July 14-16, 2014
103rd Annual Meeting of the Poultry Science Association
Corpus Christi, Texas

Sponsored by:

DUPONT®

"The Role of the Poultry Industry in Feeding the World in 2050"
Symposium

INDUSTRIAL BIOSCIENCES

What Role Can Science and Technology Play?

PSA, Corpus Christi 15th of July 2014
Charlotte Horsmans Poulsen,

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

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

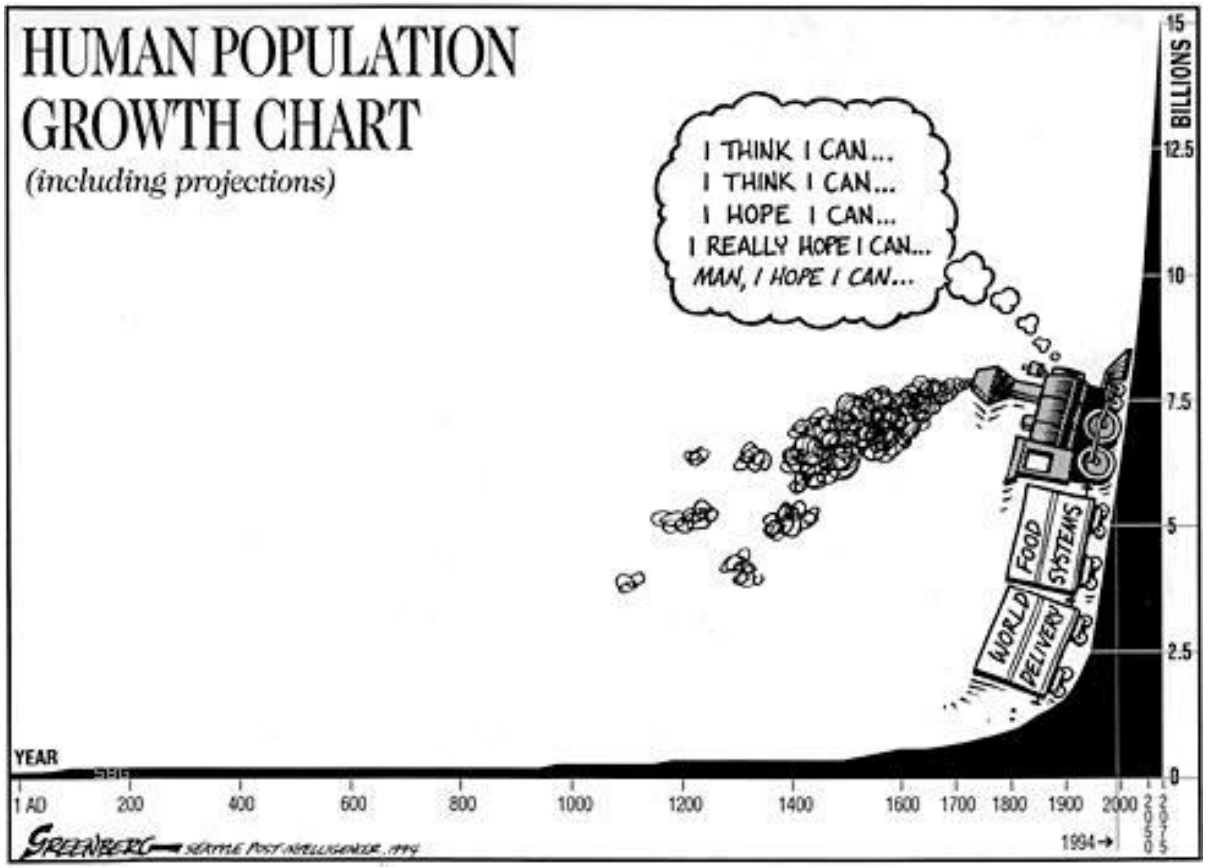
- Ranks **109 countries** according to their relative levels of food security using 29 indicators divided into three categories: **Affordability, Availability, Quality and Safety.**
- Provides a rigorous, structured framework for **understanding the drivers of food security.**

Visit foodsecurityindex.eiu.com

Protein Needs Are Increasing

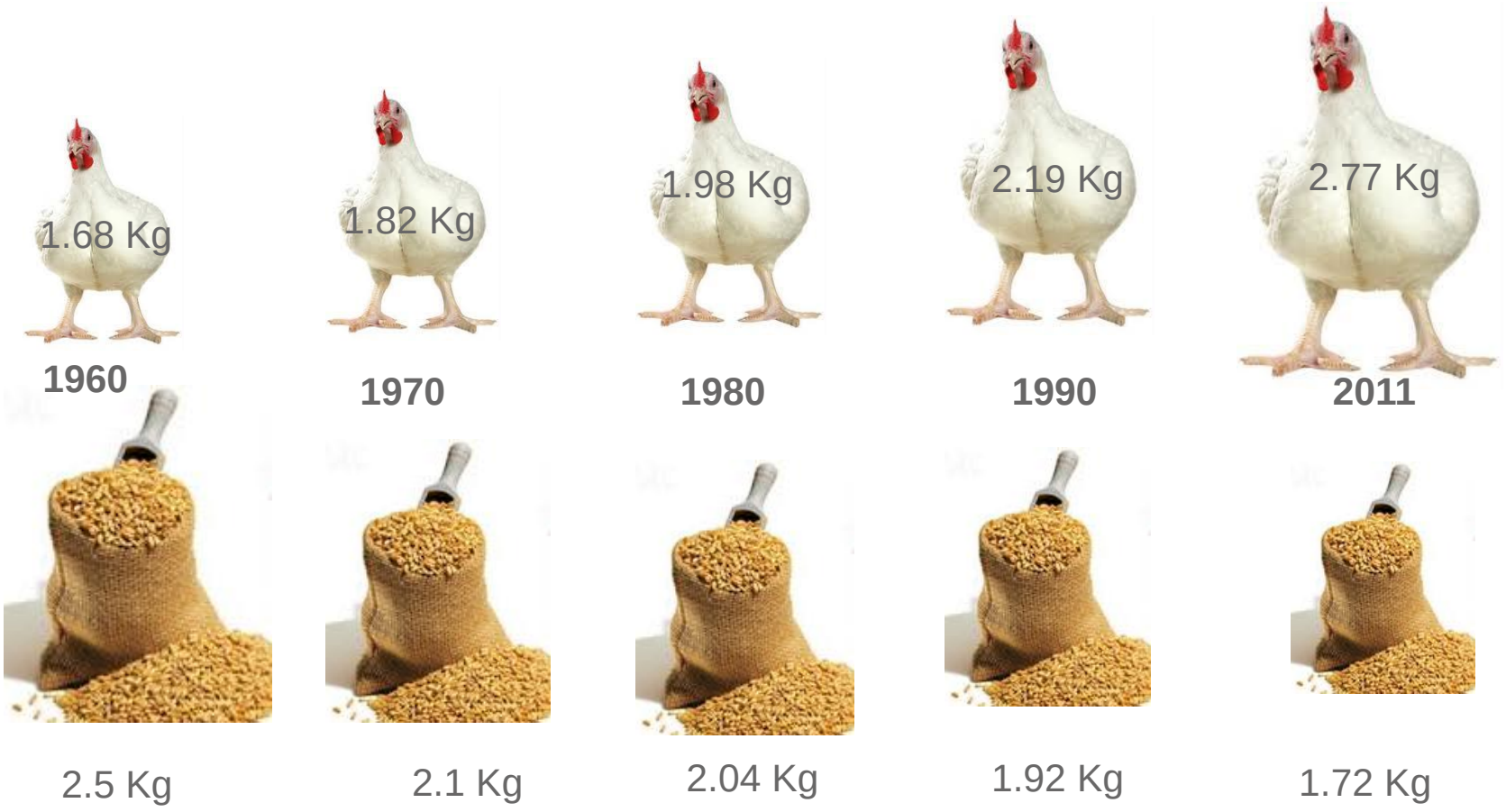
FAO* expects world demand for (animal-derived) protein to double by 2050

- 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

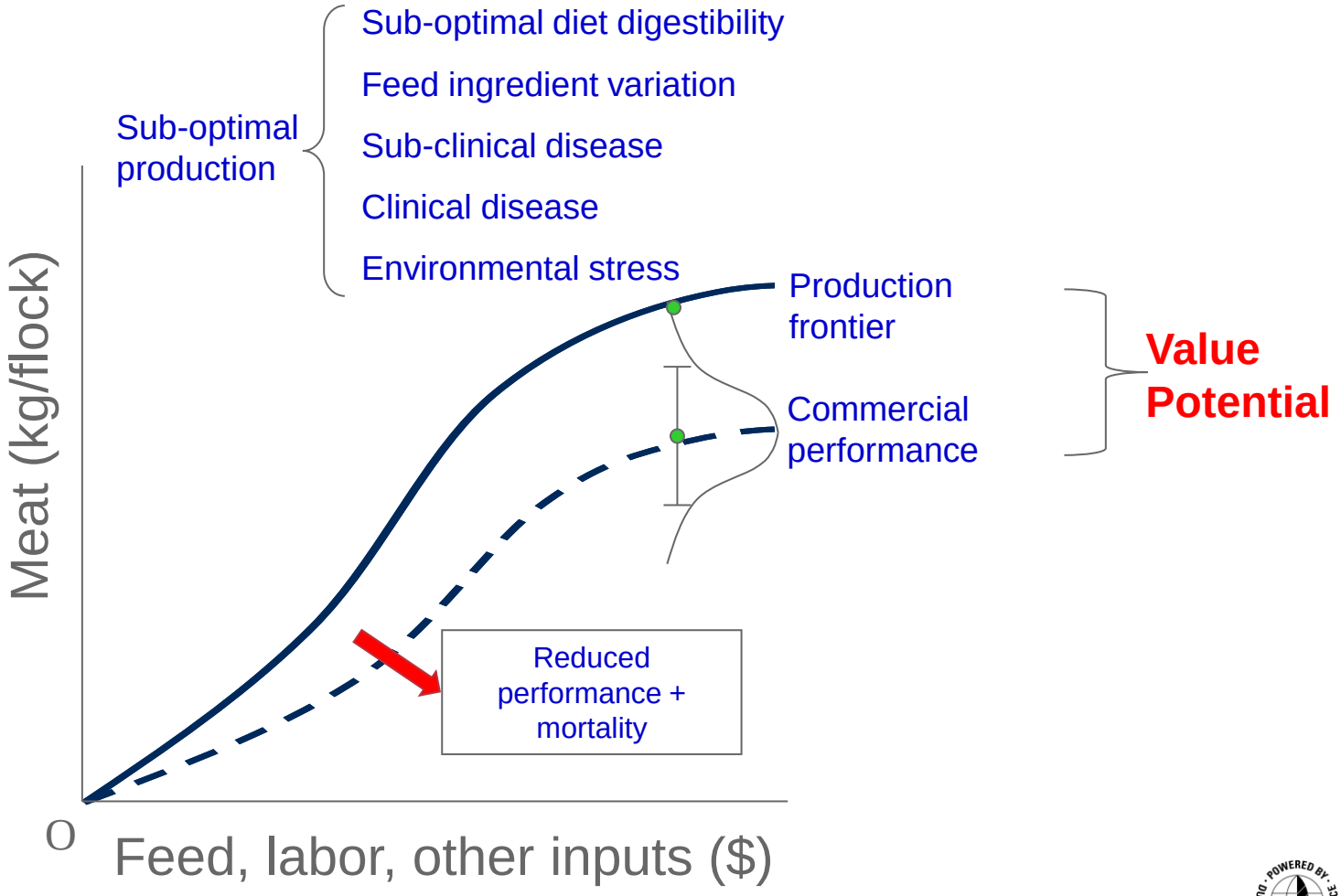
Improvement in Slaughter Weight Versus Feed Conversion Ratios*



*Amount of feed required for 1Kg weight gain

Based on Rauw et al., 1998 and Ross info

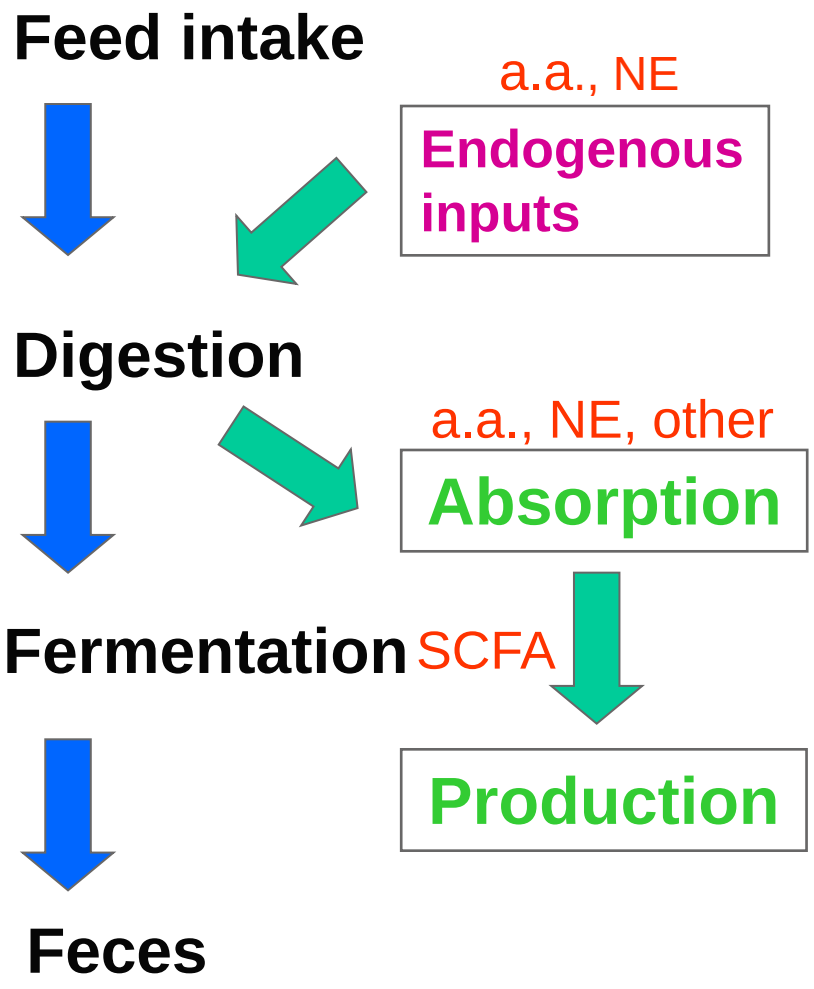
Still Genetic Potential to be Captured



Enzymes Work by Targeting Specific Substrates

Substrate	Effect of substrate	Enzyme
Soluble viscous NSPs (e.g arabinoxylans)	↑ viscosity and digesta retention time ↓ nutrient absorption ↑ proliferation of intestinal microflora	Xylanase
Insoluble, non-viscous NSPs	↓ accessibility of nutrients by physical entrapment	Xylanase
Starch	Metabolisable energy ↑ substrate for gut microflora	Amylase
Protein	Metabolisable energy and AA ↑ substrate for gut microflora (neg)	Protease
Lipid	↑emulsification, digestibility of lipids	Lipase
Raffinose and stachyose	Undigestible by animal enzymes	α-galactosidase
Beta glucan	↑ viscosity and digesta retention time	β-glucanase
Phytate	Binds minerals, protein and starch	Phytase

Exogenous Enzyme Solutions for Complex Diets.
What Positive Impact Does the Animal Get?

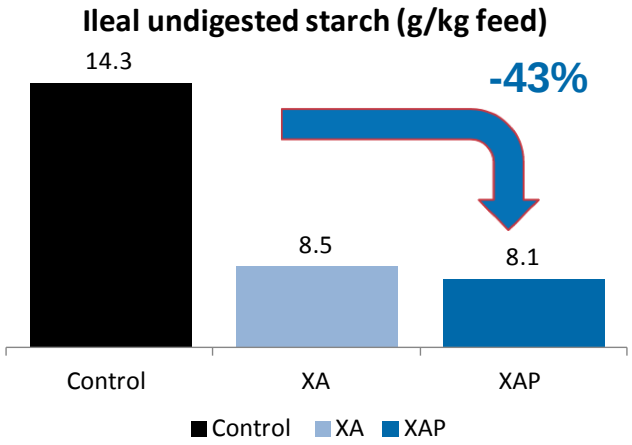


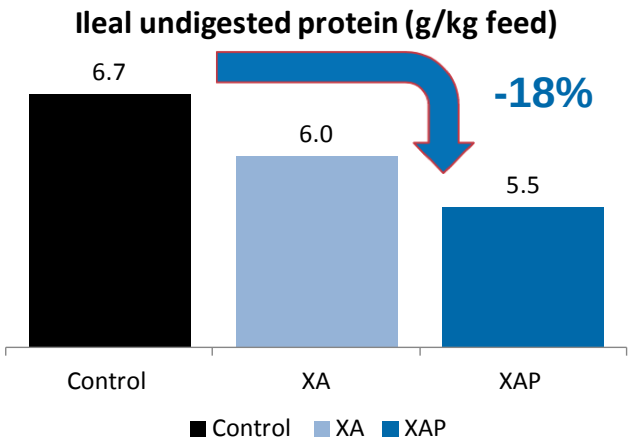
Reduce endogenous inputs (a.a., NE):
- Degrade anti-nutrients
- Reduce physical interactions between digesta and gut wall
- Modulate gut microflora
- Change organ size

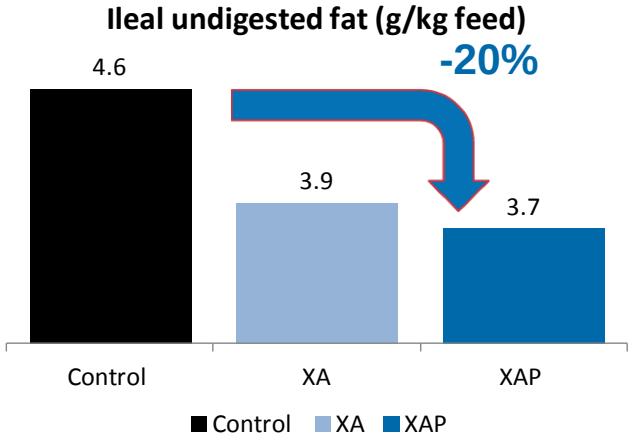
Improve digestion of starch, fat, protein, minerals:
- Addition to endogenous enzymes
- New enzyme activities
- Remove physical entrapment
- Disrupt substrate interactions

Modulate fermentation (SCFA):
- Production of pre-biotics
- Increase production of short chain fatty acids

Enzymes Reduce the Amount of Undigested Substrate Reaching the Lower Gut







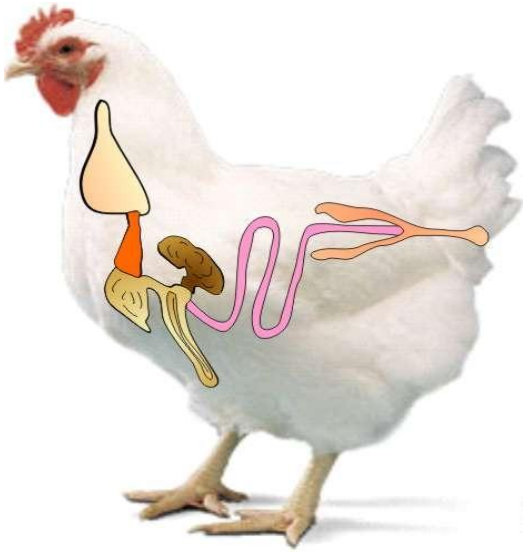
Adapted from Romero et al., 2012

X: Xylanase; A: Amylase; P: Protease

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

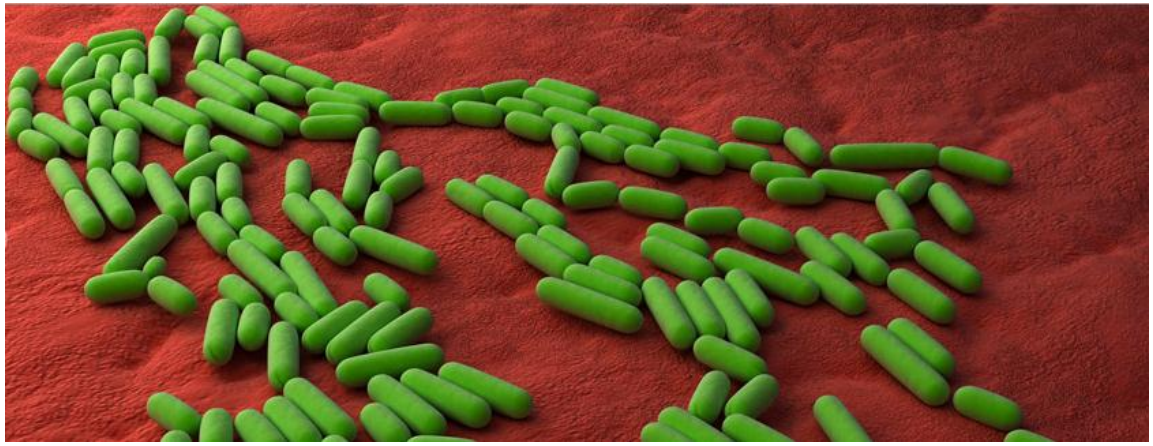
Health

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

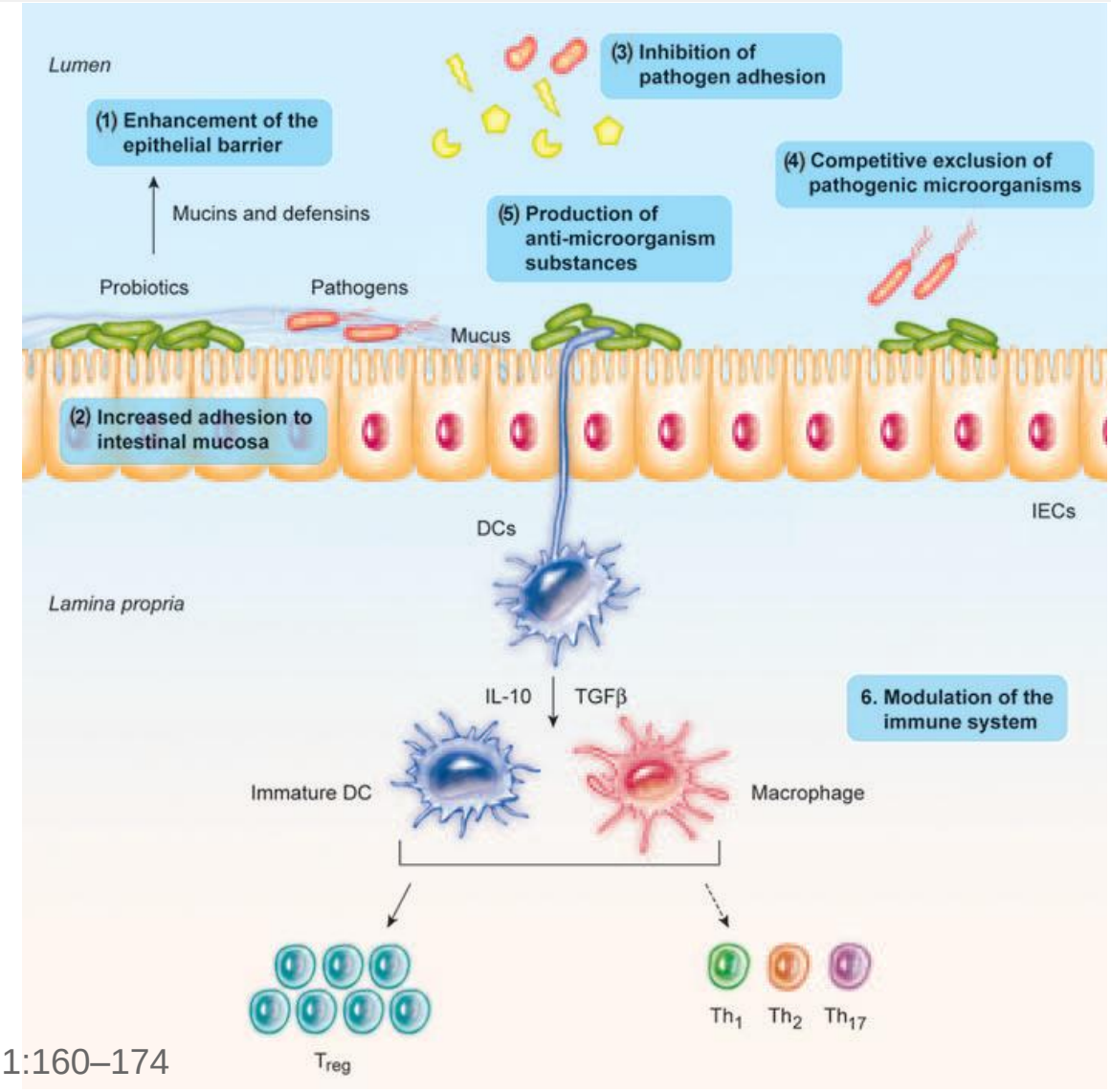


Performance

↑ Final body weight
↓ Feed Conversion Ratio
↑ Egg production



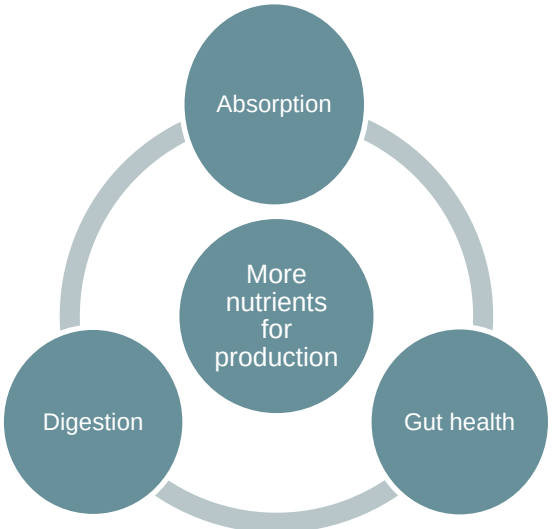
DFMs – How Do They Do Their Work?



Bermudez-Brito, et al.
Ann Nutr Metab 2012;61:160–174

Enzymes and DFMs in Poultry Nutrition

The advantage of enzymes	The advantage of DFMs
Hydrolyze substrate • Specific • Fast • pH dependent Functionality can be designed Catalysts	Live organisms • Metabolism *in-situ* • Reproduce • Adapt to substrates in the gut Modulate microbial populations Modulate immunity



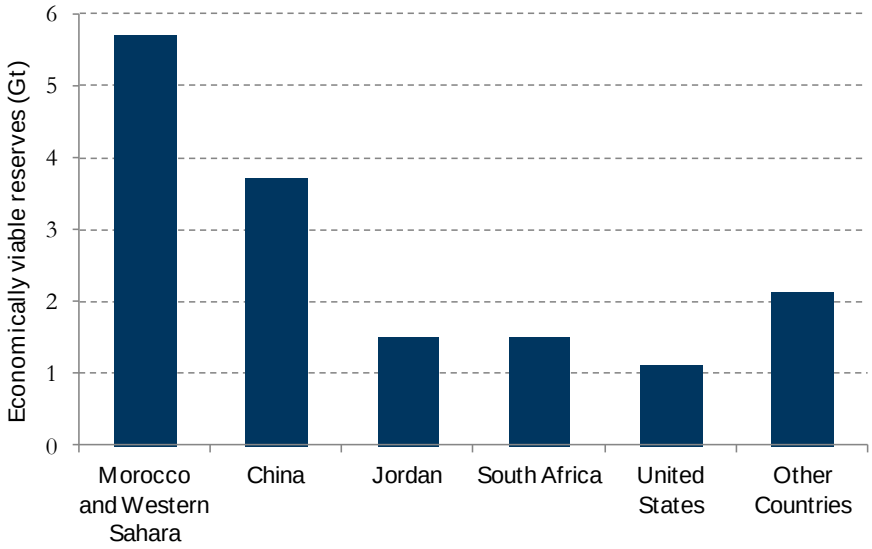
Inorganic Phosphorus: A Non-Substitutable and Finite Resource

http://nicholsoncartoons.com.au/phosphate-mines-in-vogue-226.html

Inorganic Phosphorus: A Non-Substitutable and Finite Resource

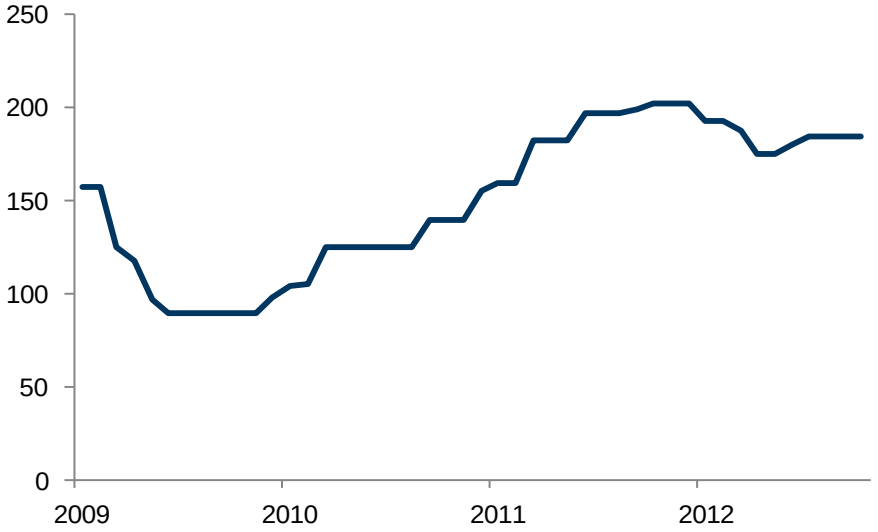
- There are no substitutes for phosphorus in agriculture
- As world phosphate demand grow, both for animal feed and fertilisers, increasing price pressures will continue

Global Inorganic Phosphate Reserves



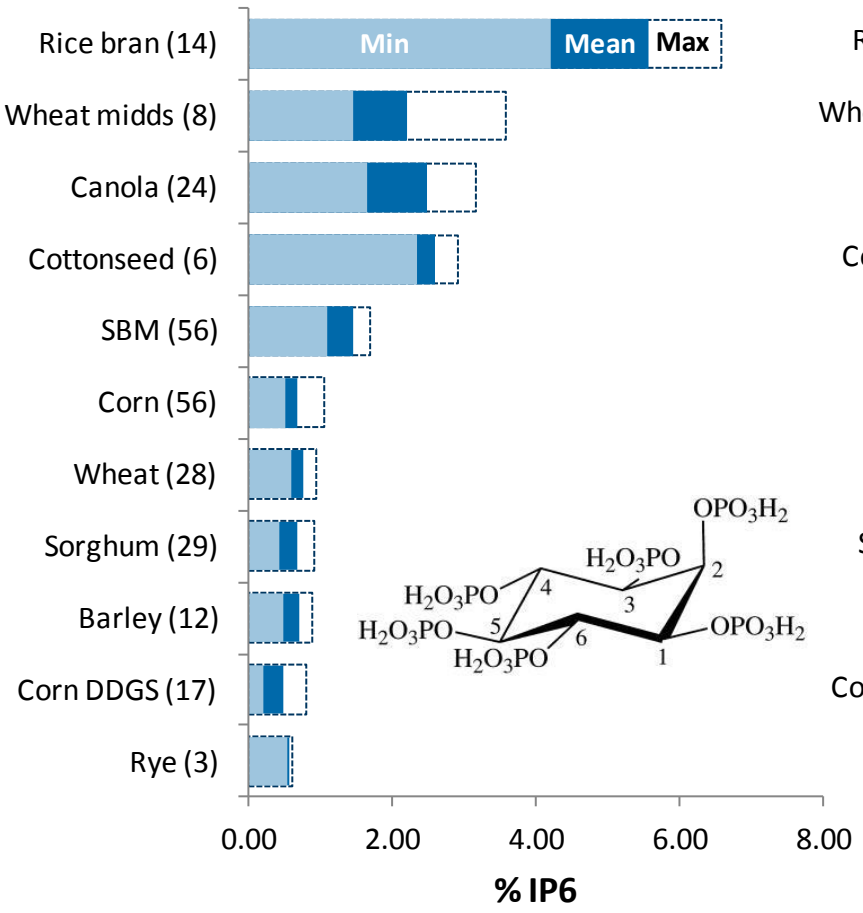
(U.S. Geological survey, 2010)

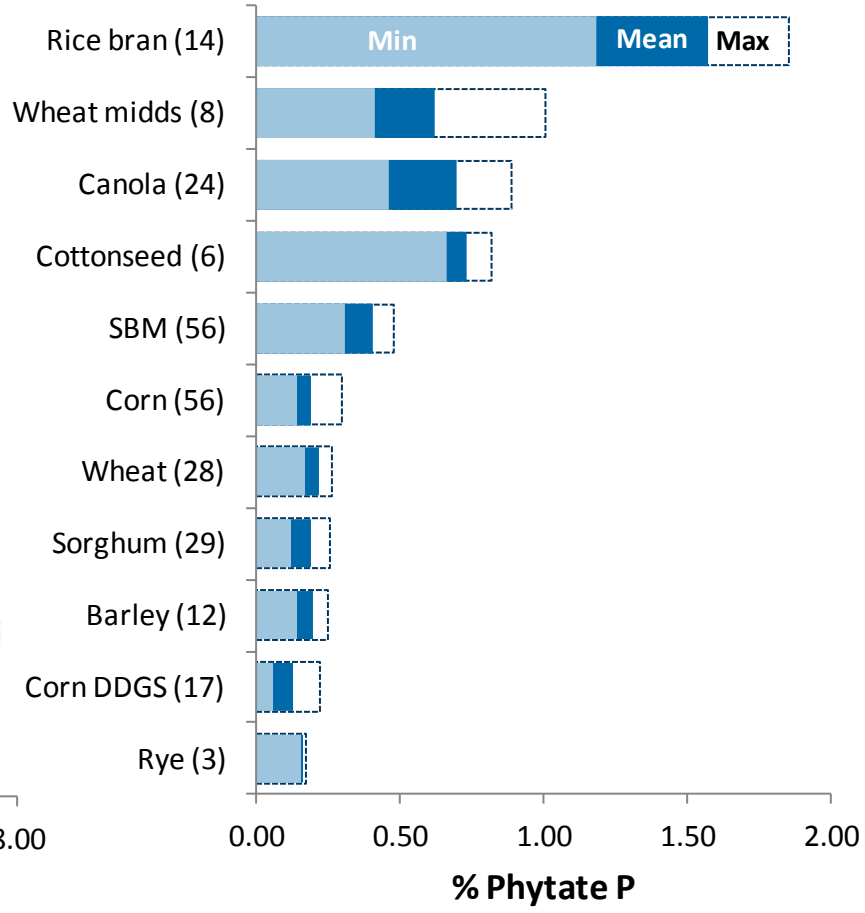
Monthly rock phosphate prices ($/MT)



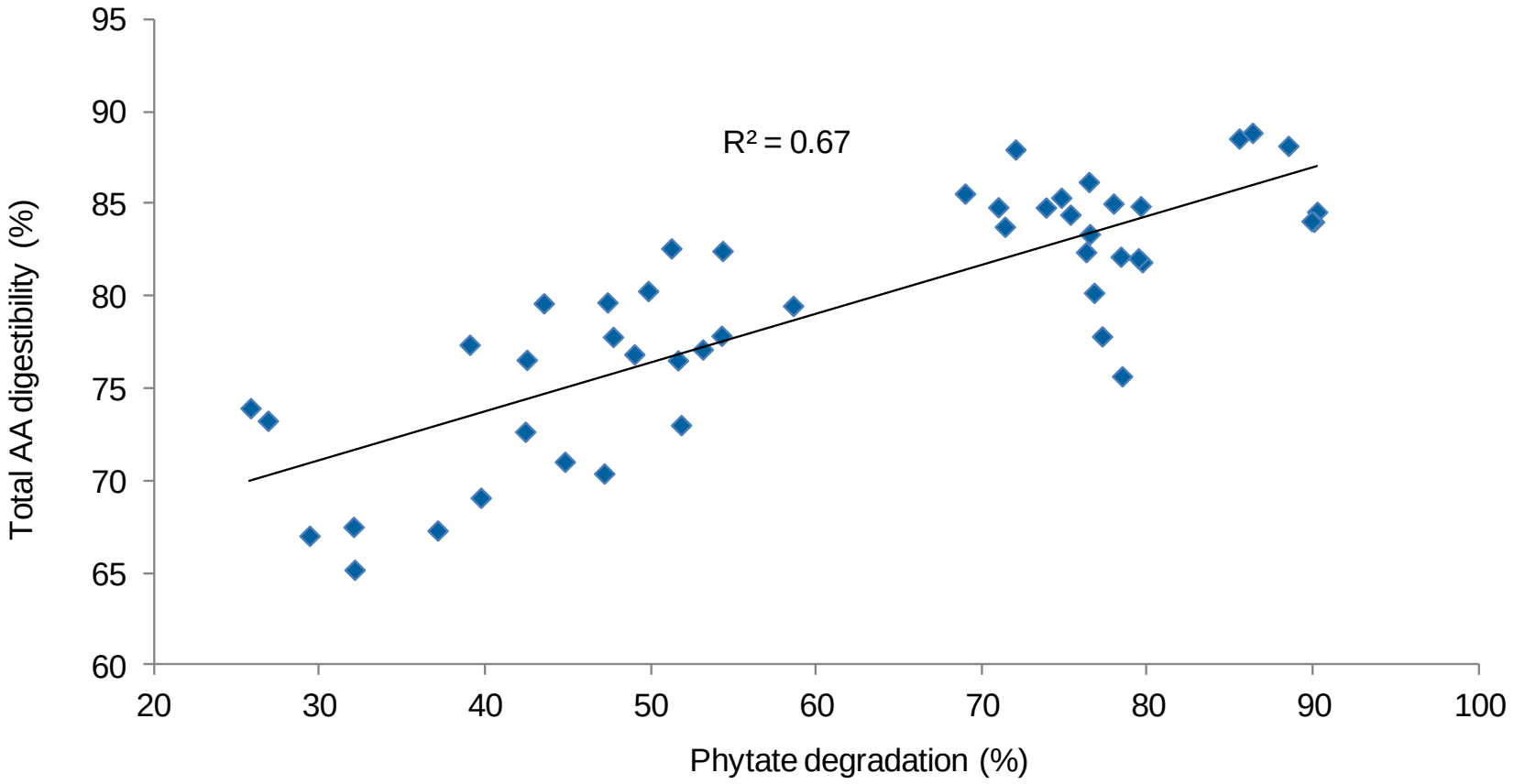
(World Bank, 2012)

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





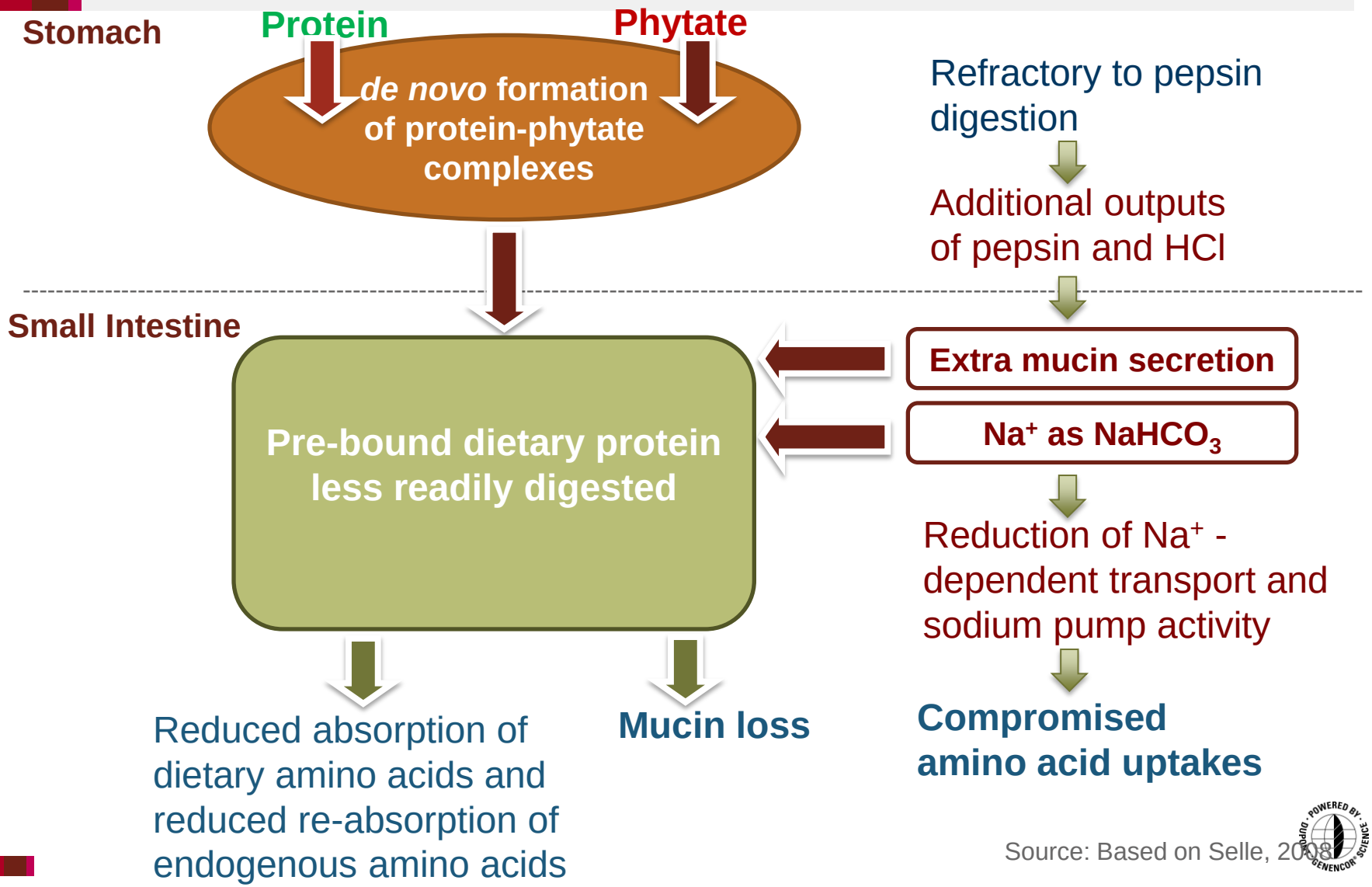
Phytate Degradation by Phytase Increases Protein Digestibility



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

Amerah *et al.* 2012

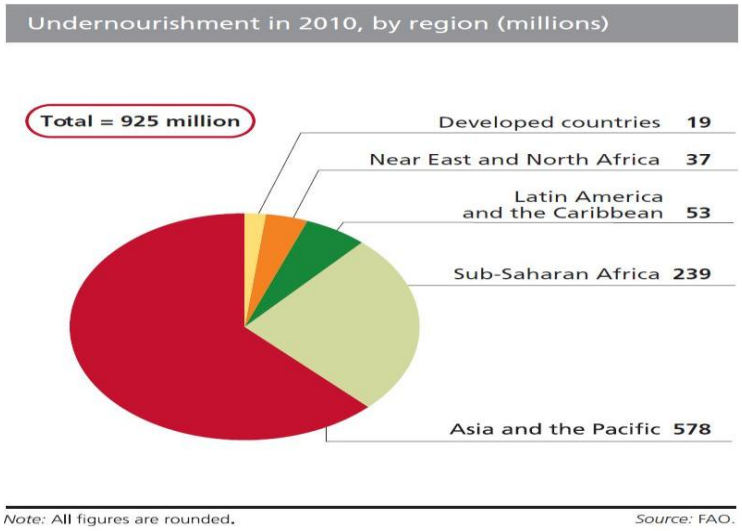
Phytate Increases Costly Endogenous Secretions

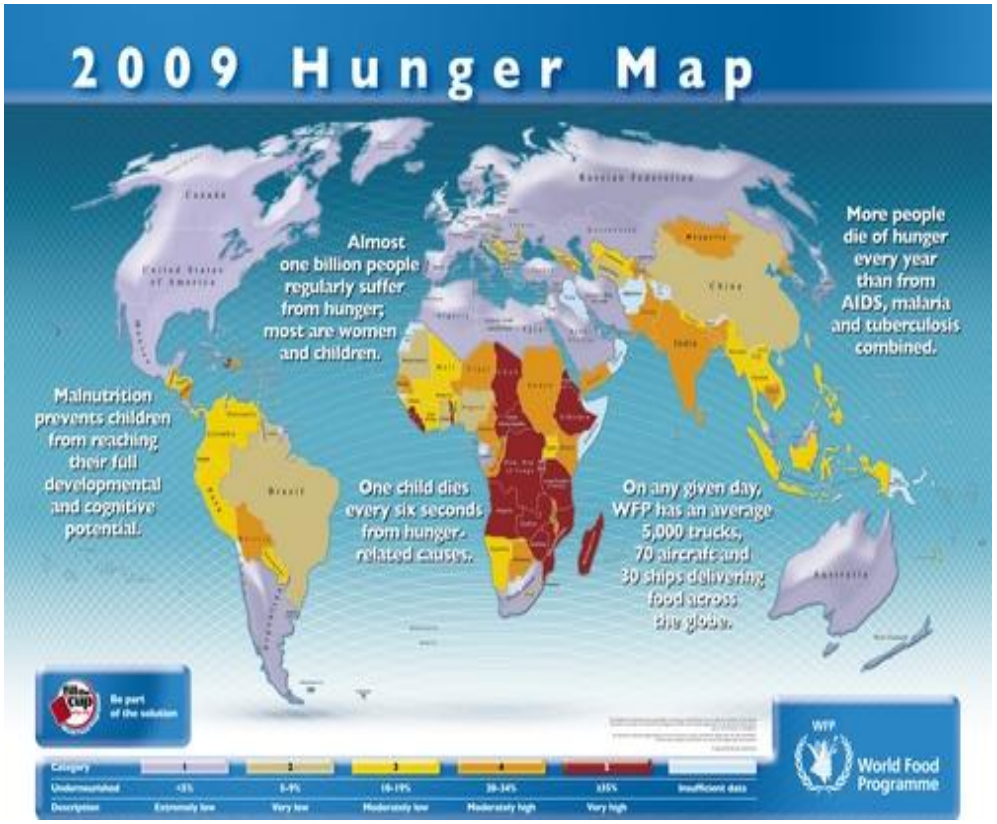


Source: Based on Selle, 2008

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

- High social impact
- High risk problem
- Highly multidisciplinary



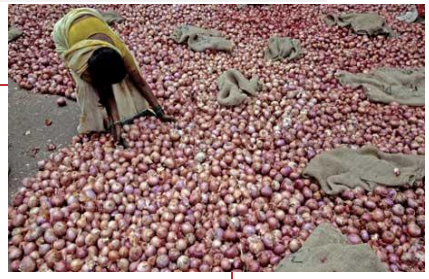


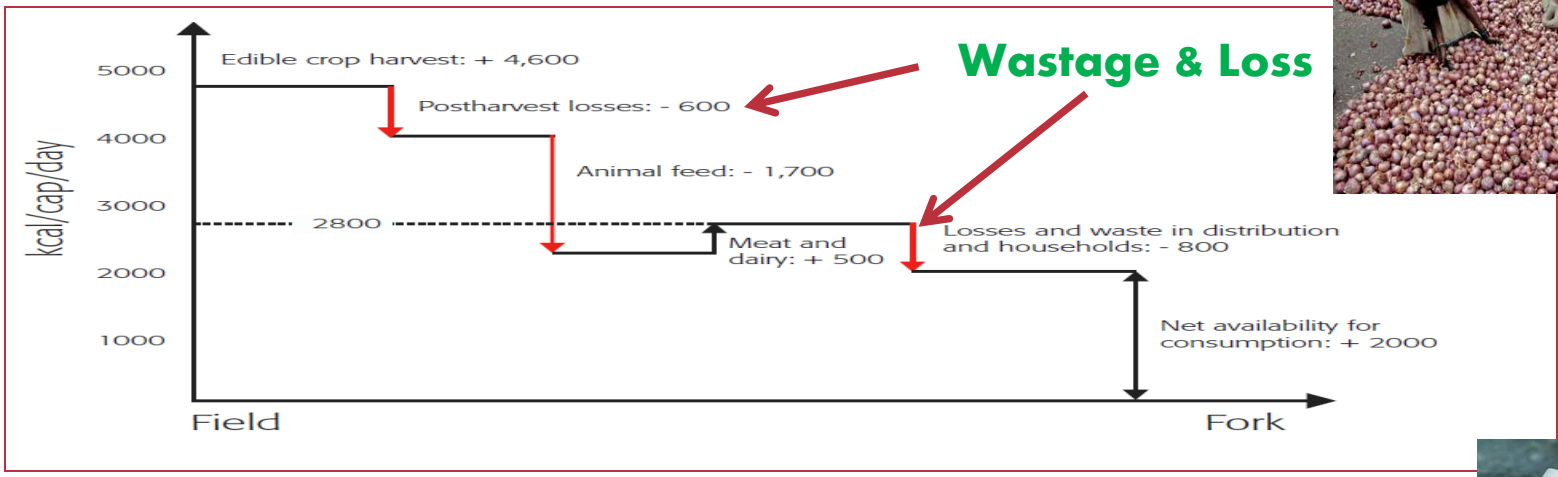





* FAO Stats 2011, http://faostat.fao.org

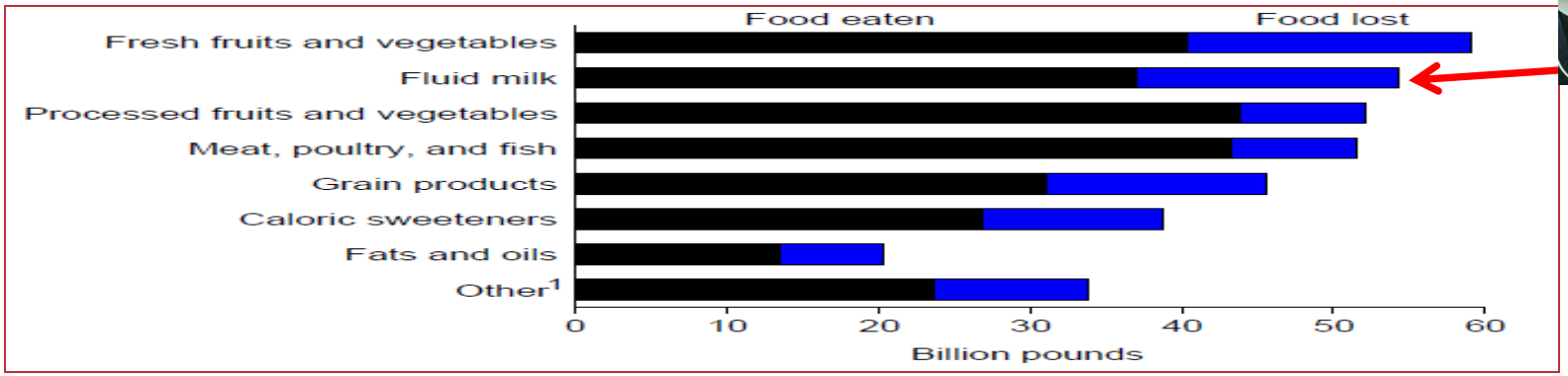
As Scientists, Can We Mitigate Even a Small Percentage of Food Wastage?





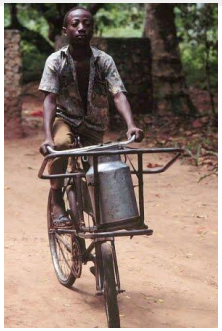
What are we doing and what should we do?

Milk



Raw Milk Preservation - an Example



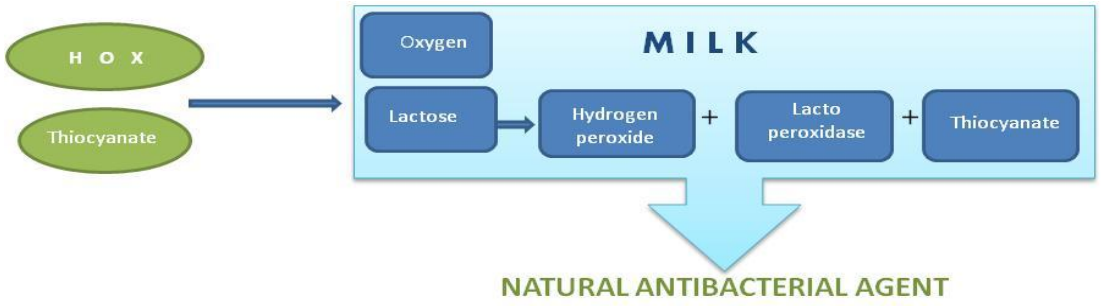



The Problem

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.

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

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

Single Plant Extracts
Proprietary Blends
of Natural Extracts

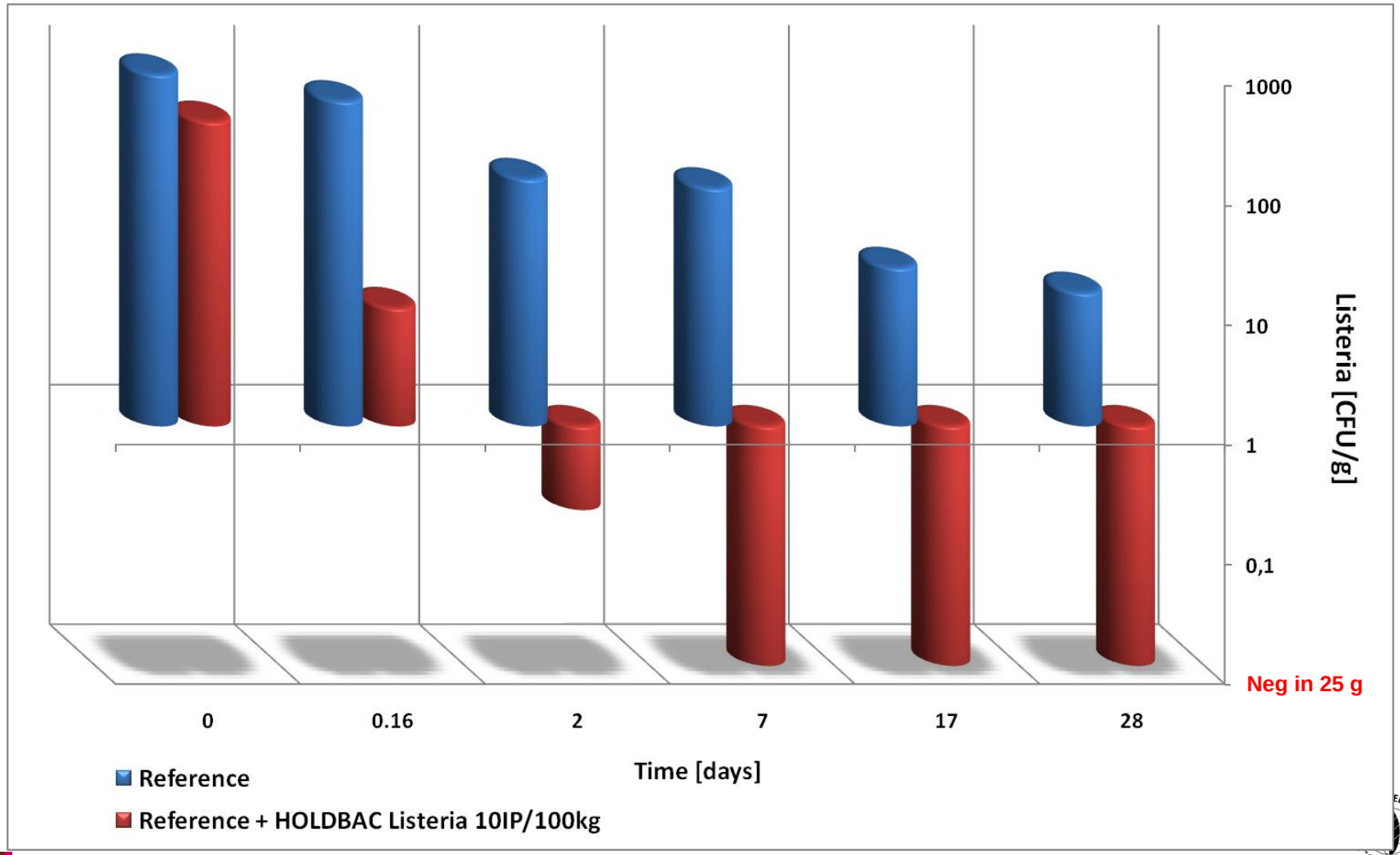
DANISCO.

HOLDBAC® Protective Cultures

HOLDBAC® Protective Cultures

- Strains selected for their natural but remarkable inhibition properties towards specific contamination flora, e.g. Listeria
- Protective capabilities validated through extensive challenge studies.
- To be applied as such or in combination with maturation starters
- Mild maturation functionalities, designed to be compatible with a large range of applications

HOLDBAC ® Protective Cultures in Dried Fermented Sausages



A Look at the Future

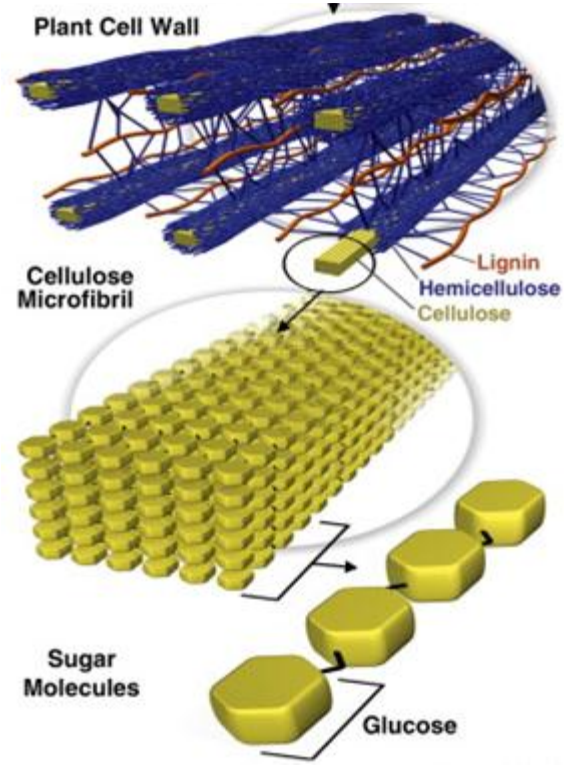
Future Feed Stocks – New Challenges

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

Biomass Challenge



Sannigrahi et al., 2010

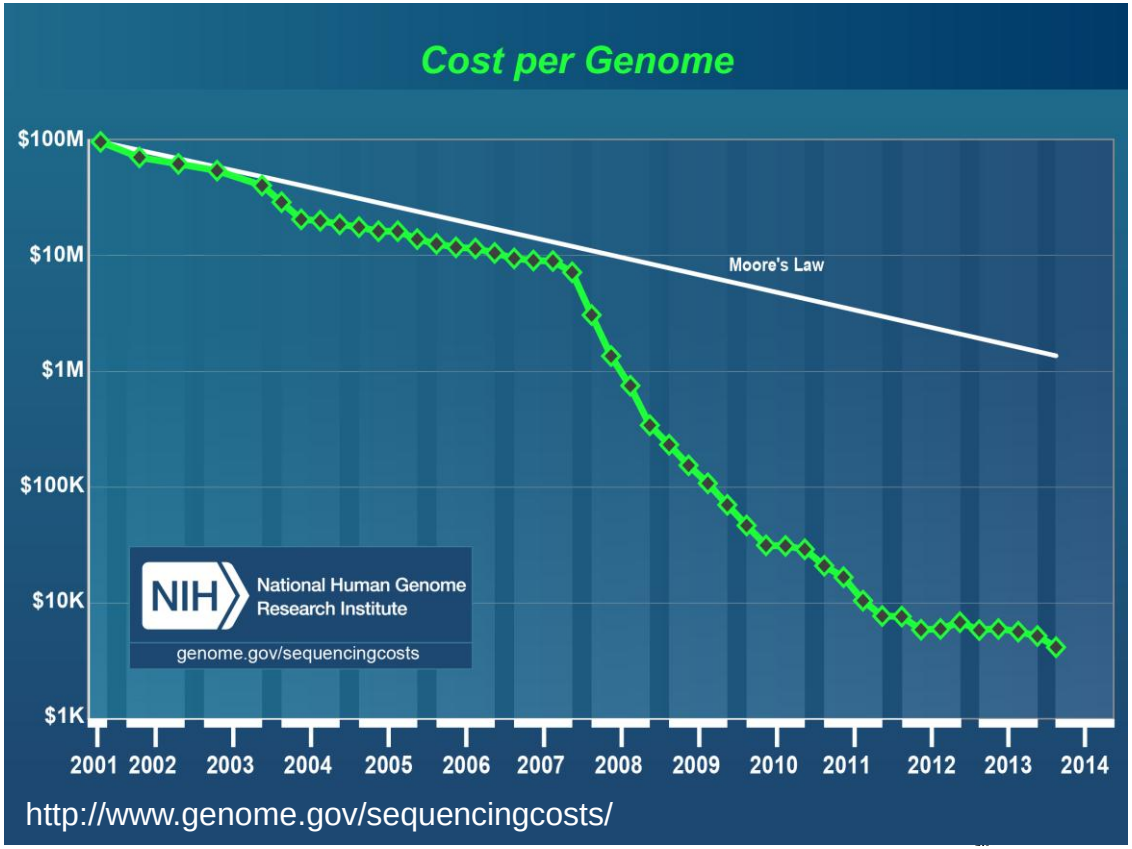
- 1. Hemicellulose: broken down with exogenous enzymes eg. Xylanase
- 2. Cellulose: Crystalline structure, difficult for enzymes to access
- 3. Lignin: non-fermentable, no energetic value for animals

Some Technical Advances Which are Game Changers

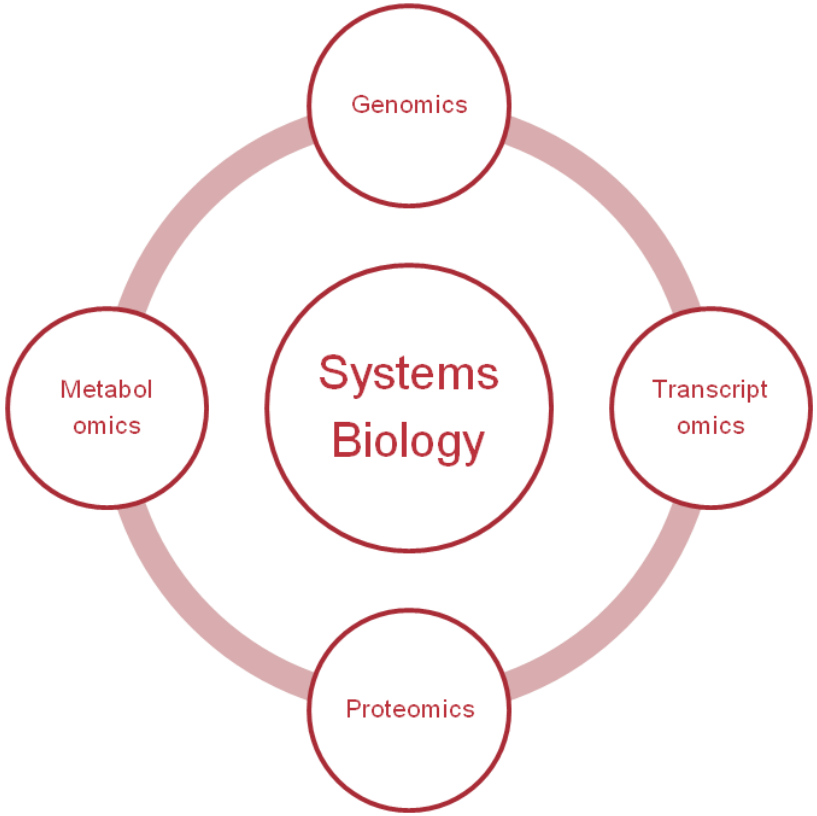
Gene expression microarray analysis, RNA sequencing
Pyrosequencing/Bioinformatics database growth
Epigenetics
Metabolomics
…

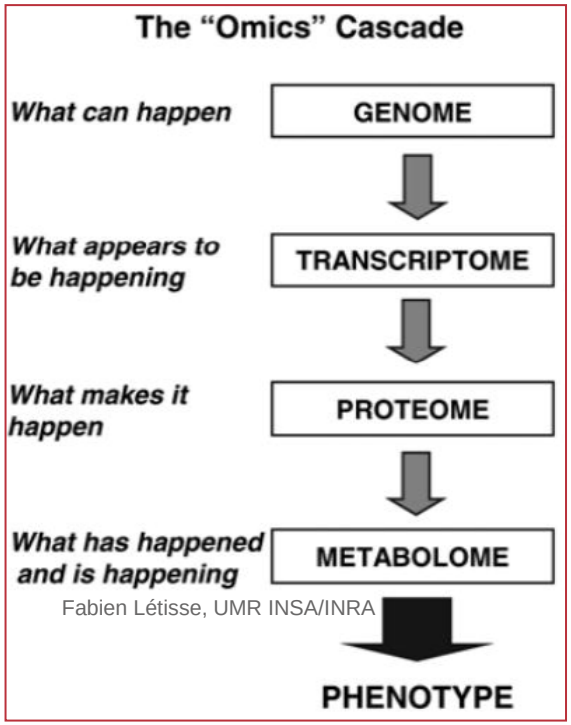
We are now capable of knowing:

1. Which host genes are up or down regulated.
2. The temporal gut microbial profile qualitative and quantitative
3. The metabolic response



The Omics Toolbox



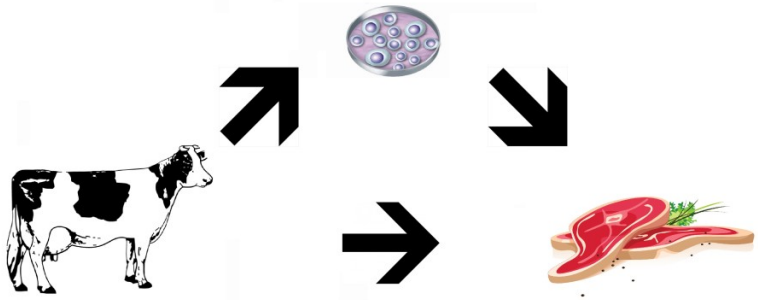


More 'omics tools needed to understand the complexity of live organisms

Personalised Nutrition/Medicine

http://www.hireanillustrator.com/i/49708/new-illustration-for-nature-magazine-medical-genomics/

Meat Without Animals



http://www.oxbridgebiotech.com/review/research-and-policy/is-in-vitro-meat-the-future-of-food-production/

https://www.fstjournal.org/features/27-1/cultured-beef

Summary

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

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Acknowledgements

- Luis Romero
- Greg Siragusa
- Ajay Awati
- Gary Partridge
- Heike Morgenstern
- Karsten M Kragh
- Marc Kolkman
- Henrik Max Jensen
- Steve Betz