



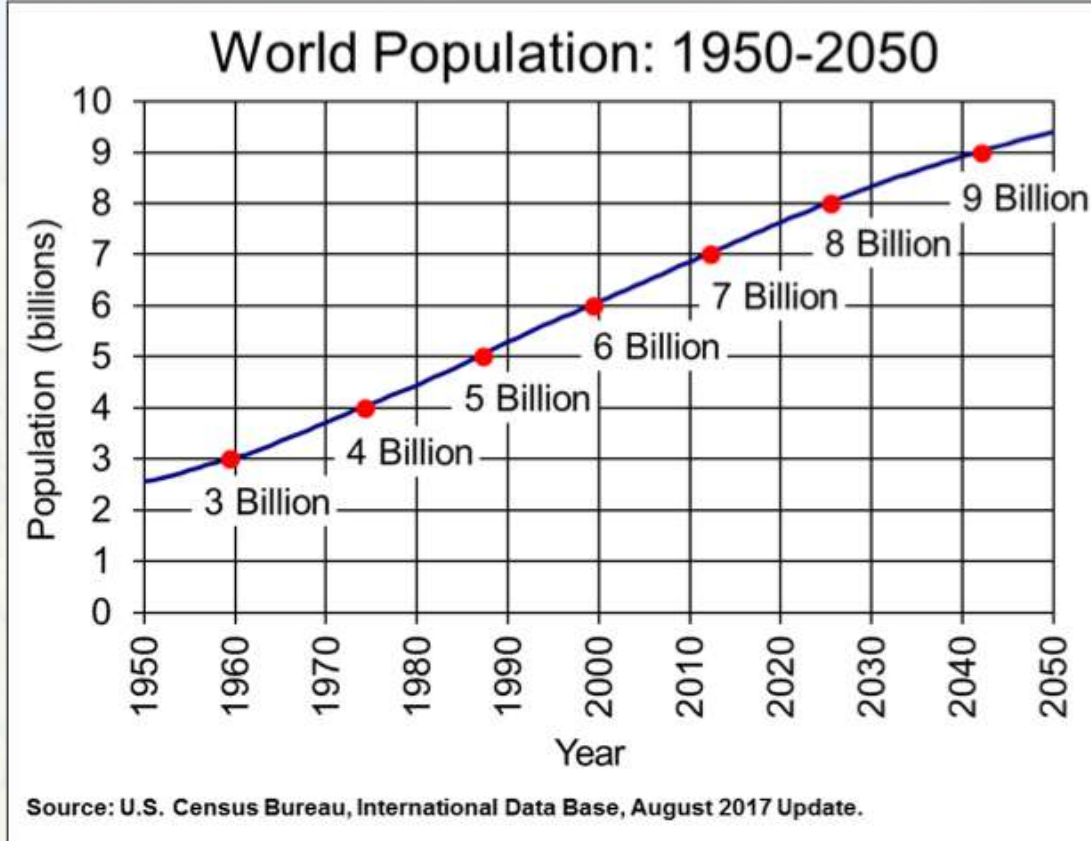
Phytobiomes and the 2050 Vision for Agriculture

Kellye Eversole

17 January 2018

Exploring Phytobiomes Workshop
Plant & Animal Genome Conference
San Diego, California

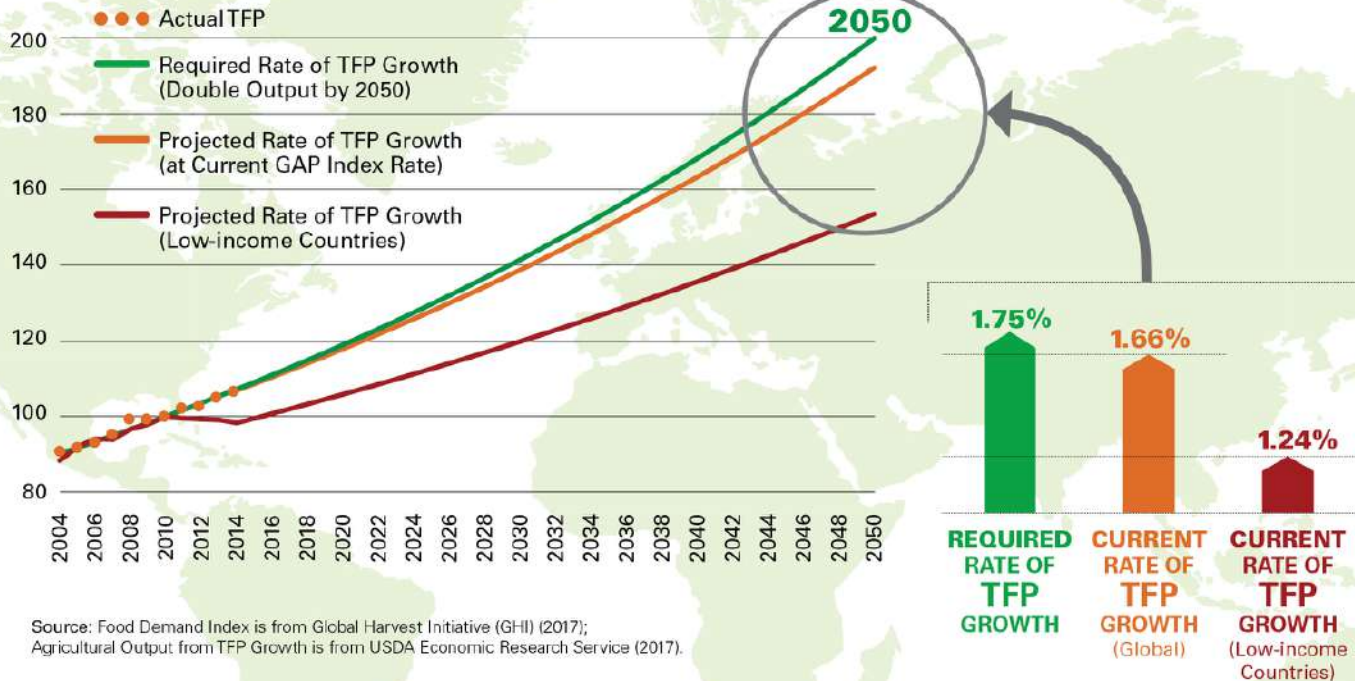
The Global Challenge



32 Growing Seasons



THE GLOBAL AGRICULTURAL PRODUCTIVITY (GAP) INDEX™



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

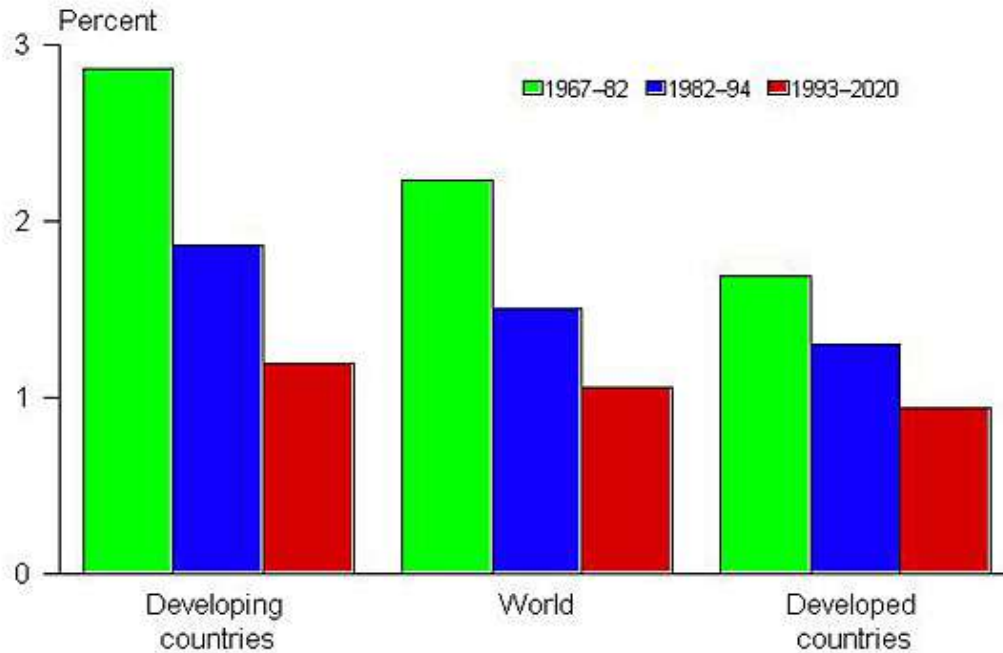
TFP= Total Factor Productivity – the ratio of outputs to inputs



#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 trend 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

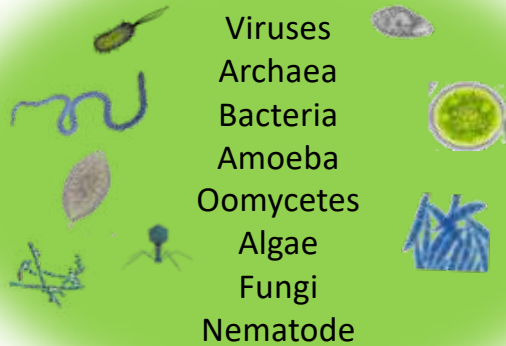
Paradigm shift to a systems approach – the phytobiome

Plant-Based Agriculture: A Complex System



A “Phytobiome”

Micro- and Macro-organisms



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

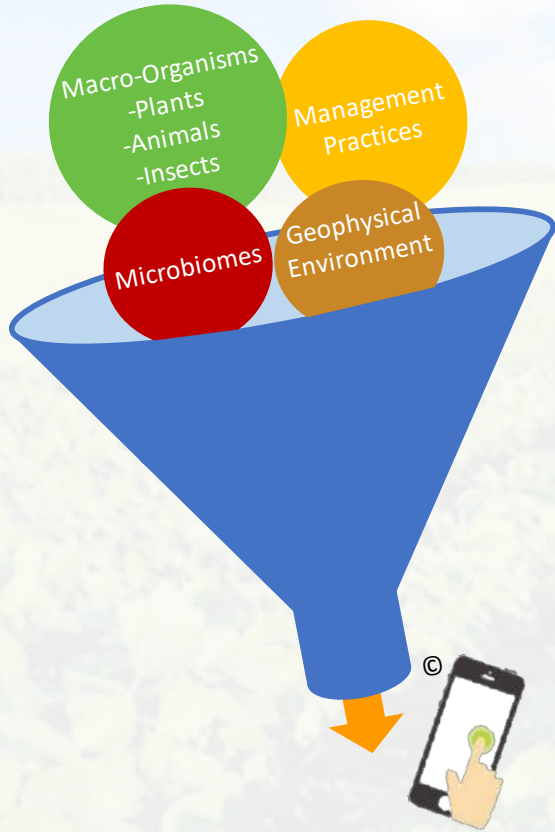
*A nonprofit consortium of industry,
academic, and governmental
scientists*

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

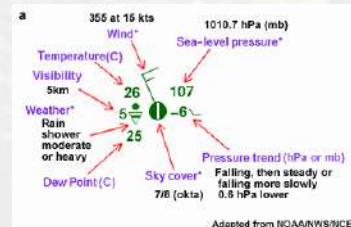
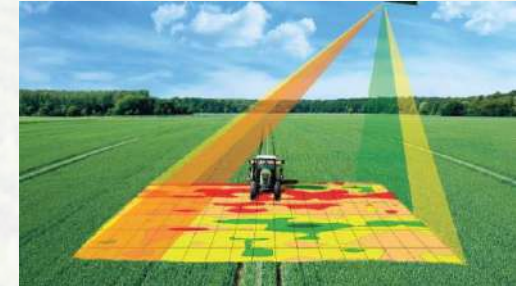
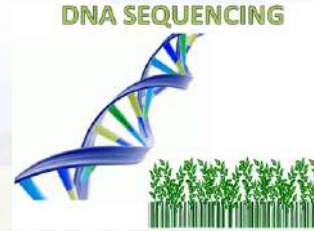


By 2050, all farmers have the ability to use predictive and prescriptive analytics based on geophysical and biological conditions for determining the best combination of crops, management practices, and inputs for a specific field in a given year.



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

- 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
- 3 to 5 year strategic roadmap with specific deliverables

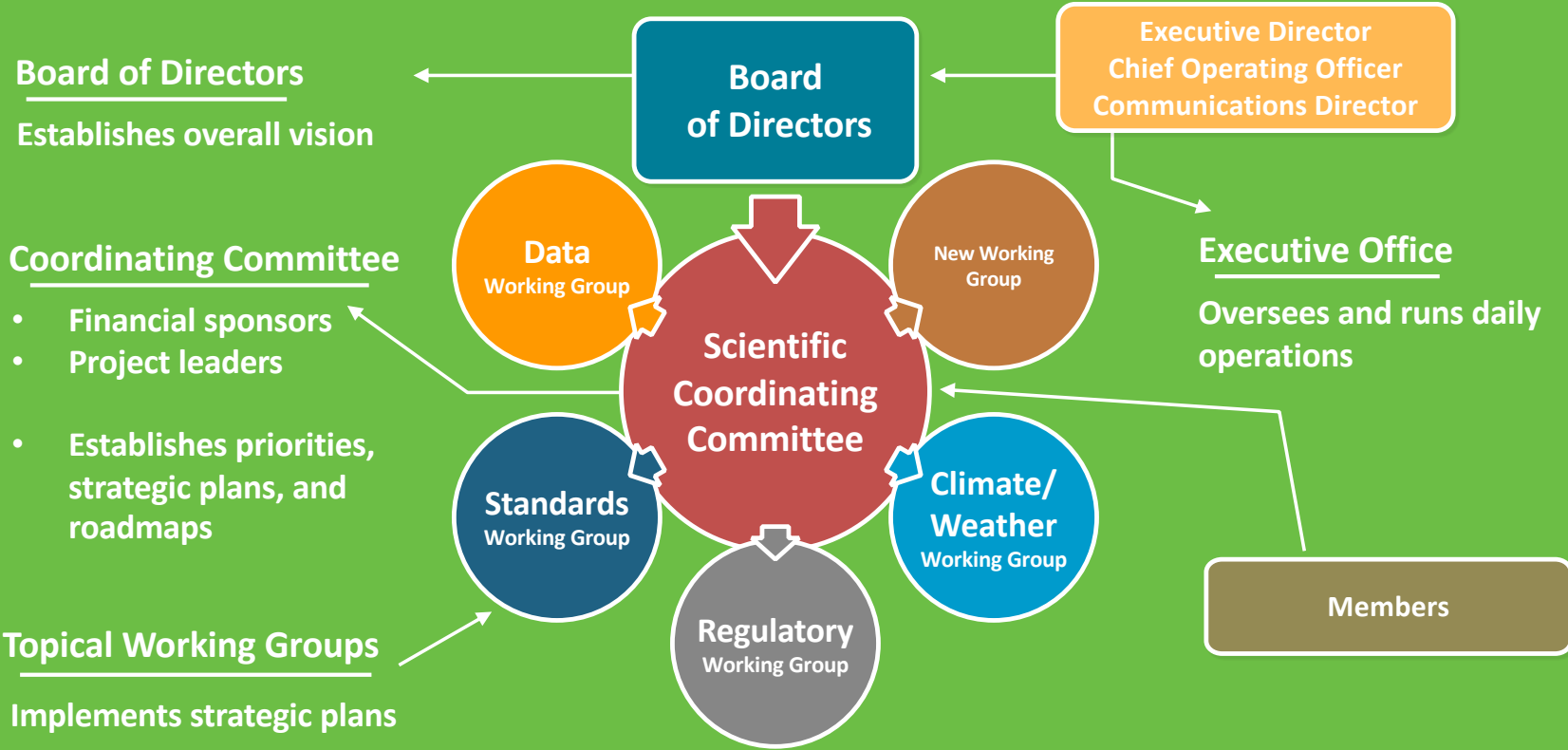


Longer-term Targets

- 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

- 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)
- Regulatory Science workshop (late 2018 or early 2019)
- Keystone Symposium on Phytobiomes, 2019



Join Us!

Scientific Coordinating Committee

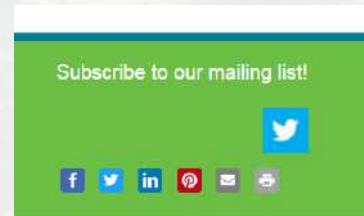
- ✓ Alliance sponsors
- ✓ Project leaders

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





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Thank you for your attention!

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