Phytobiomes: A New Vision for Agriculture

Name
Date
Conference & City Country
Phytobiomes: Complex Systems of Plant-based Agriculture

“Biomes”: Site specific environments

Viruses
Archaea
Bacteria
Amoeba
Oomycetes
Algae
Fungi
Nematode

Microbiomes and Macroorganisms/Macrofauna

Plants

Soils

Insects
Arachnids
Myriapods
Worms
Birds
Rodents
Ruminants
Weeds

Arthropods, Other Animals and Plants

All influenced by Management Practices
To understand, predict, and control emergent phenotypes within specific phytobiomes for the sustainable production of food, feed, and fiber

How do we get there?
INTERNATIONAL ALLIANCE FOR PHYTOBIOMES RESEARCH

A nonprofit consortium of industry, academic, and governmental scientists
Our **mission** is to establish a science and technology foundation for site-specific, phytobiome-based enhancement of sustainable food, feed, and fiber production.
By 2050, all farmers have the ability to use predictive and prescriptive analytics based on geophysical and biological conditions for determining the best combination of crops, management practices, and inputs for a specific field in a given year.
Why Now?

- Omics-enabling technologies and data
- Systems-level methods - convergence
- Advances in computational science
  - Machine learning, deep learning
  - Analytics
  - Predictive analytics
  - Quantum computing
- Precision Agriculture
  - Variable rate technology...seeding & input
  - Unmanned Aerial Systems (UAS)
  - Soil, plant, & weather sensors
  - Robots
Strategies

• Focus on pre-competitive science
• Determine research, resource, and technology gaps and develop roadmaps to fill them
• Coordinate and manage projects to address gaps
• Facilitate international and public-private collaborations
• Develop an interdisciplinary community of researchers committed to advancing phytobiomes science
• Empower industry growth and profitability
Fundamental Research Areas

- Universal, common, and environment-specific trends in microbiome composition
- Mechanisms by which distinct phytobiome components interact
- Genetic linkages that connect phytobiome components
- Impacts of phytobiome components on plant health
- Multidirectional feedbacks that influence phytobiome components
Short-term Priorities

• Develop national and international research projects that enhance our understanding of the interactions between plants, microbiomes, and other components of phytobiome systems
• Design databases that support correlation and network studies of site-specific and temporal geophysical and biological data, including the identification of microbes by state, province, region, and country
• Establish at least one microbial genome and metagenome sequencing repository
• Draft standards, protocols, check-lists (minimum information, sampling, reference datasets, regulatory requirements...) for phytobiomes studies
• Advance the development of a genome sequence-based classification system and risk prediction method for microbes
• Further develop a draft regulatory science roadmap for microbials
• Expand industry and academic partnerships within the microbial products, sequencing, and metagenomics arena
• Establish industry and academic partnerships within the broader precision agriculture and digital agricultural fields to further expand our interdisciplinary and multidisciplinary scope of the Alliance.
• **Genome-based circumscription and phenotyping of regulated microbes, especially the select agent *Ralstonia solanacearum* - LINS**
  Funded by the USDA Animal Plant Health Inspection Service (APHIS), USA
  Coordinator: Kellye Eversole, Phytobiomes Alliance

• **MicrobiomeSupport: Harmonising Microbiome Research Methods & Funding Worldwide**
  Funded by the European Union’s Horizon 2020 research and innovation programme
  Coordinator: Angela Sessitsch, AIT Austrian Institute of Technology, Austria

• **Succession of microbial assemblages during seed development – SEEDS**
  Funded by the Agence National de la Recherche (ANR), France
  Coordinator: Matthieu Barret, INRA, France

• **Inheritance Of Abiotic Stress Tolerance Through Seed Microbiome Modification**
  Funded by the National Institute of Food and Agriculture (NIFA), USA
  Coordinators: Ashley Shade & Chad Niederhuth, Michigan State University, USA; Matthieu Barret, INRA, France
Alliance LINS Project: Whole Genome Sequence-Based Classification & Identification Platform

Model: *Ralstonia solanacearum*

Database of sequences coupled to pathogenicity data

Precisely circumscribe the strains that should be designated as “Select Agents”

Objective: Enable rapid and precise taxonomic identification of microbes

Expand model to other agriculturally relevant bacteria

Expand to include plant-associated fungi
SCIENTIFIC COORDINATING COMMITTEE

✓ ALLIANCE SPONSORS
✓ PROJECT LEADERS

ALLIANCE WORKING GROUPS

✓ OVERALL TOPICAL LEADER
✓ INVOLVED IN PROJECTS AIMED AT FILLING GAPS IN KNOWLEDGE, RESOURCES, OR TOOLS

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Main Scientific topics

- Climate/weather
- Environmental Data Set
- Plant fitness
- Microbial community assembly and function
- Network analyses within the phytobiome system
- Modeling
- Data – framework, tools and resources, big data
- Genetic linkages
- Carbon sequestration
- Interactions within phytobiomes for abiotic stress
- Engineering microbes and microbial communities
- Precision agriculture/digital Ag
- Fertilizer, nutrient, and chemical input efficiency
- Product development
- Regulatory requirements
- Greenhouse & Field trials
- Industry research needs
International Alliance for Phytobiomes Research Sponsors
Thank you for your attention!

www.phytobiomesalliance.org