From “Microbiomes” to “Phytobiomes”: A Systems’ Approach

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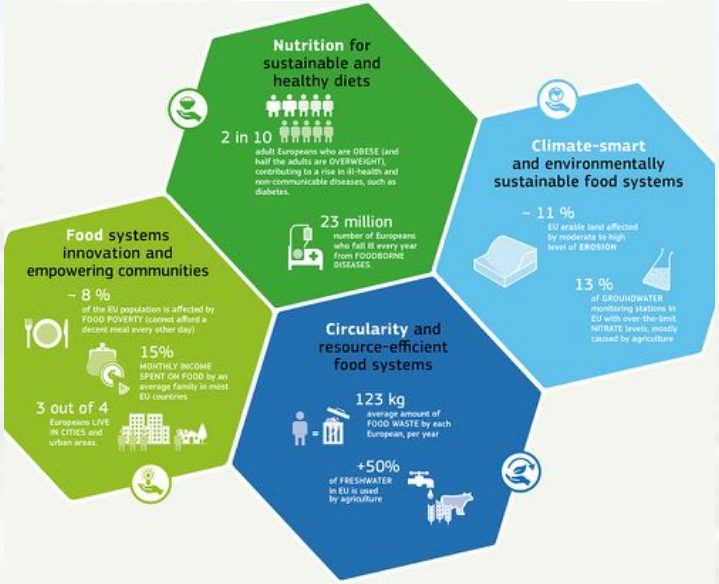
Microbiome Definition Workshop

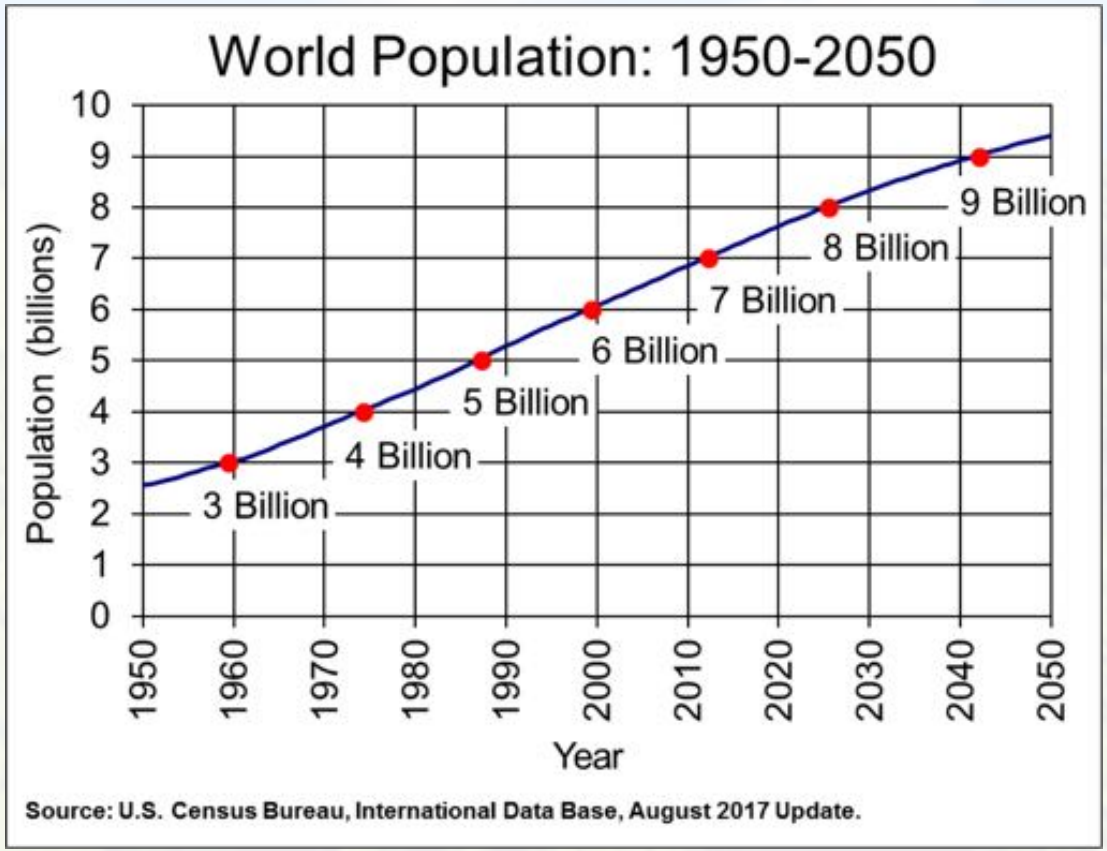
Tulln, Austria

Why are we here?

- MicrobiomeSupport will –
  - ✓ be a key driver to implement FOOD 2030 strategies
  - ✓ advance the applicability and impact of microbiomes from various environments such as terrestrial, plant, aquatic, food and human/animal on the **food system**.
- What is the context?



The Global Challenge



31 Growing Seasons

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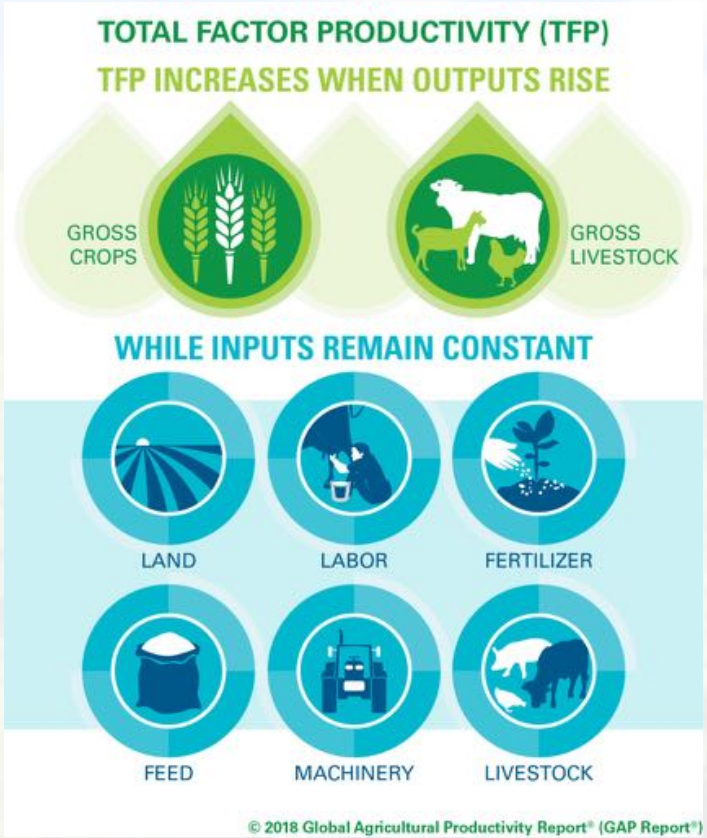
Measuring Sustainability: Total Factor Productivity



Total Factor Productivity (TFP) is a ratio that measures changes in how efficiently agricultural inputs (land, labor, fertilizer, feed, machinery and livestock) are transformed into outputs.

TFP rises when producers use technologies and production practices that result in more output from existing resources.

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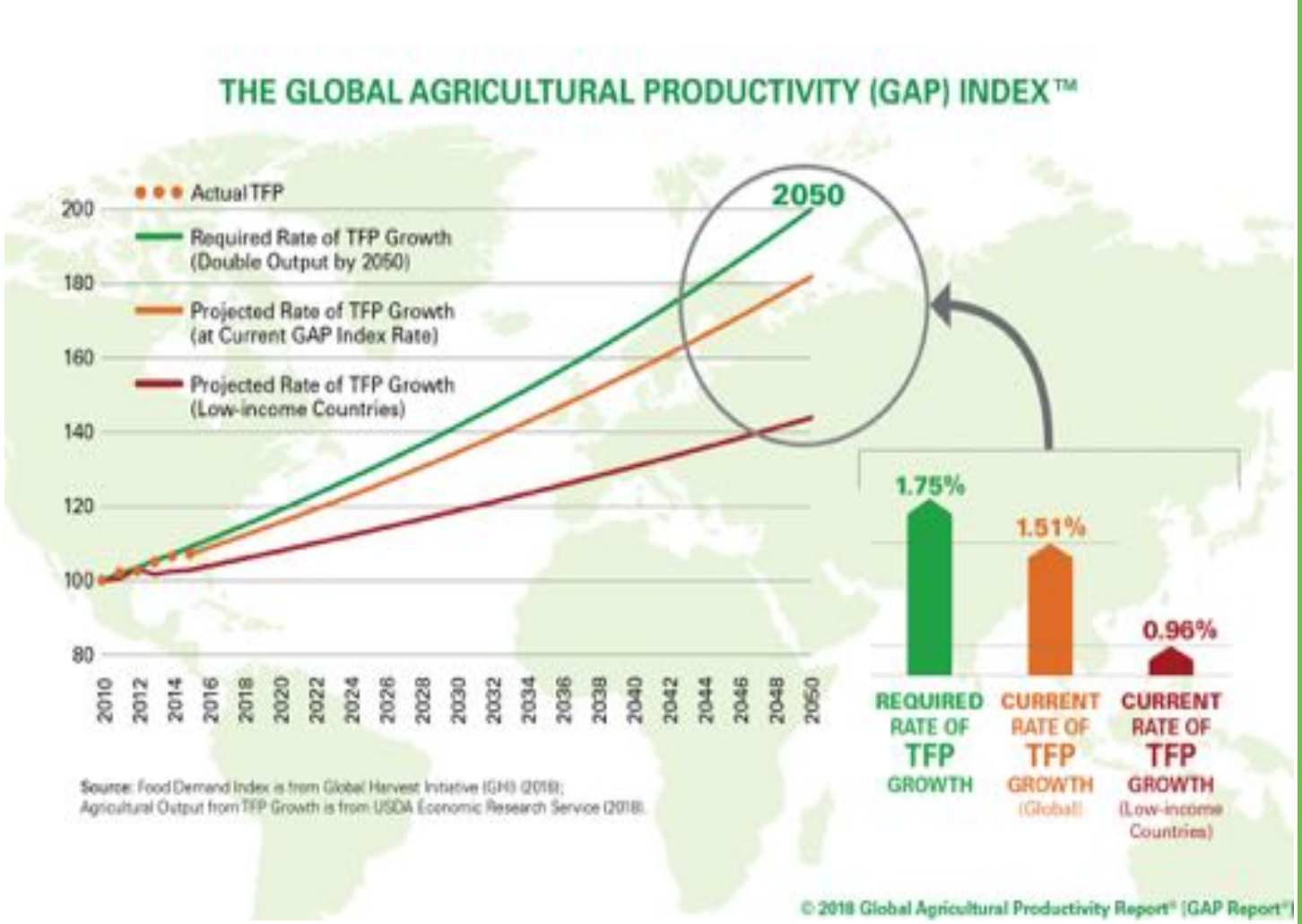
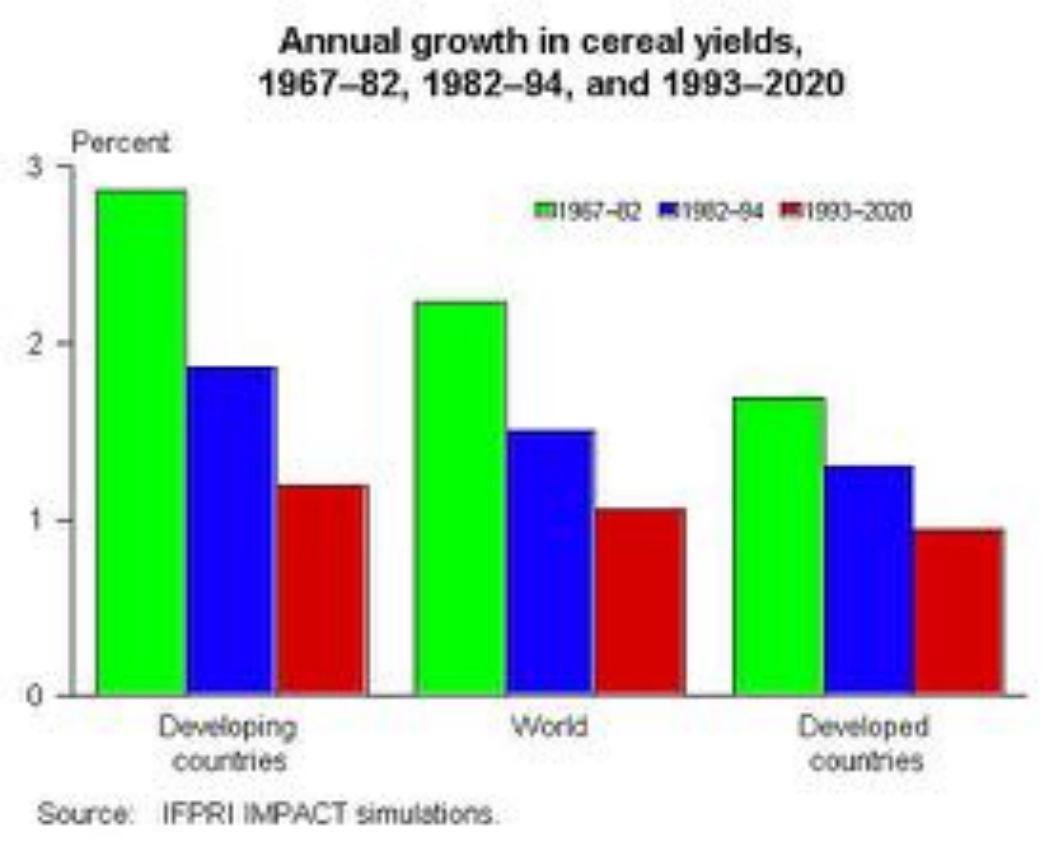


Agricultural Productivity is not rising fast enough to sustainably feed the world in 2050

#GAPReport
@Harvest2050

Declining Cereal Yield Growth



How do we reverse the trend and achieve sustainable production in 31 growing seasons?

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Move From Simple to Complex

Traditional science approach

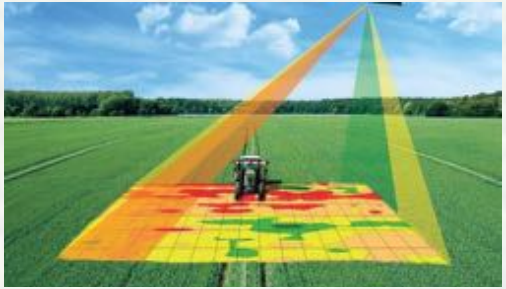
- Reductionist
- World is linear and can be understood by focusing on individual components or within individual disciplines
  - Soils
  - Plant genetics
  - Weather
  - **Microbes**

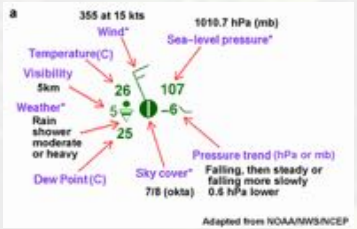
Reality – agriculture is a **complex system**

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

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





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Defining “microbiome”

- What is the goal?
- Why have clarity?
- For whom is the meaning important and how do we wish to use it?
- Can we move to an easily understood term that is relevant to scientists from various disciplines as well as the general public?

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What's in a word…

- Does "biome" mean "biology", "biota", or a specific niche or environment?
- Is it "micro-BIOME" or "microbe-OME"?
- Is it "BIOme" or "biome"?
- 1950s… microbiome referred to all of the microorganisms in a specific environment.

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Defining “Microbiome”

- Marchesi & Ravel have proposed that “it is the entire habitat, including the microorganisms (bacteria, archaea, lower and higher eurkaryotes, and viruses), their genomes (i.e., genes), and the surrounding environmental conditions.”*

- Human centric definition is the genetic material of all the microbes that live on and inside the human body.

*Marchesi & Ravel, Microbiome, 2015

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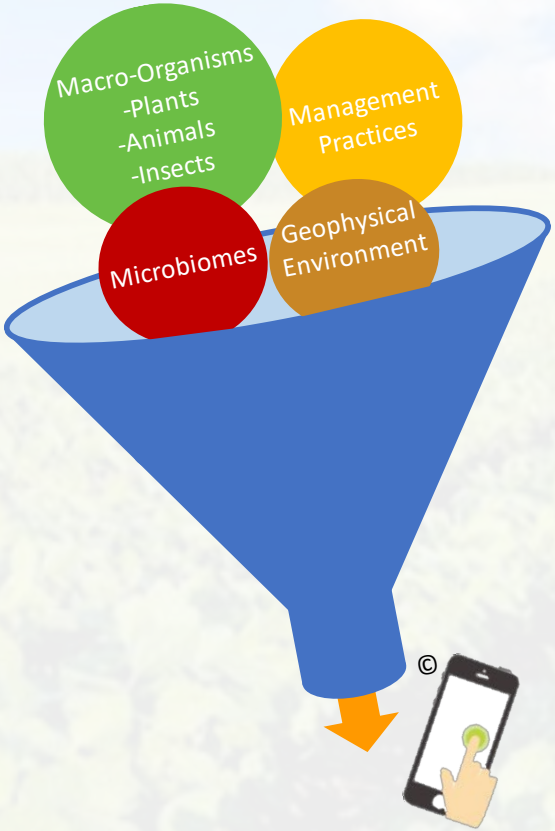
Context for Microbiomes: A Vision



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.

Phytobiomes Alliance

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Core Principles for Defining Microbiome

- Technology neutral
- Audience-neutral
- Context specific
- Industry specific – products and progress, requires function
- Understanding microorganisms within a specific biome

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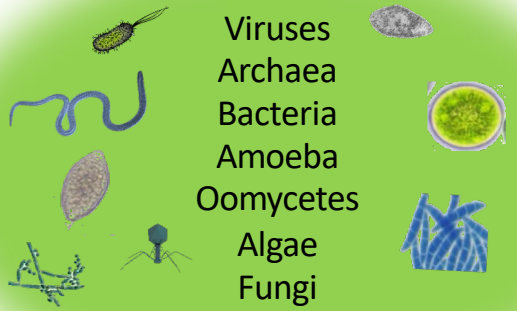
Plant-Based Agriculture: A Complex System

Climate and Weather

A “Phytobiome”

Micro- and Macro-organisms



Viruses
Archaea
Bacteria
Amoeba
Oomycetes
Algae
Fungi
Nematode

“Biome” – Site specific environment

Plants

Soils

Arthropods, Other Animals and Plants

Insects
Arachnids
Myriapods
Worms
Birds
Rodents
Ruminants
Weeds

Associated organisms

Industry Holy Grail

To understand, predict, and control emergent phenotypes within specific environments (biomes) for the sustainable production of food, feed, and fiber

“Microbiome” – all microorganisms within a biome

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Thank you for your attention!

www.phytobiomesalliance.org