop #3: Sustainable, Integrated and Smart Systems

Food water and energy nexus has recently seen many interests in the mechanics of data-driven decision making. Efficient interactions among different entities of such systems require systematic approaches while designing the systems. Apart from these systems, understanding the big complex systems that include transportation, social systems, weather and climate change information systems, economics, analytics, IoT, quality control, decision making, cyber security and others requires a systematic research procedure to develop holistic solution approaches. However, developing such system of system require sufficient resources for effective implementation, such as support from local, state, federal entities, communities, collaboration with industries, non-profit organizations, research centers and universities. Use of distributed AI, high performance cloud computing, computer-based models, and agent-based models helps to develop efficient system of systems that can make better decisions.

3A: Hands-off intensive Agriculture: Automation, Robotics, and Sensors

Challenges identified by this group include the ag requirements of big energy, the fresh water footprint, top soil loss and a growing population; adoption of new technology can be difficult; sensing is important for controlled environment agriculture; language barriers between disciplines; who will make the decisions; climate and disease variations in different locations; tracking of food from farm to stores (block chain technology can be used); distributed supply to improve efficiency in shipping, time reduction when product is ready for consumption (use of an app allowing consumers to order food from an indoor growing location; indoor ag construction/design has not included architectural design and education; and lighting and music design for workers and plants. Big ideas identified by this group include build databases of fields that track long term trends for planning and decision making; databases, algorithms and machine learning can be used identify, track and mitigate outbreaks in ag and grading produce; integrated framework to inform growers of real-time demand; inexpensive sensing technology; direct data transfer without sophisticated processes; and use of premium payments from the technology to fund future developments. Goals and impacts identified by this group include the use of temperature, water, humidity, light and sound frequencies that can affect the growth; precision farming and decreasing the ecological footprint; monitoring nitrogen, phosphates levels, and the quality of food; local management of monitoring of water; use of sensors that are biologically imbedded; and integrated data collection user-centered system; and distributed farms that reduce the size/number of food deserts. High-impact deliverables identified by this group include sensors and software, e.g. nitrogen sensors for waste water treatment and optimization, and a network of sensors with readouts and alerts from different points in a stream; future lines of communications/collaboration to facilitate stakeholder partnerships between academia, industry and municipal partners; logistics and tracking to reduce food waste through tracking of contamination; multiple sensors and continuous data analysis to inform future predictions to increase yield; and the use of a digital twin to simulate and evaluate the use of energy, lighting and other performance goals. Barriers to implantation identified include a disconnect from stakeholders and connecting industry to people and getting their involvement.

3B: Artificial Intelligence, Machine Learning, Big Data and Analytics

Challenges identified by this group include comparing agroecology, indoor farming, industrial farming and other agricultural approaches on their true potential be sustainable; lack of access to foods to communities in food deserts in spite of having SNAP; lack of data on food demand, supply and initiatives; decision support in the presence of misinformation and uncertainty; the use of novel and low-cost technology to support farmers in extreme environments; the balance of food production and sustainability; the development of a data drive approach to assess growing versus importing food; and understanding the food security phase transition due to natural geo-political, agroecology, different types of agricultural methods and environmental effects. Big ideas identified by this group include the use of a systems modeling framework and associated decision-support methodology to integrate across many systems and several scales; link environmental data to predictive outcomes using XAI/ML + models; stakeholder-driven approaches; a multiplex network modeling approach with a system of systems modeling effort; and a scale up mobile food market using big data (ISDA surveys on food security, algorithms, ML and citizen science). Goals and impacts identified include regional testbed creations; increase resilience of communities; understand food security needs and pain points of specific communities in extreme environments and food deserts; and the scale up mobile food market from 7 food deserts to 70. High-impact deliverables identified include the compilation of all relevant data in a systemic manner to train XAI/ML models coupled to physical model support system-of-system studies, causal analysis, etc.; integration of existing cyberinfrastructure, DSS, and Ag models; and the development of ontologies and know graphs for extreme environments and food deserts. Barriers to implementation identified include the identification of useful data sources and gaining access to those data in a comprehensive way; engaging the AI/ML development community in solving these challenges; perceptions and attitudes of stakeholders including actors/decision makers/public; and barriers to adoption and implementation of new technologies that interface with communities.

3C: Agronomy, Soil, Crops, and Policy

Challenges identified by this group include global climate change, soil restoration with N-fixing, critical bacteria; water safe and chemical free food production; next generation education about ag; building food system resilience to withstand extreme environments; managing the microbiome for biotic and abiotic stress resilient food production and ecosystem services; renewable fertilizers and climate stress; defining property rights and consumer and farmer behavior; understanding the root causes of food insecurity in extreme environments; water availability; and infrastructure and training. Big ideas identified include placing food at the center of everything; floating farms; microgrid supported hydroponic crop cultivation; rooftop farms for urban food deserts and building cooling; increasing information access and use; self-sufficient generation of renewable N-fertilizers; education via urban and school gardens; temperature-controlled growth containers; food and cropping system diversification; and deification of the cause of food deserts. High-impact deliverables identified include web/mobile applications allowing consumers to find healthy, low-cost food; capacity factor analysis online assessment tool; regenerative agriculture; soil health monitoring tools and web-based applications; water reuse and nutrient recovery; N-fixers and drylands bacteria; tools to better understand the interconnections between production, processing, shipment, consumption and waste; network analysis; modular substrate preparation system and growth chamber to demonstrate the mushroom production process which is scalable; and targeted delivery capsules for agrochemicals.

3D: Data Collection, Communication, Systems, and Controls

Challenges identified include lack of awareness among stakeholders; cost and ease of deployment; internet access in remote locations; data availability to a broader community; safety hazards on farms; battery enclosures; sensor commercialization; and policy, subsidies for extractive management strategies. Goals and impacts identified include open data transport/access/interoperability, (e.g., Things Network for LoRaWAN); IoT for improving food production, transportation, distribution, safety, and environmental impacts; outstanding figure-of-merit (sensitivity, lifetime, power, consumption); ultra-low cost; low-cost reliable sensors for Ag; long lived, non-toxic, biodegradable, or field reclaimable/reusable sensors; and MEMS nanotech, animal wearable sensors. Big ideas identified include ambient energy harvesting technologies and ultra-low power communication protocols; block chaining IoT/trusted data chains from edge/sensor to AI/smart monitoring; right scale prototypes to enable community farmers; cybersecure systems; and tracking pathogens in food supply. Barriers to implementation identified include lack of infrastructure; market adoption investor/market apathy; significant value end-user proposition; lack of prototyping infrastructure and tradition and technology aversion. High-impact deliverables identified include a pathogen tracking system for food; right scale prototypes for farmers; storage and distribution systems; improvements in animal husbandry; chain of custody tracking to validate product claims; urban farm systems and Internet Backpacks as an edge connectivity/compute/IoT sensor network. Convergent ready ideas identified include sensors, infrastructure and feedback systems; proactive desalinization on saltwater-intruded farms; sensors and storage technology; IoT based Trailer size prototypes for community farmers; food safety/tracking systems and runoff reduction.

3E: Materials for Energy and Sustainable Systems

Challenges identified by this group include redirecting sunlight; dynamic control of light; renewable energy and energy harvesting using magnetic materials; supply-side issues related to energy infrastructure; refrigeration; thermally insulating materials; competing land uses, and upcycle of waste. Big ideas identified by this group include energy harvesting generators; systems approach; getting electricity from ambient air; passive thermal management coatings; autonomous controlled environment farming using only renewable energy; use degraded/unproductive land for food production; low energy, sustainable, low cost ways to obtain clean water from unconventional sources; engineering microbial communities to promote crop growth, reduce waste, and remediate dirty water; using food waste to make new materials; and coordinated service-learning for design, implementation and evaluation. Goals and impacts identified include the development of multifunctional materials to enhance light transmission, and power and energy management; food producing systems that can be taken to the point of need; and critical materials with dual functions for energy and insulators. High-impact deliverables identified include triboelectric generators; magnetic refrigerator; zero net-energy and water vertical farming container; increase food production from unproductive land; lighting control systems; sustainable engineered microbial communities/materials; cheap and versatile materials capable of obtaining clean water; and novel materials developed from food waste. Convergent readiness ideas include GIS Databases; thermal management coating and the emergence of new critical and dual functional materials. Barriers to implementation identified include energy cost for food produces; space/land for large scale deployment; scalability and cost of materials and rethinking how silos are used and where food is held.

Workshop #4: Social Engagement, Policy, Education and Workforce Development

The social and health sciences play a crucial role in determining the societal impact of new efforts to increase food security in extreme environments and food deserts. Researchers have conceptualized and measured locations with high physical and/or social barriers to food security, including food deserts and socially extreme environments. This research develops a common definition and operationalization of vulnerable areas of interest and permits analysis on these areas.

The social and health sciences also have an established framework—the demand and supply of food—for understanding and achieving user-inspired designs. To reduce food insecurity, it is essential to determine the preferences and extent of food demand among food insecure households, and surveys can help identify this demand in a given context. Key stakeholders in sustainable food production and distribution, including academia, private companies, nonprofit organizations, and government agencies, can use this information to guide new ideas and identify promising solutions that are socially acceptable and politically viable.

Social and health sciences also have developed several methodological tools for estimating the effects of new interventions on human behaviors and health outcomes. As new deliverables aimed at increasing food security emerge, the deliverables can be implemented in the field to permit valid causal inferences on intervention effects. Difference-in-difference research designs, along with statistical analysis, can estimate the causal effects on food security, community engagement, health, and other outcomes. Qualitative analysis methods, including process tracing and in-depth interviews and observation, can help identify the pathways that contribute to estimated effects. These methods help to establish the societal impact of any new interventions.

4A: Food and Social Policy, Ethics, Engagement and Economics

Challenges identified by this group include social inequality with respect to access to education, technology and policy-makers; availability of locally produced food; education in acquiring food; uncertainties; incentive systems; logistics of food access and distribution; transportation accessibility; representation in the planning process; emphasis on grains that impacts hunger and health; food system greenhouse gas emissions and the need for resilient production in the face of climate change. Big ideas identified include the development of better social learning systems; the creation of test beds for food security hubs; building cooperative farms and farm incubators; bringing small farmers to the front of the discussion; and considering the human aspect determining the impacts to consumers and stakeholders. Goals and impacts identified include the development of regional stakeholder networks around food security and climate resilience; the inclusion of less resilient small farmers; and an expectation of metrics to be collected and the social/environmental challenges to be addressed. High-impact deliverables identified include workshops bringing together multiple voices.

4B: Education and Workforce Development, and Jobs Creation

Challenges identified by this group include enabling convergence and fostering real interdisciplinary education; defining the workforce demand resulting in career/technical education program development; disconnection between what's taught in the classroom and what's required agricultural fields; integration including social science, arts and engineering, making learning skill based and relevant to society; going beyond content-based education to including competency-based education; and a paradigm shift is needed in education and research to go beyond “Here is STEAM content, go solve the Food challenge” to “Here is the Food challenge, find the STEAM content to solve it”. Big ideas identified include place-based challenges across disciplines; youth engagement; a cultural shift encouraging innovative and inclusive solutions (e.g., mass food production to personal food production and locally produced food with less waste); and to create opportunities for “reskilling and upskilling”, with pathways to advancement for stackable digital badges, stackable credentials, stackable certificates and degrees, and interdisciplinary minors. Goals and impacts identified include food literacy principals and associated scope and principals; and the development of a national curriculum and research program on “data-driven decision making for food systems” and combine with stakeholder needs, including industry and community. High-impact deliverables identified include tested program and food justice models for food production; food literacy principals, associated scope and sequence curricula; create university or multiple universities transdisciplinary centers for FEW solutions breaking the silos and including cutting edge education; build on best practices from this conference a create a structure for a sequence of “Summits or Idea Labs” on themes related to food systems and producing recommendations on important priorities that align with NSF big ideas and national priorities; internships; and teacher professional development programs. Convergence readiness include AP/IB agricultural course; and building a “Research Experiences for Community College Students in Food Systems (RECCF)” regional hub that can be linked through a national network. Barriers to implementation identified include the silo driven disciplinary structure and the lack of place based practical interdisciplinary education; and focused attention on standards and standardization of education results in siloed/discrete/disparate curricula.

4C: Stakeholder Roundtable: Academia, Industry, Government, NGOs, Foundations and Others

Challenges identified by this group include metrics for promotion in academia disincentivize transdisciplinary collaboration; lack of mechanisms, platforms and knowledge for cross-sectoral coordination; women empowerment; resilience; collapse of Agroecosystems; SES tradeoffs; urban pollution and ground contamination; gaps in engineering practice; engaging multiple stakeholders towards a common vision; translating research to policy; engaging a majority of conventional farmers in the technologies; and scaling-up small scale farming while generating social, racial and environmental benefits. Big ideas identified include tax incentives for small farmers to provide produce to food banks; additional support for food, co-op, and mental health NGOs; integrating grassroots input into research problems and as a testbed for solutions; machine learning in Ag; and addressing hidden hunger. Goals and impacts identified include getting a larger population to eat the recommended fruits and vegetables; and promotion of culturally appropriate nutritional recipes that support reduced animal products and calories values. High-impact deliverable identified include revisions to Ag engineering curricula; more diverse USDA cost studies; couple energy production to food production and reduced water uses with solar development in arid systems; medical cost savings through improved nutrition and health outcomes; tools for stakeholders to assess social, economic and ecological tradeoffs; and increased civility between opposing factions for more effective policy development. Convergent readiness ideas identified include interest in Congress to support medically tailored meals for seniors; current efforts in Double Up Food Bucks programs for SNAP at farmers markets; and openness to expand interdisciplinary efforts to transdisciplinary work by vested stakeholders. Barriers to implementation identified include lack of boundary organizations; cultural hinderances for supporting low-income people and dissemination of information.

Innovation, Convergence and Acceleration – "Open Mic"

This session was open to all workshop participants who were not enrolled in a specific workshop. This session was designed as a "Convergence" session, where the participants represented multiple disciplines, expertise and organizations, brainstorming together to address the same issues in the breakouts, but as a much larger convergent group of over 100 participants. Participants were given 2 minutes each to discuss and brainstorm, with an open mic and video, live to the group. Participants were given time on a first-come basis of the raised hand in Zoom. Highlights of the brainstorming open mic session are presented below.

The greatest challenges we face identified by this group include STEM education; entrenched political and economic interests; cooperation and transparency; policies; wildfires; consumer education; soil health, conversion and degradation; stakeholder awareness and involvement; misinformation and disinformation; lack of equitable food distribution; citizen scientists and synthesis; competing land use needs; interdisciplinary education; use of new technology to address food security; lack of highly valued jobs in agriculture; political economies and institutional constraints; climate change; water access; other socioeconomic problems; equality among communities; food as a cultural construct; human waste as part of the fold lifecycle; policies and markets that drive production of certain crops; and breaking down disciplinary barriers. Big ideas identified by this group include circular economies of agriculture; urban food production; utilizing more of existing crop production for human consumption; cooperation and transparency; resilient cropping systems; and getting emerging technologies in the hands of farmers world-wide. Impacts identified include greater resilience; economic opportunity; higher level of communication and coordination across different interconnected sectors; innovative solutions including each person growing their own food; and creation of an integrated user-centered curriculum that engages students at all levels. High-impact deliverables identified include land access and stewardship; good food networks; teams of different groups; community gardens; use of big data, computing and AI; and sustainable/easy blockchain/smart contracts with microgrid energy for decentralized trusted food security and recycling waste, with tokens for collaborative transdisciplinary education-modules/short courses/supply chains. Convergence readiness identification include the need for a broad array of disciplines and the existence of the technology. Barriers to implementation identified include cultural values, economic status quo and STEM education.

5. TRACK RECOMMENDATIONS

In this workshop, we aimed to identify tracks that are ready for accelerated convergence, and scalable solutions for sustainable systems development enabling food security in extreme environments and food deserts, including arid regions, for societal impact, employing a convergence of food, energy, water and systems. Based on the input and feedback from the workshop participants, 11 tracks were identified and ranked by the participants using a poll. Shown below in Figure 6, is a picture of the poll in-progress. Figure 7, shows the final compilation of the poll results.

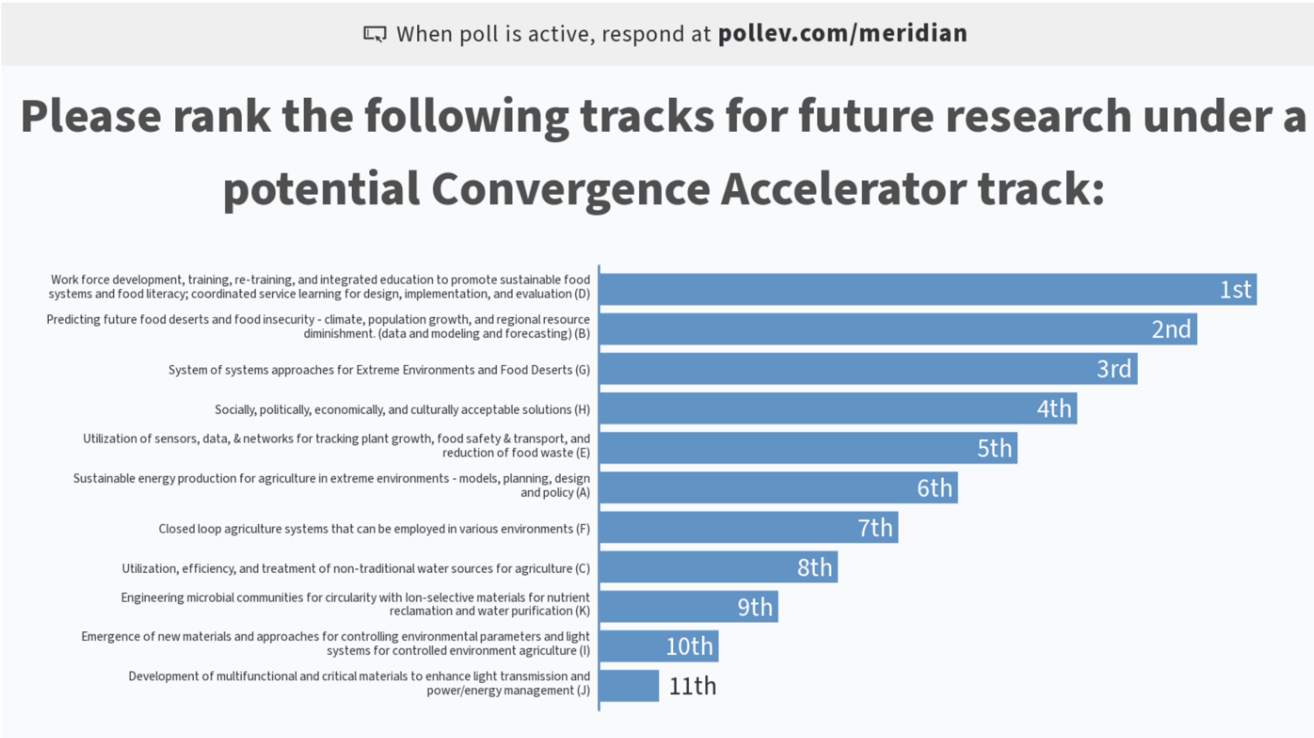


Figure 6. Eleven potential C-Accel tracks identified and in-progress ranking by participants.

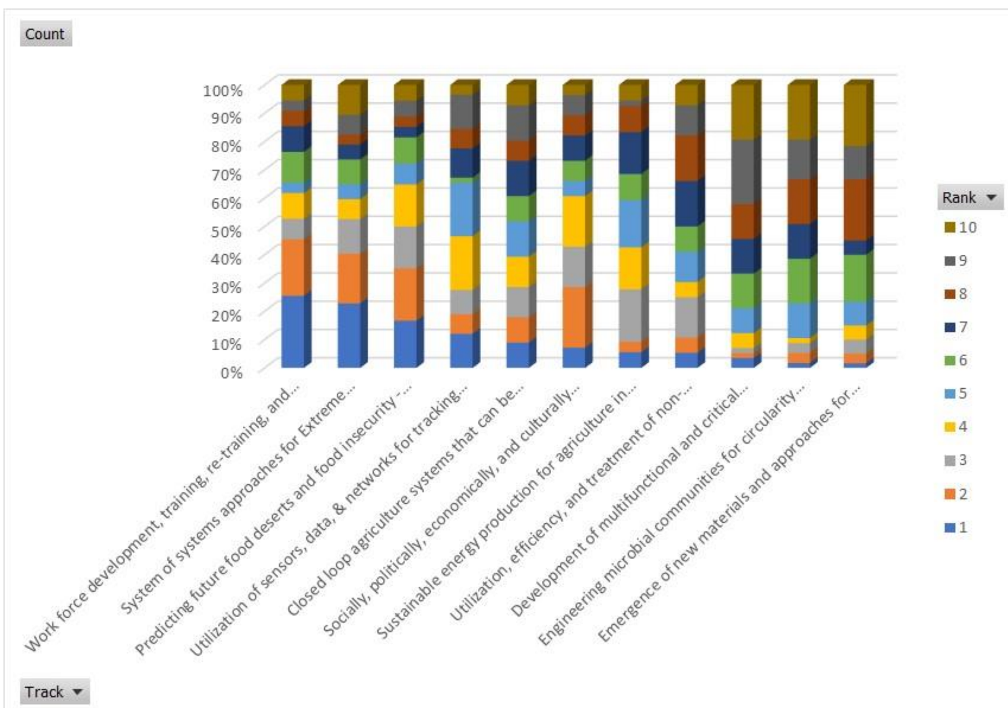


Figure 7. Final potential C-Accel tracks ranked by workshop participants.

In addition, members in the SLACK community formed as a part of this workshop were asked to identify track topics and consider teaming arrangements. The organizing committee members consolidated the workshop information and formed the recommendations for NSF C-Accel tracks to address the grand challenge of food systems and security in extreme environments and food deserts for societal impact. Additional track recommendations not included here and teaming information is documented in Appendix 8.8 SLACK Community.

Track #1 – Assessing, Modeling and Prediction of Food Deserts, Systems and Security in Extreme Environments and Food Deserts:

Sub-track #1: Predicting Future Deserts – Climate, Population Growth, Regional Resource Diminishment

Convergent teams will assess, model and predict food systems and security in extreme environments and food deserts using climate data, population growth and regional resource diminishment. Teams will use existing datasets to build upon, and using Big Data Analytics, Machine Learning and Artificial Intelligence to build predictive models and forecasting algorithms, to forecast future food deserts and sustainable systems that will enable food security in different food insecure extreme regions.

Sub-track #2: Workforce Development, Training, Re-training, and Integrated Education:

Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy. Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Track #2 – Sustainable Food Production Systems at the Intersection of Food, Energy, Water, and Systems for Societal Impact:

Convergent teams will develop a plan for sustainable food production systems at the intersection of food, energy, water and systems, including models and prototypes. Teams will use a systems-of-systems approach in the development of sustainable food systems that can be employed in extreme environments and food deserts.

Sub-track #1: Closed Loop Agriculture Systems:

Convergent teams will develop a plan, prototype or model for loop agriculture systems that can be employed in extreme environments and food deserts. Closed loop agriculture systems include precision agriculture systems, controlled environment agriculture, alternative, Next Generation, Smart Farming, robotic and Artificial Intelligence solutions.

Sub-track #2: New Materials for Power/Energy Management:

Convergent teams will develop a plan, prototype or model for the emergence of new materials, approaches and applications for controlling environmental parameters, light systems, light transmission, and power/energy management.

Sub-track #3: Non-traditional Water Sources:

Convergent teams will develop a plan, prototype or model for non-traditional water sources, including brackish groundwater, reclamation and desalination systems for sustainable agriculture in extreme and arid environments.

Sub-track #4: Workforce Development, Training, Re-training, and Integrated Education:
Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy. Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Sub-track #5: Socially, Politically, Economically, and Culturally Acceptable Solutions:
Convergent teams will develop a plan for socially, politically, economically, and culturally acceptable solutions for the development of sustainable systems enabling food security in extreme environments and food deserts.

Track #3 – Food Optimization and Minimization of Waste:

Convergent teams will plan, prototype or model for food optimization and minimization of waste, including the utilization of sensors, data and networks, and addressing policy, food labels and discard behaviors.

Sub-track #1: Utilization of Sensors, Data and Networks:
Convergent teams will develop a plan for utilization of sensors, data, and networks for tracking plant growth, food safety, and transport, and the reduction of food waste.

Sub-track #2: Policy, Food Labels, and Discard Behaviors:
Convergent teams will develop a plan for policy, food labels and discard behaviors including supply side – food production and distribution systems, and demand side – society, consumers, food preference and access.

Sub-track #3 Workforce Development, Training, Re-training, and Integrated Education:
Convergent teams will develop a plan for workforce development, training, re-training, and integrated education to promote sustainable systems enabling food security and fool literacy. Coordinated service learning for design, implementation and evaluation should be incorporated in the plan.

Sub-track #4: Socially, Politically, Economically, and Culturally Acceptable Solutions:
Convergent teams will develop a plan for socially, politically, economically, and culturally acceptable solutions for the development of sustainable systems enabling food security in extreme environments and food deserts.

6. EXAMPLE TEAMS AND PARTNERSHIPS

This workshop engaged participants' expertise, creativity and ideas from researchers, innovators, experts, stakeholders and other partners from multiple disciplines, expertise and organizations from academia, industry, non-profit organizations, government and other sectors, including underrepresented groups who converged to identify innovative tools, techniques, prototypes and methods, solutions that improve human well-being, the environment and natural resources, and ideas that can yield high-impact results in three years.

Teams are ready to engage projects in the proposed tracks identified in this report evidenced in the documented in the workshop participation and in the SLACK community comments in Appendix 8.8. We have identified examples of cross-cutting teams and partnerships to address challenges identified in the recommended tracks.

(1) Analytics + AI/ML + Agri-scientists + Population Demographic + Engineers + Nutritionists + Weather/Climatologist + Decision Scientists + Economists + Policy Makers

(2) Modeling + Planners + Designers + Forecasters + Policy

(3) Plant Physiologists + Biotech + Synthetic Biologists

(4) Environmental + Social Scientists + Information Scientist + Regulation

(5) Geospatial Data Scientists + Remote Sensing

In addition, we had participation from an active NSF C-Accel Team that has highlighted below how they may converge with Sustainable Systems Enabling Food Security in Extreme Environment and Food Deserts. NSF Award # 2040676, C-ACCEL Track D: Artificial Intelligence and Community Driven Wildland Fire Innovation via a WIFIRE Commons Infrastructure for Data and Modeling Sharing, Lead PI: İlkay Altintaş, University of California San Diego. The WIFIRE commons 2020 Cohort Track D – AI Driven Innovation via Data and Model Sharing Accelerator has agreed to converge with the Sustainable Systems Enabling Food Security Accelerator, because of the paired synergy with the requirement for artificial intelligence methods, and computational data science translation to practical applications. The WIFIRE commons Convergence Accelerator Phase I project is creating a data-driven, artificial intelligence (AI) enabled and model-based scientific approach that ultimately aims to limit and even prevent the devastating effects of wildfires by using advanced technologies to support fire mitigation, preparedness, response, and recovery. The combination of wildfire data, AI and the physics of fire behavior in the main design of WIFIRE Commons drives multidisciplinary collaboration and engagement with educators, municipal leaders, and fire managers to ensure the Commons is designed for translational use. Data and model sharing are core to the WIFIRE commons effort, as is strategic partnerships and close collaboration with the private and public sectors.

7. HIGH-IMPACT DELIVERABLES

The proposed NSF Convergence Accelerator tracks focused on Sustainable Systems Enabling Food Security in Extreme Environments and Food Deserts employing a convergence of food, energy, water, and systems for societal impact could have deliverables across education and workforce development training programs, tools for users and platforms, and prototype systems development, all with high-impact and capable of a three-year development timeframe.

7.1 EDUCATION AND WORKFORCE DEVELOPMENT TRAINING PROGRAMS

High-impact education deliverables proposed include revisions to Agriculture engineering curricula, the development of food literacy principals, and associated scope and sequence curricula; the creation of university or multiple universities transdisciplinary centers for Food-Energy-Water solutions breaking the silos and including cutting edge education; building on best practices from this conference and creating a structure for a sequence of “Summits or Idea Labs” on themes related to food systems and producing recommendations on important priorities that align with NSF big ideas and national priorities; internships; teacher professional development programs; teacher training and K-12 outdoor education; hosting undergraduate students in regular academic classes, internships, and research courses; using acres of varied habitats, and classroom and laboratory facilities for establishing education and field research projects; education, teacher development, interdisciplinary/holistic practices, and appropriate integration of learning across multiple literacies; and exploring/testing/experimenting with curriculum and teacher development to transform established perspectives limited by "old/non-sustainable" perspectives for teaching and learning. High-impact workforce development deliverables proposed include programs that engage the next generation workforce in STEM Education; the development of water and energy training opportunities for both the novice and practicing industry professionals; pipeline development; the creation sustainable solutions for innovation and workforce development programs for K-12, Community College and Undergrad/Grad education and research as well as teacher professional development connecting challenges centered around food to building curriculum maps and creating integrated content and enhancing pedagogical practices.

7.2 TOOLS FOR USERS AND PLATFORMS

High-impact tools for users and platforms’ deliverables proposed include model-based optimization tools supported by data analytics to help make the food distribution and delivery systems more efficient, an early warning system, a mobile phone app and social messaging informed from data, regulatory approval of food spoilage mitigation technologies, labeling consistency technology, support for advertising campaigns, transdisciplinary food councils, refrigerated distributed networks and mobile markets; physical, management and coordination, financial, and societal layers deliverables; the creation of a framework for food-grid similar to the energy-gride; development of strategies for prioritizing demand curtailment while minimizing adverse financial consequences; the development of a point-of-use treatment unit, comprehensive accounting of costs and benefits, controlled environment testing, studies, collaborations and new systems; continuous data analysis tools to inform future predictions to increase yield; and the use of a digital twin to simulate and evaluate the use of energy, lighting and other performance goals; the compilation of all relevant data in a systemic manner to train XAI/ML models coupled to physical model support system-of-system studies, causal analysis, etc.; the integration of existing cyberinfrastructure, DSS, and Ag models; and the development of ontologies and know graphs for extreme environments and food deserts; the development of web/mobile applications allowing consumers to find healthy, low-cost food; capacity factor analysis online assessment tool; regenerative agriculture; soil health monitoring tools and web-based applications; water reuse and nutrient recovery; N-fixers and drylands bacteria; tools to better understand the interconnections between production, processing, shipment, consumption and waste; network analysis; tools for stakeholders to assess social, economic and ecological tradeoffs; the use of big data, computing and AI; and sustainable/easy blockchain/smart contracts with microgrid energy for decentralized trusted food security and recycling waste, with tokens for collaborative transdisciplinary education-modules/short courses/supply chains.

7.3 PROTOTYPE SYSTEMS DEVELOPMENT

High-impact prototype systems development deliverables proposed include remote and local sensing technology for what farmers need, pilot manufacturing and food processing facilities, pilot scale demonstration environments and potential demonstration/deliverable living solar panels generating electricity from living, green plants growing in the ground; the development of vertical farming systems; open source, high quality germplasm/seed varieties for indoor growth of high-quality, nutritious, low-input plants and microbial treatments for crop resilience in controlled environments; the development of implementation plans for several protype communities in different areas, smaller impactful testbeds, a shared resource of ecosystem models and educational tools; sensors and software, e.g. nitrogen sensors for waste water treatment and optimization, and a network of sensors with readouts and alerts from different points in a stream; the development of a system to open and enhance future lines of communications/collaboration to facilitate stakeholder partnerships between academia, industry and municipal partners; logistics and tracking to reduce food waste through tracking of contamination; multiple sensors and continuous data analysis to inform future predictions to increase yield; and the use of a digital twin to simulate and evaluate the use of energy, lighting and other performance goals; the development of a growth chamber to demonstrate the mushroom production process which is scalable; and targeted delivery capsules for agrochemicals; a pathogen tracking system for food; right scale prototypes for farmers; storage and distribution systems; improvements in animal husbandry; chain of custody tracking to validate product claims; urban farm systems and Internet Backpacks as an edge connectivity/compute/IoT sensor network; triboelectric generators; magnetic refrigerator; zero net-energy and water vertical farming container; a model that demonstrates increased food production from unproductive land; lighting control systems; sustainable engineered microbial communities/materials; cheap and versatile materials capable of obtaining clean water; novel materials developed from food waste; and a prototype that couples energy production to food production and reduced water uses with solar development in arid systems.

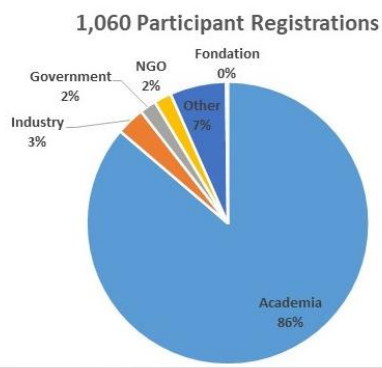
8. APPENDICES

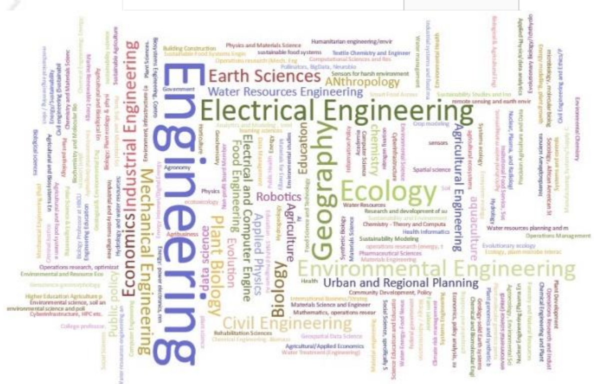
8.1 PARTICIPANT STATISTICS, AND PARTICIPATING ORGANIZATIONS

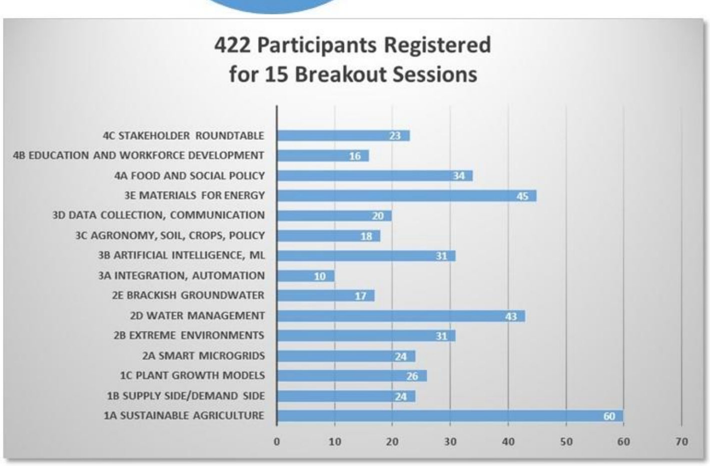
The workshop featured 4 plenary speakers, 19 convergence session speakers, 83 lightning talks, 15 breakout sessions, and open-mic Innovation session, and a Teaming, Collaboration and Community session with Q&A with an NSF C-Accel awardee.

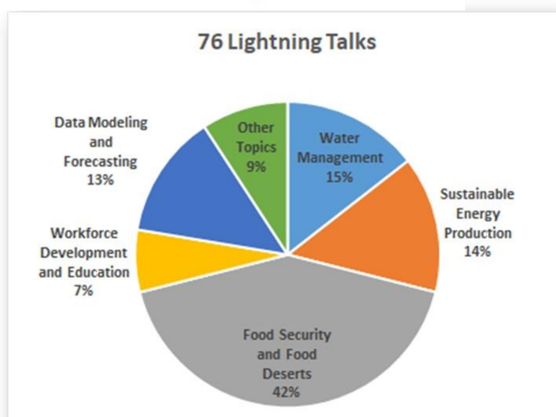
The workshop occurred virtually, May 19-21, 2021 and featured 24 world-renowned expert speakers, 15⁺ organizing committee members, 1,060 participant registrations (before closing registration) from academia, industry, government, NGOs, foundations and others, 422 registrations in 15 different breakout sessions, interactive and integration sessions, and 83 lightning talks. Due to overwhelming demand, breakout sessions and registrations exceeded capacity, resulting in early registration closure. Interest is also indicated by the website's Google analytics showing almost 6,000 website users worldwide. The word cloud highlights the workshop's participants' disciplines, showing both representative multiple disciplines and different stakeholders. A slack community was created with 183 active members who exchanged 1,560 messages.

1.	United States	5,713 (96.32%)
2.	China	37 (0.62%)
3.	Canada	16 (0.27%)
4.	United Kingdom	15 (0.25%)
5.	India	14 (0.24%)
6.	Germany	11 (0.19%)
7.	Mexico	9 (0.15%)









PARTICIPATING ORGANIZATIONS

FIU Florida International University

Freight Farms

Fybraworks Foods

George Mason University

Georgia Tech School of Civil and Environmental Engineering College of Engineering

Global Greengrants Fund

GIWS Global Institute for Water Security USASK

gfi Good Food Institute

GRAPES GRid-connected Advanced Power Electronic Systems

gqc HydroTrek

Helical Farms Outpost

HWISE Research Coordination Network

INL Idaho National Laboratory 70 Years of Science & Innovation

Illinois

IPReP Integrated Pennycress Resilience Project

Iowa State University

Johns Hopkins Center for a Livable Future

KWT Katz Water Technologies

Kelly Center for Hunger Relief

Kean World-Class Education

Lehigh

Local First Arizona Rural Development

MAX-IR Labs

University of Maryland School of Architecture, Planning & Preservation Maryland's Built Environment School

Meridian Institute

Michigan State University

Missouri S&T University of Science & Technology

Modern Agriculture Foundation Changing Food for Good

Old Dominion University MMARC Monarchs Maximizing Access to Research Careers

Montana State University

Morgan State University

NSF

NM State University

NEWT

NYBG New York Botanical Garden

New York Institute of Technology

North Carolina Agricultural and Technical State University

NC STATE UNIVERSITY

Pathways to Sustainable Urban Water Security

PECAN STREET

PennState

PREL

PURDUE UNIVERSITY

Rensselaer

RICE

ST. ANTHONY FALLS LABORATORY

SDSC SAN DIEGO SUPERCOMPUTER CENTER

SCALE MICROGRID SOLUTIONS

SM SoilMetrics

SOUTH DAKOTA MINES
An engineering, science and technology university

SIU Southern Illinois University CARBONDALE

ESF
State University of New York College of Environmental Science and Forestry

Stony Brook University

SEARCH Study of Environmental Arctic Change

TENNESSEE STATE UNIVERSITY
College of Agriculture

TEXAS A&M UNIVERSITY

Texas Center for Educational Technology TCET

TEPRI Texas Energy Poverty Research Institute

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

The Hunger Consortium
LAUNCH: CAPSTONES

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

The University of Akron

THE UNIVERSITY OF TENNESSEE KNOXVILLE

THE WATER TOWER

UNESCO United Nations Educational, Scientific and Cultural Organization
University of Dundee
Centre for Water Law, Policy and Science under the auspices of UNESCO

Umida AG

USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

USDA Agricultural Research Service

THE UNIVERSITY OF ALABAMA

UAF UNIVERSITY OF ALASKA FAIRBANKS

UNIVERSITY OF ARKANSAS

UCDAVIS VITICULTURE & ENOLOGY

UCLA

UC San Diego

UC Santa Cruz

UC RIVERSIDE

UC SANTA BARBARA

UCONN
UNIVERSITY OF CONNECTICUT

UNIVERSITY OF GEORGIA

UNIVERSITY of HAWAI'I WEST O'AHU
Sustainable Community Food Systems

UNIVERSITY of HOUSTON
COLLEGE of TECHNOLOGY

KU THE UNIVERSITY OF KANSAS

UMBC

Mizzou
University of Missouri

University of Nevada, Reno

UTEP

UNIVERSITY of VIRGINIA

W UNIVERSITY of WASHINGTON

UtahState University

VANDERBILT UNIVERSITY

VinSense TECHNOLOGY

VT VIRGINIA TECH.

WAFERx
WATER AGRICULTURE FOOD ENERGY RESEARCH NEXUS

WASHINGTON STATE UNIVERSITY

WASHINGTON UNIVERSITY IN ST. LOUIS 1853

XENDEE

8.2 WORKSHOP SPEAKERS

Workshop Speakers

PLENARY SPEAKER

Martin Keller

Director, National Renewable Energy Laboratory

Martin Keller has served as Director of the National Renewable Energy Laboratory (NREL) and President of the Alliance for Sustainable Energy, the company that operates NREL for the U.S. Department of Energy, since 2015. Under his leadership, the number of full-time employees at NREL has increased by more than 32%. Martin is a visionary leader who is committed to people, teams, and partnerships. He innovatively and pragmatically applies private sector best practices at NREL to achieve game-changing scientific outcomes. Working collaboratively with his leadership team, Martin developed a strategy for NREL focused on three key initiatives: integrated energy pathways, circular economy, and electrons to molecules. This strategy drives advanced scientific research, programs, projects, and partnerships at NREL. For example, NREL's partnership portfolio—which includes Eaton Corporation, Wells Fargo, Hewlett Packard Enterprise, the New York State Energy Research and Development Authority, and more than 900 private and public sector organizations—has generated over $1 billion of research and development for the Laboratory. From 2006 to 2015, Martin led energy, biological, and environmental research programs at the Oak Ridge National Laboratory (ORNL). His efforts culminated in his being promoted to serve as the Associate Laboratory Director for the Energy and Environmental Sciences Directorate during his last six years at ORNL. Earlier In his career, Martin's dedicated work in a variety of research management positions at Diversa Corporation enhanced and developed the microbiology expertise of this biotech company. Martin received his Ph.D. in Microbiology from the University of Regensburg, Germany.

PLENARY SPEAKER

Christopher Barrett

Professor, Cornell University

Chris Barrett is an agricultural and development economist at Cornell University. He is the Stephen B. and Janice G. Ashley Professor of Applied Economics and Management, and an International Professor of Agriculture at the Charles H. Dyson School of Applied Economics and Management, as well as a Professor in the Departments of Economics and of Global Development, and a Fellow of the Cornell Atkinson Center for Sustainability. He is an elected Fellow of the American Association for the Advancement of Science, the Agricultural and Applied Economics Association, and the African Association of Agricultural Economists, and has won numerous university, national and international awards for teaching, research and policy outreach and public service. He is co-editor-in-chief of the journal Food Policy, edits the Palgrave Studies in Agricultural Economics and Food Policy book series, co-edits the Elsevier Handbook of Agricultural Economics, volumes 5 and 6, and previously edited the American Journal of Agricultural Economics. His more than 350 publications have been cited more than 45,000 times. He has served as a principal investigator on more than $43 million in extramural research grants from various corporate, foundation, government agency and nongovernmental organization sponsors. He has supervised more than 100 graduate students and post-docs now working at leading universities and research institutes worldwide. He has held leadership roles at Cornell and externally and serves on a variety of boards and panels. He previously served on faculty at Utah State University and has been a visiting scholar at Harvard, Melbourne, Monash, Notre Dame, and Stanford Universities.

PLENARY SPEAKER

Martin Bloem

Professor, Center for a Livable Future, Johns Hopkins Bloomberg School of Public Health

Martin W. Bloem, MD, PhD, is the inaugural Robert S. Lawrence Professor and director of the Johns Hopkins Center for a Livable Future in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health. He joined the Center in 2017, after 12 years as a senior nutrition adviser at the United Nations World Food Programme and as a Global Coordinator for the Joint United Nations Programme on HIV/AIDS. At the Center, he is guiding research and programs to adopt a global view of food systems problems, emphasizing the needs of undernourished, low-income populations. Hailing from the Netherlands, Martin earned his medical degree from the University of Utrecht and his doctorate in Nutritional Sciences from the University of Maastricht. His career includes posts in the Netherlands, Thailand, Bangladesh, Indonesia, Singapore and Italy. He has co-authored and co-edited seven books and more than one hundred peer reviewed articles.

PLENARY SPEAKER

Liz Specht

Director of Science and Technology, The Good Food Institute

Liz Specht oversees GFI's Science and Technology department to build a roadmap for accelerating alternative protein research while empowering scientists to execute on this vision. Her areas of expertise are plant-based meat, fermentation, technical analyses, forecasting and modeling, synthetic biology, and public speaking. Liz works to identify and forecast areas of technological need within the alternative protein field. Her efforts also catalyze research to address these needs while supporting researchers in academia and industry to move the field forward. Liz has a bachelor's degree in chemical and biomolecular engineering from Johns Hopkins University, a doctorate in biological sciences from the University of California San Diego, and postdoctoral research experience from the University of Colorado Boulder. Prior to joining GFI in 2016, Liz had accumulated a decade of academic research experience in synthetic biology, recombinant protein expression, and development of genetic tools. She is a firm believer in the power of technology to enable us to meet growing food demands in a sustainable way.

TEAMING & COLLABORATION SESSION

İlkay Altıntaş

University of California San Diego: Chief Data Science Officer, San Diego Supercomputer Center / Founder & Director, WorDS Center of Excellence and WIFIRE Lab / Founding Fellow, Halicioglu Data Science Institute

Dr. İlkay Altıntaş, a research scientist at the University of California San Diego, is the Chief Data Science Officer of the San Diego Supercomputer Center as well as a Founding Fellow of the Halıcıoğlu Data Science Institute. She is the Founding Director of the Workflows for Data Science (WorDS) Center of Excellence and the WIFIRE Lab. The WoRDS Center specializes in the development of methods, cyberinfrastructure, and workflows for computational data science and its translation to practical applications. The WIFIRE Lab is focused on artificial intelligence methods for an all-hazards knowledge cyberinfrastructure, becoming a management layer from the data collection to modeling efforts, and has achieved significant success in helping to manage wildfires. Since joining SDSC in 2001, she has been a principal investigator and a technical leader in a wide range of cross-disciplinary projects. With a specialty in scientific workflows, she leads collaborative teams to deliver impactful results through making computational data science work more reusable, programmable, scalable, and reproducible. Her work has been applied to many scientific and societal domains including bioinformatics, geoinformatics, high-energy physics, multi-scale biomedical science, smart cities, and smart manufacturing. She is also a popular MOOC instructor in the field of "big" data science and reached out to more than a million learners across any populated continent. Among the awards she has received are the 2015 IEEE TCSC Award for Excellence in Scalable Computing for Early Career Researchers and the 2017 ACM SIGHPC Emerging Woman Leader in Technical Computing Award. Ilkay received a Ph.D. degree from the University of Amsterdam in the Netherlands.

CONVERGENCE SESSION

Sarah Beebout

National Program Leader, Sustainable Agriculture Systems, USDA

Dr. Sarah Beebout is National Program Leader for Sustainable Intensification with the U.S. Department of Agriculture's Agricultural Research Service (USDA ARS), based in Beltsville, MD. Her passion is improving the environmental, social, and economic sustainability of food and agriculture systems, including crops, livestock, and people. She has been with ARS since 2019, following 15 years in sustainable cropping systems research at the International Rice Research Institute in the Philippines. She grew up in Iowa, received her BS in chemistry from Wheaton College (IL), her MS in soil chemistry from Texas A&M University (TX), and her PhD in soil science from Cornell University (NY). She has in-depth experience working in multiple cultures within the US and during her time in Asia.

CONVERGENCE SESSION

Crysten Blaby-Haas

Biologist, Brookhaven National Laboratory

Dr. Blaby-Haas is the lead principal investigator of the DOE-sponsored Quantitative Plant Science Initiative at Brookhaven National Laboratory and adjunct professor in the Department of Biochemistry & Cell Biology at Stony Brook University. Dr. Blaby-Haas received her PhD from the University Florida in Microbiology and Cell Science. As a postdoctoral fellow at UCLA, Dr. Blaby-Haas received the prestigious NIH Ruth L. Kirschstein NRSA Postdoctoral Fellowship and the 2015 Boyer-Peter Award for her research on the diverse and complex world of metal usage by plants and algae. In 2015, Dr. Blaby-Haas moved to BNL to establish the Quantitative Plant Science Initiative, a team-oriented consortium of researchers from the National Laboratories, academia, and USDA-ARS who leverage multi-disciplinary research to address the challenge of trace-nutrient limitation to sustainable bioenergy. Dr. Blaby-Haas's research leverages genomics and post-genomic experimentation to discover and understand biological pathways for the biogenesis of enzymes, metabolites, and biomaterials, specifically related to transition metals and photosynthesis. She has over a decade of experience in genome redesign and engineering in prokaryotes (archaea, gram-negative, gram-positive, cyanobacteria) and eukaryotes (algae, plants, yeast), synthetic (Bio-CAD, DNA assembly and gene editing) and systems biology approaches (transcriptomics, proteomics, metabolomics), and HTP assay design.

CONVERGENCE SESSION

Ximing Cai

Lovell Endowed Professor of Civil and Environmental Engineering, Associate Director, Institute for Sustainability, Energy and Environment, University of Illinois at Urbana-Champaign

Professor Ximing Cai is a leading scholar in hydro-economic modeling. His current research areas include integrated food-energy-water systems (INFEWS) analysis and coupled human-natural system analysis with an emphasis of human interferences in hydrological processes. He has authored or co-authored over 190 peer reviewed journal papers, 3 books and several monographs. He is an AGU Fellow and served as Editor for Water Resources Research (Am. Geophysical Union, AGU, 2012-2017). He has worked as a consultant to the World Bank, United Nations and other international agencies. Before joining the faculty of the University of Illinois in 2003, Professor Cai was a Research Fellow at the International Food Policy Research Institute in Washington, D.C. He holds a B.S. in Water Resources Engineering (1990) and an M.S. in Hydrology and Water Resources (1994) from Tsinghua University, Beijing, and Ph.D. in Water Resources Engineering (1999) from the University of Texas at Austin.

CONVERGENCE SESSION

Brian Curtis

Founder & CEO, Concentric Power

Brian Curtis, Founder & CEO of Concentric Power Inc., has over 20 years of engineering, finance and strategic management experience in energy and high growth technology industries. He founded Concentric Power in 2011. Curtis has spent his career in and out of power plants and processing facilities for the energy and food industries. He started his career as a design engineer at the power plant on campus at the University of California, Los Angeles and further honed his mechanical systems design skills as a refinery engineer for Chevron. Curtis later joined the U.S. Department of Energy where he worked within the Energy Efficiency and Renewable Energy (EERE) Group, along with several clean energy startups. Curtis holds a B.S. in mechanical engineering from UCLA, with an emphasis in electro-mechanical systems design and control, and an MBA from MIT.

CONVERGENCE SESSION

John Cushman

Foundation Professor, Graduate Program Director, University of Nevada-Reno

John C. Cushman is a Foundation Professor at the University of Nevada and Director of the Biochemistry Graduate Program in the Department of Biochemistry & Molecular Biology. He earned a B.S. degree in Biology from Ursinus College, and his M.S. and Ph.D. degrees in Microbiology from Rutgers University. He was awarded an NSF postdoctoral fellowship in Plant Biology and conducted postdoctoral research at the University of Arizona on the induction of Crassulacean Acid Metabolism (CAM) by environmental stress. Professor Cushman's research is focused on plant responses to abiotic stress with an emphasis on cold, salinity, drought responses and mechanisms of desiccation tolerance. More recently, his laboratory has used engineered tissue succulence and crassulacean acid metabolism (CAM) to improve the water-use efficiency, salinity, and water-deficit stress tolerance in model plant species with the long-term goal of moving these water-conserving adaptations into food, feed, and (bio)fuel crops enabling production on marginal or abandoned agricultural lands. His laboratory is also investigating the productivity and irrigation response of highly productive CAM crops such as cactus pear (Opuntia spp.) to serve as food and feed sources and as a biofuel feedstock for semi-arid and arid regions of the world. His research is currently funded by the Nevada Agricultural Experiment Station, the National Science Foundation, and the U.S. Department of Agriculture-National Institute of Food and Agriculture. He currently serves on the editorial boards of several journals including The Plant Journal, Journal of Plant Physiology, and the Journal of the Professional Association for Cactus Development.

CONVERGENCE SESSION

Tim Hade

Co-Founder and COO, Scale Microgrid Solutions

Tim Hade (LEED AP) is a co-founder and the Chief Operating Officer at Scale Microgrid Solutions, where he focuses on developing sustainable distributed generation technologies to serve mission critical facilities. Prior to founding Scale, Tim served as the Business Development Manager for ENER-G Rudox (now Centrica Business Solutions), where he oversaw development of the company's microgrid projects. In 2015, Tim's white paper "Sustainable Load Balancing: Integrating Distributed Natural Gas, Solar PV, and Energy Storage Assets" was named the 2015 Renewable Energy World Paper of the Year. Prior to joining the clean tech industry, Tim served on Active Duty as an officer in the United States Air Force. He holds a B.S. from the United States Air Force Academy, an MBA from Stanford University.

CONVERGENCE SESSION

Alex Grossman

Director of Communications, Global Greengrants Fund

Alex Grossman is the Director of Communications at Global Greengrants Fund. She has a background in indigenous rights, women's rights, and environmental policy. Alex previously developed communications content and strategy for The Center of Effective Global Action at U.C. Berkeley and The Climate Reality Project. Alex has a M.A. in Latin American Studies and International Development from Boston University and B.A.s in International Relations and Anthropology from the University of Colorado Boulder.

CONVERGENCE SESSION

Craig Gundersen

Professor, University of Illinois

Craig Gundersen is ACES Distinguished Professor and Director of Undergraduate Studies in the Department of Agricultural and Consumer Economics at the University of Illinois, is on the Technical Advisory Group for Feeding America, is the lead researcher on Feeding America's Map the Meal Gap project, and is the Managing Editor for Applied Economic Perspectives and Policy. He is also a Round Table Fellow of the Farm Foundation, a Faculty Affiliate of the Wilson Sheehan Lab for Economic Opportunities (LEO) at the University of Notre Dame, and a Research Fellow at the Baylor Collaborative on Hunger and Poverty. His research concentrates on the causes and consequences of food insecurity and on the evaluation of food assistance programs, with an emphasis on SNAP.

CONVERGENCE SESSION

Michael Kudenov

Associate Professor, North Carolina State University

Dr. Kudenov obtained his BS in Electrical Engineering from the University of Alaska Fairbanks in 2005 and his PhD in Optical Sciences from the University of Arizona in 2009. He is currently an Associate Professor in Electrical and Computer Engineering at North Carolina State University. His research interests focus on use-inspired imaging spectrometer and polarimeter sensors for applications spanning agriculture, plant phenotyping, space situational awareness, and quality control. He also serves as the academic advisor for the NC State SPIE student chapter.

CONVERGENCE SESSION

Dirk Maier

Professor, Agricultural and Biosystems Engineering, Iowa State University

Dr. Maier is a Professor and Post-Harvest Engineer in the Department of Agricultural and Biosystems Engineering, the Department of Animal Science, and the Department of Food Science and Human Nutrition at Iowa State University where he is responsible for leading an internationally recognized research and outreach program in post-harvest engineering and technology applied to global food and nutrition security. He serves as the director and lead PI of the International Consortium for Innovation in Post-Harvest Loss and Food Waste Reduction which focuses on building academic and entrepreneurial capacity of the next generation by facilitating multi-institutional projects, providing linkage to its members, collaborators, and larger network to successfully conduct a range of capacity building programs for sustainable food systems. Dr. Maier is a registered professional engineer, a fellow of the American Society of Agricultural & Biological Engineers, and a member and officer of several academic, professional and scholarly societies. He has traveled extensively throughout the world as a speaker and participant in many national and international industry meetings, scientific conferences, and technical assistance projects. He currently has active projects in the U.S., Tunisia, Ghana, Uganda, Kenya, Tanzania, and Rwanda. His most recent graduate students are from the U.S., Ivory Coast, DR Congo, Rwanda, Uganda, Ghana, and the Philippines.

CONVERGENCE SESSION

Sruthi Narayanan

Assistant Professor, Crop Eco-physiology, Clemson University, Department of Plant and Environmental Sciences

Dr. Sruthi Narayanan, an assistant professor of crop eco-physiology, joined the department of Plant and Environmental Sciences at Clemson University in 2015. She grew up in a farming family and knew the challenges of production agriculture which was her motivation to pursue a career as a crop scientist. She earned her bachelor's degree in Agriculture in 2007 from Kerala Agriculture University, India and a Master's degree in Agronomy in 2011 and Ph.D. in Agronomy in 2015 from Kansas State University. Her passion has led to the development of a cutting-edge research program at Clemson, focusing on interdisciplinary research, relating climate change, food security and sustainable agriculture. Her two broad research themes are crop response and adaptation to climate change and improving field crop production through sustainable agronomic practices. Her research program focuses on understanding how different crops develop responses to abiotic stresses, such as drought or heat, at various levels – field, plant, cellular, and molecular. Her novel lipidomic approach to characterize plant heat tolerance is widely acclaimed. Her nationally recognized research program finds its roots in stakeholder needs as she spearheads the mandate of the Land Grant system's mission. Dr. Narayanan combines instruction and research to engage students and promote critical thinking. She teaches graduate and undergraduate courses, offer internship training to undergraduates in her laboratory, and through a well-funded program, advises Master's and PhD students. Her goal is to prepare future generation of scientists who would carry the vision of sustainable cropping systems which provide food security for all.

CONVERGENCE SESSION

Megan O'Rourke

National Program Leader, Sustainable Agriculture Systems, USDA

Dr. O'Rourke is an agroecologist with scientific expertise in conservation, pest management, and climate change. Prior to joining NIFA, Dr. O'Rourke was an associate professor of Sustainable Food Systems at Virginia Tech and served as a climate change advisor in the U.S. Foreign Agricultural Service (FAS) and Agency for International Development (USAID). She has led research in the U.S. to develop and evaluate on-farm conservation strategies for field crops, vegetables, and grasslands, and in S.E. Asia to advance sustainable pest management for vegetable production. She holds a Ph.D. in Ecology from Cornell University, an M.S. in Entomology from Iowa State University, and a B.S. in Biology from Stony Brook University.

CONVERGENCE SESSION

Zack Pecenak

Lead Engineer, XENDEE Inc.

Zack Pecenak, PhD. is the lead engineer at XENDEE Inc. He is a thought leader in the microgrid space and has worked extensively on agriculture energy projects. Before Joining XENDEE he was a researcher with UCSD and the Air Force Research Lab.

CONVERGENCE SESSION

Shaked Regev

Director of International Engagement, The Modern Agriculture Foundation

Shaked holds a B.Sc. and M.Sc. in Biomedical Engineering from Ben Gurion University and is currently a PhD student at the Institute of Computational and Mathematical Engineering at Stanford University. His research involves physical, mathematical, and computational modeling of biological and energy systems. Shaked is Director of International Engagement and Co-founder at "The Modern Agriculture Foundation" (MAF), an Israeli non-profit organization set out transform global food culture by replacing traditional animal-based foods with Clean Meat, Cellular Agriculture and plant-based alternatives. MAF was founded in 2014 and was the first organization in Israel with this focus. Due in large part to MAF's work over the years, Israel has become a world pioneer in the field of alternative proteins. In addition to overall oversight, Shaked's main fields of contribution at "The Modern Agriculture Foundation" are fundraising, lecturing, media, writing and translating. Shaked aspires to make commercial clean meat a reality, both with his work at the foundation and, in the future, as a researcher in the field.

CONVERGENCE SESSION

Erik Runkle

Professor / Floriculture Extension Specialist, Department of Horticulture, Michigan State University

Dr. Erik Runkle is a Professor and Extension Specialist in the Department of Horticulture at Michigan State University. Erik obtained a B.S. in Ornamental Horticulture from the University of Illinois and an M.S. and Ph.D. in Horticulture at Michigan State University. Since he joined the faculty in 2001, he and his graduate research team have performed numerous practical experiments in controlled environments to determine the effects of light, temperature, and other environmental factors on plant growth and development. Experiments have been performed on a wide range of herbaceous specialty crops including leafy greens and ornamentals. Erik recently developed the Controlled-Environment Lighting Laboratory to better understand how the photon spectrum can be manipulated to produce crops with desired attributes. He is the director of OptimIA, a USDA-supported Specialty Crop Research Initiative project on improving the profitability and sustainability of indoor leafy-greens production.

CONVERGENCE SESSION

Luke and Yvonne Rosenbohm

Owners of Better Earth Logistics (Peoria, Illinois)

Luke grew up in Peoria working on a farm and helping his parents start Better Earth Compost and is now a retired Air National Guard Pilot with a degree in Aviation management. Yvonne was a dance instructor and outreach worker in Scotland before marrying Luke and moving to the United States in 2012. They are now the proud owners of Better Earth Logistics, offering custom recycling services for food scraps in Central Illinois focused on closing the loop of sustainability through end-to-end composting services. The company launched in 2015 to be a hauling solution for a customer of Better Earth Compost. After testing the waters with the seasonal work, they quickly saw the need to divert more food scraps from the landfill and help other businesses go green. They have focused on education, creating practical solutions, and teaching the younger generation with the goal of making composting the norm not the exception. The best part about this small business is seeing real results with multiple closed loops where nothing is wasted and the earth wins!

CONVERGENCE SESSION

Heike Sederoff

Professor of Plant Biology, North Carolina State University

Dr. Heike Sederoff is a Professor at North Carolina State University, where she is involved in research, teaching and training. She serves as the chair for the Systems and Synthetic Biology Cluster at NCSU and is a member of the NCSU Research Leadership Academy. Her research interest and experience combine the elucidation of basic plant signaling pathways to sense and respond to environmental changes and the genetic engineering of novel pathways to improve plant performance and resilience for sustainable agriculture. She received her undergraduate and graduate training at the University of Goettingen in Germany and was awarded a postdoctoral fellowship from the Alexander-von-Humboldt Foundation to research the molecular interactions of plants and microbes at the Flinders University in Adelaide (South Australia) and University of Western Australia (Perth). Dr. Sederoff has successfully led large research projects funded by NASA, DOE, NSF and USDA. Research under her guidance let to discoveries disseminated as publications and patents. As a coPI and trainer of two graduate training programs funded by the NIH and NSF in "Molecular Biotechnology" and "Agricultural Biotechnology in Food, Energy, and Water Systems" she is training students in inter- and cross disciplinary projects. Dr. Sederoff is actively involved in several international projects. She is leading a research effort to improve native crops (lupin, quinoa) via gene editing at the University in Arequipa, Peru, and collaborating on a large research project with Danish universities to evaluate the molecular basis for crop improvement using soil microbial communities.

CONVERGENCE SESSION

Rick Vanzura

CEO, Freight Farms

Rick Vanzura joined Freight Farms as CEO after 20+ years spent in executive roles at major consumer brands, the most notable being his role as the original CEO of Wahlburgers where he grew the burger concept from a single unit to a $100 million brand. Rick's leadership focuses on transforming and growing consumer and technology-enabled businesses, which he combines with a passion for sustainability. Originally from Albuquerque, NM, Rick received his BsC from Santa Clara University and his MBA from Harvard University.

CONVERGENCE SESSION

Shuyang Zhen

Assistant Professor, Texas A&M University

Shuyang Zhen is an assistant professor in Controlled Environment Agriculture in the Horticultural Sciences Department at Texas A&M. She received her Ph.D. in Horticulture from University of Georgia in 2017 and worked as post-doctoral fellow and then research scientist in the Crop Physiology Laboratory at Utah State University from 2017 to 2020. Her current research focuses on environmental plant physiology and the optimization of specialty food and ornamental crop production in controlled environments. Her research interests include photosynthesis and crop yield, LED lighting, plant nutrition, hydroponics, and the selection of crops with improved performance in greenhouses and indoor vertical farms.

DAY 1 Wednesday, 19 May 2021

12:00 - 1:30 PM ET

Welcome Plenary

- *Opening Remarks:* Deidra R. Hodges, The University of Texas at El Paso, Associate Professor, Solar Energy, Energy Sustainability, Energy Harvesting, Photovoltaics and Radiation Detection
- *National Science Foundation Convergence Accelerator Program:* Michael Pozmantier, Program Manager, National Science Foundation
- View keynote speakers

1:45 - 3:15 PM ET

Workshops #1 and #2

See workshop topics below. *"Invite only"*

3:30 - 4:00 PM ET

Integration Breakouts

"Invite only"

1:45 - 3:15 PM ET

Innovation, Convergence and Acceleration: Open-Mic

Join a live forum for sharing innovative solutions that will accelerate food security in extreme environments and food deserts through cross sector and cross-disciplinary partnerships.

WORKSHOP #1 TOPICS

Food Security and Sustainable Food Systems

1a | Sustainable Agriculture: Precision, Controlled Environment, Alternative, Next Generation and other Smart Farming and Artificial Intelligence Solutions
1b | Supply Side: Food Production and Distribution. Demand Side: Society, Consumers, Food Preference and Access
1c | Plant Growth Models, Selection and Pathology. Plant: Science, Physiology, Agroecology, Biology, Genomics, and Breeding

WORKSHOP #2 TOPICS

Renewable Energy and Sustainable Water Resources

2a | Smart Microgrids, Photovoltaics, Wind and Battery Storage
2b | Pushing the Bounds: Finding Food Solutions in Extreme Environments
2d | Transdisciplinary Water Management – Opportunity for Food Security
2e | Brackish Groundwater, Reclamation and Desalination

DAY 2 Thursday, 20 May 2021

12:00 - 1:30 PM ET

Convergence Panel Session #1

> View speakers

1:45 - 3:15 PM ET

Workshops #3 and #4

See workshop topics below. **Invite only**

1:45 - 4:00 PM ET

Lightning Talks

Talks are available to watch here!

3:30 - 4:00 PM ET

Integration Breakouts

Invite only

WORKSHOP #3 TOPICS

Sustainable, Integrated and Smart Systems

3a | Hands-off intensive Agriculture: Automation, Robotics, and Sensors
3b | Artificial Intelligence, Machine Learning, Big Data, and Analytics
3c | Agronomy, Soil, Crops, and Policy
3d | Data Collection, Communication, Systems, and Controls
3e | Materials for Energy and Sustainable Systems

WORKSHOP #4 TOPICS

Social Engagement, Policy, Education & Workforce Development

4a | Food and Social Policy, Ethics, Engagement and Economics
4b | Education and Workforce Development, and Jobs Creation
4c | Stakeholder Roundtable: Academia, Industry, Government, NGOs, Foundations, and Others

DAY 3 Friday, 21 May 2021

12:00 - 2:00 PM ET

Convergence Panel Session #2

> View speakers

2:15 - 3:15 PM ET

Teaming, Collaboration and Community

- **Deidra R. Hodges**, The University of Texas at El Paso, Associate Professor, Solar Energy, Energy Sustainability, Energy Harvesting, Photovoltaics and Radiation Detection
- **İlkay Altıntaş**, University of California San Diego: Chief Data Science Officer, San Diego Supercomputer Center / Founder & Director, WorDS Center of Excellence and WIFIRE Lab / Founding Fellow, Halicioglu Data Science Institute [view bio]

3:15 - 3:45 PM ET

Closing Ceremony

8.4 Organizing Committee

Organizing Committee

Deidra R. Hodges

The University of Texas at El Paso
Associate Professor, Solar Energy, Energy Sustainability, Energy Harvesting, Photovoltaics and Radiation Detection

Mark A. Engle

The University of Texas at El Paso
Professor, Geochemistry, Hydrogeology, Drylands, Soil Quality, Agricultural Sustainability, Biodiversity-ecosystem Functioning

Gregory S. Schober

The University of Texas at El Paso
Assistant Professor, Social Policy, Political and Civic Engagement, and Global Health

Sreenath Chalil Madathil

The University of Texas at El Paso
Assistant Professor, Resilient Power Network Design and Smart and Sustainable Systems

Malynda A. Cappelle

The University of Texas at El Paso
Associate Director, Center for Inland Desalination Systems

Ximing Cai

University of Illinois at Urbana-Champaign
Lovell Endowed Professor of Civil and Environmental Engineering; Associate Director, Institute for Sustainability, Energy and Environment

Brendan O'Connor

North Carolina State University
Associate Professor, Mechanical and Aerospace Engineering, Organic Semiconductors for Advanced Sensing, Energy Harvesting, and Agriculture

Victoria Finkenstadt

National Institute of Food and Agriculture, U.S. Department of Agriculture
National Program Leader, Division of Agricultural Systems, Institute for Food Production and Sustainability

Janie McClurkin Moore

Texas A&M University
Assistant Professor, Post-harvest, Oxidative Degradation, Agricultural and Biological Engineering

Workshop Facilitators

Molly Mayo
Meridian Institute
Senior Partner

Jeana Holer
Meridian Institute
Senior Project Coordinator

Seth Blum
Meridian Institute
Project Associate II and Ruckelshaus Fellow

Annika Freudenberger
Project Consultant, Website Designer

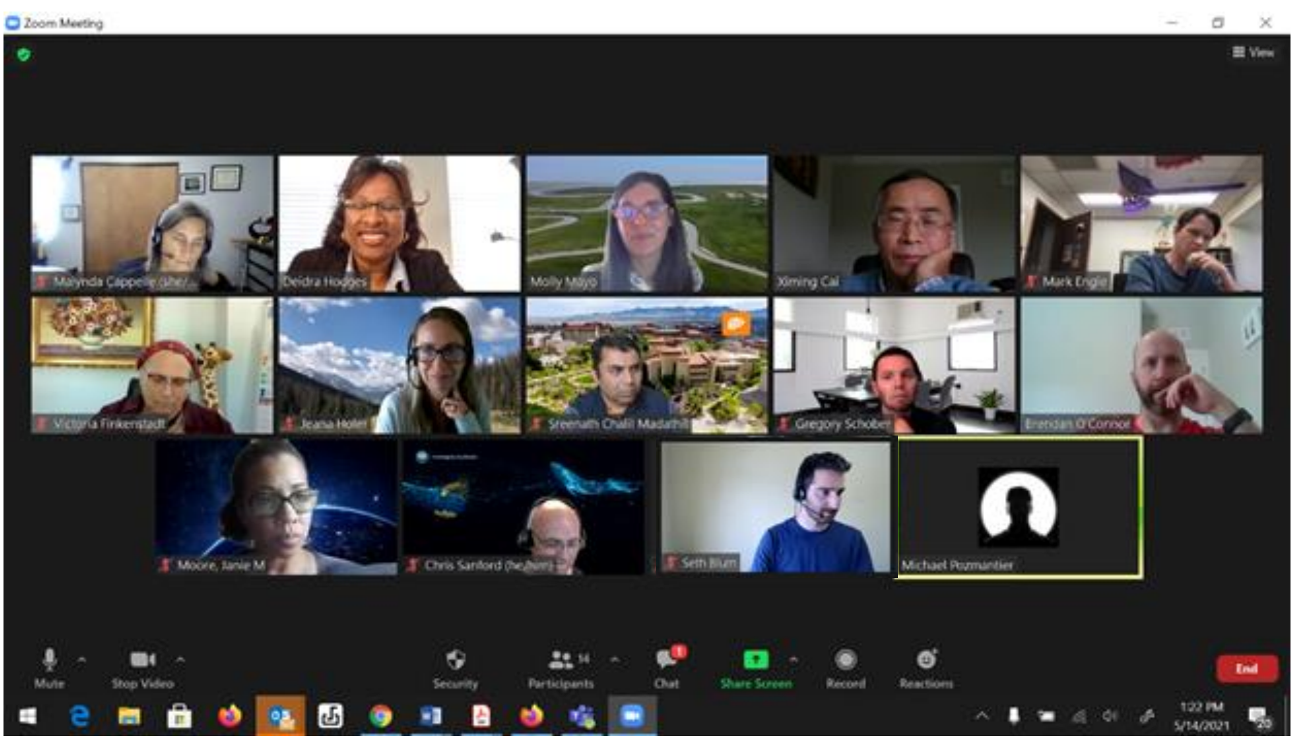
Supported by

Christopher Sandford
National Science Foundation (NSF)
Program Director, Convergence Accelerator

Mike Pozmantier
National Science Foundation (NSF)
Program Director, Convergence Accelerator

Barbara Ransom
National Science Foundation (NSF)
Program Director, GEO, IUCRC

Laura Lautz
National Science Foundation (NSF)
Program Director, EAR, HS SRS RNs



8.5 LIST OF PLENARY AND LIGHTNING TALKS

Day 1: Welcome Plenary, Keynote Speakers, & Open Mic.

Below we provide the schedule and links to Day 1 (May 19, 2021), which featured the welcome plenary and four keynote speakers spanning energy, systems, sustainable development, and alternative proteins. The embedded links are for the videos of the talks.

12:00 - 1:30 PM ET: Welcome Plenary

Opening Remarks:

- Deidra R. Hodges, The University of Texas at El Paso
- Michael Pozmantier, Program Manager, National Science Foundation

Keynote Speakers:

- "Accelerating Clean Energy: Contributing to Food Security and Equitable Outcomes" Martin Keller, National Renewable Energy Laboratory
- "Why Socio-Technical Innovation Bundles for Agri-Food Systems Transformation?" Christopher Barrett, Professor, Cornell University
- "The Sustainable Development Goals are Global Goals and Complex: The Need for a Different Approach", Martin Bloem, Johns Hopkins Bloomberg School of Public Health
- "Investment in Alternative Protein R&D to Accelerate the Transition Toward Sustainable, Secure Protein Production Methods" Liz Specht, The Good Food Institute

Because we had such a high demand for participation in the Convergence Workshops, we decided to hold an Open Mic event for interested participants. Participants that attended this lively session were able to speak, discuss questions, and participate in a convergence session led by Dr. Deidra Hodges and facilitated by Meridian.

Day 2: Convergence Session 1

The first convergence session was held on Day 2 (May 20, 2021), which included eight speakers from a variety of industry, government, non-government agencies, and academia. The embedded links are for the videos of the talks.

Convergence Session 1

- "Sustainable food systems for future climates" Sarah Beebout, USDA
- "Proven Paths to Reducing Food Insecurity in the United States" Craig Gundersen, University of Illinois (bonus video at end is here)
- "Indoor Farming: Improving Photosynthetic Lighting Efficiency for Higher Yield" Shuyang Zhen, Texas A&M University
- "Optimization Based Microgrid and DER Modelling" Zack Pecenak, Xendee

- "SUSTAINABLE ENERGY INFRASTRUCTURE FOR AG AND FOOD PRODUCTION: Ranch-scale, Industrial-scale and Community-scale Microgrids" Brian Curtis, Concentric Power
- "Indoor Farming of Leafy Greens" Eric Runkle, Michigan State University
- "Food Insecurity and Resilience: A Return to Traditional Knowledge and Agriculture as a Grassroots Climate Solution" Alex Grossman, Global Greengrants Fund
- Rick Vanzura CEO, Freight Farms

Day 3: Convergence Session 2, Teaming, Collaboration, and Community, and Closing Ceremony

The second convergence session was held on Day 3 (May 21, 2021), which included ten speakers from a variety of industry, government, non-government agencies, and academia. The embedded links are for the videos of the talks.

Convergence Session 2:

- "Balancing Trace Metal Nutrition for Food and Fuel" Crysten Blaby-Haas, Brookhaven National Laboratory
- "Sustainability, Profitability and Climate Adaptability of Agronomic Systems" Sruthi Narayanan, Clemson University
- "Climate-resilient Crops for a Hotter, Drier World" John Cushman, University of Nevada-Reno
- "Using Polarized Light to Improve High Throughput Phenotyping" Michael Kudenov, North Carolina State University
- "For Indoor Farming to be Scalable It Must Be Sustainable" Tim Hade, Scale Microgrid Solutions
- "Engineered Biology in Engineered Environments" Heike Sederoff, North Carolina State University
- "Developing converging solutions to complex water management problems: opportunities for food security" Ximing Cai, University of Illinois at Urbana-Champaign
- "Global Perspective on Food Security and Sustainable Food Systems" Dirk Maier, Iowa State University
- "Opportunities at USDA-NIFA to Tackle Food Security in Extreme Environments & Food Deserts" Megan O'Rourke, USDA
- "Making composting the norm, not the exception" Luke and Yvonne Rosenbohm, Better Earth Logistics

Teaming, Collaboration and Community

Dr. Deidra Hodges hosted a conversation about Teaming, Collaboration, and Community with Phase 1 recipient İlkay Altıntaş from the University of California at San Diego. This was a great opportunity to learn from Dr. Altıntaş' experience with Phase 1 and Phase 2 proposal development and project logistics.

8.6 SUBMISSION FORM

Registration Form

Before completing this registration form, please take a moment to view the NSF Convergence Accelerator video here.

1. First Name:

2. Last Name:

3. Email:

4. Affiliation:

5. Position/Title (Professor, PI, CEO, VP, Director, Engineer, Student, etc.):

6. Stakeholder Group: ☐ Academia ☐ Foundation ☐ Government Agency ☐ Industry ☐ NGO ☐ Other - Please specify:

7. How will your experiences and skills help address food security in extreme environments? (100 words or less)

8. This NSF-sponsored Convergence Accelerator workshop features concurrent workshop breakout sessions, for a selected number of participants. These sessions are expected to be interactive and focused on identifying pathways to sustainable systems enabling food security in extreme environments and food deserts employing a convergence of food, energy, water and systems, and team formations. If you would like to be an active participant in these breakout sessions (as opposed to an observer), please select your top choices, up to 3 selections. **Breakout sessions will be capped at a size to facilitate convergence and discussion, so everyone may not be assigned to a breakout session.**

First choice: Choose an item. **Second choice:** Choose an item. **Third choice:** Choose an item.

Workshops	Breakout session #	Breakout Sessions
#1 Food Security and Sustainable Food Systems	**1a**	Sustainable Agriculture: Precision, Controlled Environment, Alternative, Next Generation and other Ag Smart Farming and Artificial Intelligence Solutions
	1b	Supply Side: Food Production and Distribution Demand Side: Society, Consumers, Food Preference and Access
	1c	Plant Growth Models, Selection and Pathology Plant: Science, Physiology, Agroecology, Biology, Genomics, and Breeding
	1d	Organic, Regenerative and Permaculture

		Agronomy, Soil Management and Crop Production
	1e	Plant: Policy, Economics and Ethics
#2 Renewable Energy and Sustainable Water Resources	**2a**	Smart Microgrids, Photovoltaics, Wind and Battery Storage
	2b	Extreme Environments, Arid Climates, Artic and Space
	2c	Materials for Energy and Sustainable Systems
	2d	Water Management, Rain Harvest and Water Storage
	2e	Brackish Groundwater, Reclamation and Desalination
#3 Sustainable, Integrated and Smart Systems	**3a**	Integration, Automation, Smart Sensors and Robotics
	3b	Artificial Intelligence, Machine Learning, and System Models
	3c	Big Data and Data Analytics
	3d	Internet-of-Things (IoT) Systems, Remote Sensing and Imaging
	3e	Wireless Communication, Networking, Systems and Controls
#4 Social Engagement, Policy, Education & Workforce Development	**4a**	Food and Social Policy, Ethics, Engagement and Economics
	4b	Education and Workforce Development, and Jobs Creation
	4c	Small Business Startups, Venture Capital, Entrepreneurship, Follow-on funding, and Investment Opportunities
	4d	Stakeholder Roundtable: Academia, Industry, Government, NGOs, Foundations, and Others
	4e	Developing partnerships and collaborations with local agriculture

9. **Lightning talks:**

The conference will be open to all registrants to attend, observe, and ask questions. We also have a limited number of slots for lightning talks. The **lightning talks** (3-5 minutes) are expected to be about emerging solutions that can be applied to sustainable food systems in extreme environments and/or ongoing efforts by researchers/industry/foundations/government agencies in this area. Lightning Talks should contain original content, preferably with a slideshow). If you are interested and willing to submit a lightning talk, please provide a title and short description below. If selected, a link will be sent to your email to upload your talk. Instructions for preparing the presentation/talk are listed on the website.

10. **Social media challenge:**

Use your preferred social media platform (eg. TikTok, Twitter, Instagram, Facebook, LinkedIn, Youtube, Pinterest, etc.) to create an original, impactful, artistic and illustrative creation about sustainable systems enabling food security in extreme environments and food deserts employing a convergence of food, energy, water and systems. Use hashtags #NSFFunded and #NSFConvergenceAccelerator. Share your content with smc2021@ConvergentFoodSystems.org. Send a screen shot or another way to show engagement, eg. likes and shares.

You must be registered to participate. Content must be original. Winners will be announced on day 3 of the workshop.

11. **Code-of-conduct:**

By submitting this form, you agree to abide by the workshop's code-of-conduct below.

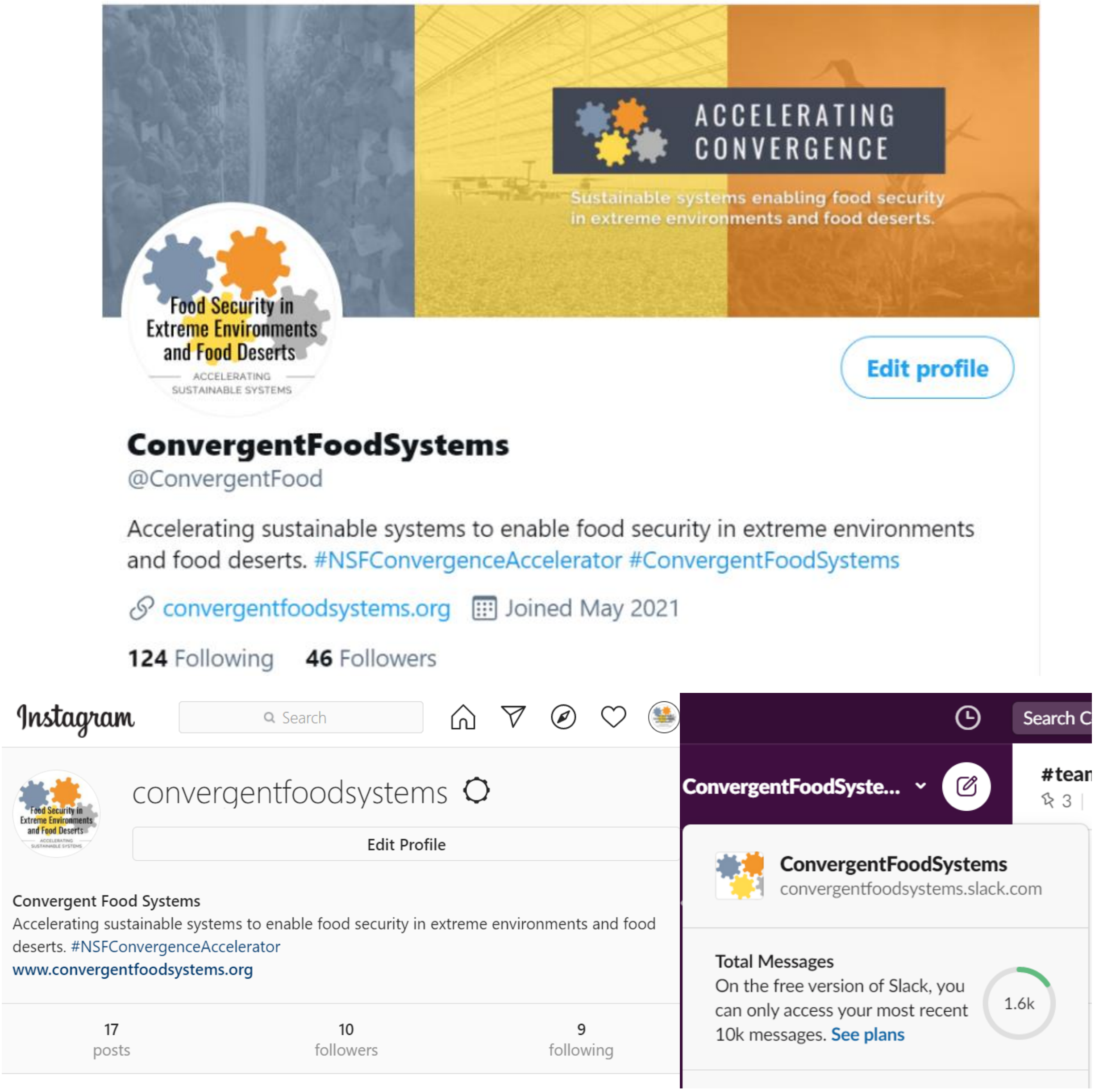
All attendees, speakers, sponsors and volunteers at our conference are required to agree with the following code of conduct. Organizers will enforce this code throughout the event. We expect cooperation from all participants to help ensure a safe environment for everybody.

Our conference is dedicated to providing a harassment-free conference experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. We do not tolerate any form of harassment of conference participants in any form. Sexual language and imagery are not appropriate for any conference venue, including talks, workshops, parties, Twitter and other online media. Conference participants violating these rules may be sanctioned or expelled from the conference at the discretion of the conference organizers.

If you are being harassed, notice that someone else is being harassed, or have any other concerns, please contact a member of conference staff immediately (staff@ConvergentFoodSystems.org).

8.7 Social Media Engagement

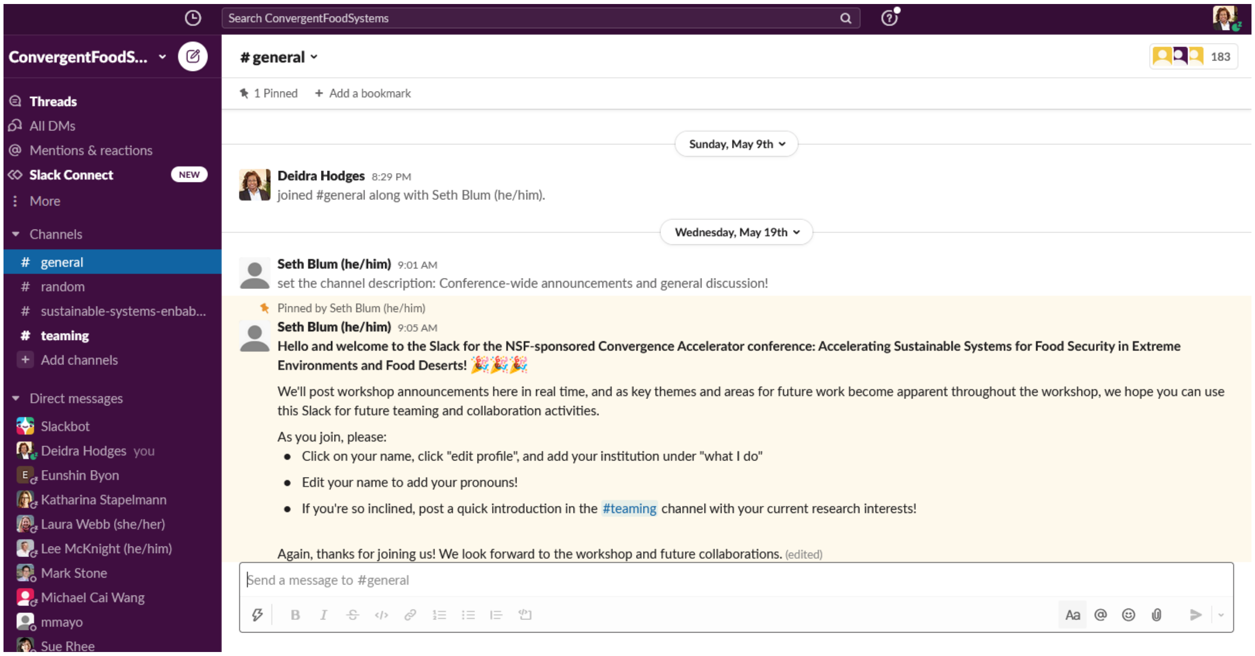
Throughout the conference, the members of the organizing committee and Meridian team utilized Twitter, Instagram, and later, Slack, to communicate about speakers, themes, and ask for input. By the end of the conference our group gained 46 followers on Twitter, 10 followers on Instagram, and 183 members on Slack.



8.8 SLACK COMMUNITY – TRACKS AND TEAMING

A slack community was created with 183 active members who exchanged 1,560 messages.

https://tinyurl.com/convergentslack



Deidra Hodges
Proposed Tracks and Deliverables: All we are thinking of tracks and corresponding deliverables to include in the final report to NSF that might be used in the solicitation. Below are our initial thoughts. Please feel free to add to the list, so that we can begin to converge in the teaming session on Friday! Remember: 10-20 teams per track will be selected, and only 2-3 tracks, for Phase I.

#1. Sustainable energy production for agriculture in extreme environments - Models, planning, design and policy
#2. Idea for a track: Predicting future food deserts - climate, population growth, and regional resource diminishment. (data and modeling and forecasting)
#3. Utilization, efficiency, and treatment of non-traditional water sources in food deserts. [formerly: One water focused theme can be on the utilization, efficiency, and treatment of low quality water sources for food creation]
#4. Work force development and education

Stephen Boss
I have interests in systems dynamics of the global agriculture system and partitioning of agricultural energy output among various reservoirs and flow paths.

Rick Vanosdall(he/him)
I have interests in education, teacher development, interdisciplinary/holistic practices, and appropriate integration of learning across multiple literacies. This includes, specifically, exploring/testing/experimenting with curriculum and teacher development to transform established perspectives limited by "old/non-sustainable" perspectives for teaching and learning. (edited)

Laura Webb (she/her)
I'm a geologist with expertise in solid Earth systems (petrology/tectonics/geochronology/(micro)structure) and growing interests in medical geology.

Janie Moore
Howdy All... just to briefly introduce myself, my name is Janie Moore and I'm an Assistant Professor in the Biological and Agricultural Engineering department at Texas A&M University...(that's why i said Howdy instead of Hello). I'm already enjoying this accelerator. my research is focused on engineering post-harvest treatment technologies for two purposes; 1) reduce food spoilage and increase shelf-life and 2) transform agro-industrial waste into higher value chemicals.

Mark Engle
I am a hydrogeologist interest in the utilization of brackish, saline, and waste waters from industrial processes to either be used directly for food or to offset freshwater uses to increase freshwater availability.

Esra Buyuktahtakin Toy
Hi all, I am an associate professor in industrial engineering and operations research. I am focusing on optimal resource allocation at the food-energy-water nexus to minimize costs and environmental footprint using mathematical modeling and data science tools.

Eunshin Byon
I am an associate professor in the industrial and operations engineering at University of Michigan. I have expertise in data analytics in energy and environmental systems. I am interested in understanding the influence of the climate change/extreme weather conditions on the energy, environmental and food systems and developing mitigation strategies.

Katharina Stapelmann
Hi everyone! I'm an Assistant Professor in the Nuclear Engineering department at North Carolina State University. I use technical plasmas (the 4th state of matter) for life science applications. We can generate reactive oxygen and nitrogen species by using air and electricity. I'm leading an internal large-scale seed funding project in which we investigate the use of plasma-treated water to fix nitrogen from air as fertilizer for "fertigation on demand" in combination with fiberoptic soil sensors for water and nitrogen content. I'm looking for collaborations in particular for combining our "fertigation on demand" system with renewable energies

Piran Kidambi
My group's interests are in catalysis for nitrogen fixation and membranes for water purification.

Mustafa Ozkaynak
Hello All! I am interested in (1) designing technology based interventions to change food practice related behavior; (2) Implementation science particularly on large scale societal interventions.

Lee McKnight (he/him)
Hi everyone, I am an associate professor in Syracuse University's School of Information Studies (iSchool). My prior research led to the development of the Internet Backpack, a sustainable edge connectivity system/microgrid, developed following prior NSF research projects, now in early use including in sustainable agriculture education by rural and indigenous communities, and in extreme environments (e.g., volcano observatories) in about a dozen countries. Also, I am involved with NIST Office of Cyber-Physical Systems, which does smart grid, IoT, and smart city standards. Plus, in pre-historic times, I was a (family) wheat farmer/laborer in my high school and college years...so have some knowledge of agriculture if not expertise like you all! :)

Andrea Pierce
I'm associate professor in the Biden School of Public Policy at the University of Delaware. I study urban policy and governance and have an interest in better understanding how to overcome coordination

challenges across institutions and organizations in urban climate and resilience space, including recently on the food-water-energy nexus.

Caitlin Grady
Nice to meet you all - I am an Assistant Professor working on the boundary of systems and socio-technical analyses in the Water-food-energy nexus. I'm at Penn State and I have a joint appointment between engineering and liberal arts. www.fewslab.org

Lih Y. Lin
Hi everyone, I am a professor in the Electrical and Computer Engineering Department at the University of Washington. I am interested in developing innovative light sources to reduce the cost and increase the output for indoor farming.

Toni Kazic
hello all! I'm a computational biologist studying complex phenotypes. Right now: we're using deep learning to interpret aerial imagery captured by cheap, consumer-grade drones; modelling complex phenotypes mathematically and computationally; and building simple machines to help with our maize research crop. I'm at the University of Missouri in the Electrical Engineering and Computer Science department.

Ruchie Pathak
Hi everyone! I am a PhD student at the University of Alabama. I'm currently working towards understanding the barriers to irrigation technology adoption here in Alabama. Broadly, being a social scientist my interests are in studying human-environmental interactions such as adoption of sustainable practices, evaluation of conservation practices, participatory resource management, among others. Have a good day you all!

Susanne Wiesner
Hi everyone, I am a Dairy Innovation Hub postdoc fellow at the University of Wisconsin working on understanding how shifts from conventional cropping systems to perennial systems can improve soil health and how this could translate to financial compensations for ecosystem services, co-benfits, etc., and thus understanding economic sustainability as a whole. A big interest of mine would be to collaborate with other scientists on the social side, which includes a more thorough understanding of the adoption likelihood of more sustainable farming practices by land managers

Kwame Awuah-Offei
Hi, I'm a mining engineer leading a group of engineers and scientists who work on natural (energy critical minerals and water) resource systems. We are interested in working on how to bring degraded lands into food production (especially those impacted by mineral extraction). We need collaboration with food systems and community engagement experts.

Mingming Lu
I am an environmental engineer and do research to make use of food waste, such as spent coffee grounds or trap grease, can be separated from the mixed stream, and upcycled for energy and as soil amendments, to replenish the food/energy/water needs of communities. These result in technology innovation, education/outreach and commercialization opportunities. I have a lightening talk too.

I have expertise in making biochar from urban biomass waste and use it as a soil amendment, to reduce water and nutrient use. Biochar can also be used for water pollutant removal, e.g. heavy metals/PCBs, etc.
Padhu Seshaiyer
Greetings everyone. My name is Padhu and am a computational mathematician, mathematical modeler, data scientist and also work in programs that engage the next generation workforce in STEM Education. Would love to work together in both the modeling aspects, for eg. food borne diseases, supply chain modeling etc. I am also interested in working together on creating sustainable solutions for innovation and workforce development programs for K-12, Community College and Undergrad/Grad research as well as teacher professional development connecting challenges centered around food to buidling curriculum maps and creating integrated content and enhancing pedagogical practices.

Padju Seshaiter We are a small CC and are doing Energy and Water education online. We have had NSF grants that supported us in getting our curriculum online. With a hands-on component. And we are also focusing on workforces development and partnering with high schools to get students started in their senior years. https://www.nweei.org/ Good things are happening. And teams are crucial. No more silos!
nweei.org
NWEEI | Education and Training for Energy & Water Professionals
The Northwest Water and Energy Education Institute (NWEEI) provides water and energy training opportunities for both the novice and practicing industry professional.

Amit Majumdar
Hello everyone. This is Amit Majumdar from the San Diego Supercomputer Center (SDSC) at the University of California San Diego. I am learning from all of you about food science, agricultural science and all the other associated topics of this workshop. I am interested to see if I can contribute in the areas where data guided analytics and eventually AI are used for decision making or in any other way. And another associated area, I feel, is what kind of cyberinfrastructure i.e. CI (computing, high performance computing, cloud computing, storage, network (say wireless or other network at the edge, in the field for real time data), data transfer, privacy-perserving data, security etc.) can play a role or need to play a role so that needed computing on the data is done meeting the time constraints of computing to enable AI and decision making. And how the complexities of AI and CI may need to be hidden (via some kind of abstraction) so that the end user (farmer, supply chain manager etc.) don't need to be involved, or even deeply knowledgeable, in AI and/or CI and yet can use them for their use cases.

Greg Eaton, Director of Claytor Nature Center, University of Lynchburg (Virginia). We have good experience with teacher training and K-12 outdoor education. We also host undergraduate students in regular academic classes, internships, and research courses. We also have 500 acres of varied habitats, and classroom and laboratory facilities for establishing field research projects, and a staff with expertise in Horticulture.

Sujit Datta
Hi all. My name is Sujit Datta and I am an assistant professor of chemical and biological engineering at Princeton University. My lab (http://dattalab.princeton.edu) focuses on developing and studying soft and living materials for applications in energy, environment, and biotechnology. Of relevance to this workshop, we work on (i) developing new hydrogel-based materials for low energy, low cost, and sustainable water harvesting/purification from air and dirty water sources, as well as for use as water reservoirs in agriculture to reduce the burden of irrigation; (ii) understanding the complex interactions/functions of rhizosphere microbes; (iii) engineering microbial communities capable of performing important chemical transformations e.g. water purification.

Rosibel Ochoa
Hello: My name is Rosibel Ochoa and I am the associate vice chancellor for technology partnerships at the University of California in Riverside. We are in the process of launching an initiative called OASIS that is focused on research, development and deployment of innovative solutions in areas of agriculture, community health, air/water and energy. I could not join any of the workshops but I would be interested in collaborating for this project please contact me.

Sreenath Chalil Madathil
Hello: I am Sreenath Chalil Madathil, I am an assistant professor in Industrial Manufacturing and Systems Engineering at UTEP. My research expertise is in Operations research and simulation modeling in energy, supply and demand domains

Fazleena Badurdeen
Hello! I'm a Professor in Mechanical Engineering at the University of Kentucky and also affiliated with the Institute for Sustainable Manufacturing. My research has been in the area of sustainable manufacturing systems and closed-loop sustainable supply chains. I am very interested in leveraging the knowledge/expertise from discrete product manufacturing systems/supply chains to food systems to reduce waste and create more sustainable food networks. I also am interested in education and workforce

development and am the Director for our online Manufacturing Systems Engineering MS and a new online MS in Supply Chain Engineering.

Josiah Heyman
Hello, I am Joe Heyman at the University of Texas at El Paso. We are at the US-Mexico border in an apx. 83% Latinx community and university. I am interested in that community, of course, and especially in anything that connects with borders (esp. 1st world/3rd world borders). I am interested in short distance and long distance transnational systems, esp. the North American system (people, capital, food, energy, water, culture...you name it). I've collaborated in interdisciplinary teams with hydrologists/agronomists on water sustainability and transition, and with computer scientists and similar folk on making computer based models usable and useful for diverse publics. jmheyman@utep.edu is best way to get me. (edited)

Ahmed el gendy
Hello, My name is Ahmed El-Gendy and I am an assistant professor of Physics at University of Texas at EL Paso. My nanomagnetics and biomaterials lab. focuses on synthesis, characterization and application of magnetic nanoparticles. These include energy, water, and biomedical applications. Our current work are matching with the idea of this workshop, we work on (i) developing new dual functional emergent materials for low cost magnetic refrigeration and low cost energy harvesting and sustainable water purification from dirty water sources; (ii) using green synthesis method to prepare magnetic materials for water treatment; (iii) Designing exchange bias and quantum materials for data storage application(My email is: aelgendy@utep.edu) (edited)

Maren Friesen
Hi everyone! I'm Maren Friesen, soon-to-be Associate Professor in Plant Pathology and Crop & Soil Sciences at Washington State University. My training is in mathematical biology, evolutionary ecology, and genomics and my research focuses on understanding beneficial plant-microbe interactions with an emphasis on nitrogen-fixation; other interests include disease suppression, abiotic stress tolerance, and biodiversity. We have projects in both wild and agricultural systems (bioenergy feedstock and dryland cropping systems) and I have helped organize co-innovation sessions with dryland wheat farmers interested in soil health. I am also developing a phytobacteriology education/outreach module and working with an evolutionary videogame design studio.

LAURENT PILON
Hello, I am a professor in Engineering at UCLA. I work on (i) light transfer in photobioreactors growing microalgae for water treatment as well as food and biofuel productions, (ii) synthesis of highly porous materials that are both thermally insulating (easy) but transparent (hard), and (iii) transport and interfacial phenomena in electrochemical capacitors and batteries. I am also the director of a NSF-funded research traineeship program on innovation at the nexus of food, energy, and water in urban systems (http://infews.ucla.edu/). I can be reached at lpilonau@ucla.edu

Amir
Hello everyone. I am Amir Assadi, recently retired from UW Madison, moved to San Diego, president of a small R&D Consulting company. My research has been multi-disciplinary in design and analytics of intelligent systems, and multi-disciplinary applications (systems biology, plant biology....). I have past research experience (EU Project) in interface of plant systems biology and ecology in the Mediterranean Basin. Other relevant experiences are in AI applications to quantifying phenotypic variation, design of multi-scale local-to-global solutions, complex dynamical systems, ...). I am interested in #1 in Deidra's list, and AI-assisted data-driven education and research training. My e-mail ahassadi@wisc.edu .

Lih Y. Lin
Hi everyone, I am Lih Lin, a professor in the Electrical and Computer Engineering Department at the University of Washington. My lab has been working on new LED materials and devices with easily tunable emission spectrum. I am hoping this would be of interest to people working on indoor farming and studying the effect of LED spectrum on plant growth.

Pinki Mondal

Hi all! I am an assistant professor in geospatial data science at the University of Delaware. My background is in remote sensing, primarily satellites. I have interests in mapping saltwater intruded farmlands in order to provide economically/culturally viable and environmentally sustainable solutions to stakeholders. Interested in collaborating on proposals. Email: mondalp@udel.edu (edited)

Pinki Mondal
replied to a thread:Proposed Tracks and Deliverables: All we are thinking of tracks and corresponding deliverables to include in the final report to NSF that might be used in the solicitation. Below are our initial thoughts. Please feel free to add to the list, so that we can begin to converge in the teaming session on Friday! Remember: 10-20 teams per track will be selected, and only 2-3 tracks, for Phase I.…
Hi all! I am an assistant professor in geospatial data science at the University of Delaware. My background is in remote sensing, primarily satellites/aerial. I have interests in mapping saltwater intruded farmlands in order to provide economically/culturally viable and environmentally sustainable solutions to stakeholders. I would be interested in collaborating on #2 by bringing in place-based realities derived from satellite sensors. You can reach me at mondalp@udel.edu. More on our work: www.easel-lab-mondal.com (edited)

Govind Hariharan
Good morning, everyone. I am an applied interdisciplinary economist at Kennesaw State. Law- regulation, information systems, health informatics, investments, conflict management, disasters, agriculture, decision models are areas where I have collaborated. Current work in progress- 1) treatment of uncertainty in decision making and regulations: Interested in what AI and Decision Science experts are working on in this. 2) Teaming: Species of Fish behavior have been characterized by some biologists as schooling fish as opposed to shoaling fish. Trying to learn this and apply in building effective teams ; Any biologists specializing in this? gharihar@kennesaw.edu

Sudip Mittal
replied to a thread:Proposed Tracks and Deliverables: All we are thinking of tracks and corresponding deliverables to include in the final report to NSF that might be used in the solicitation. Below are our initial thoughts. Please feel free to add to the list, so that we can begin to converge in the teaming session on Friday! Remember: 10-20 teams per track will be selected, and only 2-3 tracks, for Phase I.…
Hi all, I am assistant professor in the Dept of Computer Science and Engineering at Mississippi State University. My research areas are AI, data science, knowledge graphs and cybersecurity. I have previously worked on collaborative AI systems for precision agriculture. I am really interested in #1 and #2, from Deidra's list. You can reach me at mittal@cse.msstate.edu

Heyden
Hi, I am professor at the University of South Carolina working in computational catalysis and selective separation from aqueous environments. My groups strengths are in first principles modeling of processes at solid-liquid (water) interfaces.

Josiah Heyman
Keep in mind poorer and more marginalized communities. Above all, listen to find out what they want and think. Also, keep in mind cheaper, simpler, more lasting, and easier to imitate. Principles of appropriate design.

Krishna Kant
Hello, I am a professor of Computer Science at Temple University with very broad interests in many areas. In the food area, my interests are in making the fresh food distribution logistics more efficient and reduce food waste. I have a lightening talk on the topic -- creating a comprehensive fresh food quality/contamination monitoring system. Also interested in built urban water systems. Would love to collaborate on any aspects of fresh food and urban water issues.

Becky Bott-Knutson
Greetings! My name is Becky Bott-Knutson and I serve as Dean of the Honors College at SDSU. I co-lead a multi-institutional, multi-disciplinary, collaborative consortium of honors colleges and programs at Land-Grant, Public, and Minority-Serving Institutions of Higher Education. This national network develops and

supports broad access to cutting-edge resources for future leaders to innovate and transform the food, agricultural, natural and human (FANH) sciences. We would be very interested in contributing to a track on education and work force development. Rebecca.Bott@sdstate.edu

murti salapaka
Murti Salapaka, Professor, Electrical and Computer Engineering, University of Minnesota (UMN), Twin-Cities. We have good experience with Distributed Energy Resources with a a recent focus on recovery of energy and power during a disaster for critical infrastructures and for managing independent energy networks toward providing ancillary services to the gird. My group has expertise in controls, optimization, learning and identification. My lab can emulate residential scale microgrid solutions using hardware in the loop setting. Please see the Rapidly Viable Sustained Grid project funded and led by UMN under ArpaE Open 2018 competition.

Ilya Zaslavsky
Hello, I am director of Spatial Information Systems Lab at the San Diego Supercomputer Center, UCSD. Working at the intersection of urban planning, spatial data science, and cyberinfrastructure - in particular with the U of California's Global Food Initiative - to develop tools for inventory and analysis of food systems and support food surveys. See our lightning talk. Would love to collaborate on CI development, spatial data science, urban food deserts, water issues, and workforce/education.

Eunshin Byon
I am an associate professor in the industrial and operations engineering at University of Michigan. I work on data analytics in spatial energy and environmental systems. I develop statistical models to forecast spatially correlated environmental conditions using both sensor measurements and global climate model projections. ebyon@umich.edu, https://ebyon.engin.umich.edu/

Becky Bott-Knutson
Deidra, Thanks for all you've done to facilitate convergence this week! Several months ago I accepted an invitation to speak for another national professional society from 2-3pm CST today. I'm afraid that means I will be missing out on some of the important work on teaming. I truly hope to see education and work force development selected, either as a stand alone track, or integrated as a part of the comprehensive, systems approach within the 2-3 tracks that move forward in Phase I. I have several ideas to offer regardless of which way this takes shape. Please let me know how I can be supportive to the process moving forward. Rebecca.Bott@sdstate.edu (Dean of Honors College at South Dakota State University, animal scientist/biomedical scientist by training, experience in agricultural development both internationally and in Tribal Nations)

Suzanne Russo she/her
Hi all - I'm CEO of a non-profit, Pecan Street Inc., that works with university and industry partners to bridge data gaps holding back innovation for climate solutions and to accelerate development and adoption of effective solutions. Would love to partner on proposals to these future NSF tracks. We're working with the Texas Advanced Computing Center right now to run a working group with university and industry partners bringing together carbon offset market managers, soil scientists, data scientists and AI/ML developers to identify the needs and potential AI applications that could solve some problems around data-model integration for soil carbon M&V, model benchmarking as well as modeling and sensor innovation. We also are PI on a NSF CC planning grant with CSU, Cornell and A&M and farming communities in upstate NY, Colorado's front range and Austin, TX to combine socio-technical R&D along with new ecosystem services markets to determine if/how farming communities rather than individuals can profitably transition to regenerative agriculture.
Feel free to email me directly at srusso@pecanstreet.org if you'd like to chat. We're also embarking on a research project to understand and map racial disparities in information flow and access to new technologies amongst farmers and ranchers.

Katy Roodenko
I am a founder and CEO of a small-business company developing sensors for in-line bacterial metabolomic analysis (carbon sources, nitrogen sources and various products) directly in aqueous solutions. We are

experimenting to get rid of complex bioassays with our spectroscopic real-time tool. We also develop nitrogen (nitrate, ammonia) sensor for real-time process control for wastewater (sewage) treatment plants. Here is the company's website: www.max-ir-labs.com On the bacterial / plant metabolomics, we would be happy to spec out the sensors in accordance to the pressing needs, and work together on a prototype development based on the requirement of your projects and your labs.

Gina Rico Mendez
Hi everyone, I am a Research Assistant Professor at the Mississippi State University-Social Science Research Center (originally from Colombia). Currently leading research on school meals in Africa from a food systems approach. Interested in collaborating and hear more about the exciting opportunities that are happening here. Best!!!

Ewa Deelman
Hi! I am a computer scientist at USC, working on distributed computing and in particular on workflow management systems that allow efficient and robust execution of computational pipeline. I have worked with a variety of domain scientists to help them automate their computational processes and I am looking forward to contributing here.

Janie Moore
check out my website to see some of the technologies i work with to increase the shelf-life of food and feed products. we have to make sure we are thinking about how we will keep food safe once its produced.
https://pheed.tamu.edu

Anthony Elam
Hello everyone, I'm Tony Elam the Associate Director of the Center for Computational Sciences at the University of Kentucky. I have interest in Cyberinfrastructure support of computational research across multiple domains and complex systems. My expertise is in systems engineering, project management, industrial relations and building partnerships and collaborations. I also have interest and experience in the use of serious games for decision support, advanced training and education.

Kiruba - FEAST Lab
Hello Everyone, I am Kiruba Krishnaswamy leading the Food Engineering and Sustainable Technologies (FEAST) labs at the University of Missouri. We are a transdisciplinary group of researchers working at the interface of science, engineering, and technology connecting the food system.
Addressing Hidden Hunger
(An interconnected challenge of food and nutrition security)
Considering the complex nature of the global challenges, we look forward to collaborate (SDG 17) with partners interested in SDG 2: Zero Hunger to **improve the health of people & planet!**
www.feastlab.org

Lining Yao
This is Lining from Carnegie Mellon University, School of Computer Science. I direct Morphing Matter Lab, having quite a few food - agriculture related interests. Email (liningy@andrew.cmu.edu). Exited to exchange with anyone but in particularly context-experts in soil sensing, farming/growth, food nutrition, ecology since we are more of a design/engineering+advance manufacturing team. Three related projects from our lab: 1) Self-burial and self-drilling sensors/seedpod can be deployed with drones (https://www.youtube.com/watch?v=6-BzTbYmuOk). 2) flat-pack food for saving logistic cost, storage space and plastic packaging waste (https://www.morphingmatter.cs.cmu.edu/projects/morphing-pasta-and-beyond). 3) Additive manufacturing of food for nutrition balance (https://www.morphingmatter.cs.cmu.edu/projects/freeform-food-printing). (edited)
YouTube | ACM SIGCHI
E-seed: Shape-Changing Interfaces that Self Drill

Kyunsoo Yoo
Hi everyone, I am a professor of soil biogeochemistry and geomorphology at the Univ. of Minnesota, Twin Cities. I am interested in collaborating on global agriculture particularly associated with smallholder farmers.

I have research expertise in the soil carbon cycle, biogeochemistry, earthworm impacts, and hillslope processes. I also have a teaching interest in soil management types across diverse world cultures.

Mike Barnett
Hi all, I'm a professor of science education and technology in the Lynch School of Education at Boston College. We have been working with youth and teachers to engage them in learning about hydroponics, setting up farmers markets, conducting agricultural research with transparent soil. We work closely with partners in India, China, and Ghana and we have designed and scaling out mini-automated desktop greenhouses that engage whole families in learning about growing plants and managing a greenhouse (also in use in classrooms where the data is streamed directly to google sheets to make it easy for teachers to download). We are interested in any project that gets youth excited about science (our #1 goal is to get them into college and keep them there). Would be interested in developing/implementing educational and workforce development curriculum and strategies. We currently have five NSF grants and several foundation grants to build out and would love to get more youth excited about food, energy, water.... Looking forward to collaborating. I've posted a couple of our recent 3 minute videos about our work so if there are connections (or not, we love to make those).https://stemforall2021.videohall.com/presentations/2106https://stemforall2021.videohall.com/presentations/2105

Lee McKnight (he/him)
Just a further comment, and a tentative invitation: I/Syracuse University are preparing a Blockchain Research Workshop for later this summer. Obviously that is orthogonal to but could intersect with the topics of Convergent Food Systems discussed here. But: we will plan a panel/topical area and possible teaming suggestions also in that context. Tentative dates are Aug. 16-17, event will be online and (partially) in person; a possible visit to one of the largest (and hydro/solar-powered) crypto mines in North America on Aug. 18th is also being planned. That is a couple hours from Syracuse; a remote view/livestream from there may also happen. So: anyone here interested in blockchain/distributed ledger as a possible part of a cloud to edge (fields :) research team following this workshop, feel free to contact me directly lmcknigh@syr.edu or comment here. thanks, Lee McKnight, School of Information Studies, Syracuse University, and volunteer, NIST Office of Cyber-Physical Systems (which does smart grid/IoT/smart city standards).

Alicia Boymelgreen
Hi Everyone. I am an Assistant Professor in the department of Mechanical and Materials Engineering at Florida International University. I am seeking new applications for MEMS and Microfluidic technologies to examine environmental impacts on live organisms/plants at the micro/nanoscale which can then inform our understanding of the macroscale effects. These systems are amenable to the creation of highly controlled environments and integration of real-time sensing. This approach would most closely align with the goals of Track #2.
Pinned by

Adina Paytan
Hi All, I am at UCSC and I focus and have a lot of experience in developing and facilitating education and outreach materials including within the FEW nexus and I am a PI on one of the Belmont Forum funded projects in this area and serve as the person responsible for communication and education. Will be happy to join this group

Toni Kazic
@Kyunsoo Yoo, well C flow for sure in the ag/ecosystem part. One thing that probably needs attention is what happens to C flows when land usage changes --- for example, subtler changes like who's grazing the grasslands (not just chopping down forests for feedlots). This isn't my area so I'm just shooting in the dark, but I have a feeling there are other people here who can speak to those issues very well.

Garrick Louis
I am interested in assessing the need for and use of hydroponics for food security in extreme environments and food deserts. I have a special focus on Small Island Developing States (SIDS) and coastal agricultural communities facing sea level rise. I would like to collaborate with groups working on these issues.

Else Kolmos
Hello everyone, I work with horticultural lighting and Im interested in plant sensing for the optimization of plant growth in CEA. Im a senior scientist at Rensselaer Polytechnic Institute and I have a background in circadian biology and basic plant biology.

Hankui Zhang
Hello everyone, I am from South Dakota State University. My work focuses on using satellite (remote sensing) data for earth surface monitoring, that can used to derive crop cover type, crop condition and soil moisture information.

Malynda Cappelle
I work with brackish water desalination, resource recovery (circular economy?), and I have a company that is commercializing water quality sensors.

Amir
replied to a thread:Hello, I am director of Spatial Information Systems Lab at the San Diego Supercomputer Center, UCSD. Working at the intersection of urban planning, spatial data science, and cyberinfrastructure - in particular with the U of California's Global Food Initiative - to develop tools for inventory and analysis of food systems and support food surveys. See our lightning talk. Would love to collaborate on CI development, spatial data science, urban food deserts, water issues, and workforce/education.
Hi Ilya. I have a continuing (and evolving) research interest in "Local-to-Global" solutions , broadly speaking. I live in San Diego. It would be wonderful to get together sometime and discuss topics of mutual interest. E-mail: ahassadi@wisc.edu Thank you. Amir

Kyle Smith
Hi all, My name is Kyle Smith, and I'm a faculty member at UIUC in Mechanical Science and Engineering. My group works with electrochemical separations in a number of contexts, including desalination and nutrient recovery (phosphorous and nitrogen). We are developing new materials for these purposes, as well as devices, by combining experimentation with multi-scale modeling.

Kevin Orner
Hello, My name is Kevin Orner, and I will be starting a faculty position at West Virginia University in Environmental Engineering in August. The driving focus of my research is improving human and environmental health through the safe and sustainable recovery of resources, primarily nitrogen and phosphorus, from urine and organic waste streams. I am also very interested in workforce development.

Sara Constantino
Hello! My name is Sara Constantino, I am currently at Princeton and will be starting a faculty position at Northeastern in January 2022. I generally work on environmental social sciences, with a focus on governance, decision-making and social norms. I also work on social policies - specifically, cash-based assistance. Recently I have been working on how these sorts of institutions and policies (cash assistance, social norms, governance) relate to sustainable diets, health, well-being and equity, and how they interact with culture and world views. I am also working on a project in India on the implications of the introduction of solar pumps in water scarce regions for the food-water-energy nexus and farmer livelihoods.

Illya Hicks
Hello, my name is Illya Hicks and I'm a faculty member of the Computational and Applied Math department at Rice University. My research is in graph theory, graph algorithms, integer programming, and combinatorial optimization; in short, I work in computational decision making and data network analysis. I'm looking to team up with a group. Please contact me (ivhicks@rice.edu) if you are still interested in working with me.

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