Bayer SeedGrowth™

Biological Seed applied Technology an increasing trend

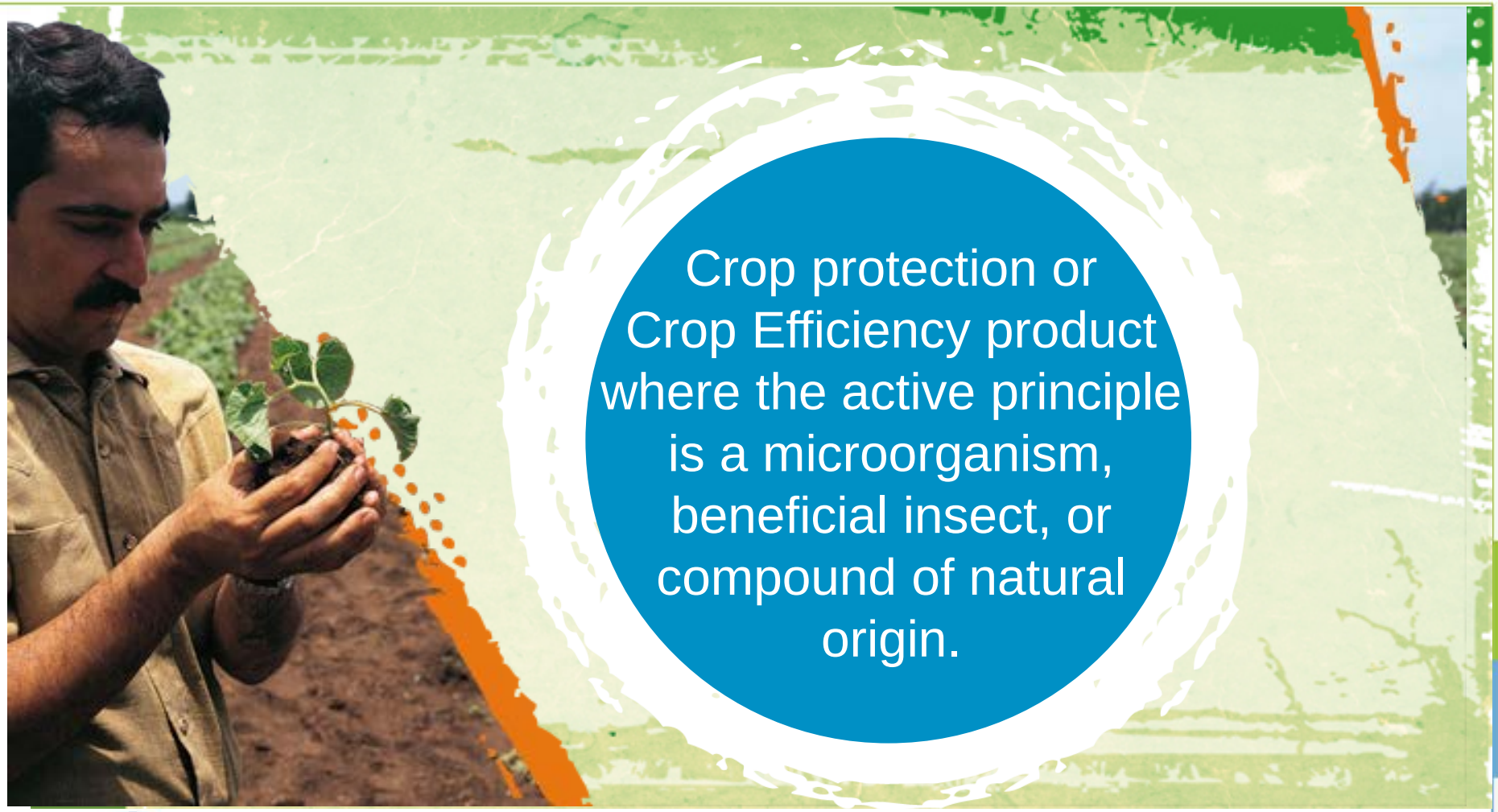
César Roberto Lamonega

5th Seed Congress of the Americas

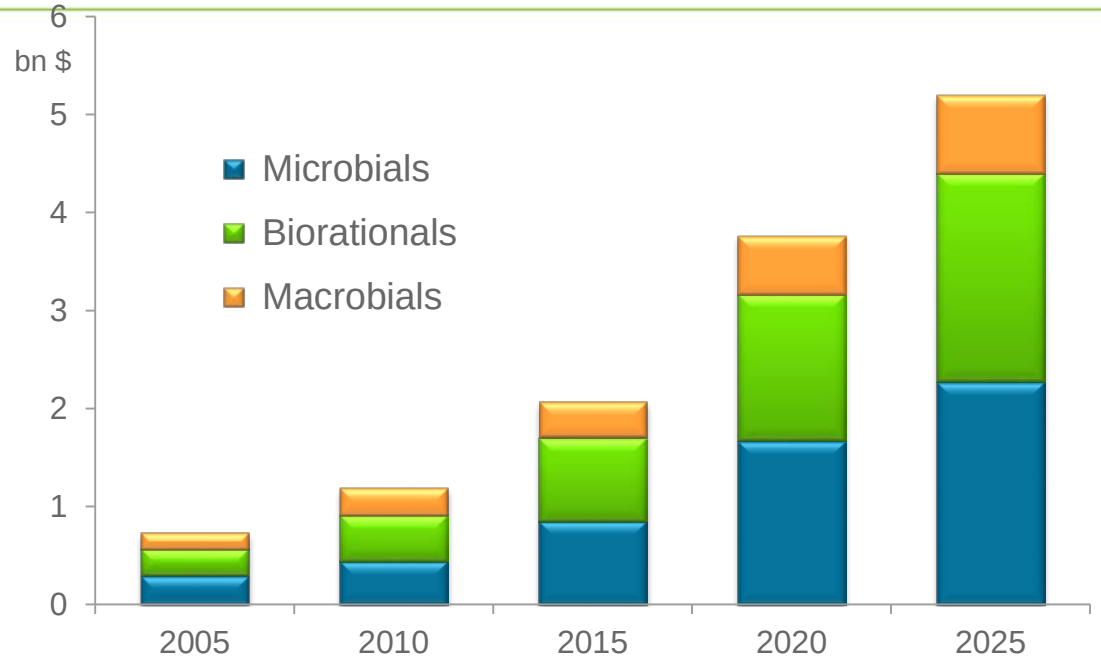
Content

1. **Definition of Biologicals**
2. Biologicals and integrated crop solutions
3. Sustainable seed technology

What are Biologicals in Agriculture?



Biologicals are in demand!



Source: Frost & Sullivan, Nov. 2009; BCC Research Survey 2010; CPL Business Consultants 2010

Short term (<3 years)

- Food Chain demands
- Sustainable Use Directive EU
- New Biological product introductions
- Country low chem programs (e.g. France)

Mid term (>5 years)

- Increasing demand for Biological solutions in emerging markets *(Brazil, China and India)*
- Sustainable growth of Biological solutions in the US and EU
- Investments BASF, Syngenta, Bayer, Monsanto & other

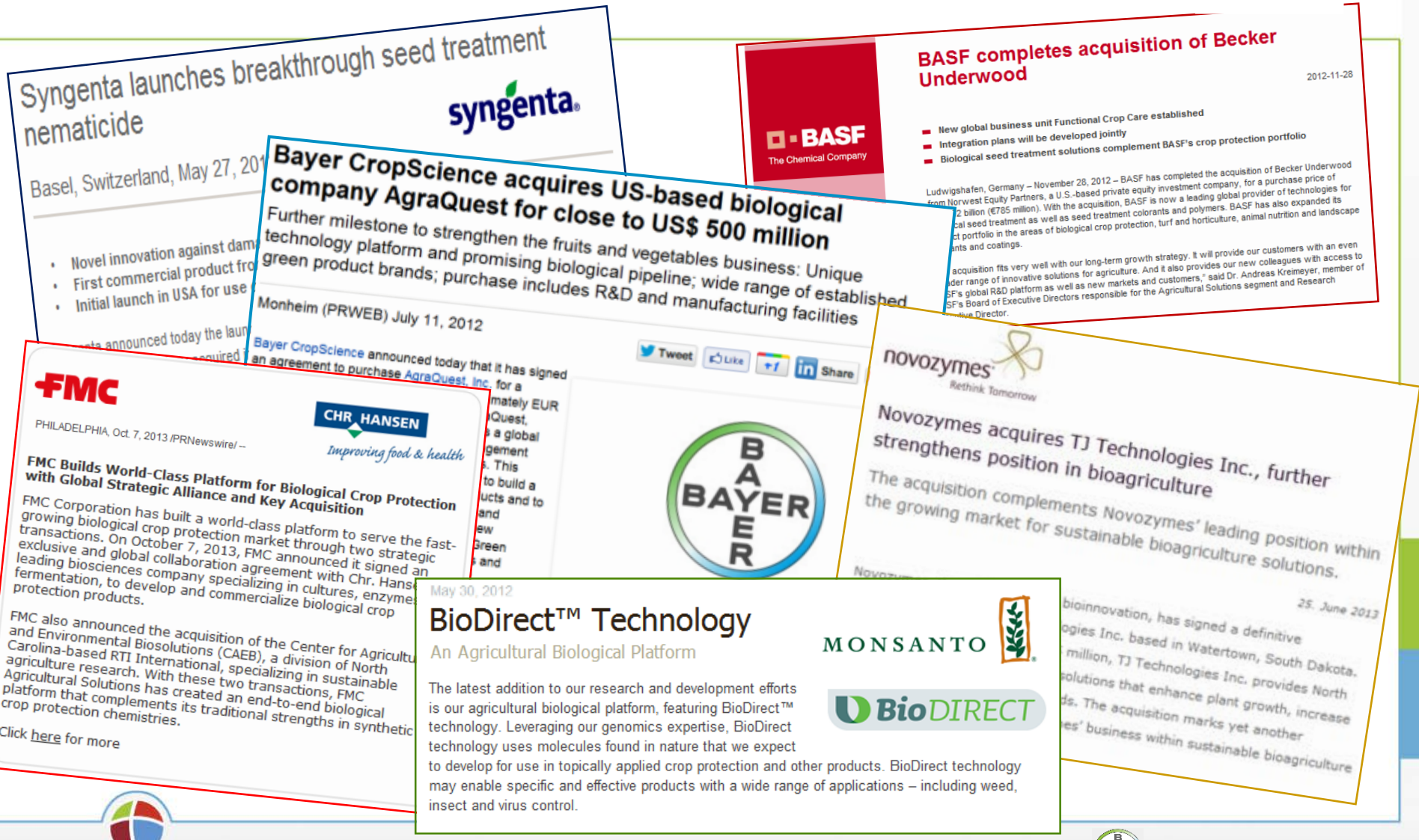
Long term (>10)

- Introduction of new Biological technologies

- **Average Market Growth (2005-2025): > 10 % Biologicals vs. Chemical < 3% CAGR**
- **Biologicals Market (2010-2020): 1.2 – 3.7 bn. US$**

Biologicals are an area of increasing investment

5th Seed Congress of the Americas



Some examples of successful Biological Technologies in global Seed/Soil solutions today

Rhizobium Inoculants	Bacillus Firmus	Bacillus subtilis	Penicillium bilaii	Trichoderma	Signal Technology	Humic accid

Optimize LCO Promoter Technology™ for Soybeans

VAULTHP

BIAGRO

RIZOBACTER

VOTiVO

SERENADE

Jumpstart®

QuickRoots®

TORQUE™ IF

fbsciences

Biological Product Categories

1. Microorganism

- Bacteria (e.g. B. thuringiensis, Bradyrhizobium, B. firmus, B. subtilis, Pseudomonas)
- Fungi (e.g. Beauveria bassiana, Verticillium lecani)
- Virus (e.g. granulosis virus)

1. Biorationals

- Plant extracts & essential oils (e.g. neem, citrus, tea tree)
- Pheromones *(semiochemicals)* (e.g. mating disruption, mass pheromone trapping)

2. Macrobials

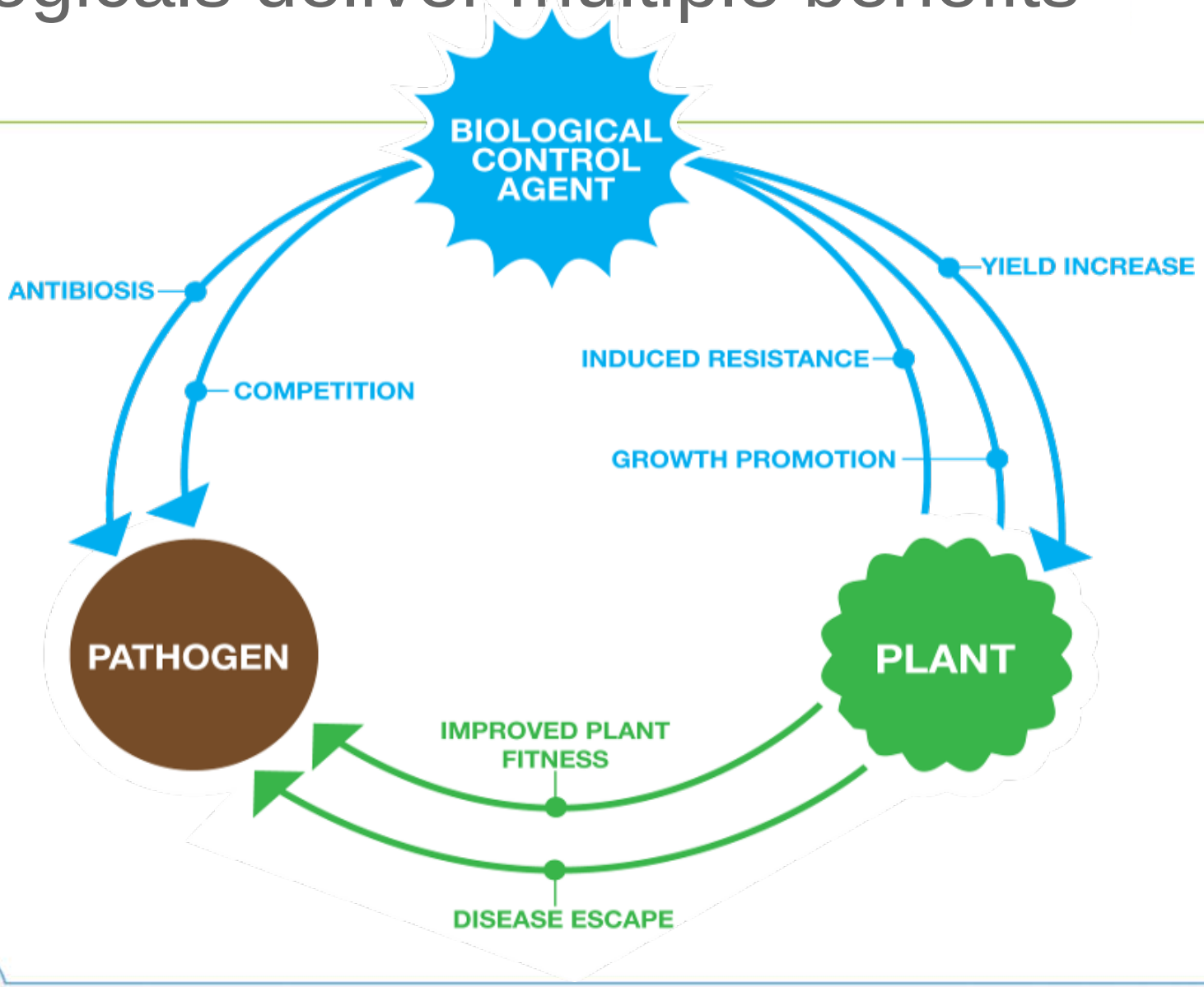
- Beneficial insects including predatory nematodes

3. Other

- Cyclic peptides
- RNAi *RNA interference: Biological process of RNA molecules inhibit gene expression (potentially using microbes as inducer/carrier)*
- Gene delivery

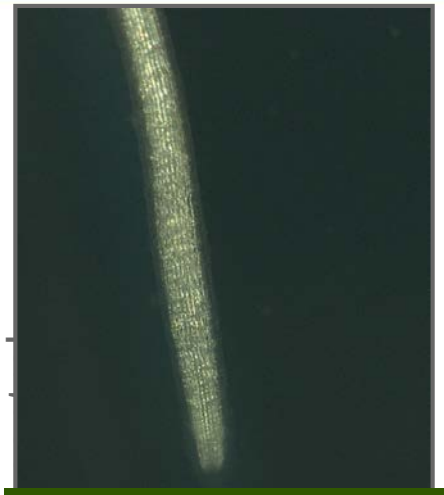
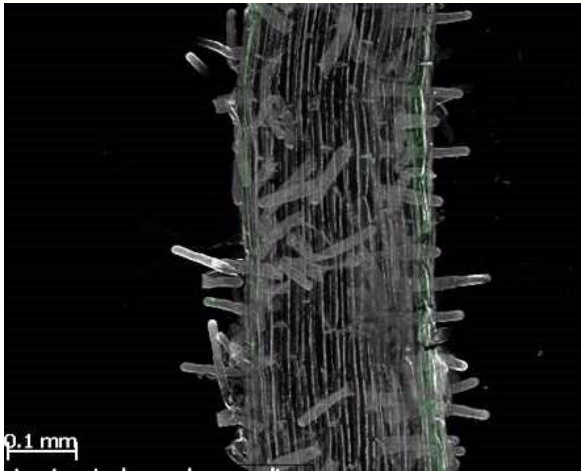
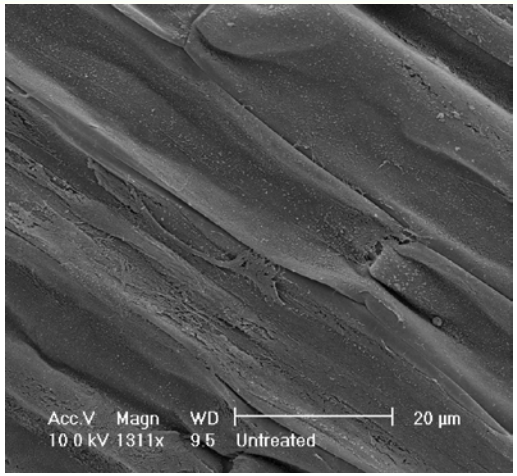
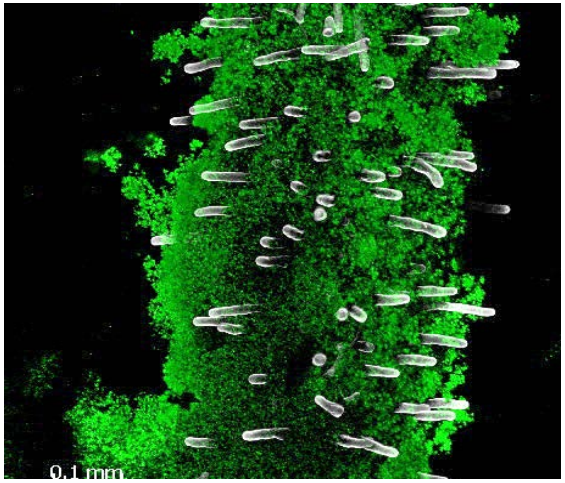
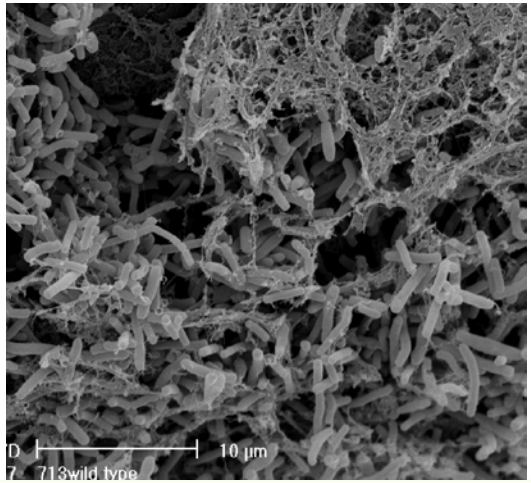
Excludes inorganic compounds (i.e. copper, sulphur)

Biologicals deliver multiple benefits



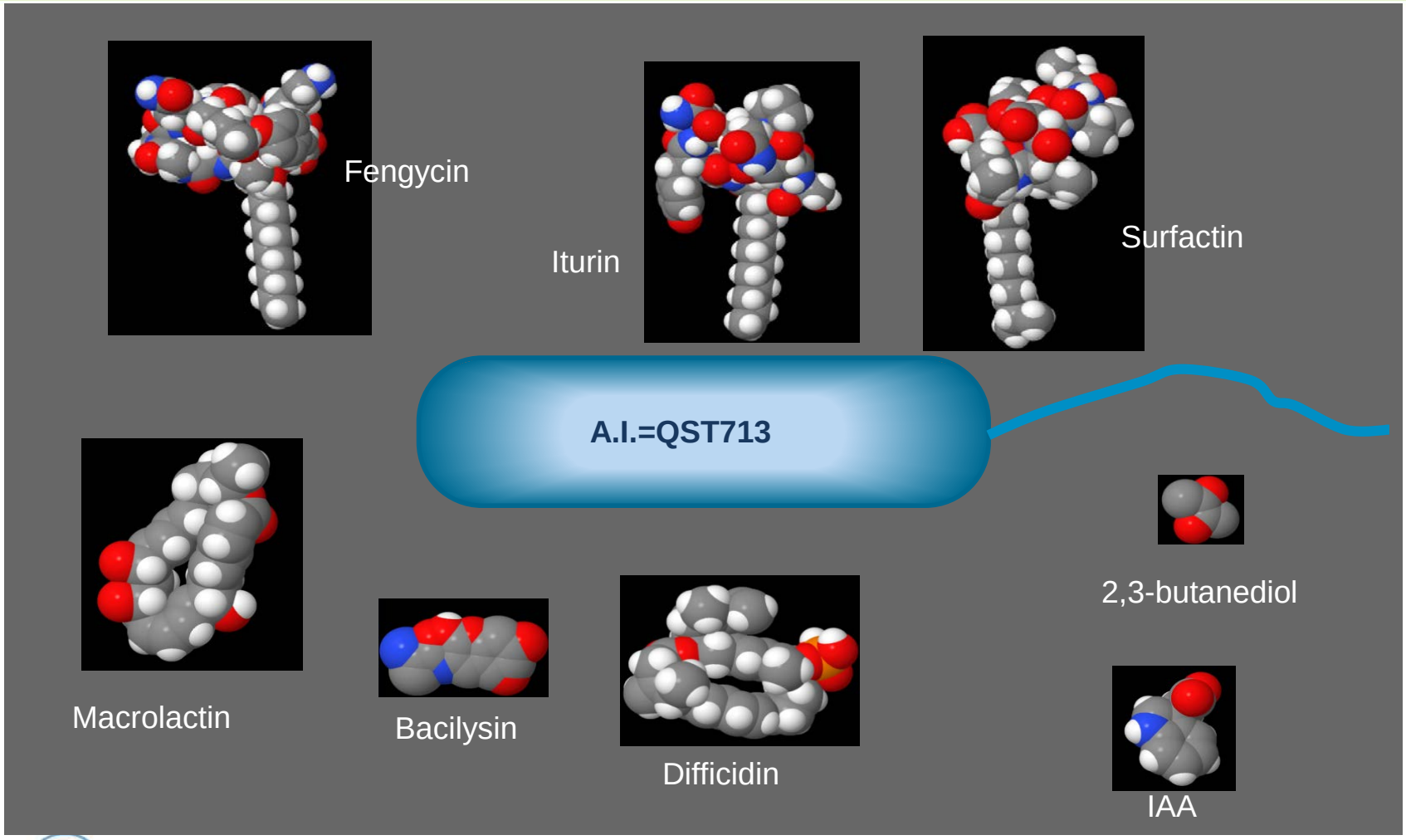
Biological root colonization

Germinated tomato seeds dipped into a QST713 suspension and placed into ½ strength MS medium. After 5 days, the roots were visualized under microscopy in order to observe colonization.

	Digital Microscopy	Fluorescence Microscopy	Scanning Electron Microscopy
Untreated water			
B. Subtilis QST713			

Biologicals produce natural chemicals

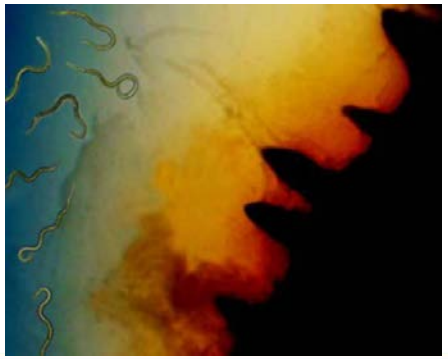
Single microbe can yield multiple products



Biological Product benefits

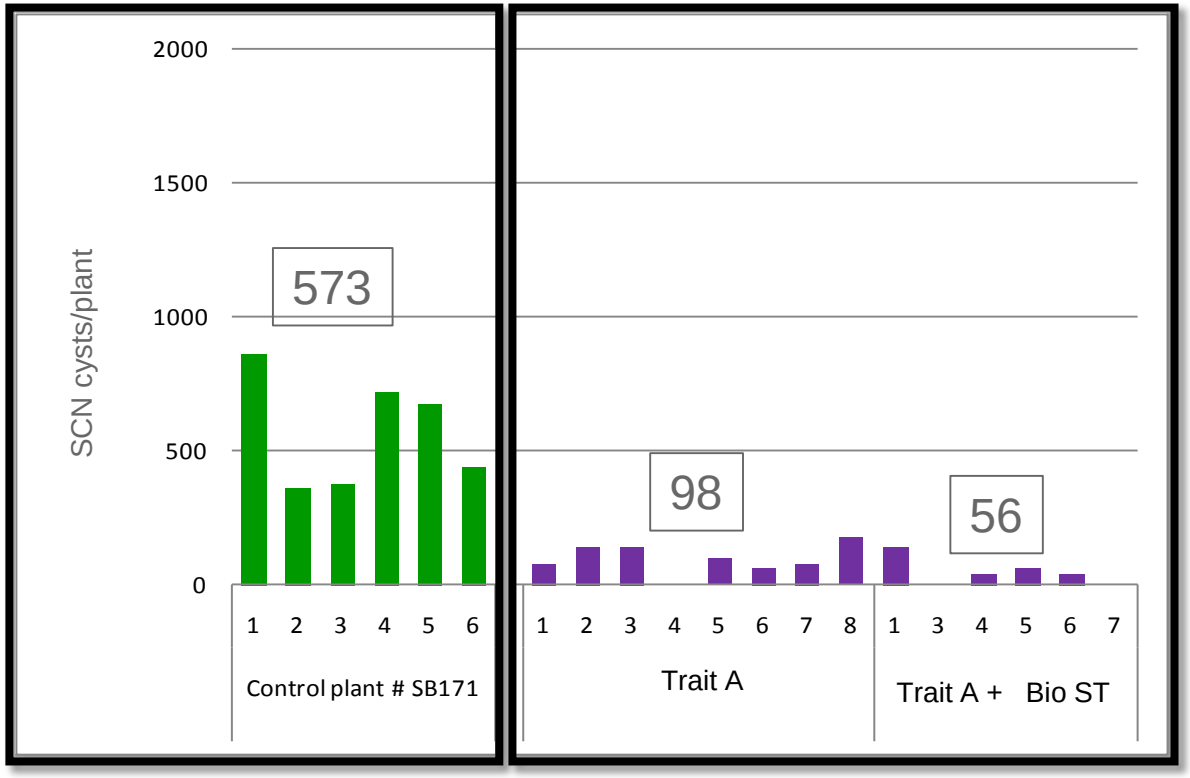
Control

- **Can be direct control or barrier to penetration of the pest/disease or a plant stimulant to accelerate growth preventing infections**
  - Many companies and institutions developing products in this class
  - Spectrum of control is expanding
  - Application stability and more broadly adaptability to a range of environments
- **Products Example**
  - Bacillus firmus launched in 2010
  - Brought unfamiliar method of pest control for nematodes
  - Widely adaptable across crops and geographies
  - Naturally occurring product
  - Partner to nematode resistant genes
  - Improved applicator safety



SCN Resistance with Biological Seed Treatment

Individual plant cyst counts for Trait A soybean



Trait A expression correlates with reduction in SCN cysts counts in transgenic soybean plants & further reduction is available with a biological seed treatment

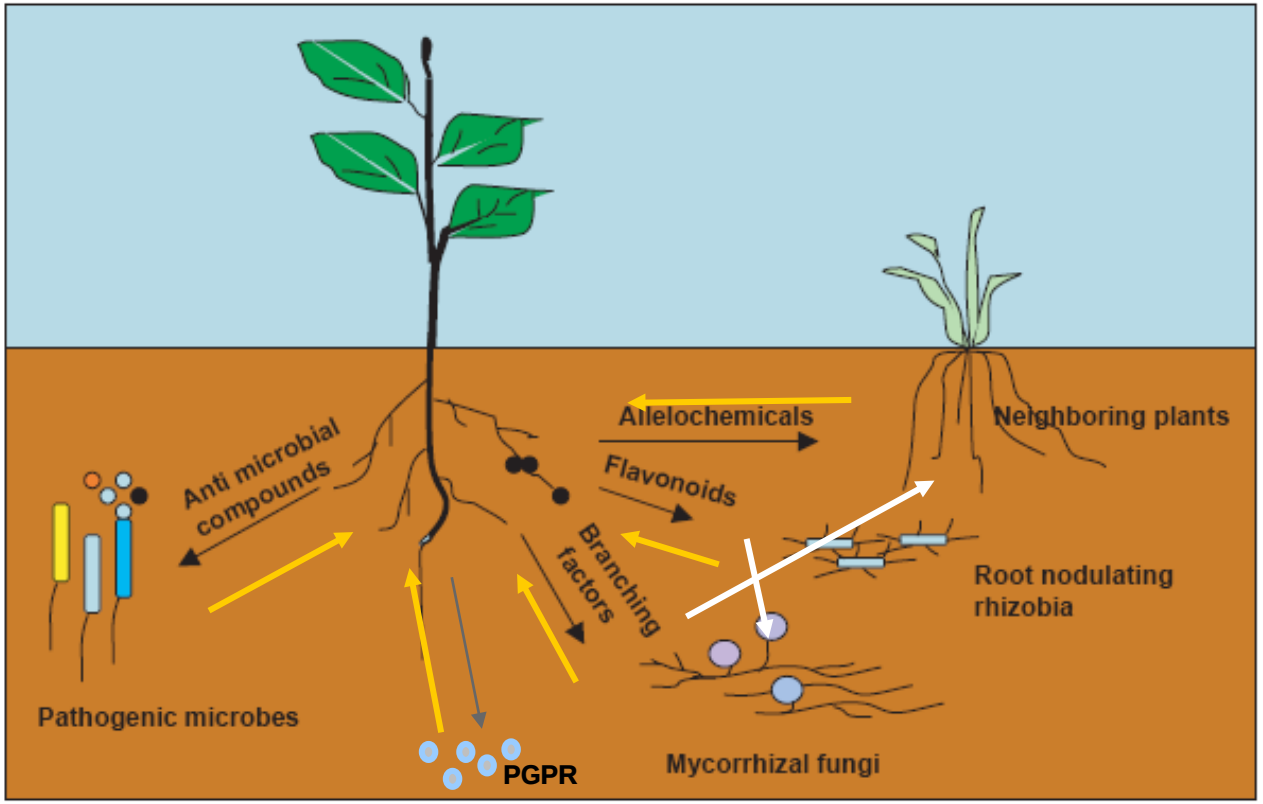
Biological Product Benefits

Plant Health

- **Plant defense** - Compounds that trigger direct health responses on the plant and could complement new traits in seed
- **Signal technology** – Compounds with effect on rhizobium bacteria or mycorrhizal fungi that could enable other plant health mechanisms
- **Anti-mycotoxins** – mycotoxin inhibitors, not necessarily something that kills the fungus with potential for residual control not achievable with traditional products

Underground Communication

Mediated by root exudates and microbial compounds



In the Rhizosphere multiple signaling products or microbes are able to have an effect on plants

Biological Product Benefits

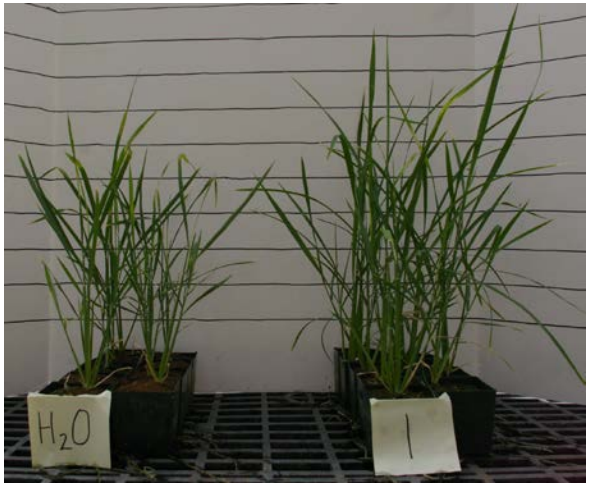
Abiotic Stress Tolerance

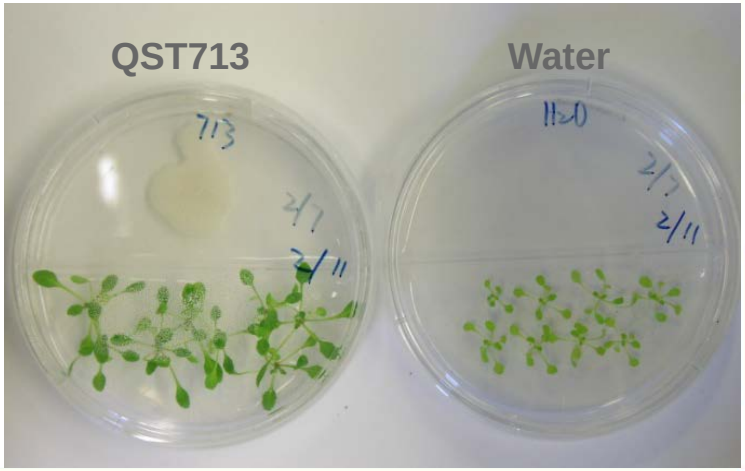
- **Partner to Plants Drought Tolerance Characteristic's**

Fertility/Yield Enhancement

- **Product improving plant health, promoting growth and yield**
  - Acquired resistance
- **Fertility**
  - Focus on minor elements with positive impact on the seed and seedling

Rice seed treated with QST713 at 64 oz/acre, grown under 60mM of salt for 4 weeks



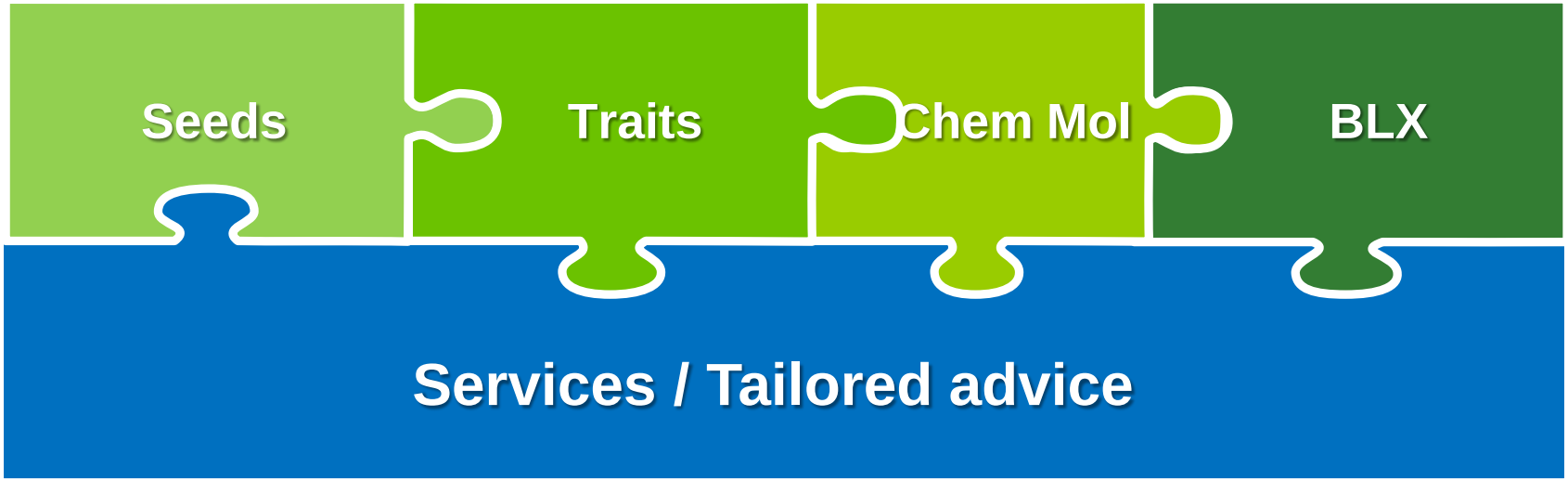


Content

1. Definition of Biologicals
2. **Biologicals and integrated crop solutions**
3. Sustainable seed technology

Biologicals are a great tool in Integrated Crop Solutions *(ICS)*

Integrated Crop Solutions are offers of any combination of **Seeds, Traits, Traditional Chemical Molecules**, **Biologicals** and Services **that are tailored** towards our target customers and **create sustainable value** for them and the value chain



Integrated Crop Solution will be Essential for Progress into Future Agriculture

5th Seed Congress of the Americas

Limited arable land coupled with rising demand

Climate change

Safeguard and increase yields from constant land area

- Better resource management (targeted use of crop protection, irrigation technology, fertilizers and resistance management)
- Increase yields through innovative technologies (hybridization, plant biotechnology, better crop protection)

Expand agricultural production in marginal areas

- New crops with greater tolerance of drought and extreme temperatures

Increase tolerance of plants to climatic variability

- Develop new varieties using state-of-the-art technologies
- Improve plant health and nutrient uptake

Research and innovation are the key to mastering the challenges of agriculture

Content

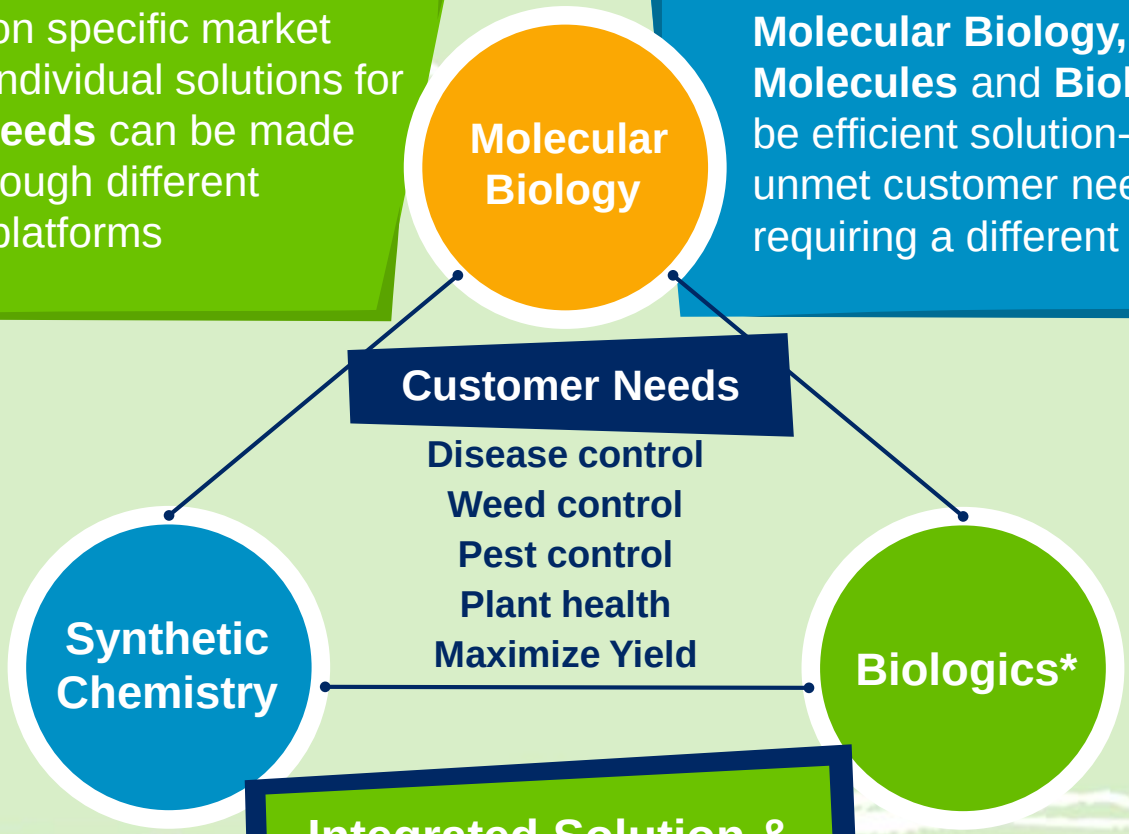
1. Definition of Biologicals
2. Biologicals and integrated crop solutions
3. **Sustainable seed technology**

Competencies exist to lead in Sustainable Crop Solutions

5th Seed Congress of the Americas

Depending on specific market conditions, individual solutions for **customer needs** can be made available through different technology platforms

Molecular Biology, Small Molecules and **Biologics** can be efficient solution-providers for unmet customer needs - each requiring a different expertise



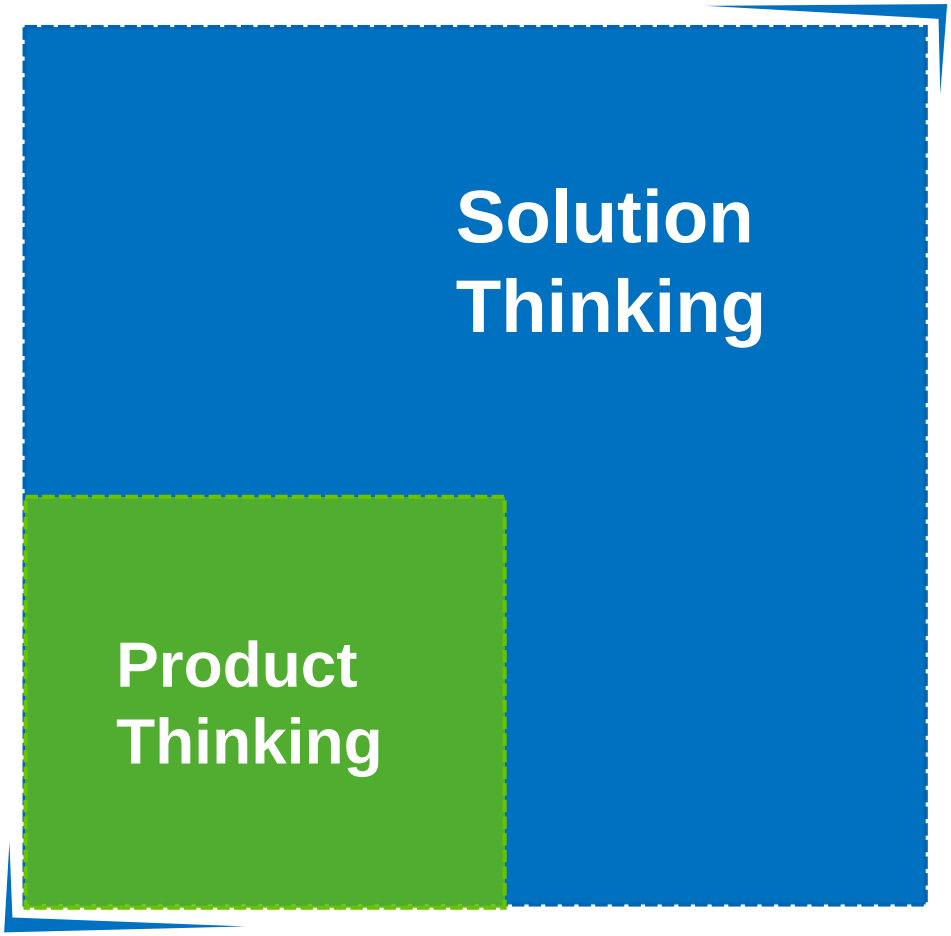
*Suitable for conventional and organic agriculture

The Pillars of Seed Technology

Quality Seed
Seed Traits
Chemical
Biological
Seed Coatings
Application Equip

Seed
Seed Treatment
Application
Seed Treatment Technology

With **Biological Innovations** the Seed Industry can address unmet needs today & in the future



Potential unmet needs*

- ✓ Sustainable Cropping
- ✓ IPM / ICM compatible *(e.g. safe for beneficials)*
- ✓ Deal with some difficult pests/ diseases (e.g. thrips, bacteria, nematodes, etc.)
- ✓ Yield increase *(quality & quantity)* i.e. p*lant health/yield enhancement*
- ✓ Resistance Management
- ✓ Lower chemical input
- ✓ Flexibility in use *(low REI or PHI)*
- ✓ Worker safety
- ✓ Enabling Global Trade *(residue management)*

** different unmet needs can also be addressed with chemical*

Science For A Better Life

Thank you!

5th Seed Congress of the Americas