



Building a Foundation to Combine Site-Specific Biological and Physical Data for Next-Generation Precision Agriculture

Kellye Eversole

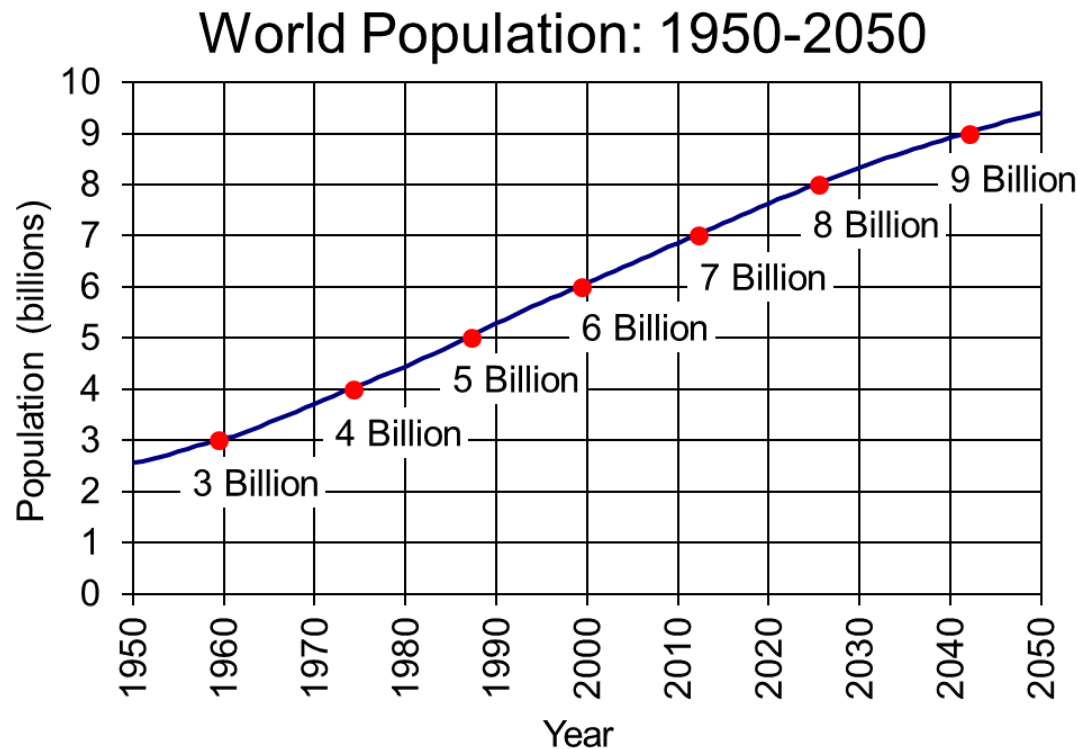
7 December 2017

Microbe-Assisted Crop Production Symposium

Vienna, Austria



The Global Challenge

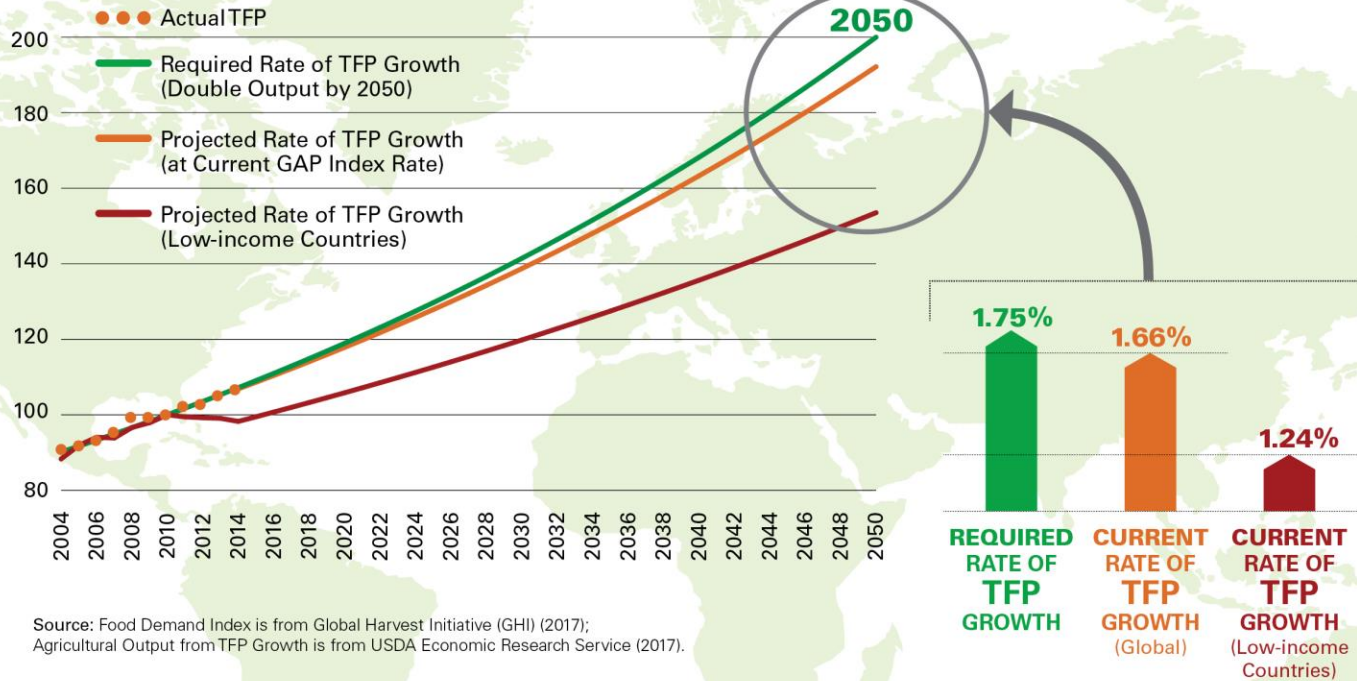


Source: U.S. Census Bureau, International Data Base, August 2017 Update.

32 Growing Seasons



THE GLOBAL AGRICULTURAL PRODUCTIVITY (GAP) INDEX™



TFP= Total Factor Productivity – the ratio of outputs to inputs

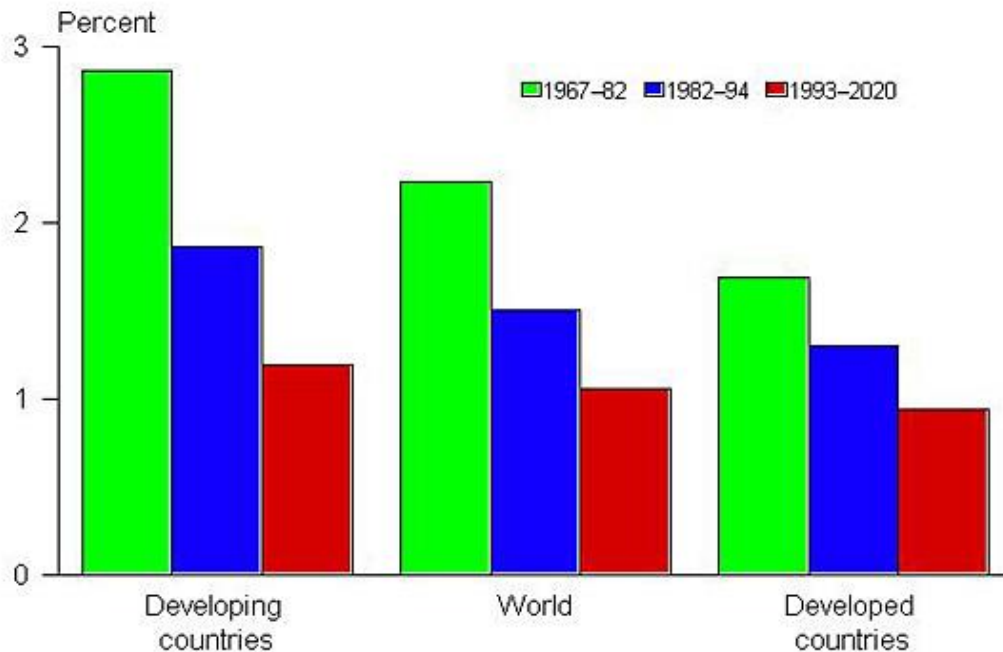


Agricultural Productivity is not rising fast enough to sustainably feed the world in 2050

#GAPReport
@Harvest2050

Declining Cereal Yields

Annual growth in cereal yields,
1967–82, 1982–94, and 1993–2020



Source: IFPRI IMPACT simulations.

How do we
reverse the
trends and
achieve
sustainable
production in
32 growing
seasons?



Moving From Simple to Complex

Traditional science approach

- Reductionist
- World is linear and can be understood by focusing on individual components
 - Soils
 - Plant genetics
 - Microbiomes or
 - Weather

Reality – agriculture is a **complex** system

- non-linear organization
- governed by multiple non-linear interactions and environmental variables
- adaptation via learning or evolution
- it can be influenced

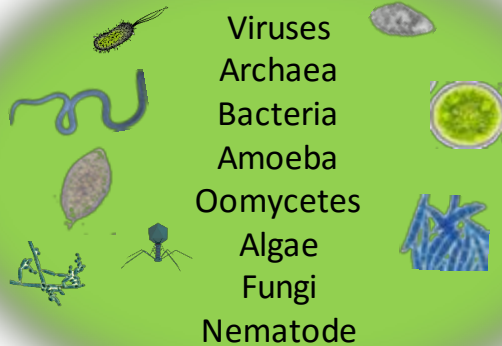
Paradigm shift to a systems approach – the phytobiome

Plant-Based Agriculture: A Complex System

Climate
and Weather

A “Phytobiome”

Micro- and Macro-organisms

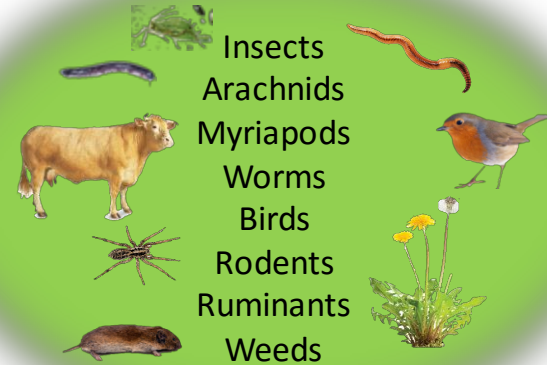


Plants



Soils

Arthropods, Other Animals and Plants



**“Biome” – Site
specific environment**

Associated organisms

Holy Grail for Phytobiomics

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

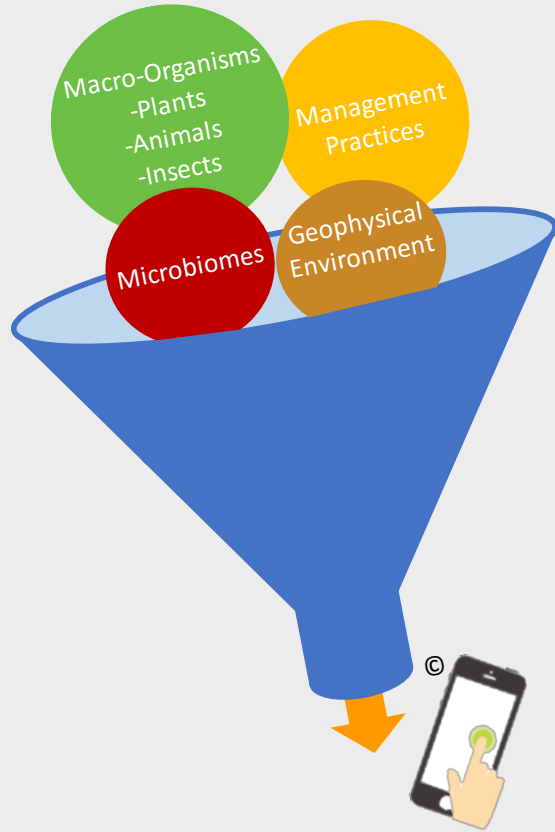
*A nonprofit consortium of industry,
academic, and governmental
scientists*

Phytobiomes Alliance

Our **mission** is to establish a science and technology foundation for site-specific, phytobiome-based enhancement of sustainable food, feed, and fiber production



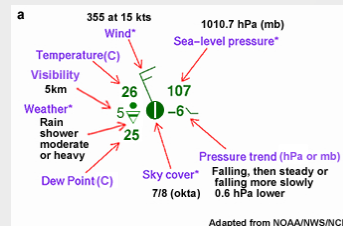
Phytobiomes Alliance Vision



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.



- Omics-enabling technologies
 - Affordable high-throughput sequencing
 - Computational biology & modeling
- Systems-level methods - convergence
- Advances in computational science
 - Machine learning
 - Analytics
 - Predictive analytics
 - Quantum computing
- Precision Agriculture
 - Variable rate technology...seeding & input
 - Unmanned Aerial Systems (UAS)
 - Soil & weather sensors



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



Short-term Priorities

- Databases that support correlation studies between biological and geophysical phytobiome components
 - Whole genome & 16S microbe sequences, metagenomics
 - **Metadata** to include crop, variety, soil characteristics, weather and climate, management practices
- Standards (minimum information, sampling, reference datasets...)
- Genome sequence-based classification system for microbes
- Preliminary crop models for several agroecosystems (cereals, vegetables, forage, trees...)
- Regulatory science roadmap for microbials
- Updated 3 to 5 year strategic roadmap with specific deliverables
- Coordinate research that links site-specific and temporal physical and biological data



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

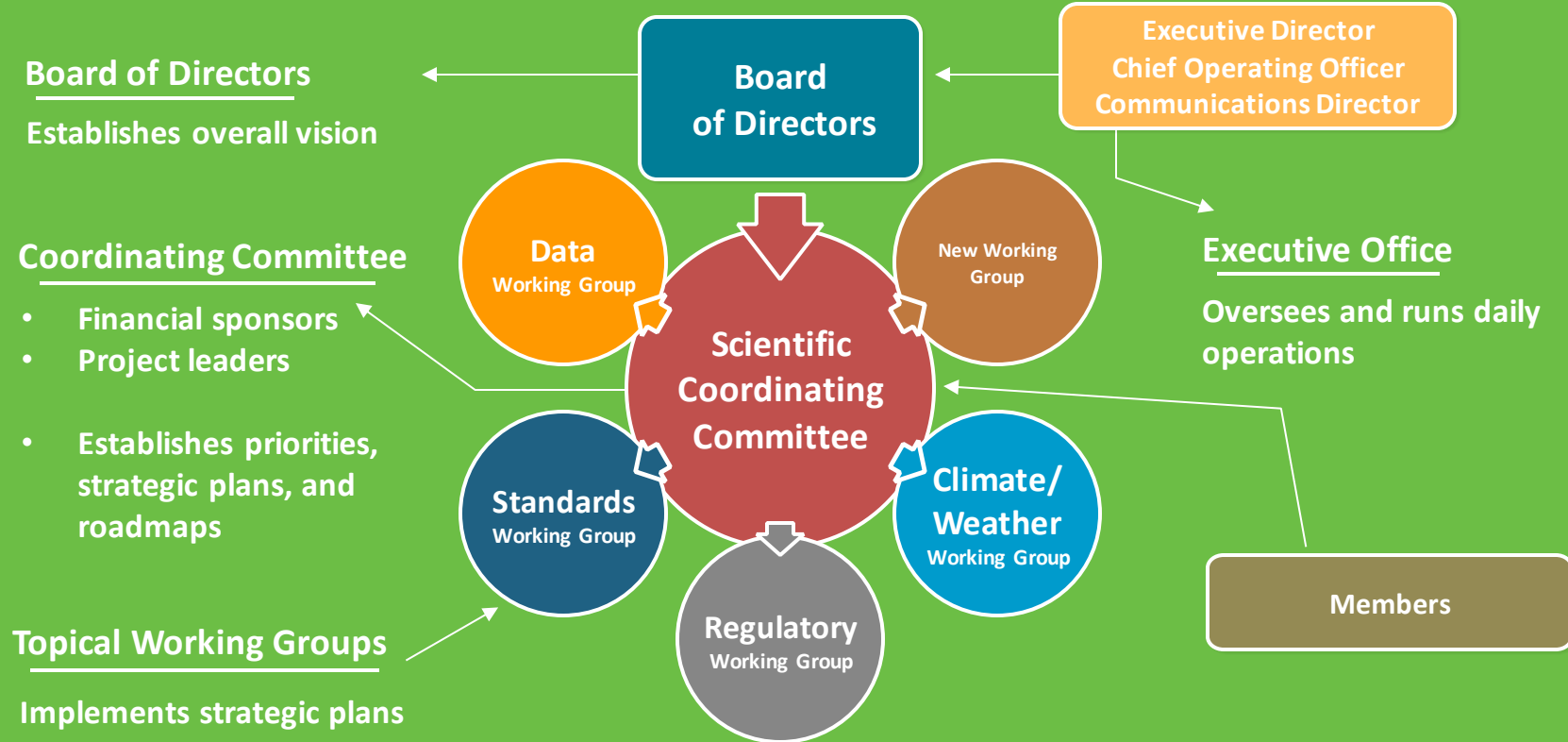


Longer-term Targets

- Simple, simulation models that are functionally accurate to real world complex conditions – e.g., greenhouse studies that reflect field conditions
- Validated and optimized models
- Trait- and gene-based microbial genomics datasets
- Integration of microbial data with databases and equipment used in precision agriculture
- Systems level predictive and prescriptive analytics for on-farm implementation



Phytobiomes Alliance Organizational Structure



Upcoming Meetings

- Exploring Phytobiomes workshop, Plant and Animal Genome conference, San Diego, CA, January 2018
- Phytobiome Research to Improve Agricultural Productivity, AAAS annual meeting, Austin, TX, February 2018
- Phytobiomes Research Symposium, France (in planning for late 2018)
- Phytobiomes Database workshop (in planning, 2018 or early 2019)
- Keystone Symposium on Phytobiomes, 2019.



Join Us!

Scientific Coordinating Committee

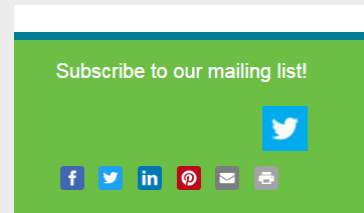
- ✓ Alliance sponsors
- ✓ Project leaders

Alliance working groups

- ✓ Overall topical leader
- ✓ Involved in projects aimed at filling gaps in knowledge, resources, or tools

Subscribe to Mailing List

- ✓ www.phytobiomesalliance.org

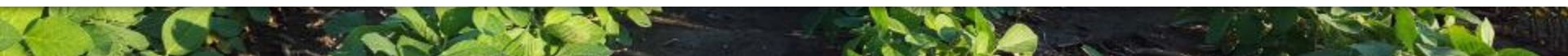




Thanks to International Alliance for Phytobiomes Research Sponsors



Science For A Better Life





Thank you for your attention!

www.phytobiomesalliance.org