Phytobiomes: Embracing Complexity to Achieve a New Vision for Agriculture

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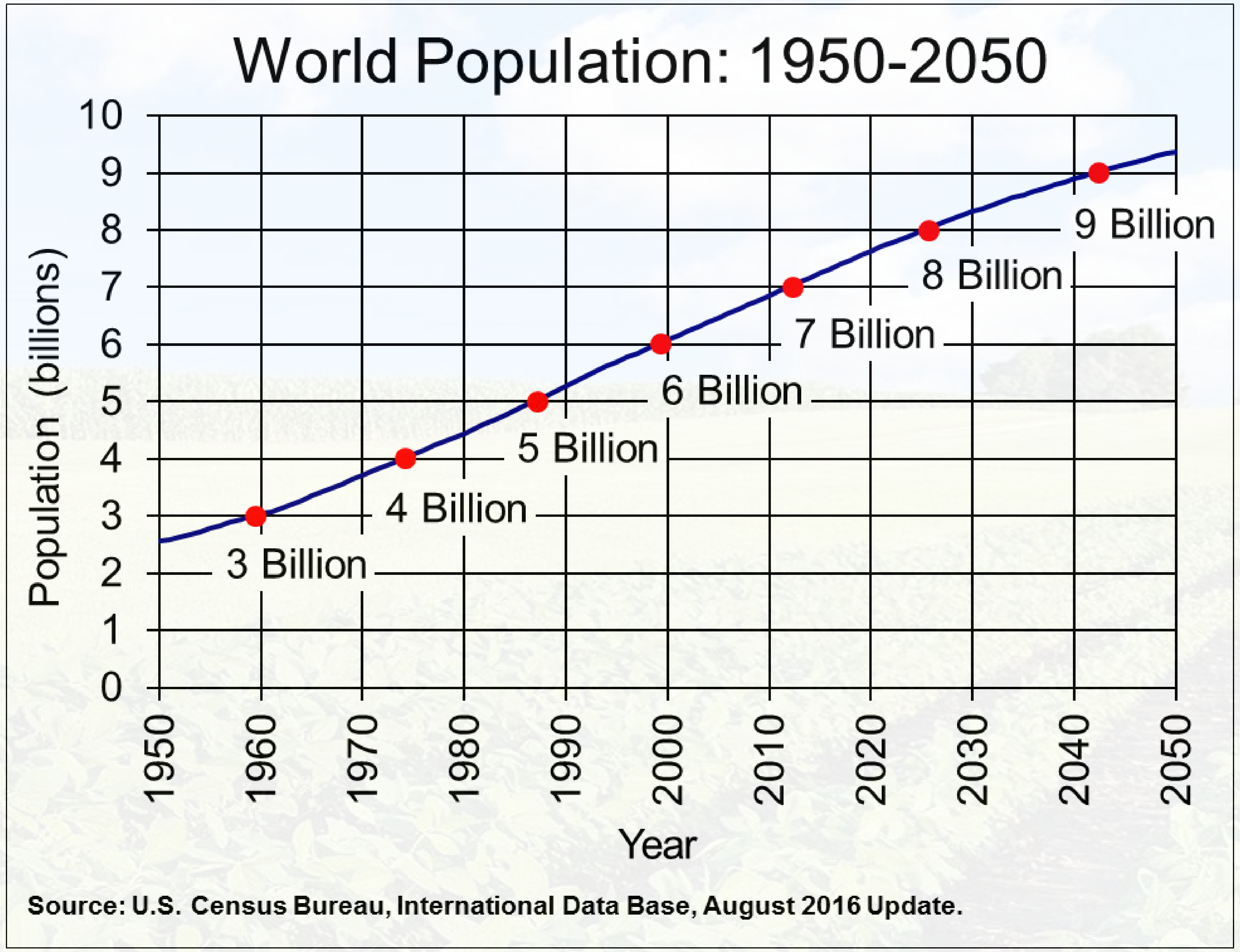
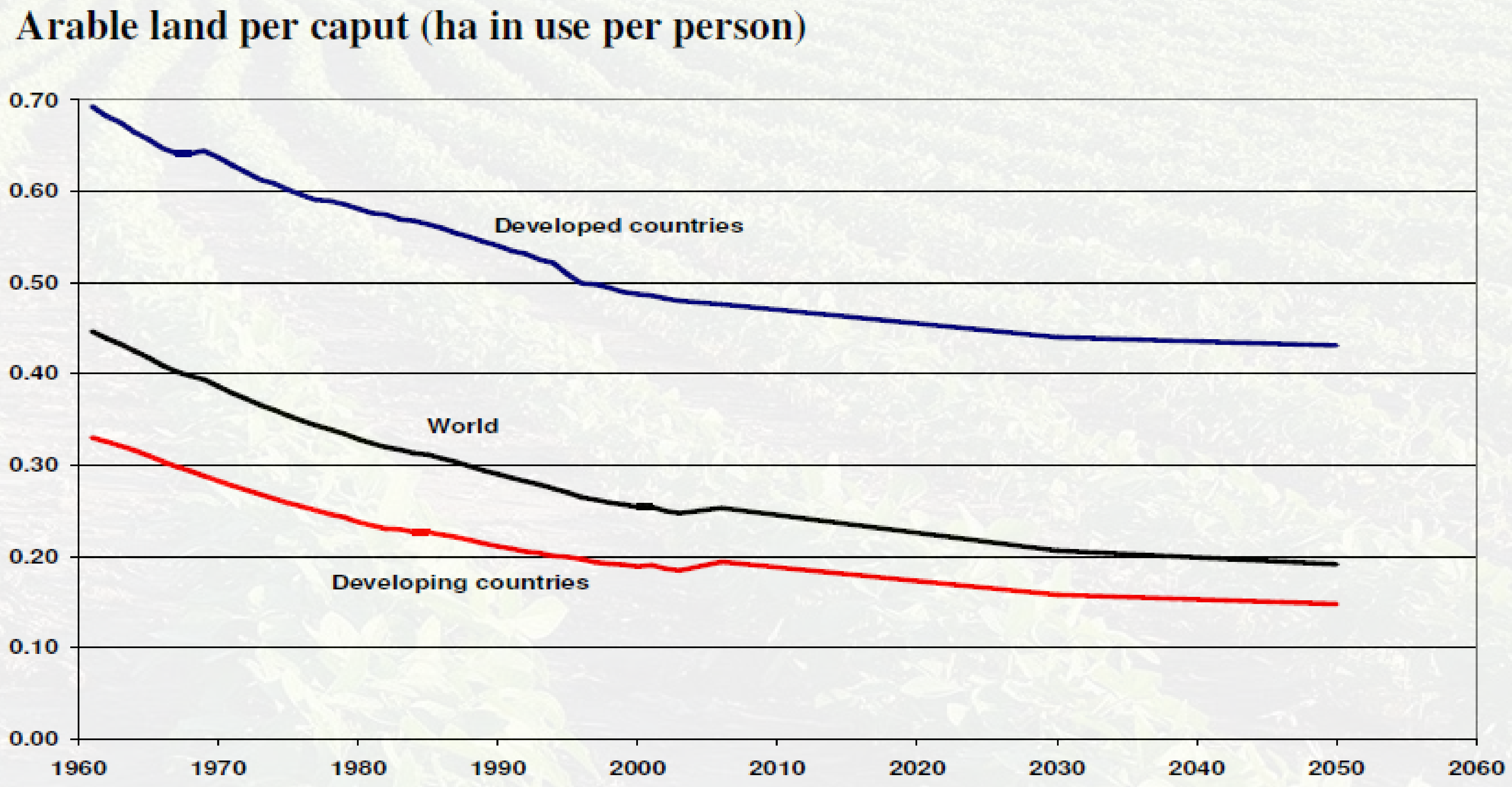
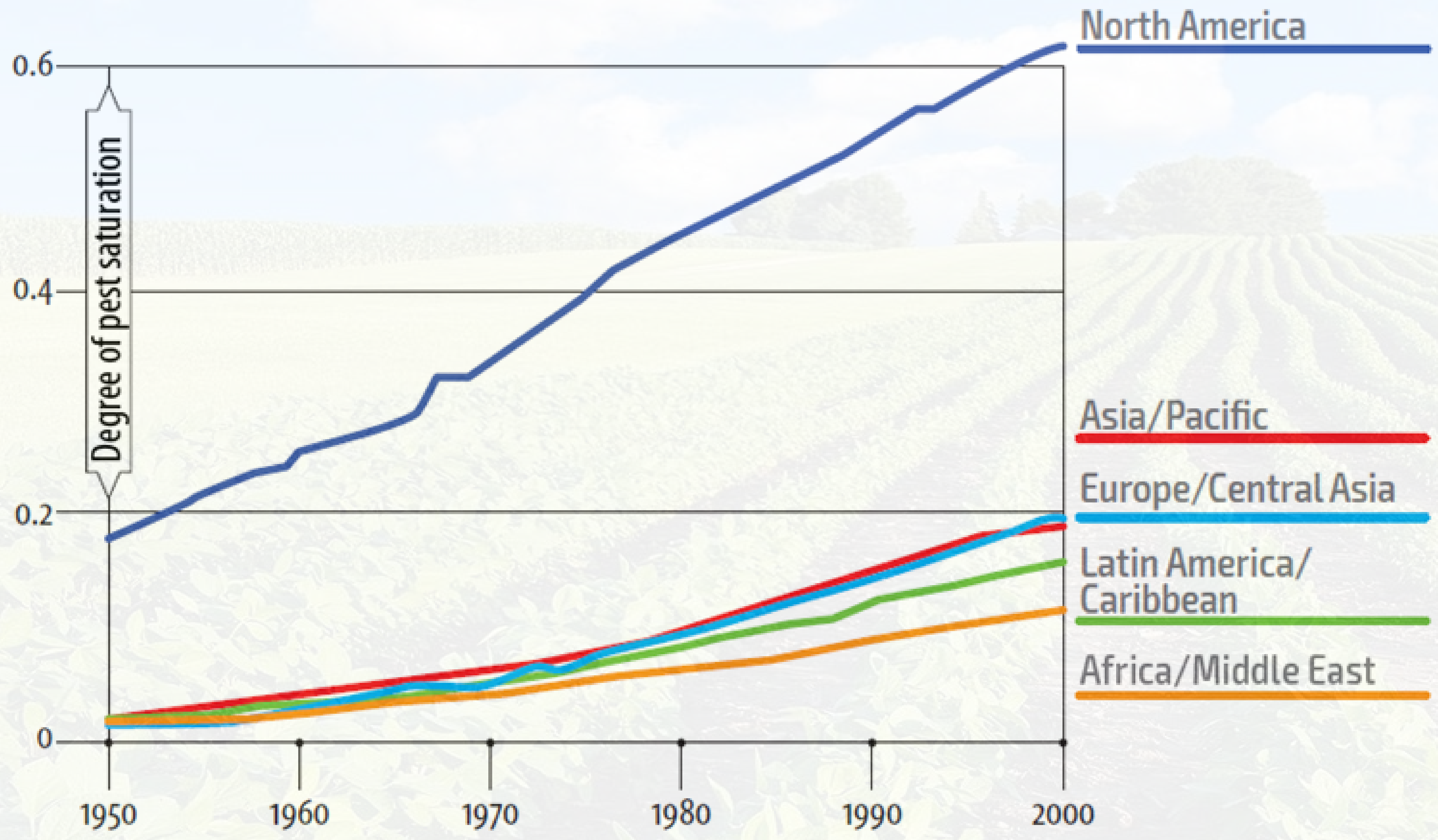
Global challenges





Losses to Pests and Diseases

Global spread of crop pests and pathogens, 1950-2000



Note: The degree of pest saturation for a region is the mean of the degrees of saturation of countries in that region. The degree of saturation in a country is the number of crop pests and pathogens (CPPs) currently present divided by the number of CPPs that could occur.

Source: Bebber, Holmes and Gurr, 2014.

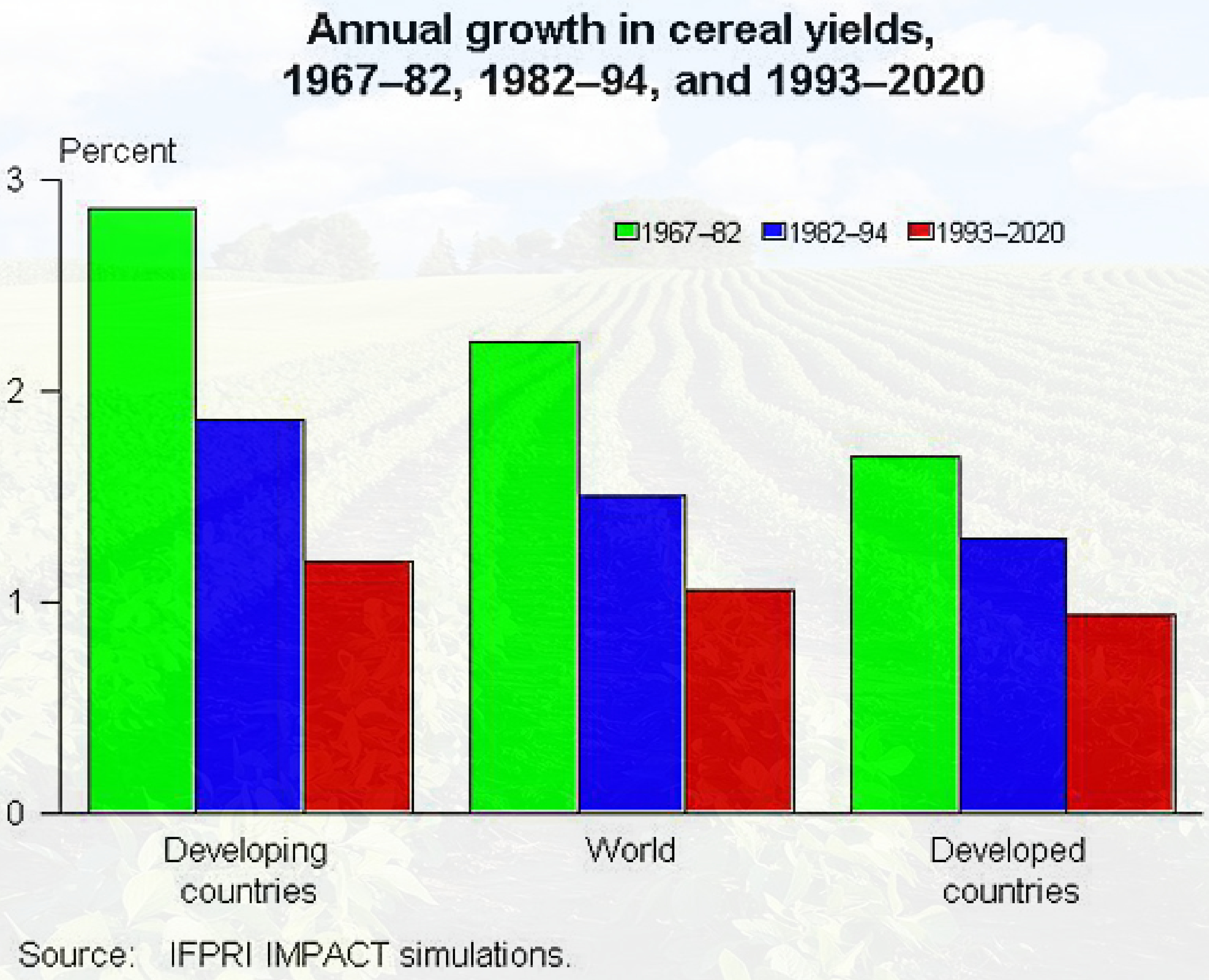
Lose 20-40% of crops each year

Cost of Annual Losses

- **$220 billion USD for plant diseases**
- **$70 billion USD for invasive insects**

FAO Report, 02-2017

Declining Productivity



Simplicity to complexity

Traditional Agricultural Sciences

- Reductionism
- World is linear – understanding parts individually
  - Soils
  - Plant genetics
  - Microbiomes or
  - Weather and environment

Real World Situation

- Complex system, non-linear organization
- Governed by multiple nonlinear interactions and multiple environmental variables

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

Decipher Phytobiomes

Phytobiomes

Climate

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

Micro- and Macroorganisms

Viruses
Archaea
Bacteria
Amoeba
Oomycetes
Algae
Fungi
Nematode

Plants

Arthropods, Other Animals and Plants

Insects
Arachnids
Myriapods
Worms
Birds
Rodents
Ruminants
Weeds

"Biome" - Site specific environment

Associated organisms

Holy Grail of Phytobiomics

To understand, predict, and control emergent phenotypes for sustainable production of food, feed, and fiber on a given farm.

How?

The International Alliance for Phytobiomes Research

Who We Are

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

PHYTOBIOMES ALLIANCE

BAYER
Science For A Better Life

MONSANTO

THE CLIMATE CORPORATION

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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….).

Strategy and implementation

- Industry leadership in identifying research, resource, and technology gaps (e.g., model development)
- Focus on pre-competitive science
- Facilitate linkages within and between industry and academia
- Coordinate projects to address gaps
- Empower industry growth and profitability in the phytobiomes space – connecting site specific biological and physical information for agriculture

Understanding and Predicting

- Develop, validate, and optimize accurate models that include all physical & biological components and their interactions
- Enable simple, simulation models that are functionally accurate to real world complex conditions – e.g., greenhouse studies that reflect field conditions
- Design systems level predictive and prescriptive analytics for on-farm implementation
- Create databases of near real-time environmental and biological data

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 and temporal physical & biological data for crops, forests, and grasslands
- Science to support the regulations that may exist for agricultural biologicals, including biopesticides and permitting

Working Groups

- Ag Data – physical & biological
- Standards
- Regulatory
- Climate/Weather

How to become involved

Scientific Coordinating Committee

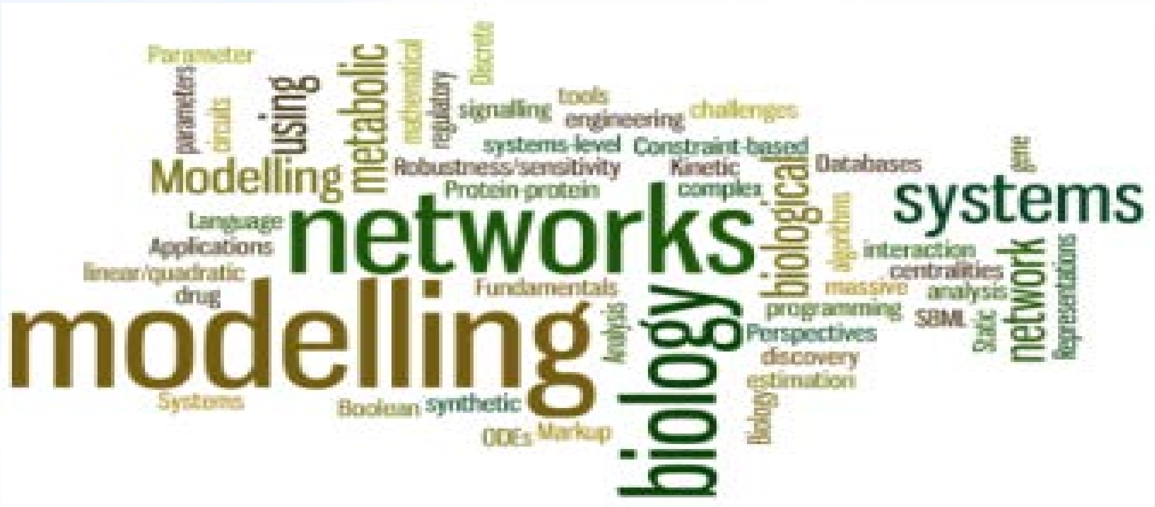
- ✓ Alliance sponsors
- ✓ Project leaders

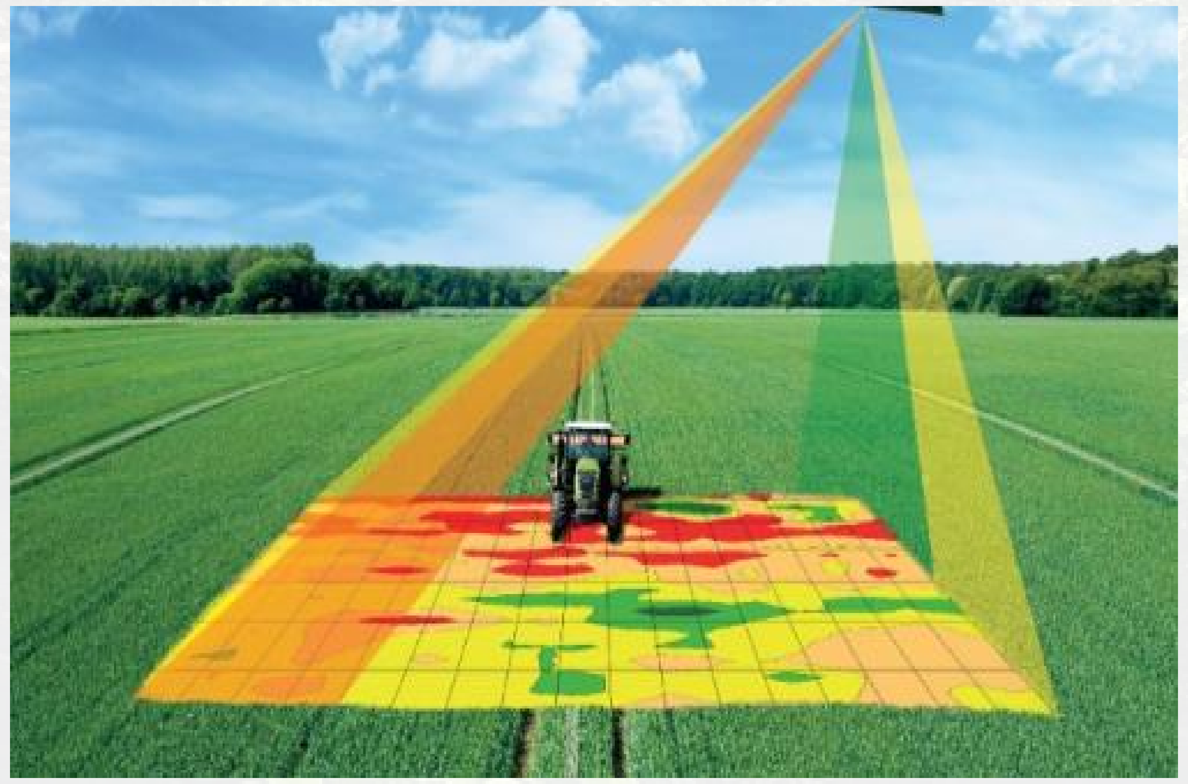
Alliance working groups

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

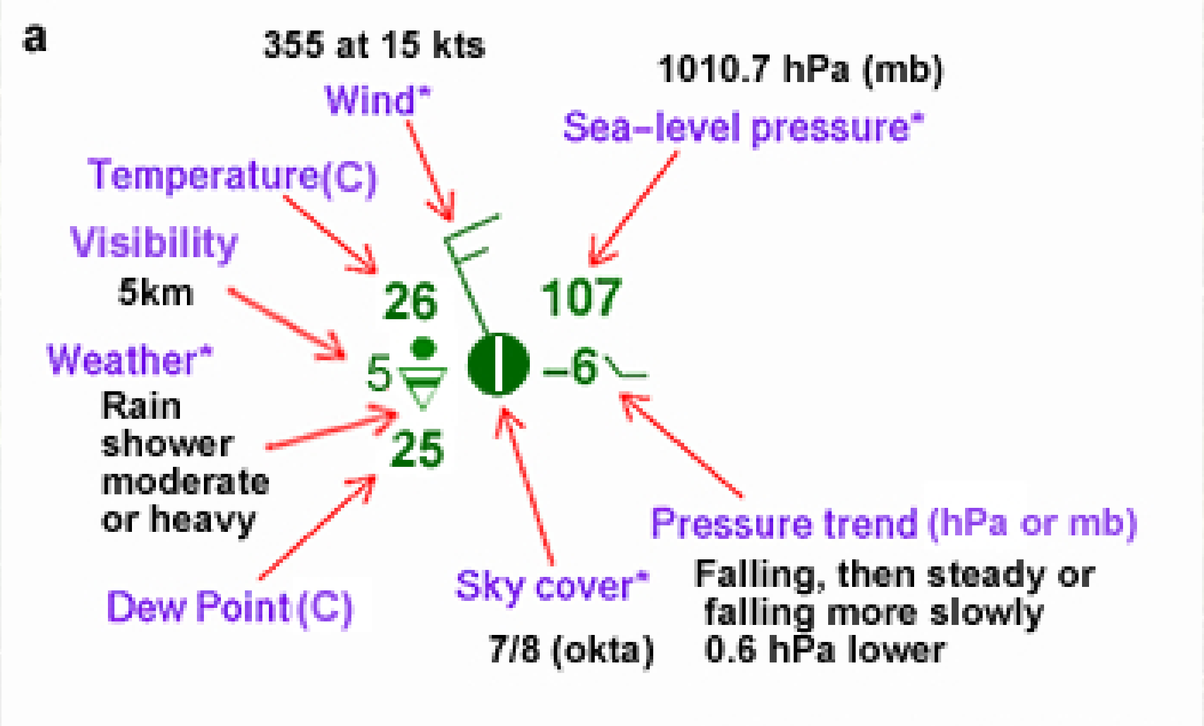
Why Now?

- Omics-enabling technologies
  - high-throughput sequencing
  - computational biology & modeling
- Systems-level methods
- Advances in computational science
  - Quantum computing
  - Machine learning
  - Analytics
  - Predictive analytics
- Precision Agriculture
  - Variable rate seeding & input
  - UASs
  - Soil & weather sensors



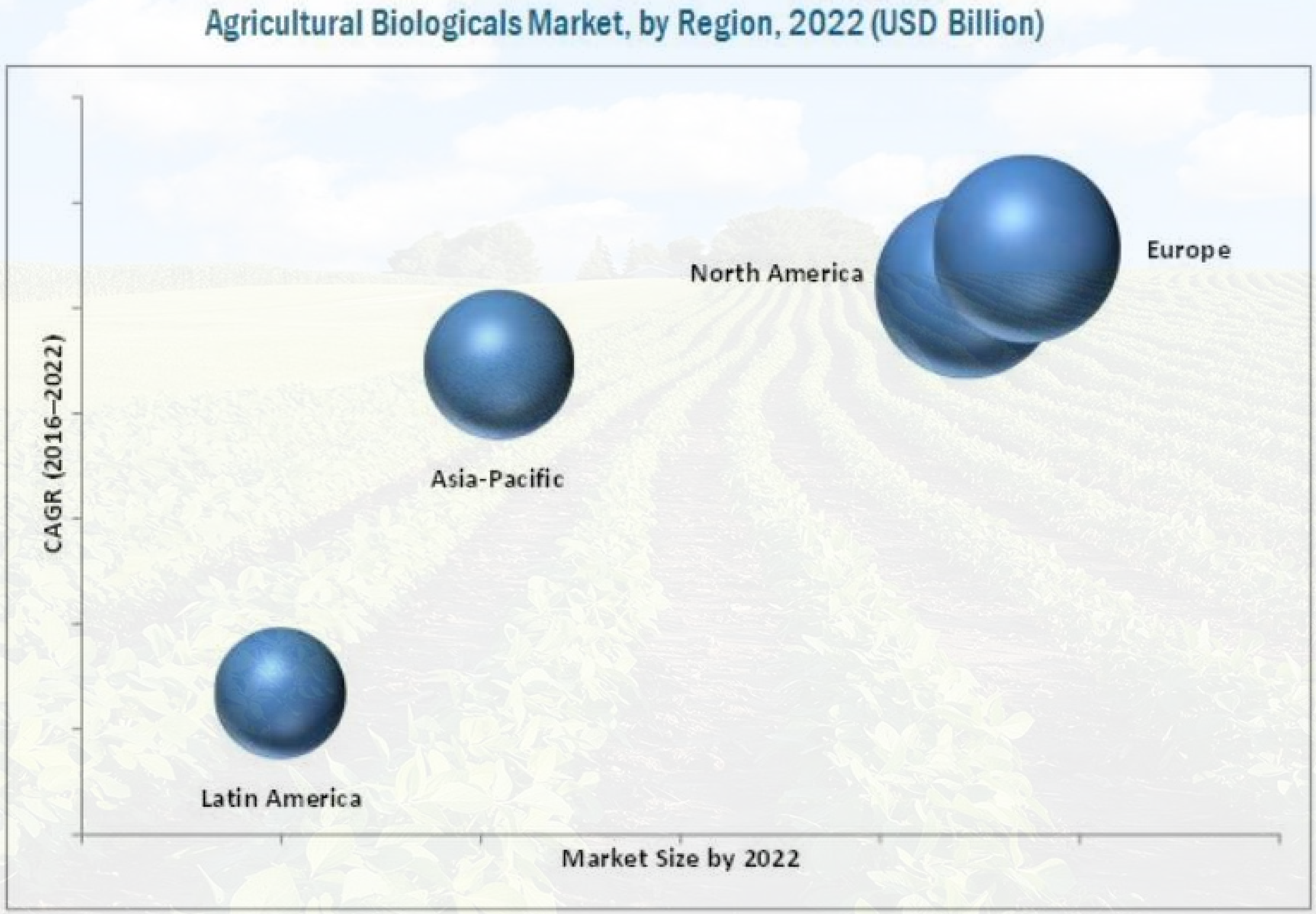


www.linkedin.com/pulse/foreign-affairs-precision-agriculture-revolution-ulrich-adam



Adapted from NOAA/NWS/NCEP

Agricultural Biologicals

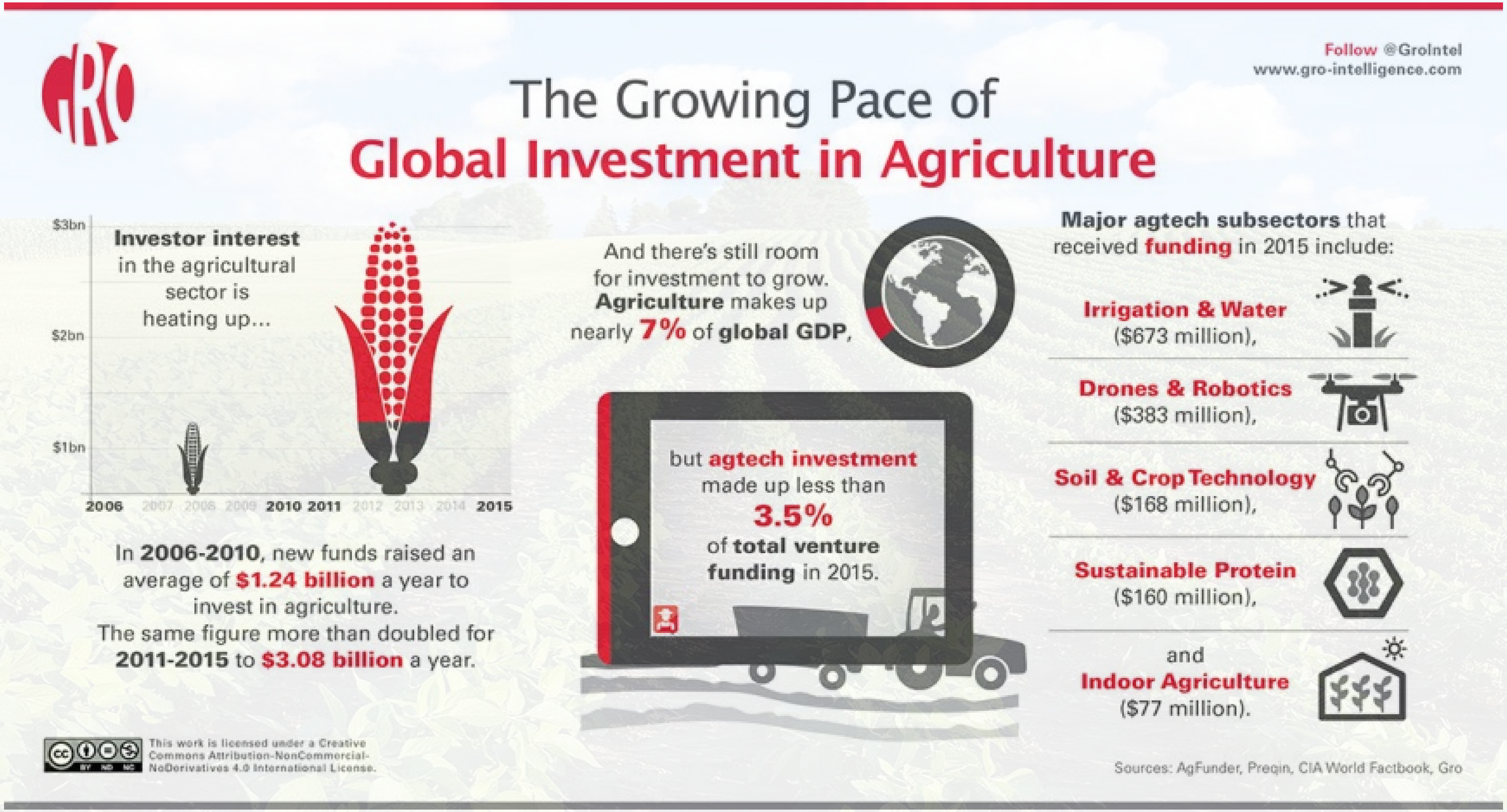


Source: Markets and Markets, 2017

2016-2022
CAGR = 12.76%

Market equals $11.35 Billion in 2022

Growing Agricultural Investments



PHYTOBIOMES ALLIANCE

Now is the time to

Join Us!

Acknowledgements

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For More Information:

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