

The role of science and technology to support profitable future of poultry industry

San Juan Del Rio, March 10th, 2015

Milan Hruby

Outline

- Food Security Index
- How enzymes and/or direct fed microbials
 - » Can help the industry to produce more protein
 - » Increase food safety and shelf life of meat
 - » Can enable new alternative raw materials
- Future technologies
 - » Which might change the industry
- Summary



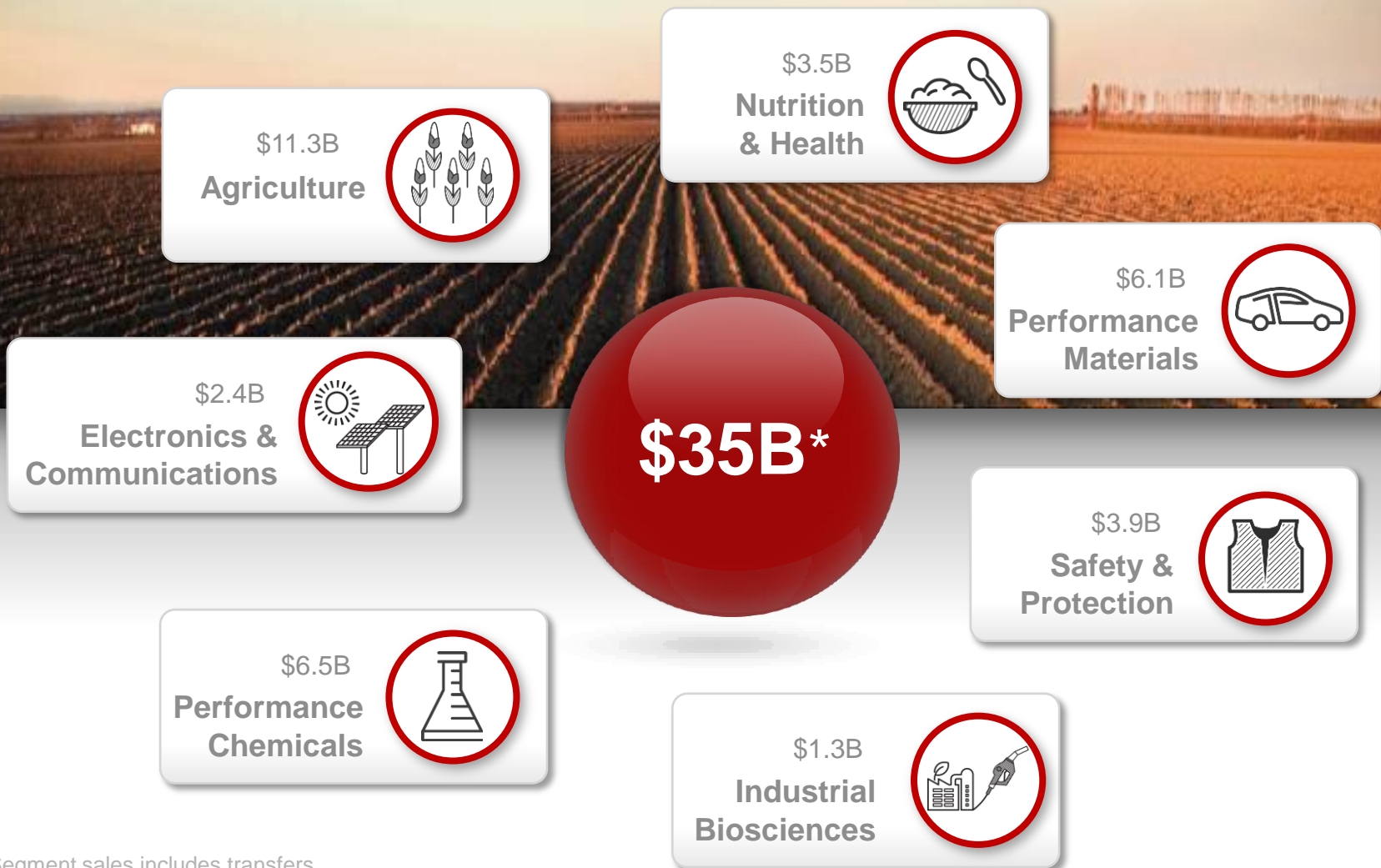
Crop
production

Animal
production

Processing
and
distribution

Consumer

DuPont 2014 Segment Sales



* Segment sales includes transfers.

The DuPont Global Food Security Goals

By the end of 2020, DuPont will help the world meet the challenge of achieving global food security



Innovating to Feed the World

We will commit \$10 billion to R&D and 4,000 new products will be introduced.



Engaging and Educating Youth

We will facilitate two million engagements of young people around the world in educational opportunities.



Improving Rural Communities

We will work to improve the livelihoods of at least three million farmers and their rural communities through targeted collaborations and investments.

The Global Food Security Index

DuPont commissioned the Economist Intelligence Unit in 2012 to develop the Global Food Security Index

- Ranks **109 countries** according to their relative levels of food security using 29 indicators divided into three categories: **Affordability, Availability, Quality and Safety.**
- Provides a rigorous, structured framework for **understanding the drivers of food security.**



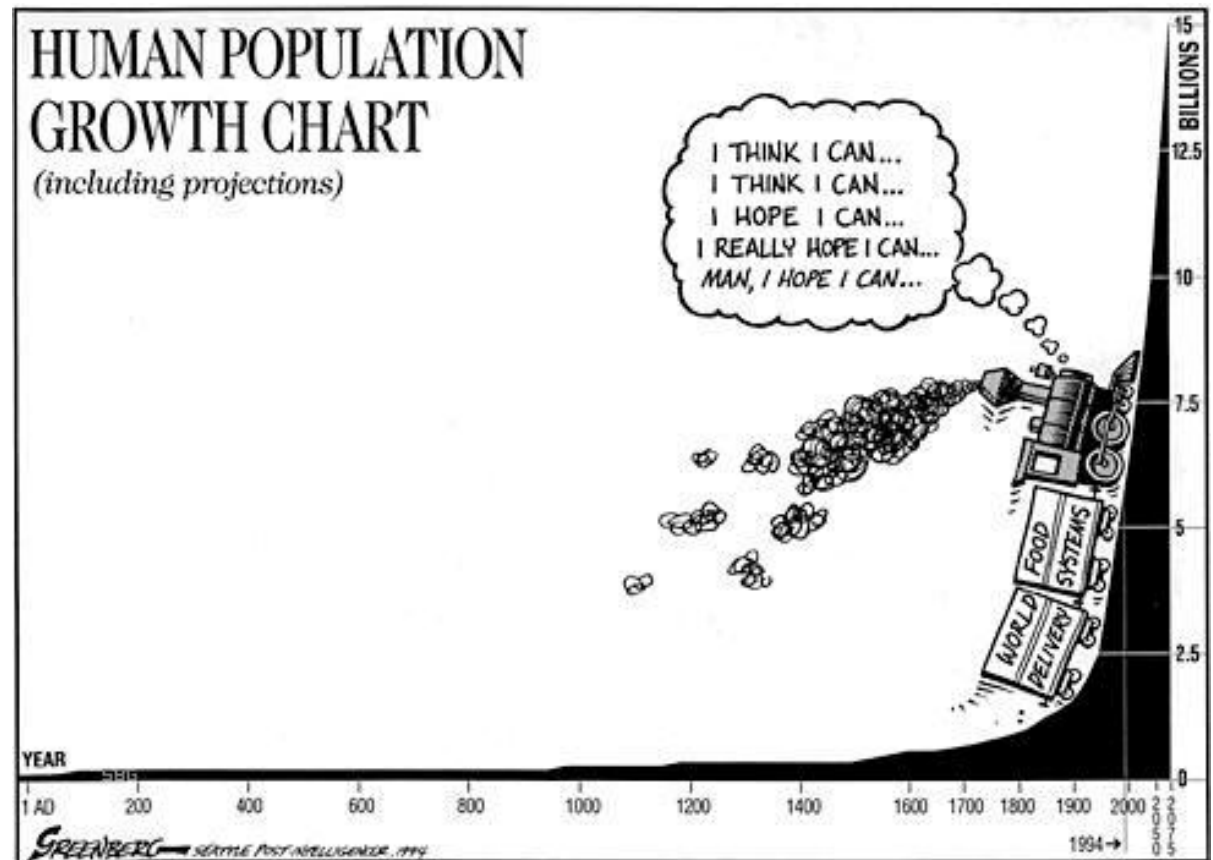
The screenshot shows the homepage of the Global Food Security Index website. The header includes the title "Global Food Security Index" with a wheat icon, and navigation links for "Home", "Key findings", "Explore countries", "Resource library", "Download the index", "Methodology", and "About". Social media icons for Facebook and Twitter are also present. The main content area features a large image of a cornfield at sunset with the text: "The path to food security begins by exploring the challenges, then developing solutions." Below this, a call to action says "The 2014 Global Food Security Index provides a worldwide perspective on which countries are the most and least vulnerable to food insecurity." A button labeled "FREE Download the index (Excel file 13mb)" is visible. The footer includes the DuPont logo and a "powered by" logo for GENENCOR.

Visit foodsecurityindex.eiu.com

Protein Needs Are Increasing

FAO* expects world demand for (animal-derived) protein to double by 2050

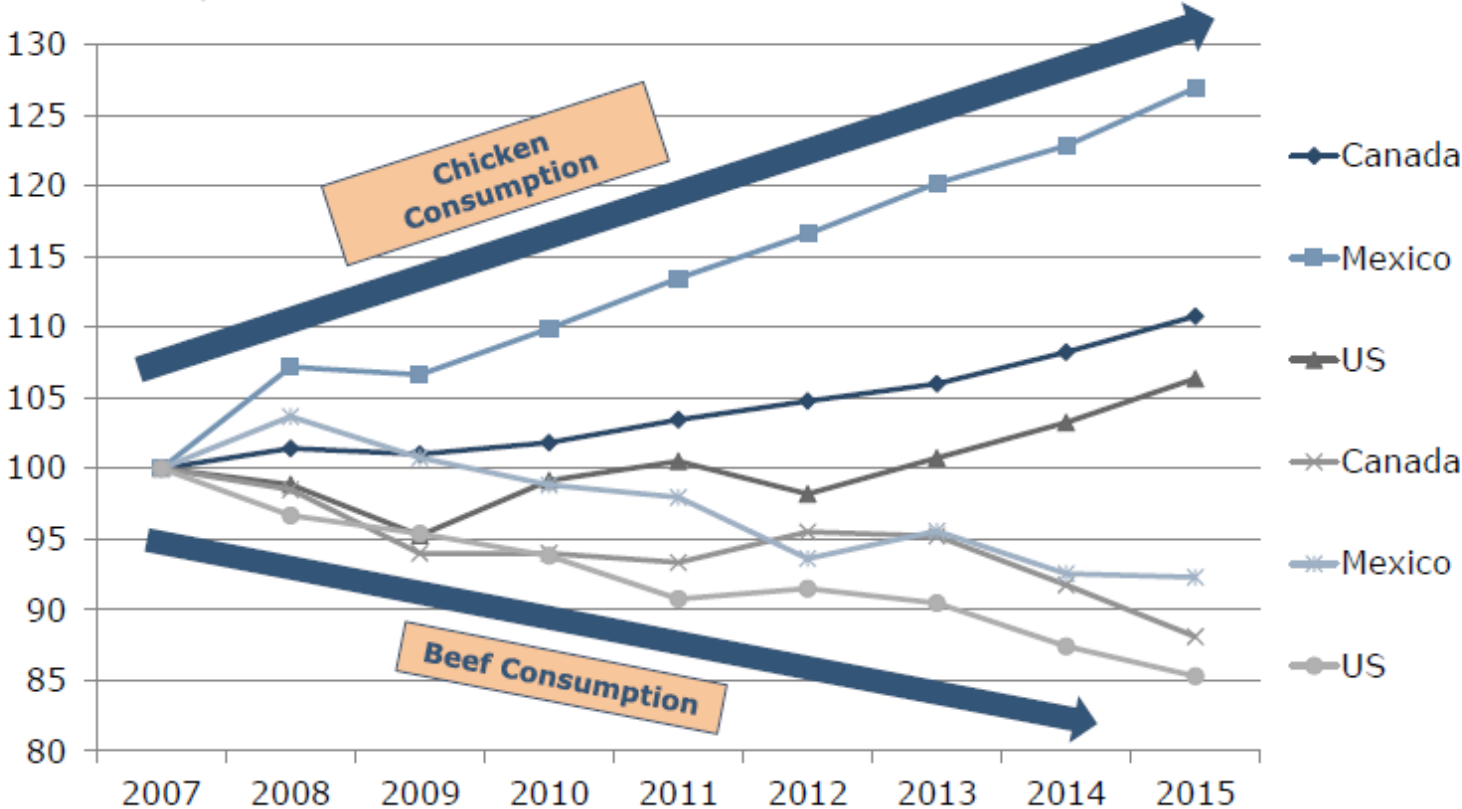
- Increasing population (9 billion by 2050)
- Emerging economies
- Increasing urbanization
- Recognition of protein's role in a healthy diet
- Increased need for protein in the elderly population



*FAO: Food and Agriculture Organization of the United Nations

More cluck, less chuck!

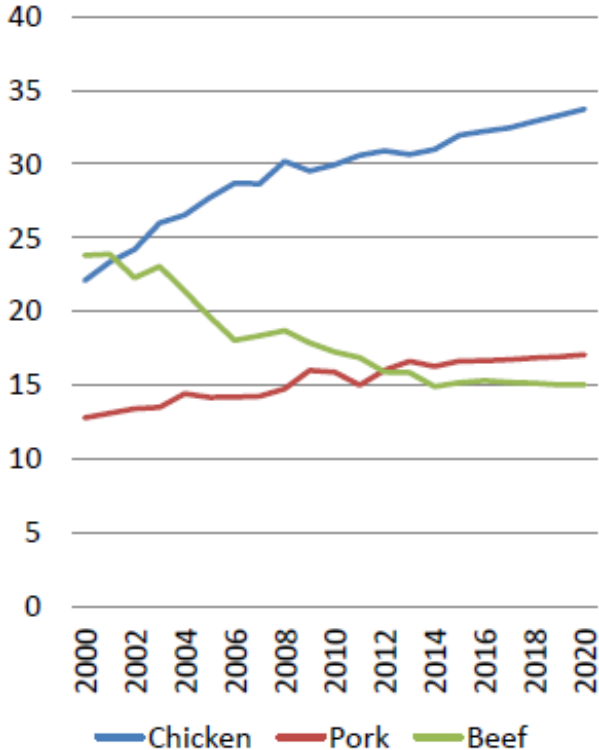
Indexed Domestic Consumption of North America



Source: USDA PSD

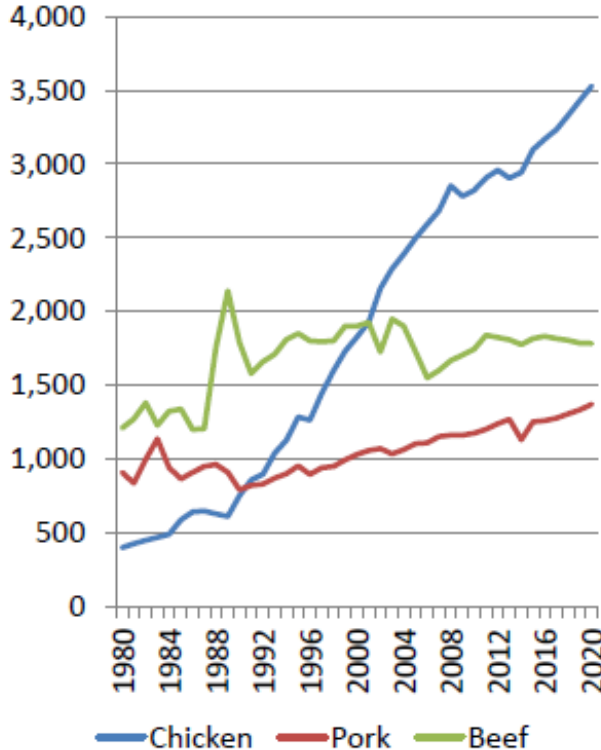
Chicken to Satisfy Rising Mexican Meat Consumption

Consumption per capita (kilos)



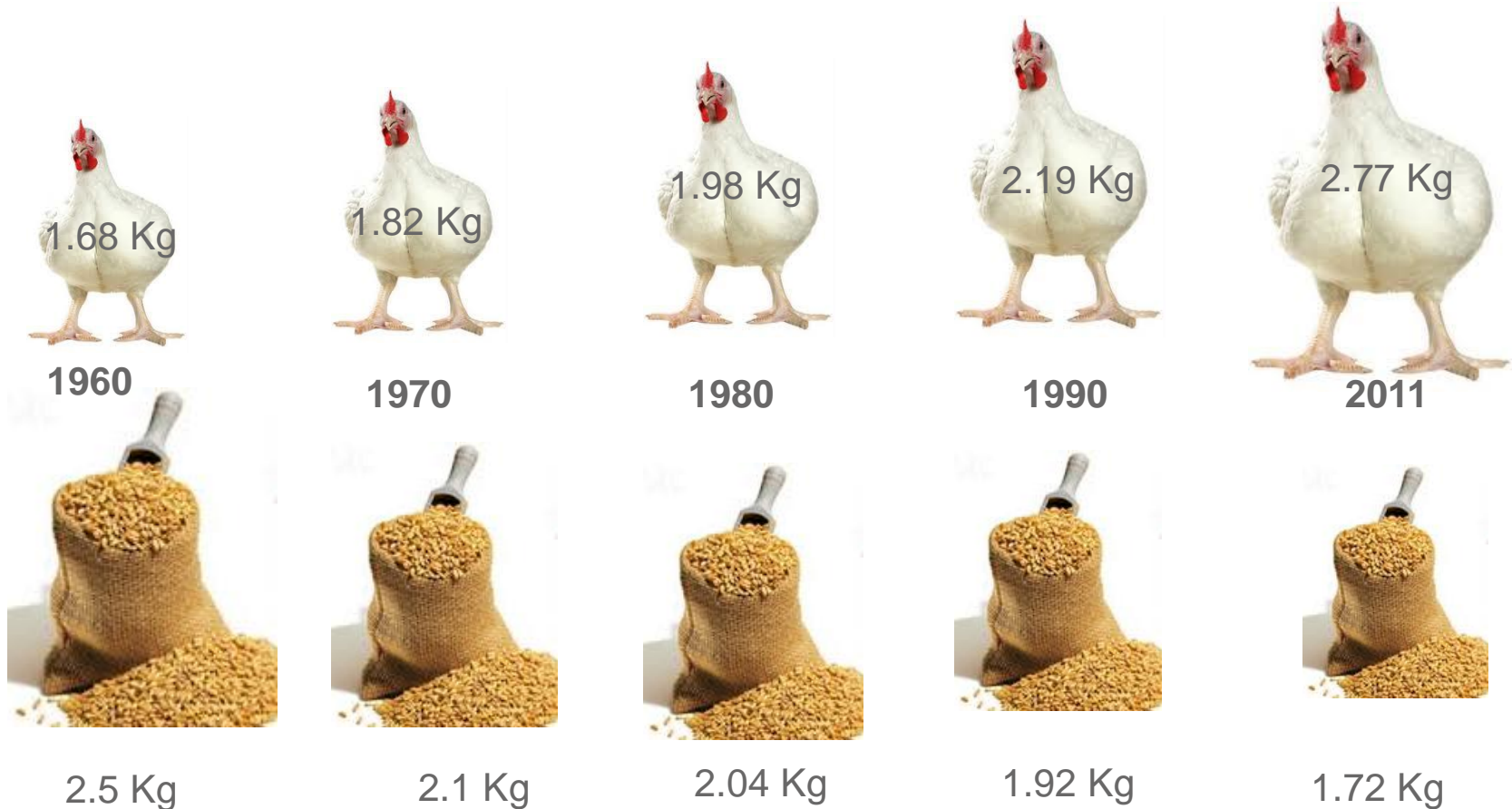
Source: INEGI, Rabobank

Production (000 tons)



Source: INEGI, Rabobank

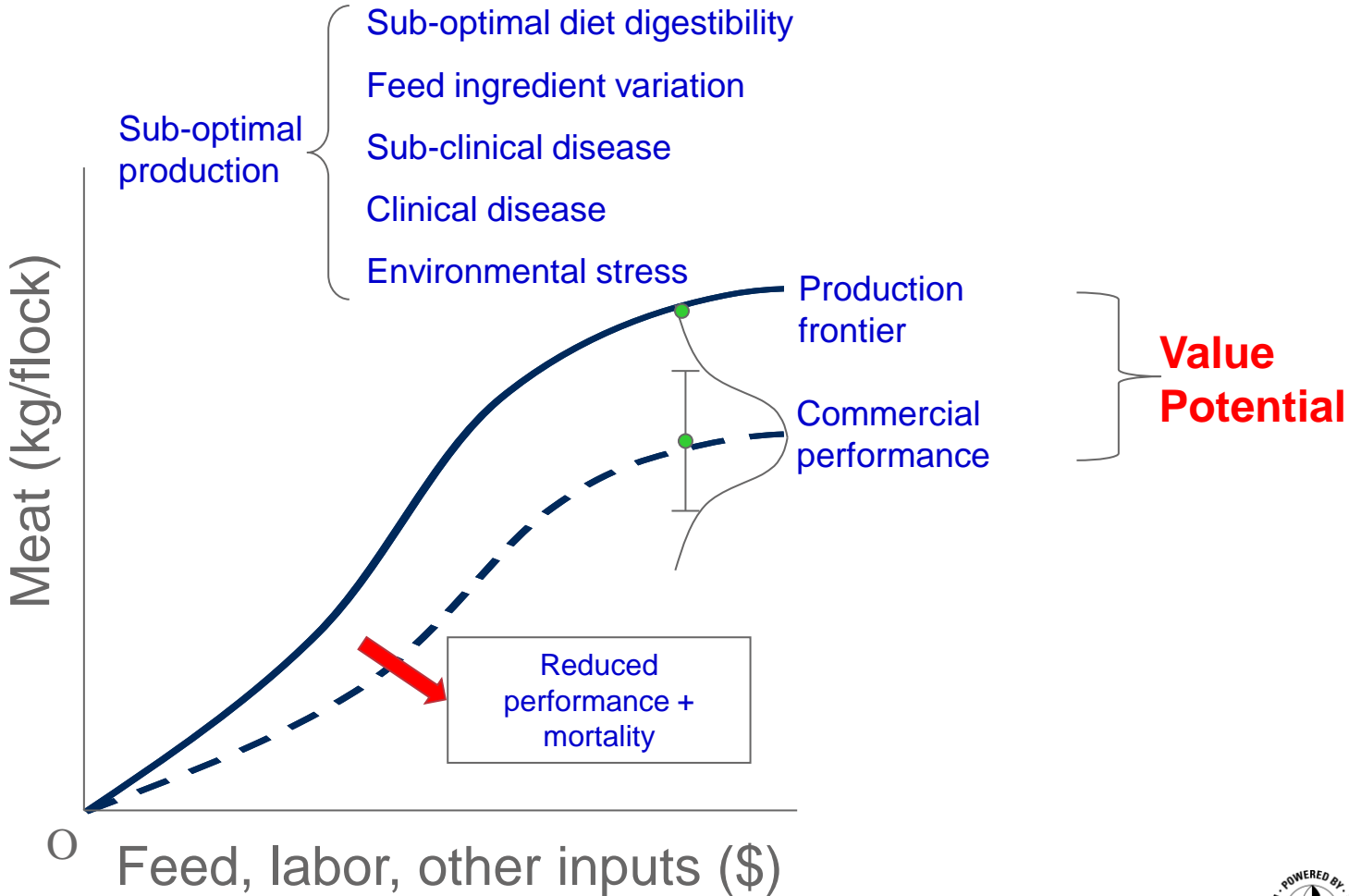
Improvement in Slaughter Weight Versus Feed Conversion Ratios*



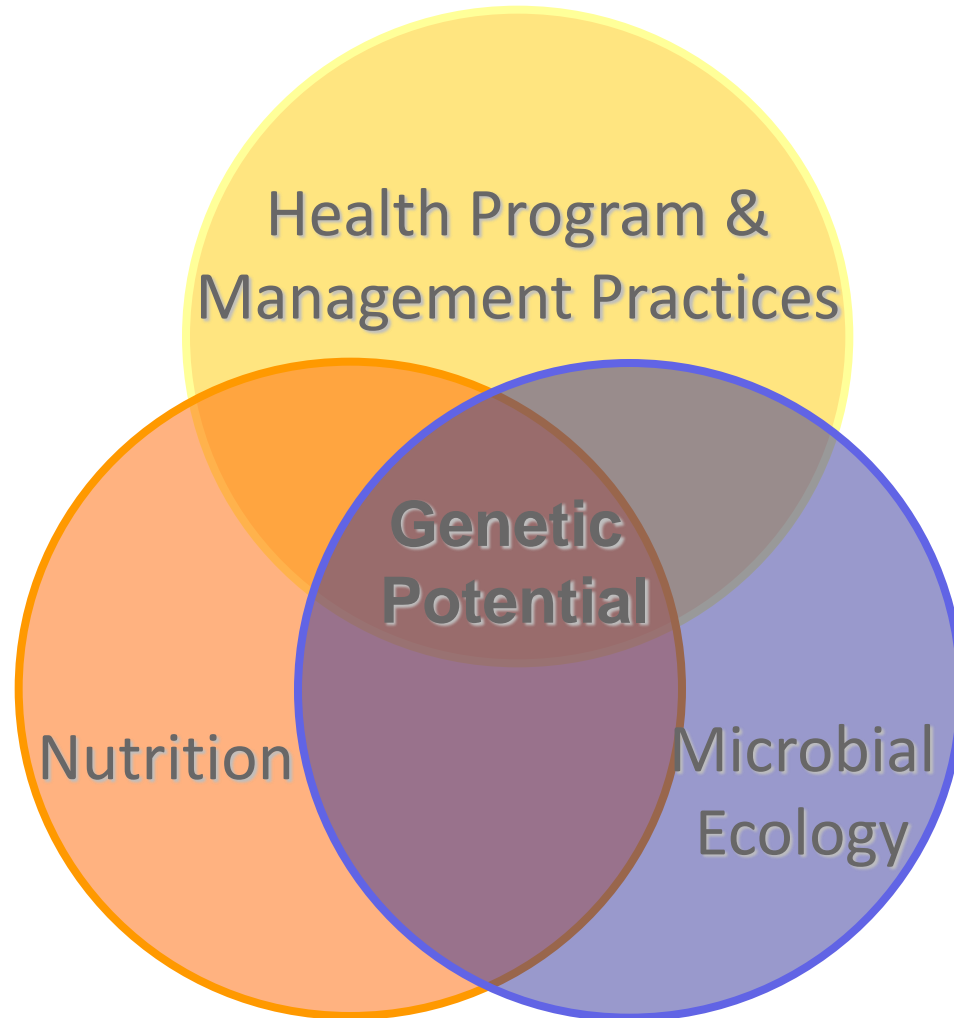
*Amount of feed required for 1Kg weight gain

Based on Rauw et al., 1998 and Ross info

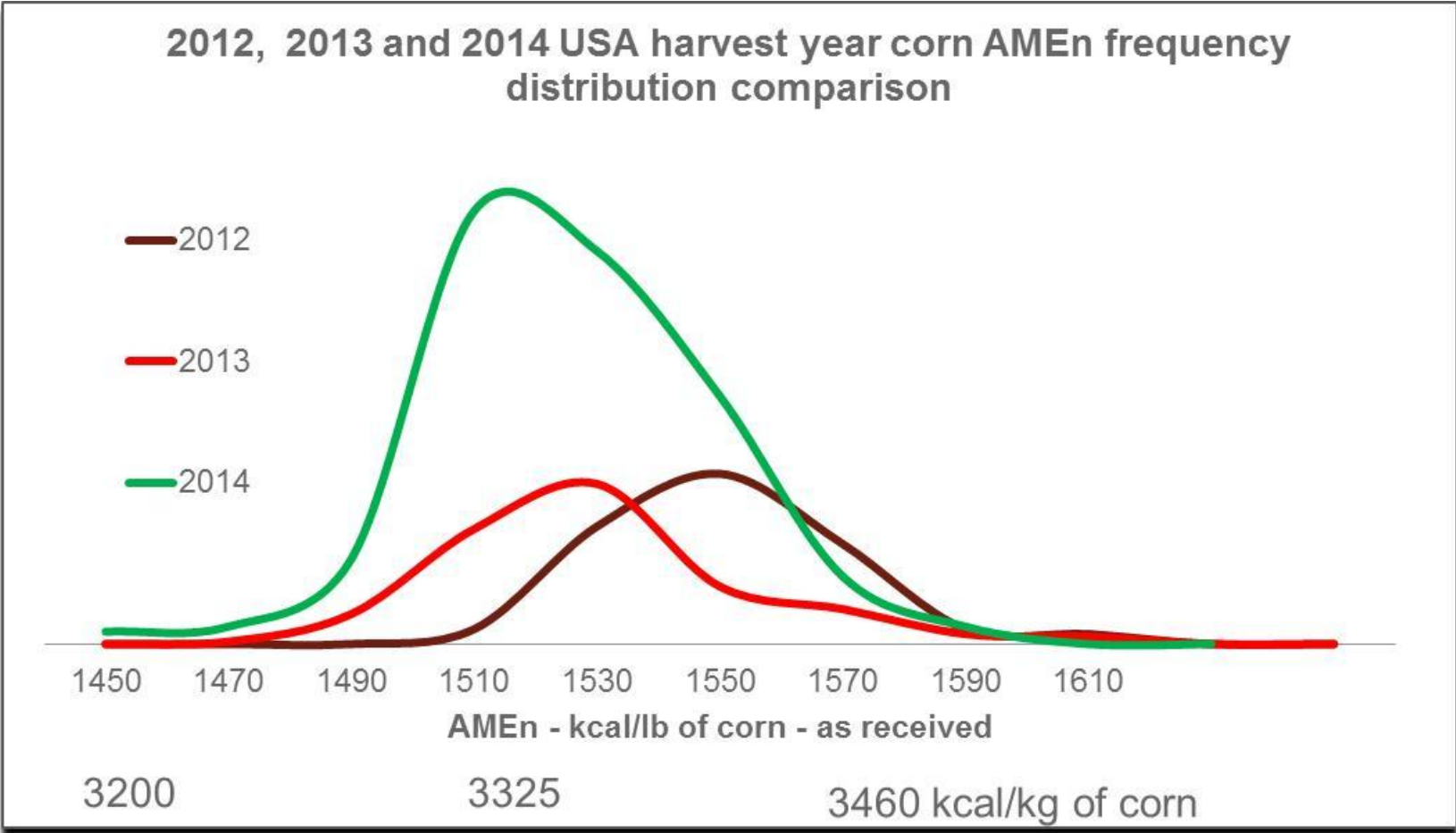
Still Genetic Potential to be Captured



Optimizing Genetic Potential:
How do we fit into this complex puzzle?



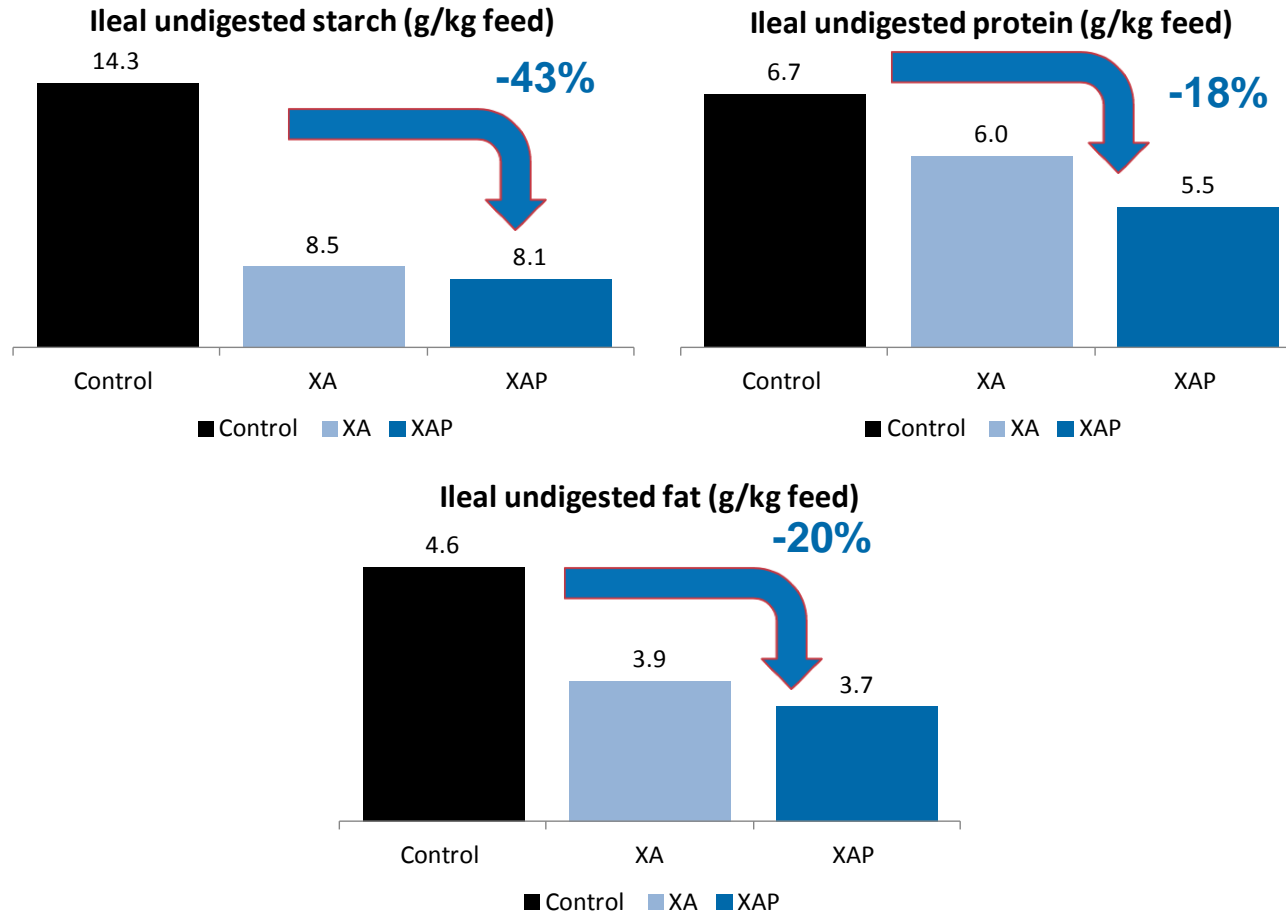
Corn quality (AMEn) varies – performance variability



Enzymes Work by Targeting Specific Substrates

Substrate	Effect of substrate	Enzyme
Soluble viscous NSPs (e.g arabinoxylans)	<ul style="list-style-type: none"> ↑ viscosity and digesta retention time ↓ nutrient absorption ↑ proliferation of intestinal microflora 	Xylanase
Insoluble, non-viscous NSPs	<ul style="list-style-type: none"> ↓ accessibility of nutrients by physical entrapment 	Xylanase
Starch	<ul style="list-style-type: none"> Metabolisable energy ↑ substrate for gut microflora 	Amylase
Protein	<ul style="list-style-type: none"> Metabolisable energy and AA ↑ substrate for gut microflora (neg) 	Protease
Lipid	<ul style="list-style-type: none"> ↑ emulsification, digestibility of lipids 	Lipase
Raffinose and stachyose	<ul style="list-style-type: none"> Undigestible by animal enzymes 	α-galactosidase
Beta glucan	<ul style="list-style-type: none"> ↑ viscosity and digesta retention time 	β-glucanase
Phytate	<ul style="list-style-type: none"> Binds minerals, protein and starch 	Phytase

Enzymes Reduce the Amount of Undigested Substrate Reaching the Lower Gut



X: Xylanase; A: Amylase; P: Protease

Adapted from Romero et al., 2012



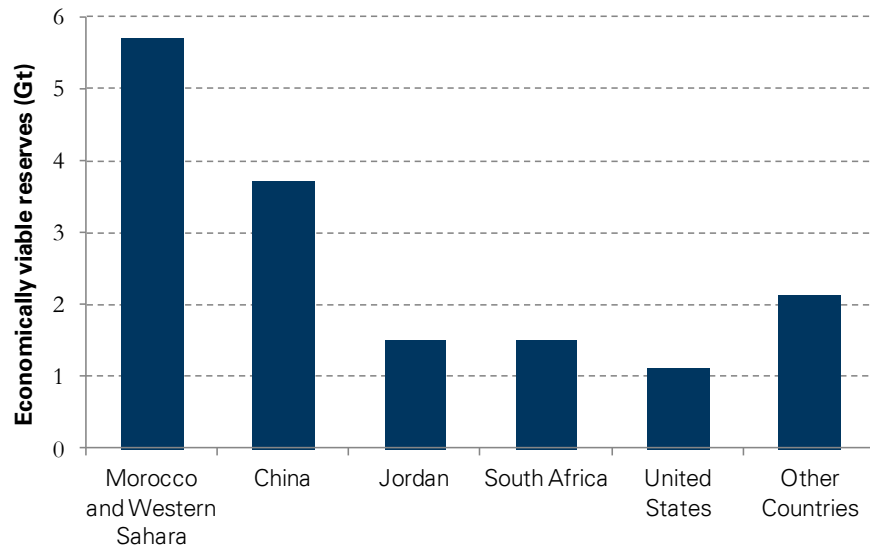
Inorganic Phosphorus: A Non-Substitutable and Finite Resource



Inorganic Phosphorus: A Non-Substitutable and Finite Resource

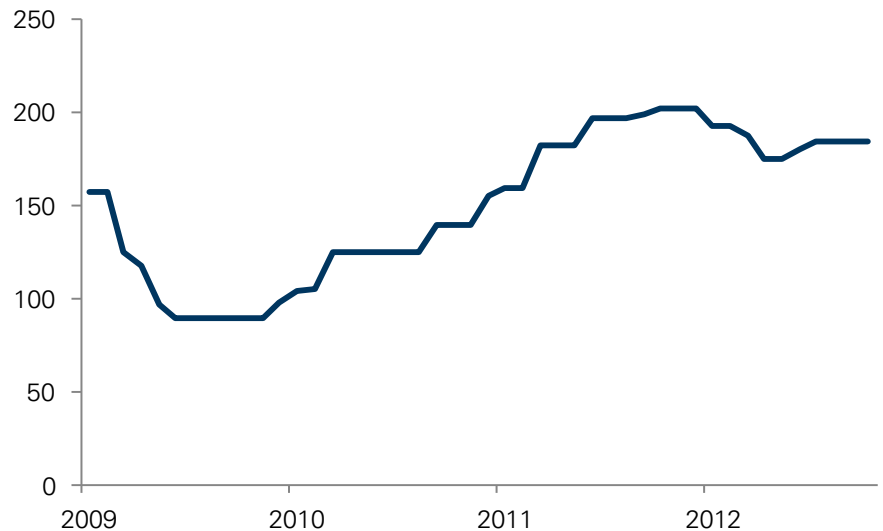
- There are no substitutes for phosphorus in agriculture
- As world phosphate demand grows, both for animal feed and fertilisers, increasing price pressures will continue

Global Inorganic Phosphate Reserves



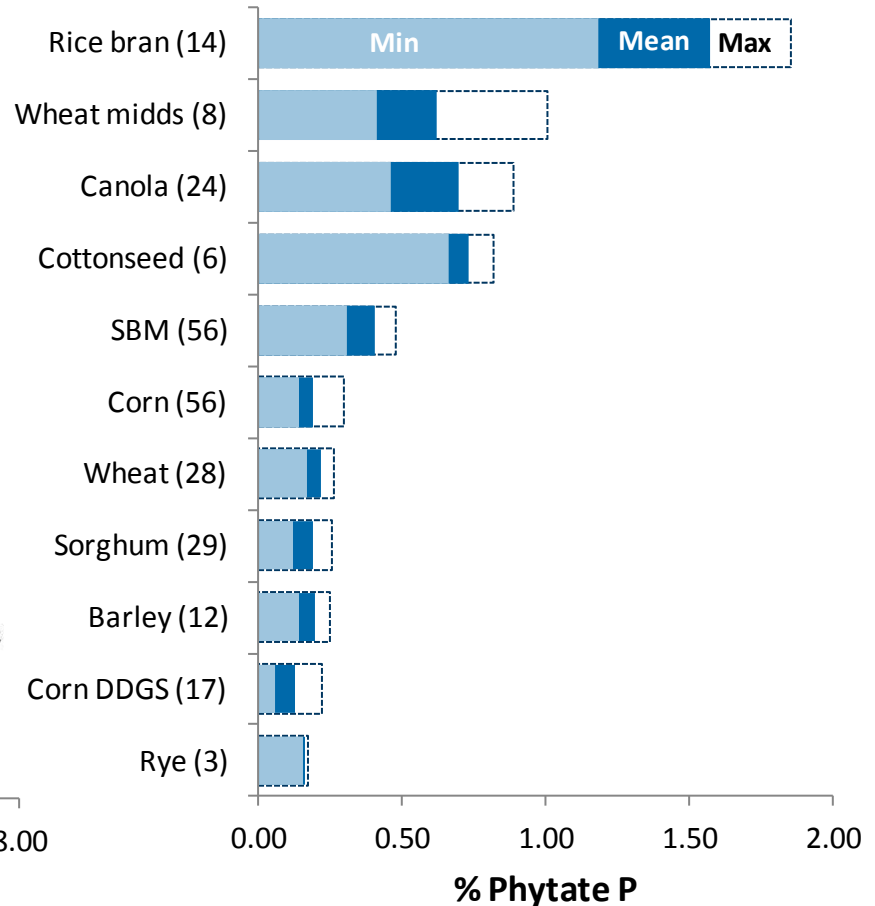
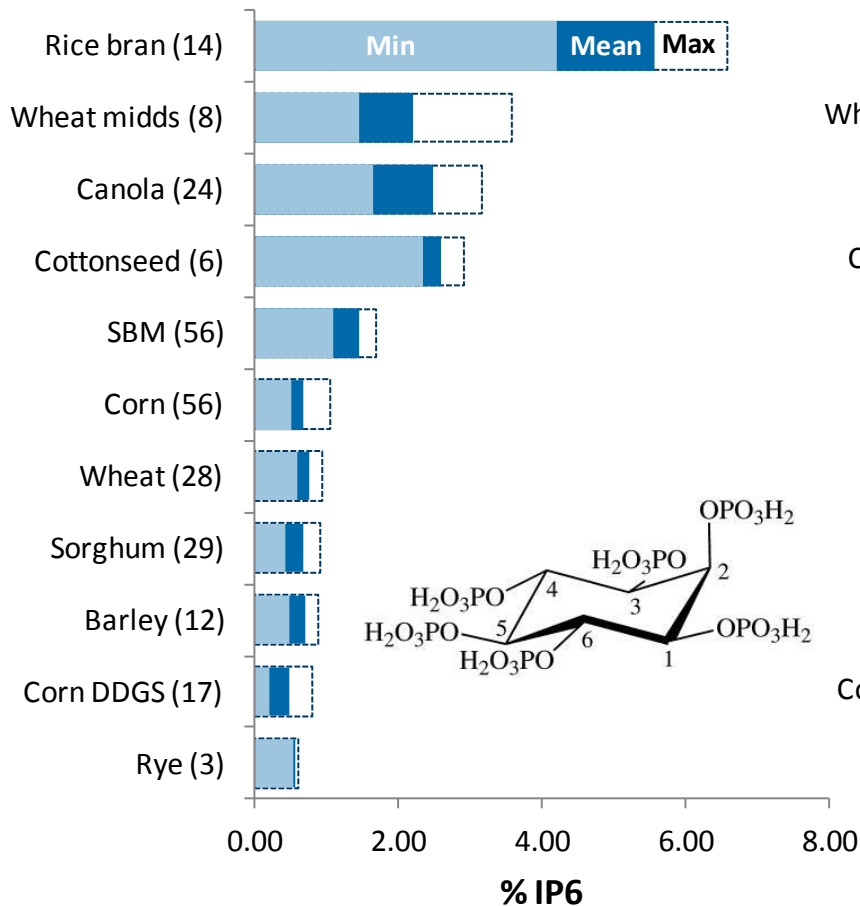
(U.S. Geological survey, 2010)

Monthly rock phosphate prices (\$/MT)

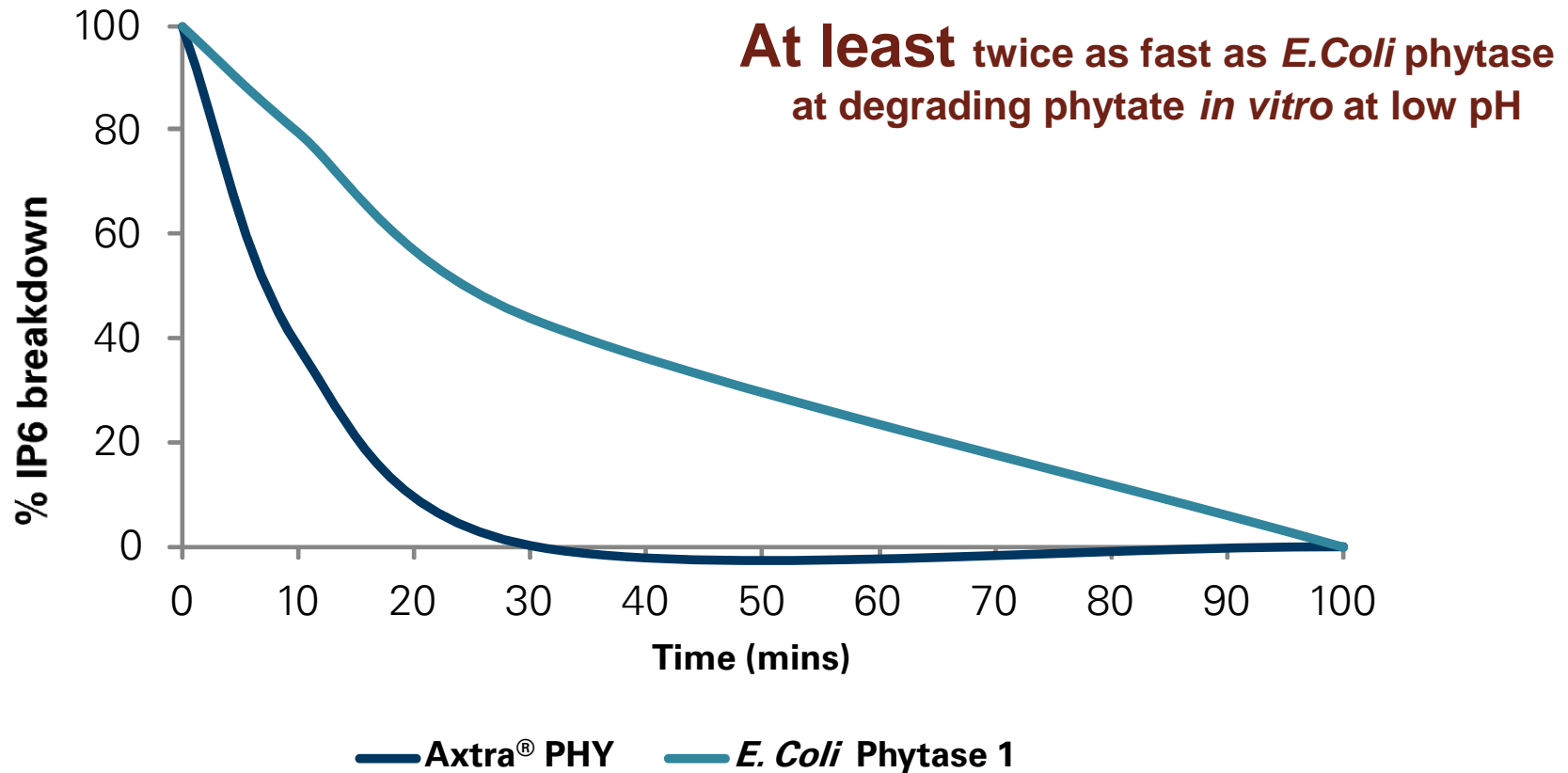


(World Bank, 2012)

Phytate also Known as IP6 is the Natural Store of Phosphorus in Plants but the Content is Variable

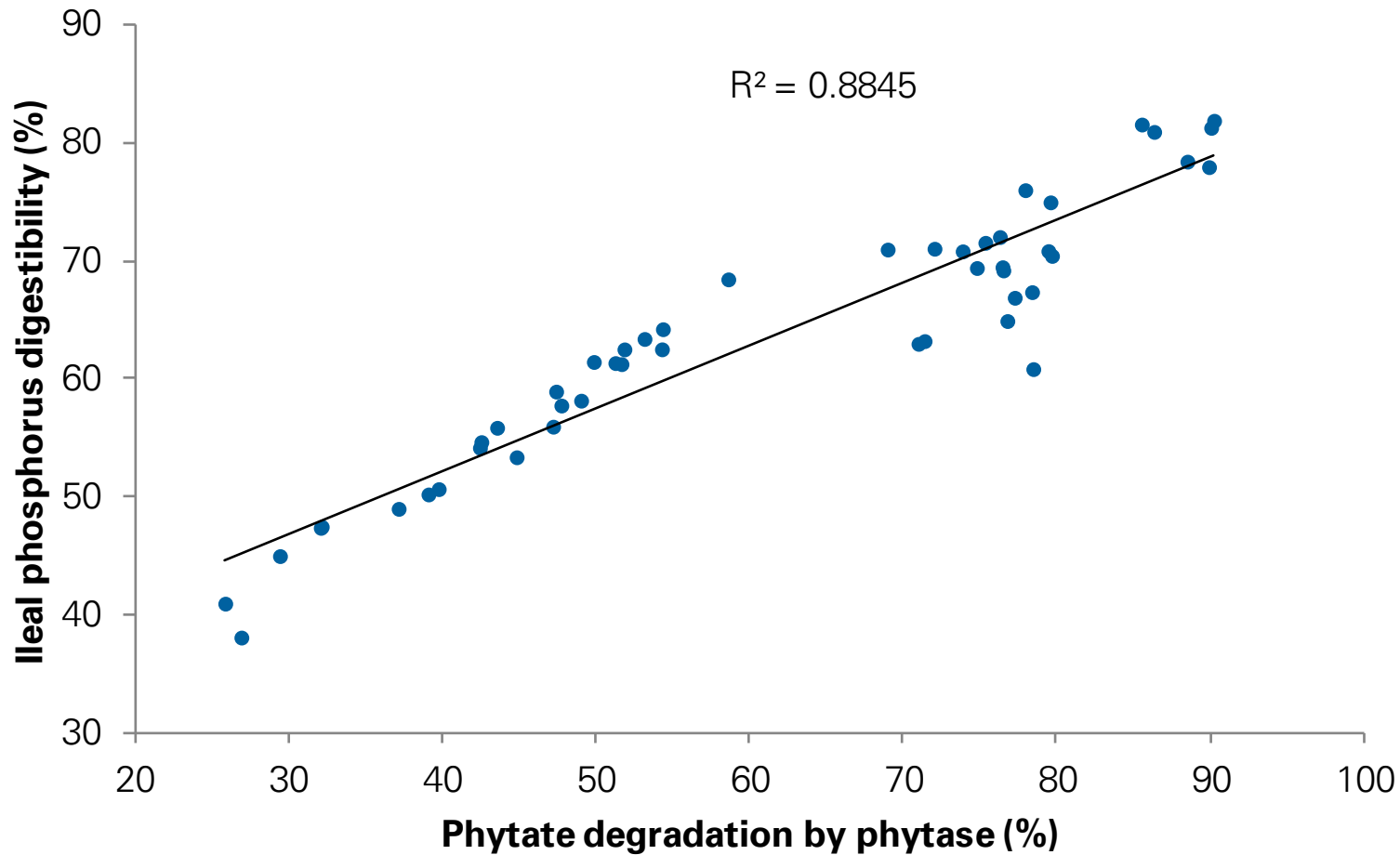


Axtra[®] PHY offers faster degradation of IP6 verses an *E. Coli* phytase (pH 2.5)

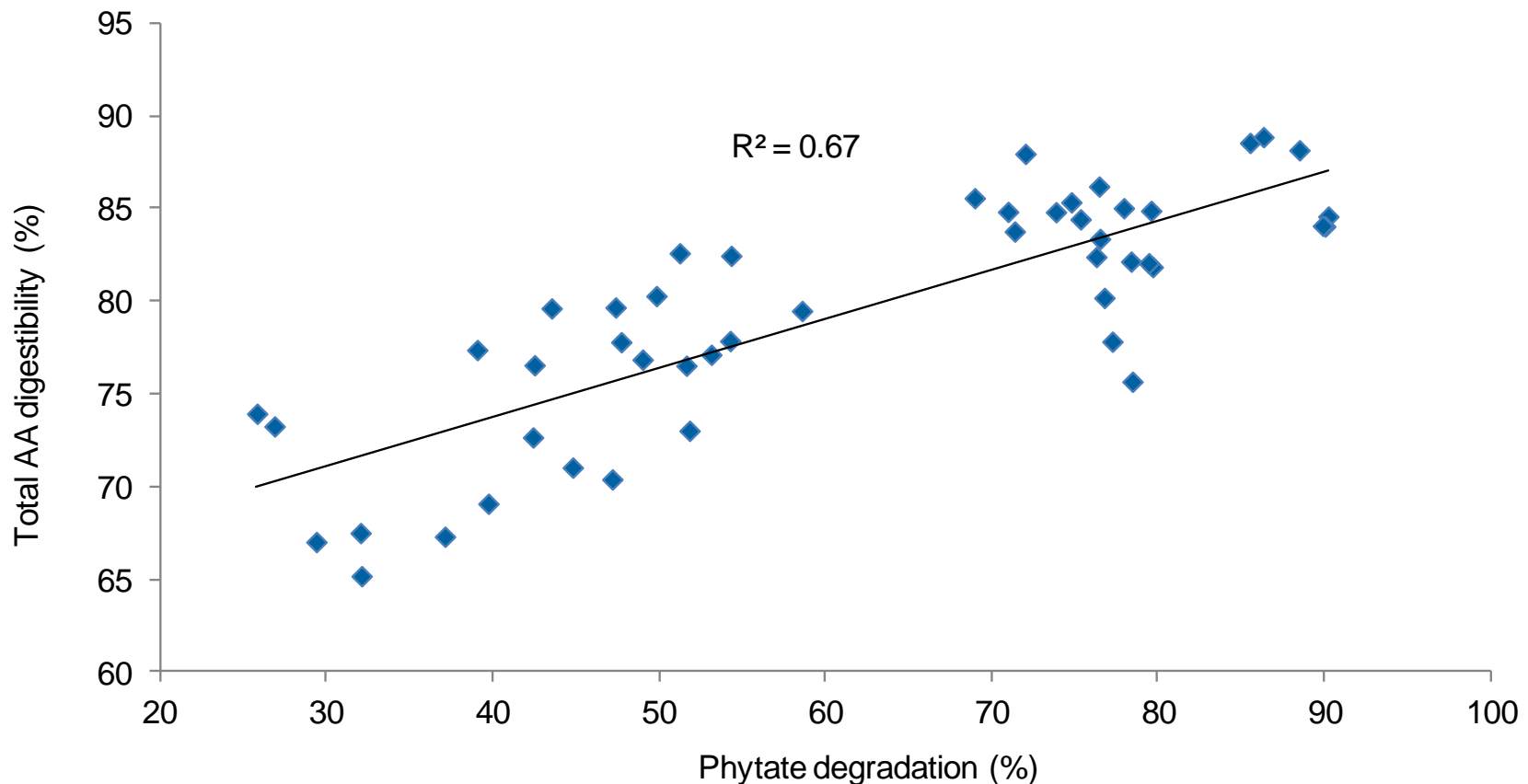


*using sodium phytate as a substrate

A nutritionists' view is driven by this strong correlation *in vivo*



Phytate Degradation by Phytase Increases Protein Digestibility

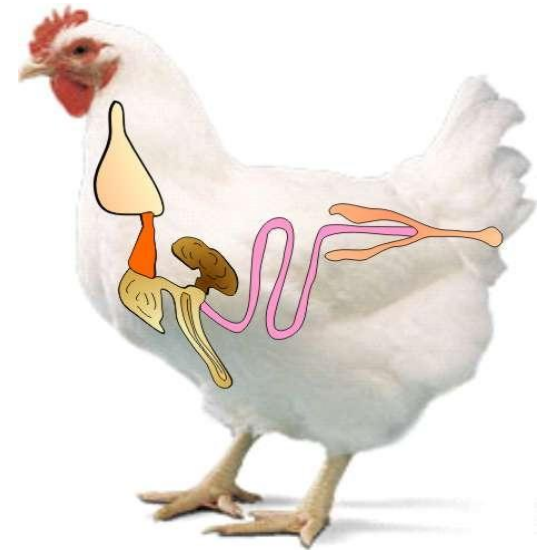


There is a strong correlation between phytate breakdown and protein digestibility in vivo

Direct Fed Microbials (DFMs) – What Are the Beneficial Effects for the Avian?

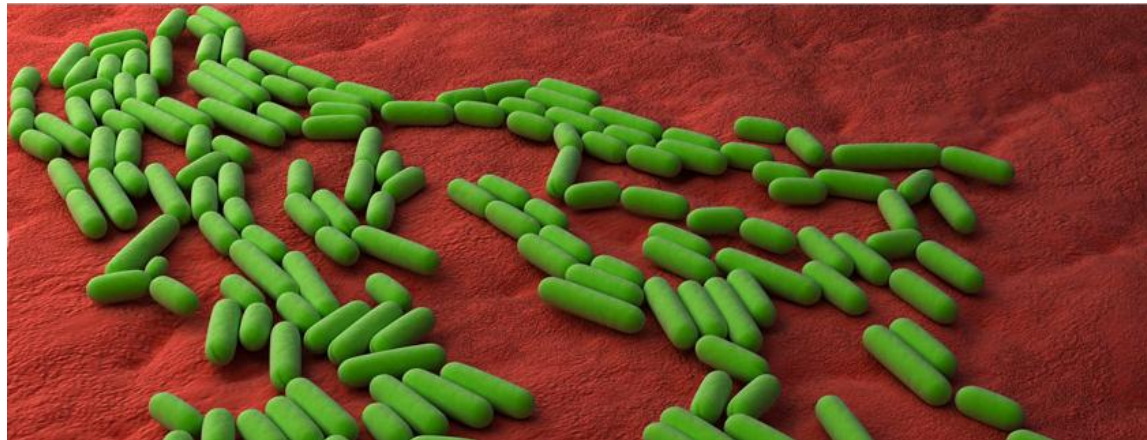
Health

- ↓ Lower mortality
- ↑ Stimulates serum antibody
- ↑ Stimulates gut Ab (sec IgA)
- ↓ Systemic, asymptomatic inflammation
- ↓ Enteric pathogen levels
- ↓ Foodborne pathogen levels



Performance

- ↑ Final body weight
- ↓ Feed Conversion Ratio
- ↑ Egg production



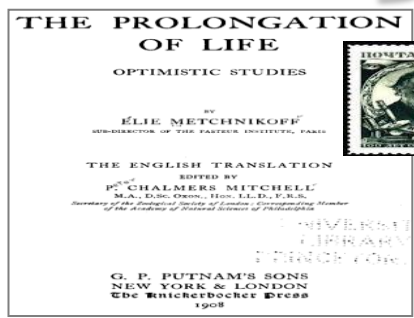
Probiotic & competitive exclusion concept for poultry

In nature, the **mother hen** provides the “starter culture”.
In production agriculture, mom is out of the picture.

Competitive Exclusion “Nurmi” concept

Feces

Cultured Feces



Probiotic

Newly-hatched Chick



Commercial

Wild

In incubator isolated from mother hen

In contact with mother hen

Deficient, Non-Protective Flora

Complete gut flora

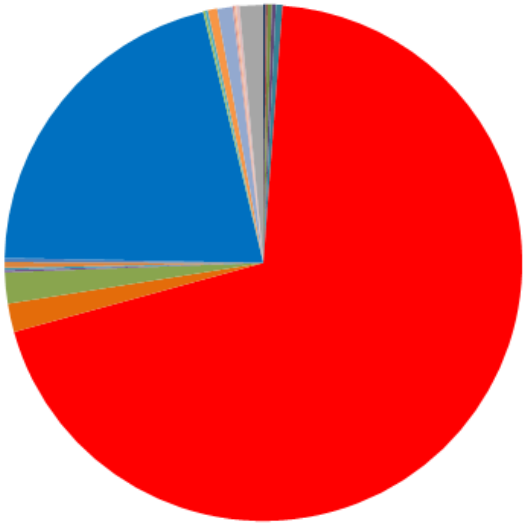
Protection

Adapted from Fuller, J. *Poult Sci.* 2001

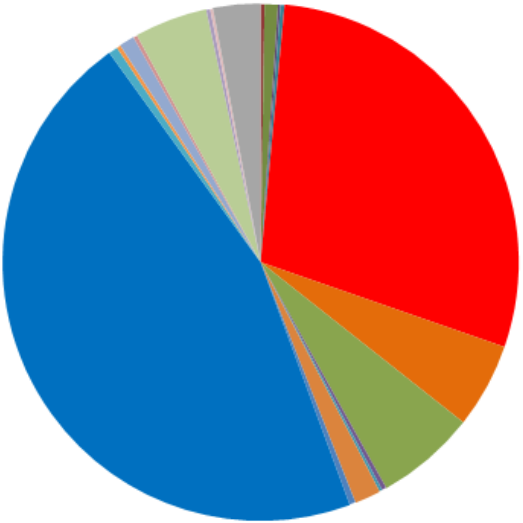


Changes in the relative proportions of bacterial populations with age

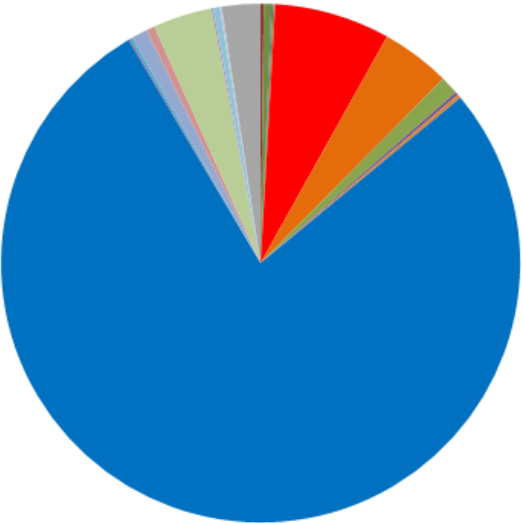
Day 14



Day 28

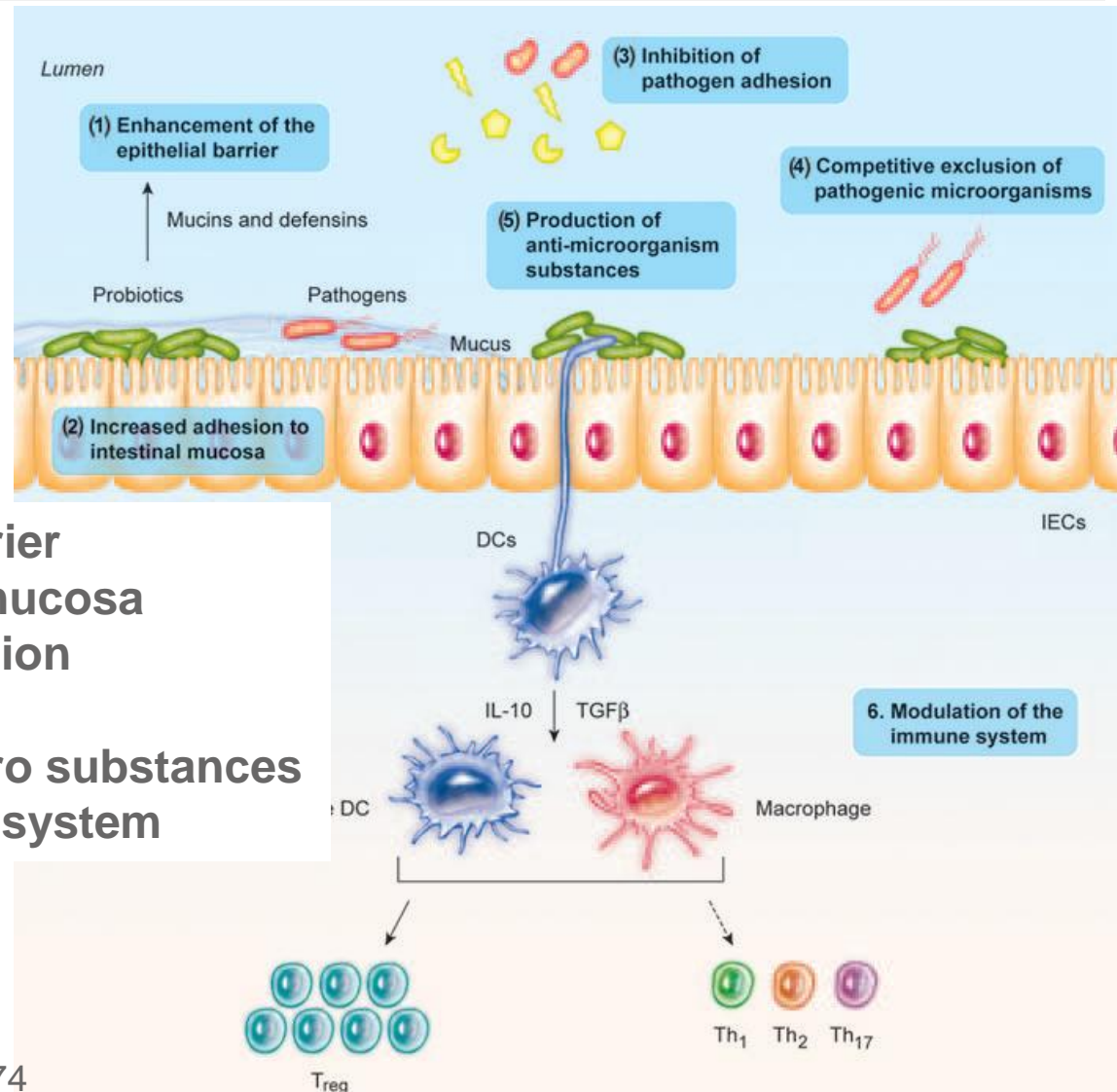


Day 42



- *Bacillus*
- *Candidatus Arthromitus*
- *Faecalibacterium*
- *Parabacteroides*
- *Subdoligranulum*
- *Bacteroides*
- *Clostridium*
- *Fusobacterium*
- *Roseburia*
- *Turicibacter*
- *Blautia*
- *Enterococcus*
- *Lactobacillus*
- *Ruminococcus*
- *Virgibacillus*
- *Brachybacterium*
- *Eubacterium*
- *Nocardioides*
- *Staphylococcus*
- *Weissella*
- *Brevibacterium*
- *Facklamia*
- *Oscillibacter*
- *Streptococcus*
- *Yaniella*
- *Butyricicoccus*
- *Other*

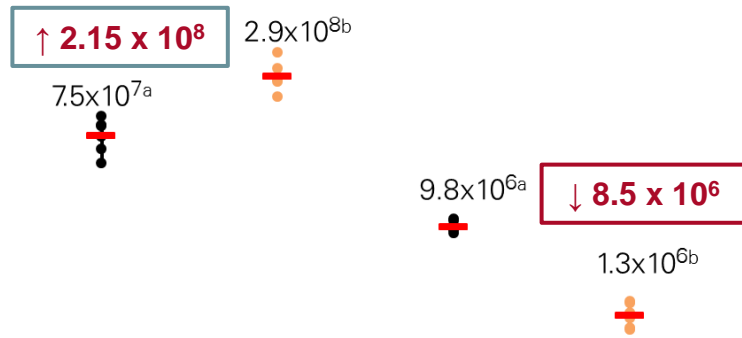
DFMs – How Do They Do Their Work?



- 1) Enhance epithelial barrier
- 2) Increase adhesion to mucosa
- 3) Inhibit pathogen adhesion
- 4) Competitive exclusion
- 5) Production of anti-micro substances
- 6) Modulation of immune system

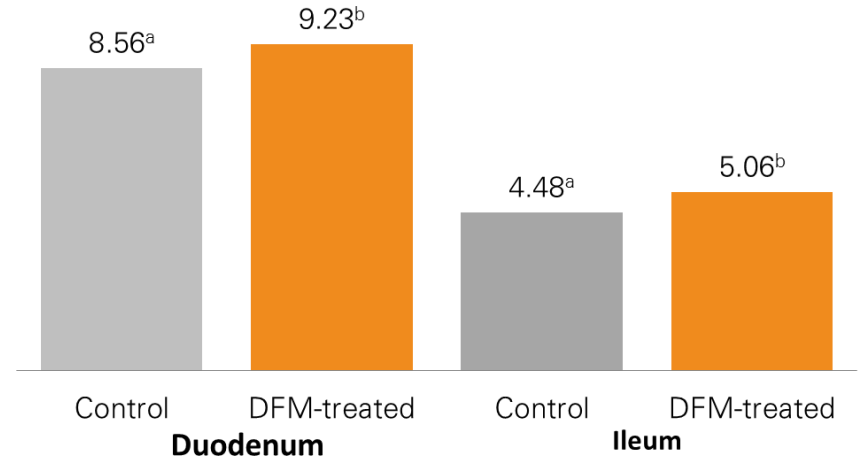
Mode of action of *Bacillus* based DFM

Microbial counts (cfu/g, 42 days)



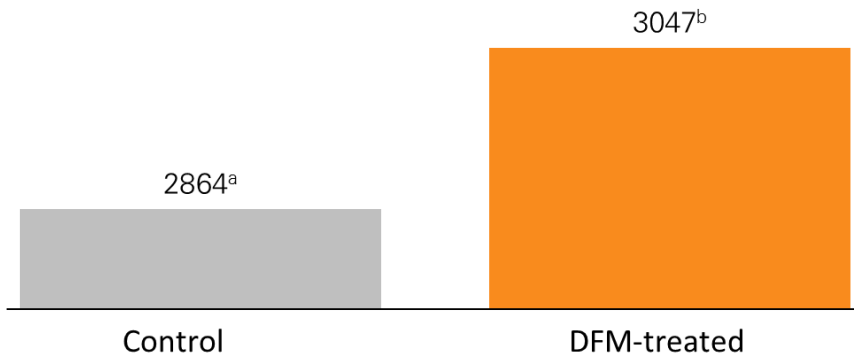
Control DFM-treated Control DFM-treated
Lactobacillaceae **Enterobacteriaceae**

Villus height: crypt depth ratio (42 days)



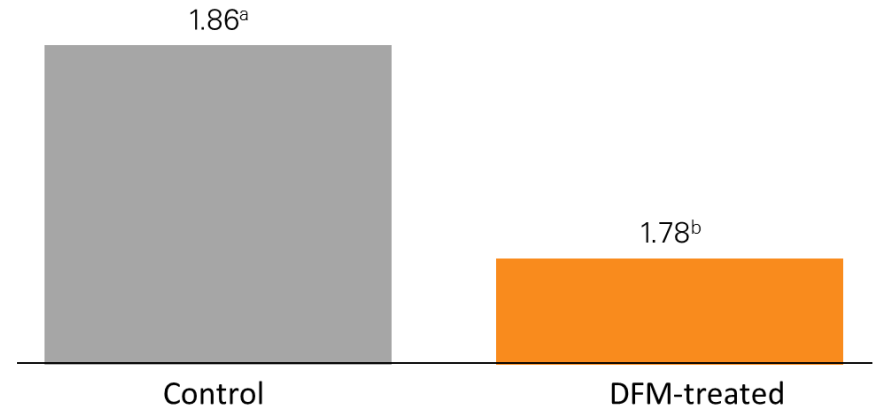
Control DFM-treated Control DFM-treated
Duodenum **Ileum**

AME (kcal/kg of dry matter, 39-41 days)



Control DFM-treated

FCRc*



Control DFM-treated

^{ab} indicates a significant difference at P<0.05

Enzymes and DFMs in Poultry Nutrition

The advantage of enzymes

Hydrolyze substrate

- Specific
- Fast
- pH dependent

Functionality can be designed

Catalysts

The advantage of DFMs

Live organisms

- Metabolism *in-situ*
- Reproduce
- Adapt to substrates in the gut

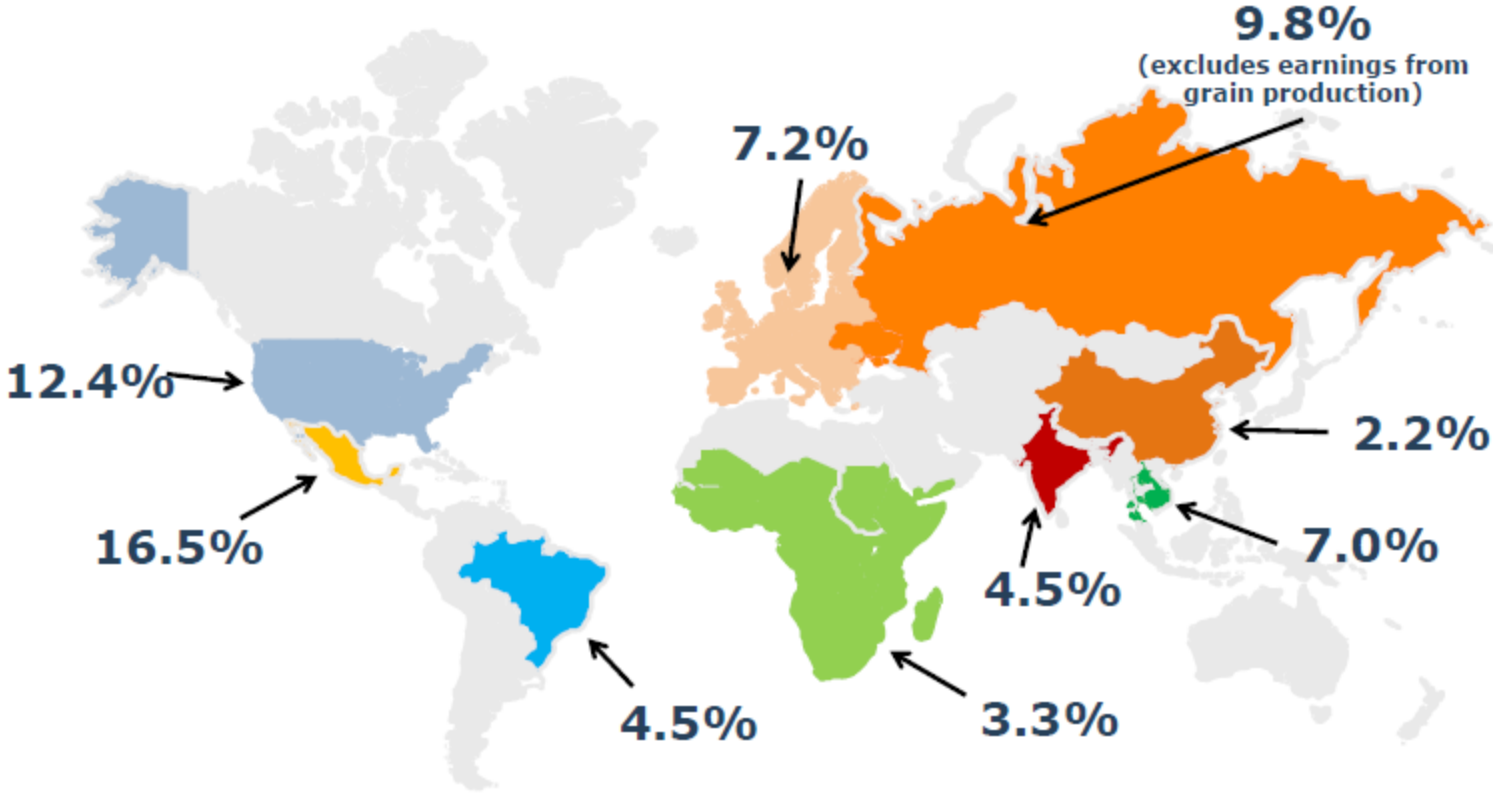
Modulate microbial populations

Modulate immunity



North America Favorable Chicken Production Margins

EBIT Margins of Publicly Traded Chicken Producers



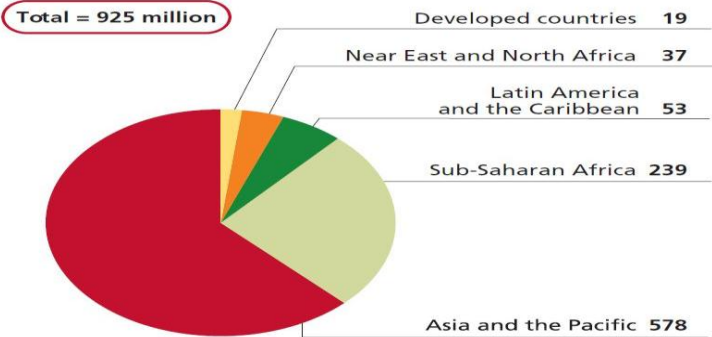
Source: Company Filings

Other areas of food security focus

Annually, Roughly 1/3 of all Food Produced..... is Wasted.*

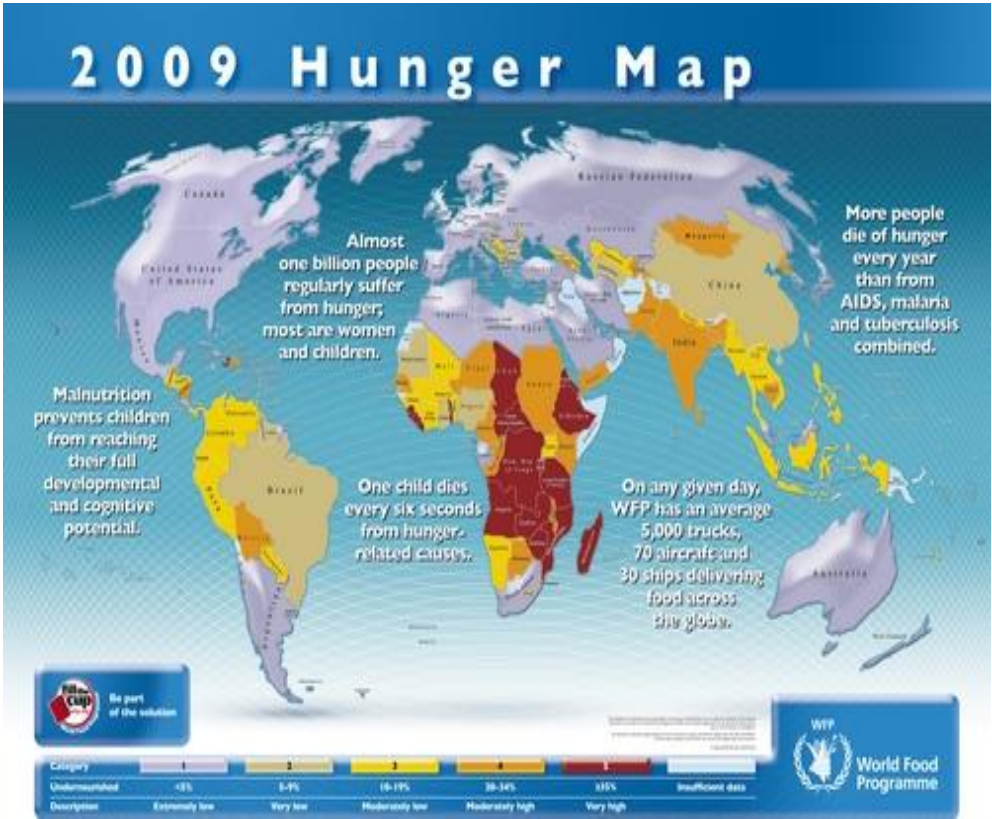
- High social impact
- High risk problem
- Highly multidisciplinary

Undernourishment in 2010, by region (millions)



Note: All figures are rounded.

Source: FAO.



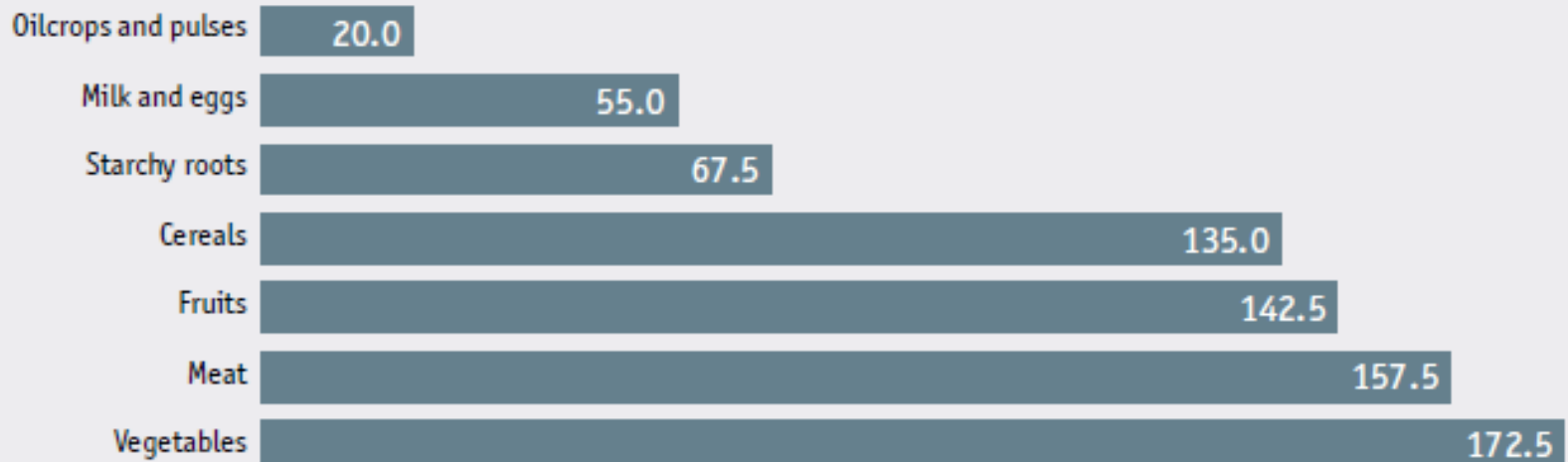
* FAO Stats 2011, <http://faostat.fao.org>

Cost of Food Wastage in \$bn per year

Global food security index 2014: An annual measure of the state of global food security
SPECIAL REPORT: Food loss and its intersection with food security

Global economic costs of food wastage, by commodity, 2007

US\$ bn



Source: Economist Intelligence Unit; Food and Agriculture Organisation

Raw Milk Preservation - an Example

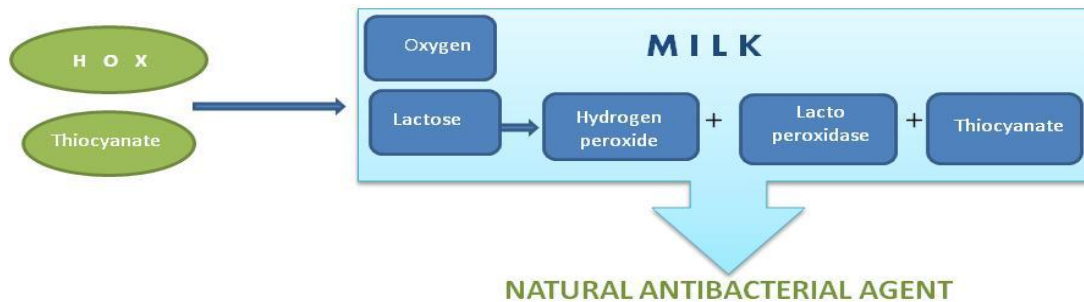


The Problem

Extending the **shelf life of raw milk**, where no refrigeration is available, for a period of approximately 15-18 hours.

A Solution

An enzyme from DuPont, HOX or Hexose Oxidase, to stimulate the milk's natural defenses against spoilage bacteria.



DuPont™ Danisco®

Food protection ingredients

Our food protection solutions help you deliver taste, freshness, food safety and food waste reduction.



Acidifying & Protective Cultures

Fermented Fresh Dairy
Cheese
Cured Meats
Yeast & Mold Inhibition
Pathogen Inhibition



Antimicrobials & Fermentates

Gram-Positive Control
Gram-Negative Control
Yeast & Mold Control



Antioxidants

Single Plant Extracts
Proprietary Blends
of Natural Extracts



A Look at the Future



Future Feed Stocks – New Challenges



Protein for poultry
from grass

**Algae from ethanol plant shows
promise as poultry feed**

<http://ethanolproducer.com/articles/8220/algae-from-ethanol-plant-shows-promise-as-poultry-feed>

A4FEED
ALGAE FOR FEED

The Insect Cookbook

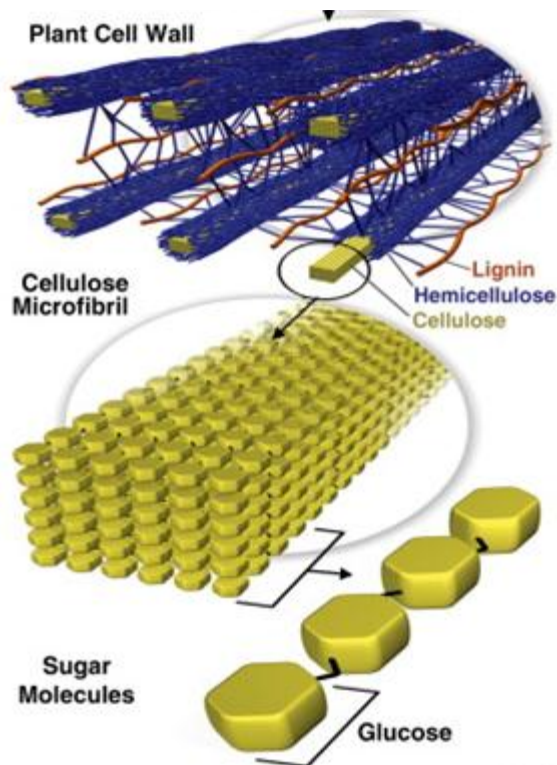
Food for a Sustainable Planet

ARNOLD VAN HARE, HENK VAN GURT, THE NATUREL BUCKAR



Biomass Challenge

- 1. Hemicellulose: broken down with exogenous enzymes eg. Xylanase
- 2. Cellulose: Crystalline structure, difficult for enzymes to access
- 3. Lignin: non-fermentable, no energetic value for animals



Sannigrahi et al., 2010



Summary

- Dupont is committed to Food Security
- Enzymes and DFMs
 - » Increased animal production efficiency
 - » More sustainable production
 - » Healthier better performing animals
 - » Profitable industry
- Reduced food waste
- New alternative non-food feedstocks
- New technologies
 - » Understanding of physiology at gene level
 - » Alternative meat production methods



BRING A FEAST OF IDEAS.
DO IT AGAIN TOMORROW.
JOIN FORCES.
MAKE FOOD SAFER.
SOW INNOVATION.

PRESERVE BETTER.
GET MORE NUTRITION OUT OF EVERY BITE.
IMPROVE THROUGH SCIENCE.
MAKE A DIFFERENCE. **CHANGE LIVES.**
ACT LOCALLY.

LET'S

USE EVERY ACRE.
ASK QUESTIONS.
ROLL UP OUR SLEEVES.
SHAKE HANDS WITH FARMERS.
BRA IN STORM.
INCREASE SHELF LIFE.
INSPIRE ONE ANOTHER.

COLLABORATE.
BE PART OF A COMMUNITY OF SOWERS.
GIVE HOPE TO THE HUNGRY.
THINK GLOBALLY.
PROVIDE FOOD WHERE IT'S NEEDED.
DISCOVER.
MAXIMIZE YIELDS.

SOLVE

Welcome to The Global Collaboratory.™

INNOVATE.
REALIZE A CROP'S POTENTIAL.
PLANT NEW THOUGHTS.
SHARE A VISION.

BREAK NEW GROUND. **HARVEST SOLUTIONS.**

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