Welcome!

- Bathrooms between cafeteria and security entrance
- Safety – nearest exit towards south side of building
- WiFi access USDA-Guest
  
  **Name:** patio  
  **Password:** test123

- Teleconference and WebEx participants
  - May take questions from WebEx chat
- Public listening session – will attempt to record session
  - All comments, written and oral may be used in any form (including edited for length, in print, web, etc.)

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Welcome!

• Research discussion, what avenues of science can hold
  • In no way connected to policy
  • Focused on longer-term future
  • We want to acknowledge there are areas of disagreement without squishing them, but try to move on to get to consensus areas.
  • Sara Scherr is helping to facilitate because of her expertise in these activities

Structure

• Few invited presentations
• Stakeholder presentations – somewhat grouped
• Pooled time for questions and discussion
• Breakout sessions – questions in slides, email and back of agenda
• Notecards are for questions comments, etc. to go in written record
• Use easel pads for group discussions

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Office of the Chief Scientist

- Ensures the Chief Scientist is the leading communicator of USDA Science nationally & internationally
- Advises the Secretary & Departmental Leadership
- Ensures a Department-wide culture of science-based decision making for science policy
- Raises the visibility of USDA Science
- Institutes, maintains, & enhances USDA’s Scientific Integrity Policy

Dr. Ann Bartuska

Acting Under Secretary, Research, Education, and Economics
USDA

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Brainstorming Approach – Beginning a Conversation

- Focus on agricultural production systems 50 years from now
- Consider how to integrate basic scientific discoveries and technology
- Please be
  - Open minded
  - Visionary
  - Bold in new ideas
  - Use systems thinking – across silos, disciplines, and commodities

What is something you wish people understood better, that would make your area of agriculture more successful?

# 1

Dr. Elise Golan

Director for Sustainable Development
Office of the Chief Economist
USDA

https://www.usda.gov/oce/sustainable/definitions.htm
Farm Bills: The 1977 and 1990 “Farm Bills” describe sustainable agriculture as an integrated system of plant and animal production practices having a site-specific application that will, over the long term:

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- sustain the economic viability of farm operations;
- enhance the quality of life for farmers and society as a whole.
Stakeholder presentations for the USDA-OCS March 2, 2017 public listening session “Visioning of United States Agricultural Systems for Sustainable Production”

Precision Agriculture

- Sensing & mapping: stratify field into management zones
  - Conditions & capacity
- Tailor inputs & treatments to management zone (vs whole field)
  - Variable inputs: time & space
  - Yield maps
- Multiple objectives: Yield, economics, environment
- Livestock: Track animal location & health, forage status

“Efficiency”

Remote Sensing

- Information: Spatial, spectral, temporal, bidirectional, polarization & phase
- Platforms: “On the go”, handheld, UAV, aircraft, spacecraft
- Processing: Calibration, formatting to map, analysis product
- Analysis:
  - Scouting “Cheat sheet”
  - Soil conditions
  - Crop conditions

“Condition & Capacity”

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“Decision Support”

• Information for producer, land manager: “Options”
• Real-time & Retrospective analysis
• Genetics x Environment x Management interactions: GxE

• Lots of data – analysis?
• “Big Data” tools?
• Models for “what if?” scenarios
• Potential not realized; adoption rates?
• R&D: Roles for public funding, industry

Walthall – USDA ARS

# 3

Dr. Mitch Tuinstra

Professor and Wickersham Chair of Excellence
Department of Agronomy
Purdue University

DOE ARPA-E

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Stakeholder presentations for the USDA-OCS March 2, 2017 public listening session “Visioning of United States Agricultural Systems for Sustainable Production”

MULTI-SCALE ANALYSIS OF FIELD-GROWN CROPS TO ENHANCE CROP IMPROVEMENT AND PRODUCTION RESEARCH

Mitch Tuinstra1, Christopher Boomsma1, Javier Ribera1, Yuhao Chen1, Fangning He1, Weifeng Xiong1, Zhou Zhang1, Addie Thompson1, Karthikeyan Natesan Ramamurthy1, Aurelie Lozano2, Naoki Abe2, Ayman Habib1, Edward Delp1, Larry Bieth1, Michael Leasure1, Keith Cherkauer1, Clifford Weil1, and Melba Crawford1

1Purdue University, West Lafayette, IN
2IBM Research, Yorktown Heights, NY

Purdue University is an equal access/equal opportunity institution.

PRECISION PHENOTYPING – LINKING GENES TO PHENOTYPES

Environmental Adaptation
Climatic and Edaphic Variables

Genetic Diversity
High-value population in many crops and models

Phenotypic Characterization
• Yield Potential
• Abiotic Stress Adaptation
• Disease Resistance
• Plant Architecture
• Quality

Crop Breeding Pipeline

Genetic Information
• Genomic profiles to estimate genetic relationships
• Gene-based markers
• Pedigrees

A BIG “Big Data” Challenge and Opportunity

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**PRECISION PHENOTYPING**

*The Convergence of Biology × Engineering × Computer Science*

- **Genomics**
  - Plant, Animal, Human and Microbial
- **Cloud**
  - Distributed Database with Remote Access
- **Crop Prediction Algorithms**
- **Analytics**
  - High Performance Data Pipelines
- **AI-Machine Learning**
- **Robotics**
  - Field Deployable, Scalable and Economical

**Crop Genetic Gain and Resilience**

- **Big Data Analysis**
- **Gene and Trait Associations**
- **Phenomics**
  - Phenotype Reference Standards (Lab & Field)
- **High Resolution Crop Phenotypes**
- **Sensors**
  - Plant, Root, Soil, Microbial and Environmental
- **High Throughput Field Data Acquisition**

Innovations Enhance:
- Crop Breeding
- Agronomic Research
- Precision Farming
- Land Management
- Resource Conservation
- Market Connectivity
- **Phenomics Analytics**
  - Phenotype Reference High Performance Standards (Lab & Field)
  - Roots Soil Data Pipelines

Microbiome Innovations Enhance:
- Water
- Nutrients
- • Crop Breeding
- • Agronomic Research
- • Precision Farming
- • Land Management
- • Resource Conservation
- • Market Connectivity
- **High Resolution Crop Phenotypes**
- **Sensors**
  - Plant, Root, Soil, Microbial and Environmental
- **High Throughput Field Data Acquisition**

**SMARTER AGRICULTURE**

**MORE EFFICIENT CROP IMPROVEMENT AND AGRONOMIC RESEARCH PLATFORMS**

Smarter Agriculture™ platforms will provide plant science researchers with a data management infrastructure that will organize data from many disparate streams in a cohesive way for more robust analysis in a secure framework that allows collaboration, data reuse and publication.

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**AUTOMATED CROP PHENOTYPING PLATFORMS**

**DOE ARPA-E TERRA PROGRAM FOR HIGH-THROUGHPUT SORGHUM PHENOTYPING**

**Purdue University**
- Larry Biehl: information technology
- Christopher Boomsma: crop physiology, phenotyping
- Keith Cherkauer: UAV technology, remote sensing
- Melba Crawford: remote sensing, machine learning
- Edward Delp: image and video processing
- David Ebert: visual analytics
- Ayman Habib: digital photogrammetry, LiDAR
- Michael Leasure: UAV technology and operations
- Addie Thompson: quantitative genetics
- Mitch Tuinstra: plant breeding, genetics
- Clifford Weil: plant genomics

**IBM**
- Naoki Abe: machine learning, data mining
- Upendra Chitnis: data warehousing, spatio-temporal databases
- Aurelie Lozano: high-dimensional data analysis
- Peder Olsen: machine learning
- Karthikeyan Natesan Ramamurthy: machine learning

**University of Queensland**
- Scott Chapman: crop modeling, phenotyping
- Graeme Hammer: crop modeling

**DATA ACQUISITION PLATFORMS**

**REMOTE SENSING TECHNOLOGY**

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**GROUND VALIDATION STUDIES**

**IN SITU DATA ACQUISITION**

[Image of stakeholders at a table with data]

**GEOMETRIC CORRECTION**

**DATA PROCESSING**

- System Calibration
- RGB Image Data Processing
- Hyperspectral Image Data Processing
- LiDAR Data Processing
- GNSS/INS Integration

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Automated phenotyping technologies based on airborne and ground-based sensor systems must be developed that will enable gene discovery and optimization of crop varieties and production systems for food production.

**Objectives:**

1. **Carbon Assimilation** (CO₂ Emissions Mitigation = Soil Organic Matter)
2. **Nutrient Acquisition** (N₂O Emissions Reduction = Fertilizer Efficiency)
3. **Water Productivity** (Resource Use Efficiency = Climate Resilience)

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# 4

**Laurie-Ann Flanagan**

Executive Vice President  
D.C. Legislative and Regulatory Services, Inc.

**Sara Scherr, Ph.D. moderating**

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The Role of Biopesticides and Biostimulants in Sustainable Agriculture Systems

Prepared for USDA’s Visioning of U.S. Agriculture Systems for Sustainable Production Listening Session  
March 2, 2017

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What are Biopesticides?

Biopesticides are reduced risk pesticides that are naturally derived or synthetic equivalents of natural materials such as animals, plants, bacteria, fungi and certain minerals, generally posing little risk to humans or the environment. Biopesticides:

- Allow conventional growers to integrate reduced risk pesticides into their pest management program
- Play an important role in public health protection
- Are important components of IPM Programs
- Allow greater flexibility when harvesting due to short restricted entry intervals
- Are effective resistance management tools because of their alternative modes of actions
- Can be used as residue-management tools
- Allow organic growers to control pests while maintaining their certified status

What are Biostimulants?

Biostimulants are derived from natural or biological sources such as bacterial or microbial inoculants, biochemical materials, amino acids, humic acids, fulvic acid, seaweed extract and other similar materials. These products improve agricultural sustainability and soil health. Biostimulants:

- Enhance plant growth and development
- Improve the efficiency of plant nutrients, as measured by either improved nutrient uptake or reduced nutrient losses to the environment, or both; and/or
- Act as soil amendments, with demonstrated ability to help improve soil structure, function or performance and thus enhance plant response

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Policies that encourage the development and use of new biopesticide and biostimulant products will enhance the sustainability and productivity of both conventional and organic agriculture over the next several decades.

Suggested Policies to Further the Development and Adoption of Biopesticides and Biostimulants

- Increase funding for USDA’s Minor Crop Pest Management (IR-4) Program’s Biopesticide and Organic Support Program and other research programs related to pest control
- Add an input provider’s seat to the National Organic Standards Board
- Clarify the definition of biostimulants and consistently apply that definition across all associated regulatory structures
- Encourage the use of biopesticides and biostimulants in USDA Conservation Programs
- Task the USDA BioPreferred Program and BPIA to develop criteria for certifying biopesticides as USDA BioPreferred

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Stakeholder presentations for the USDA-OCS March 2, 2017 public listening session “Visioning of United States Agricultural Systems for Sustainable Production”

# 5

Tom Martin

Chairman & CEO
EnviroCirc

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Circular Farm Green Bond

- 3 percent, 20-year, $10B Green Bond
- Save Family Farms – Kids return to farming
  - Fund organic farm transition - Partner with lenders
  - Respected underwriter & 3rd party verification
  - Governed by ICMA Green Bond Principles
  - Tap CERES sustainability-focused fund managers
  - Issuance requires verifiable Enviro-benefits
  - Model delivers EnviroHealth improvements, profitably
  - Lake Erie & Lake Champlain Eutrophication solution
  - Circular Farm Agrarian Communities – new paradigm

EnviroCirc™
Proven Via NRCS Field Trials
On 11 Dairy/Swine Farms.
CIG Grant # NRCS 69-3A75-0-123
Aerobic Treatment Of Manure Lagoons
Showing Environmental & Economic Benefits
With Eco-Service System Paybacks

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• Makes Manure Disappear
• Transformed to 99% true liquid EnviroFertilizer™
• Odor/Pathogen-free SOLUTION enables:
  – Precision Fertigation via Pivot, Drip or SDI
  – Cover Crop + No-Till + EnviroFertilizer™ =
  – Elimination of Chemical Fertilizer
  – Transform farmland to Organic @Scale – Double Value

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# 6

Rebecca A. Dudley
Chairman & CEO
EnviroCirc

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**THE PUBLIC GAZE HAS SHIFTED TOWARDS RURAL AMERICA**

<table>
<thead>
<tr>
<th>What drives rural America?</th>
<th>How are new, digital technologies transforming farming decisions and operations?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What constrains rural America?</td>
<td></td>
</tr>
</tbody>
</table>

We talked to farmers across the US – from Oregon, Kansas, Iowa, Michigan, and Kentucky.

They're using key technologies like connected crop services, yield map analysis, droning, and precision irrigation.

---

**OUR STUDY – DIGITAL APPETITE IN RURAL AMERICA**

- **70%** access high-speed internet.
- **73%** use digital technology in day-to-day decisions.
- **84%** expressed willingness to interact with USDA online.

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They need to be reassured first.

What is the return on investment for engagement in digital?

Why isn’t the digital farming experience intuitive and easy?

How can they be sure that their data is secure?

USDA can tap into this appetite.

Focus on digital solutions that align to rural sector and farming needs.

Connect data from disparate platforms, and help users connect in.

Build on connected data for insights and enhanced analytics for predictive modeling.

And here’s how:

Build on existing programs

Rural Development: Building telecommunications

Across USDA: New farming technologies

Create new opportunities

Create digital solutions that connect data sources – from sensors in the field to weather prediction

Enable farmers easy, plug-and-play tools for predictive analytics

Contact us:

Elaine Turville, Managing Director, Human Services
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Molly Bauch, Technology Strategy Manager, AFS CleanTech
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Danny Cohanpour, Management Consulting Senior Analyst, AFS CleanTech
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# 7

Matthew Lange, PhD

Research Food and Health Informatician
Principal Investigator, IC3-FOODS
Associate Director, Initiative for Wireless Health & Wellness
UC Davis and UC Davis Health System

Semantic Web & Internet of Food
Food Systems, Food, Eating, Drinking, & Health

Enabling Decision support for:

- Food Production, Processing, Safety, Security
- Environmental Sustainability
- Personalized Products
- Wellness & Happiness

@mclange Matthew Lange, PhD mclange@ucdavis.edu

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Real World Agriculture

- Crop production is a complex system organized in a nonlinear manner.
- It is governed by multiple nonlinear interactions and multiple environmental variables.
- Agriculture requires multidisciplinary systems understanding.

We need a global, systems approach to elucidate, quantify, model, and potentially reverse engineer biological processes & mechanisms for their geophysical context.

How? Decipher Phytobiomes

Phytobiomes

Crop plants, their environment, and their associated micro- and macro-organisms.

Micro- and Macroorganisms
- Viruses
- Archaea
- Bacteria
- Amoeba
- Oomycetes
- Algae
- Fungi
- Nematode

Arthropods, Other Animals and Plants
- Insects
- Arachnids
- Myriapods
- Worms
- Birds
- Rodents
- Ruminants
- Weeds

“Biome” - Site specific environment

Soils

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The Phytobiomes Alliance

An international, nonprofit Alliance of industry, academic, and governmental partners

Vision: All farmers have the ability to use predictive and prescriptive analytics to choose the best combination of crop/variety, management practices, and inputs for a specific field in a given year taking into consideration all **physical** (climate, soil…) and **biological** conditions (microbes, pests, disease, weeds, animals…).

Alliance Priorities

- A whole genome sequence database for microbes that includes geospatial data
- Accessible, curated strain repository for all agriculturally relevant microbes with back-up at ARS genetic resources preservation labs
- Multidisciplinary phytobiomes research coordination networks
  - Standards development - sampling, storage, reference communities, reference datasets for analytical tool development
  - Research linking site-specific physical & biological data for crops, forests, and grasslands
  - Science to support the regulations that may exist for agricultural biologicals, including biopesticides and permitting

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Thank you!

For More Information:
www.phytobiomesalliance.org
Kellye Eversole
eversole@eversoleassociates.com

Visioning of United States, (U.S.) Agricultural Systems for Sustainable Production Stakeholder Listening Session Meeting
Thursday, March 2, 2017 8:30am – 4:30pm USDA South Building Cafeteria

# 9
Sara Scherr, Ph.D.
Moderated Questions and Discussion Time
Laurie Flanagan
Tom Martin
Rebecca Dudley
Matthew Lange
Kristina J. Owens

reminder: if no live comments, go to WebEx chat

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Visioning of United States, (U.S.) Agricultural Systems for Sustainable Production Stakeholder Listening Session Meeting

Thursday, March 2, 2017 8:30am – 4:30pm USDA South Building Cafeteria

# 10

20min Break and Networking

*reminder: stop and restart WebEx Recording to reduce file size*

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