

The Role That Enzymes Can Play In Terms Of Increasing The Efficiency By Which Animals Convert Feed Into Protein

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What I Will Discuss Today

- Food Security Index
- How enzymes
 - » Can help the industry to produce more protein
 - » Enable the use of new, alternative raw materials
- Future alternative feedstocks (and other) technologies
 - » Which might change in the industry
- Summary



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.**

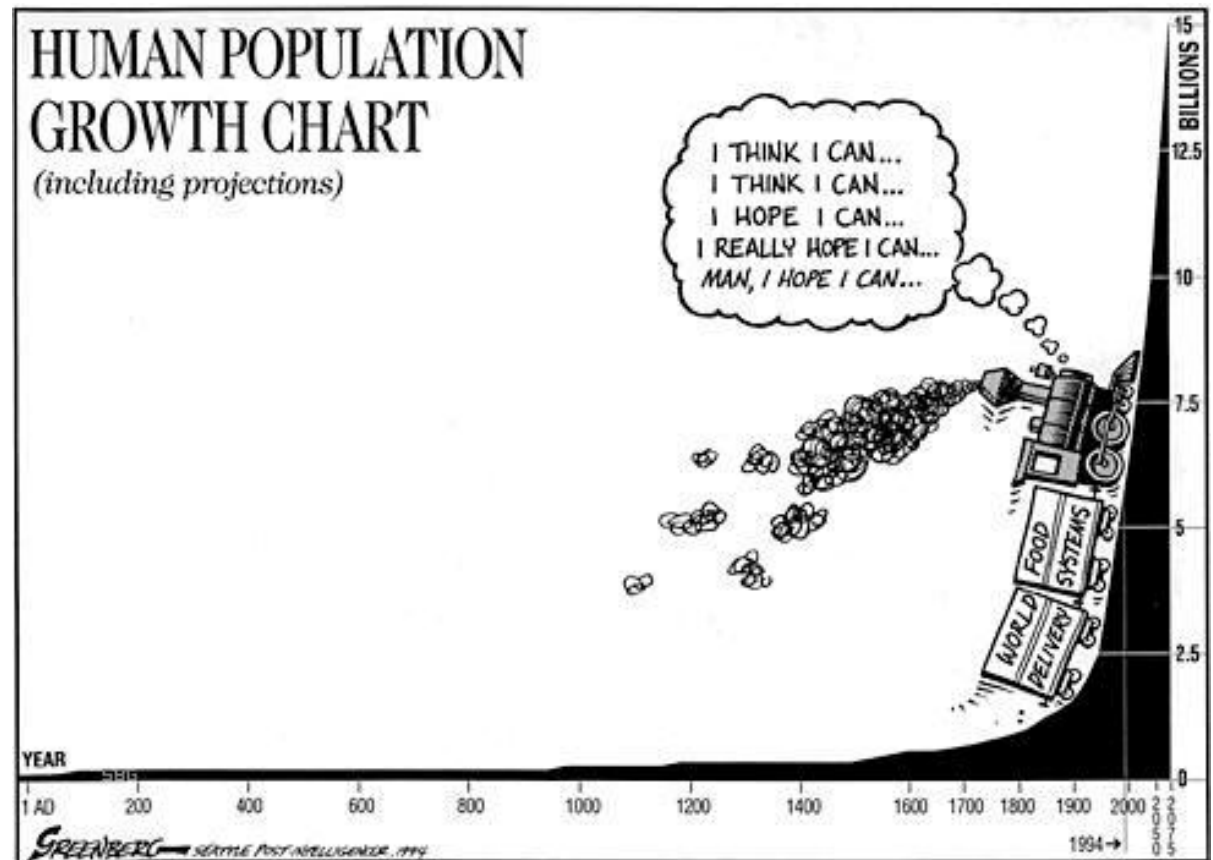
The screenshot shows the homepage of the Global Food Security Index website. At the top, there is a navigation bar with the title 'Global Food Security Index' and social media icons for Facebook and Twitter. Below the navigation bar, there are links for 'Home', 'Key findings', 'Explore countries', 'Resource library', 'Download the index', 'Methodology', and 'About'. The main content area features a large image of a cornfield at sunset. Overlaid on the image is the text: 'The path to food security begins by exploring the challenges, then developing solutions.' Below this text, there is a call to action: '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. At the bottom left, it says 'sponsored by' followed by the DuPont logo. At the bottom center, there are three circular icons numbered 1, 2, and 3.

Visit foodsecurityindex.eiu.com

Protein Needs Are Increasing

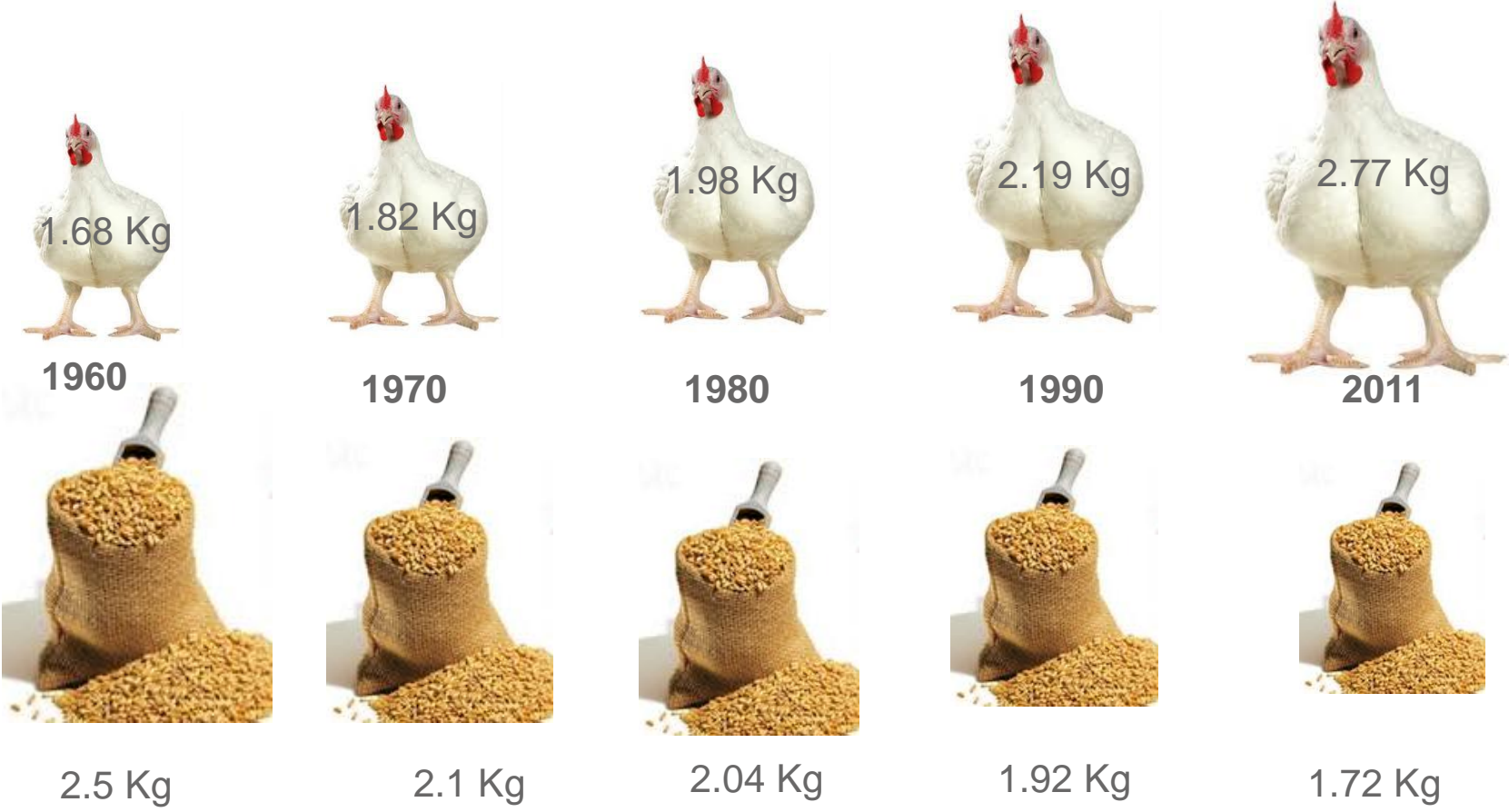
FAO* expects world demand for (animal-derived) protein to double by 2050

- 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

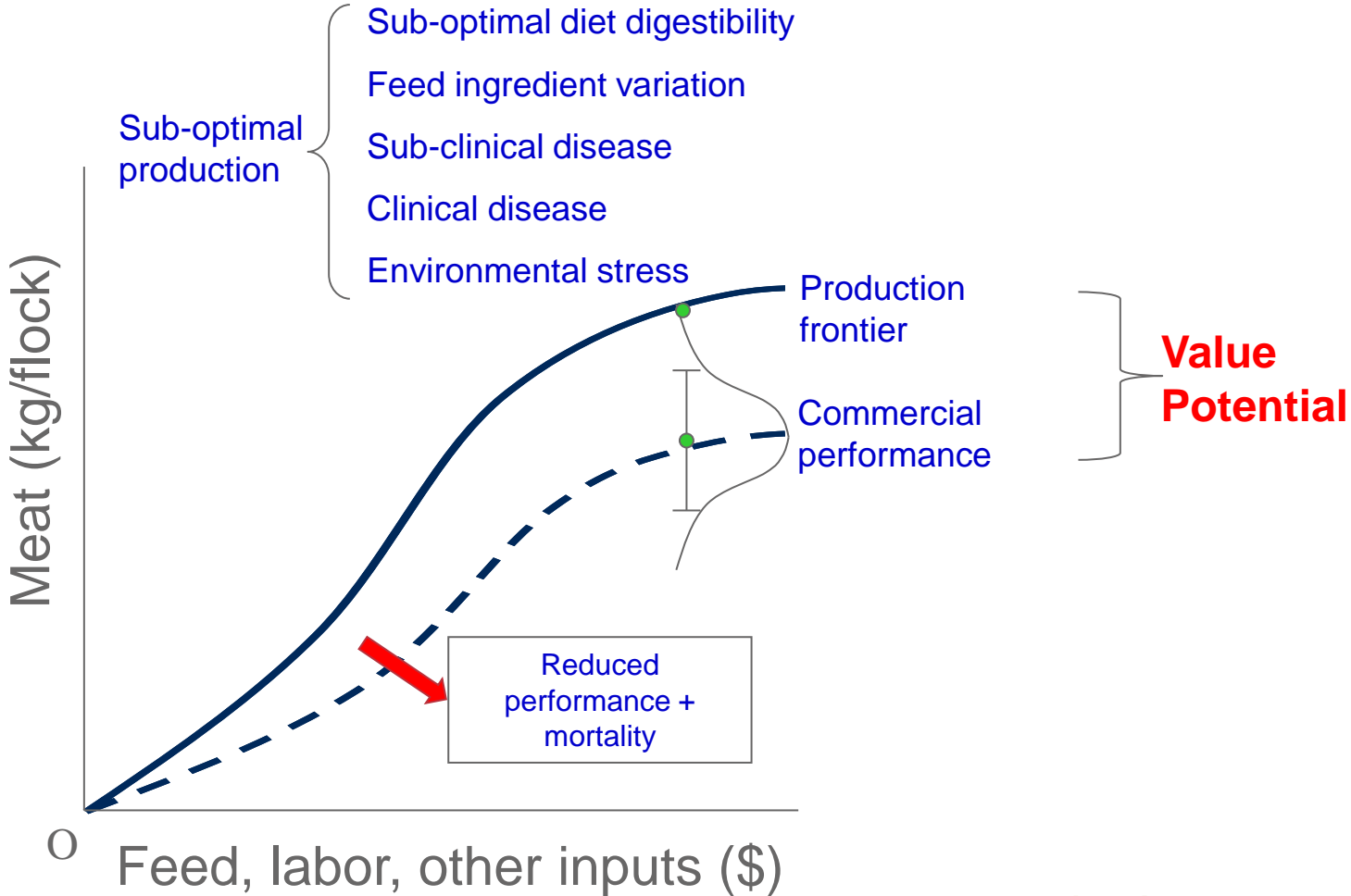
Improvement in Slaughter Weight Versus Feed Conversion Ratios*



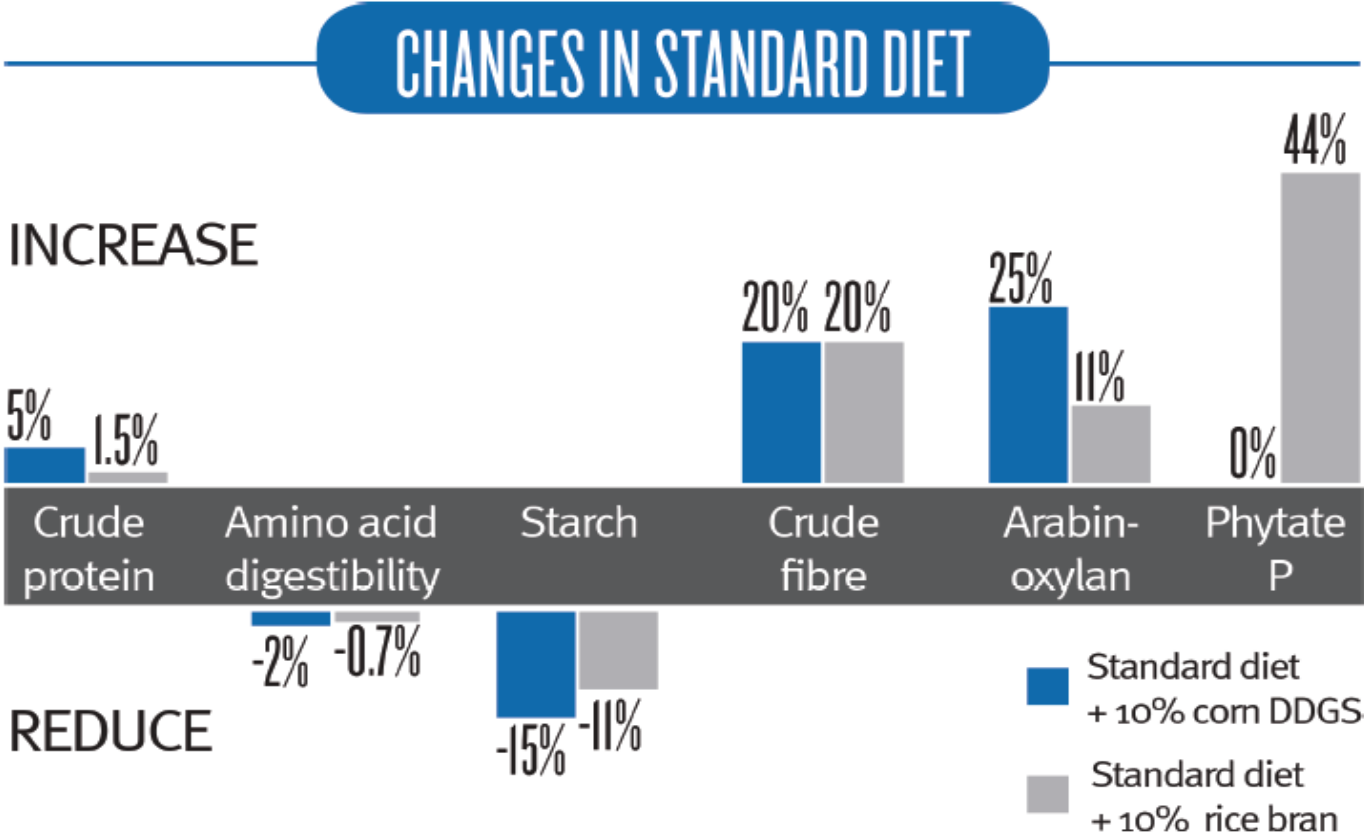
*Amount of feed required for 1Kg weight gain

Based on Raww et al., 1998 and Ross info

Still Genetic Potential to be Captured



Cheaper Protein Sources Add Dietary Variability

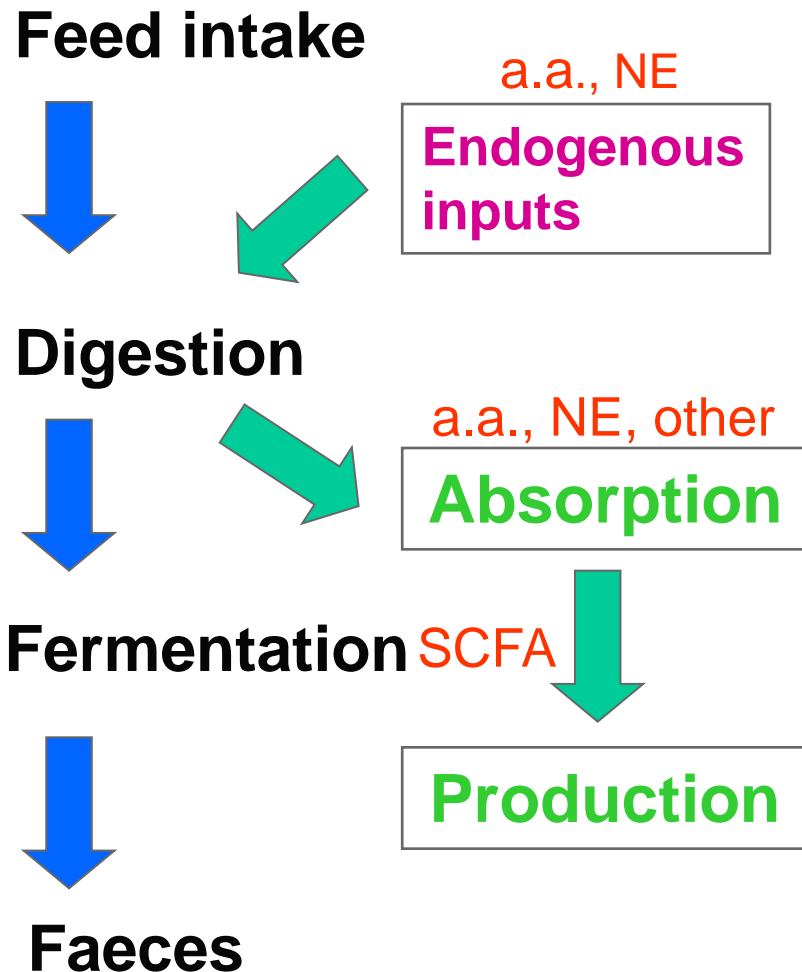


Enzymes Work by Targeting Specific Substrates

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

Exogenous Enzyme Solutions Diets To Reduce Variability

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

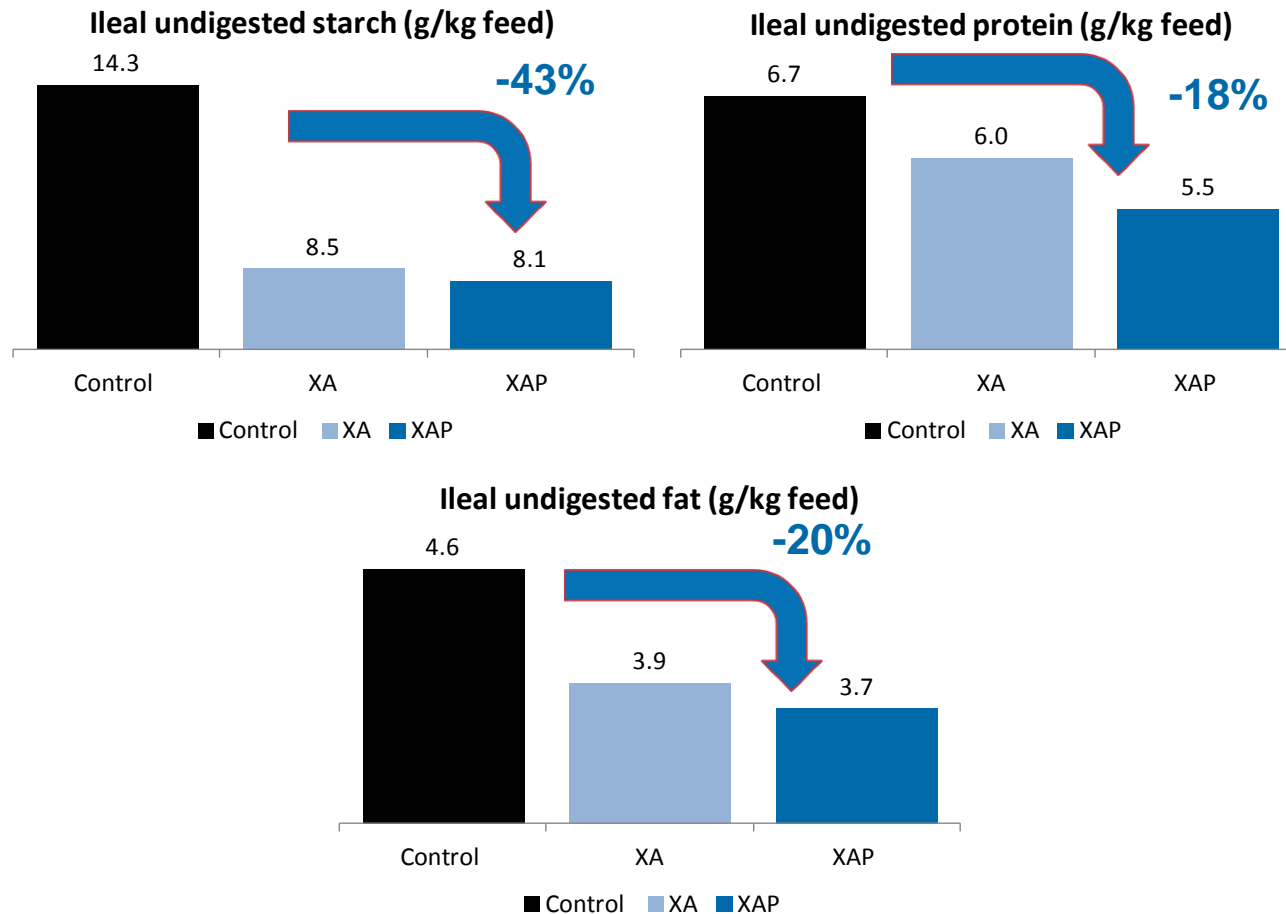
Improve digestion of starch, fat, protein, minerals:

- 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



X: Xylanase; A: Amylase; P: Protease

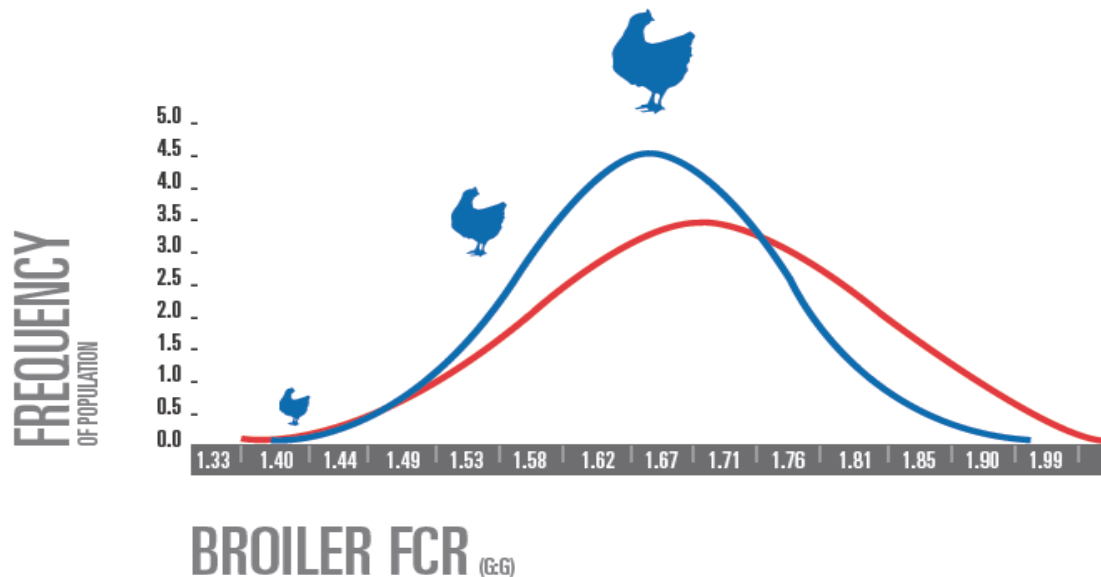
Adapted from Romero et al., 2012

AllAboutFeed

Even “Simple” Diets Can be Variable in Quality

+XAP
ENZYME

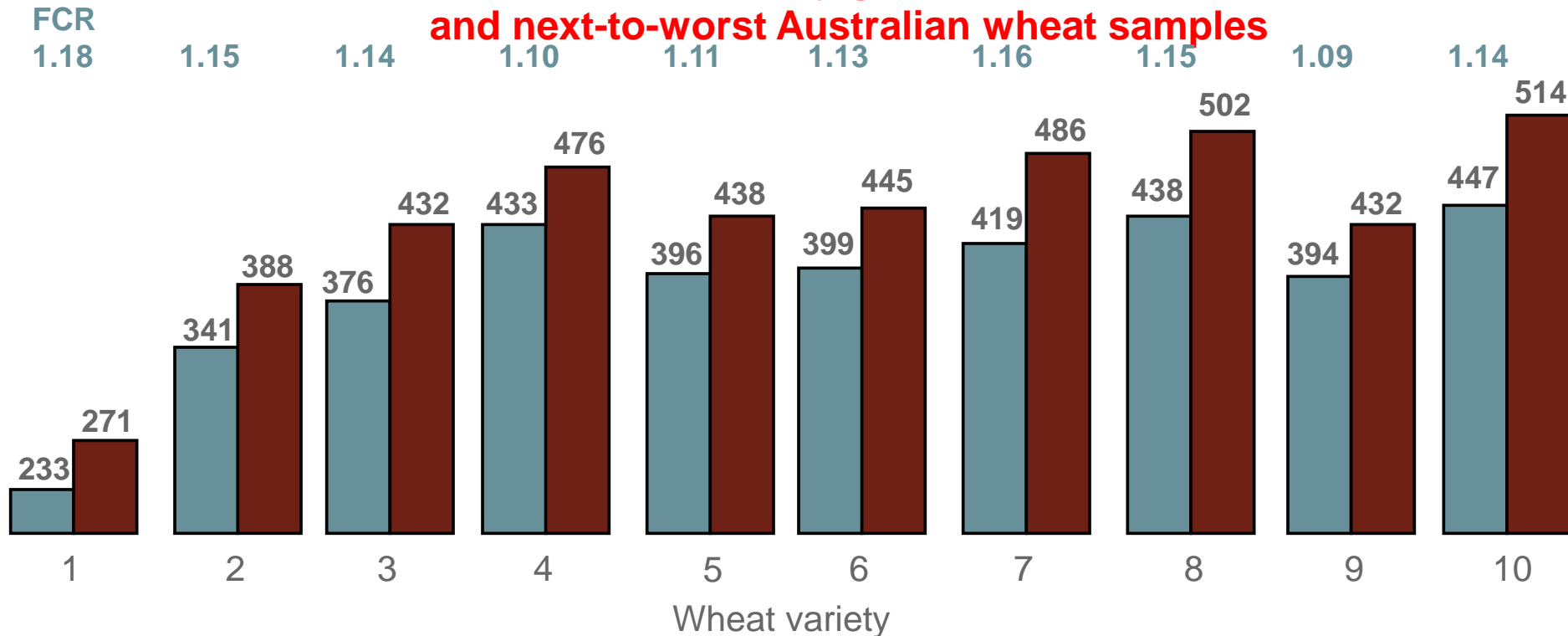
NO
ENZYME



The impact of xylanase, amylase and protease addition to 56 different corn samples included in broiler diets reduced the variation in performance measured as FCR. (Danisco Animal Nutrition, 2011)

Wheat Variety Can Influence Pig Growth And Feed Intake

31% variation in daily gain between the best and next-to-worst Australian wheat samples



Growth: $P < 0.001$

Feed intake: $P < 0.001$

Feed:gain: NS

■ Daily gain (g)
■ Feed intake (g/day)

65% wheat in diets
Weight 7-16 kg

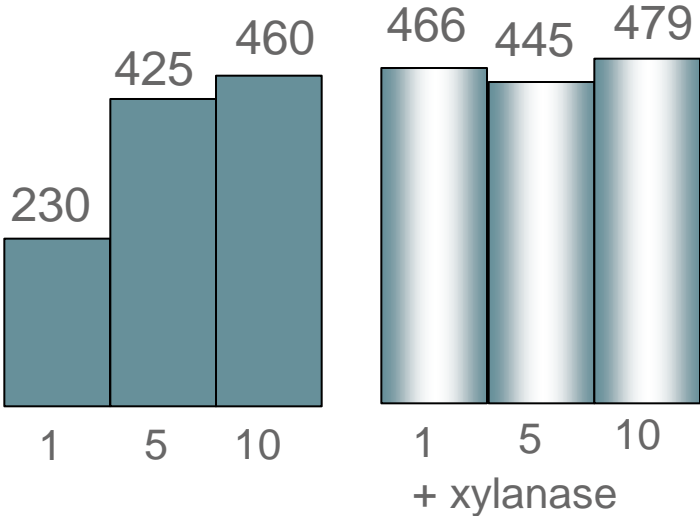
Source : Cadogan et al (1999)

Xylanase Reduces Variation in Performance Between Different Varieties of Wheat

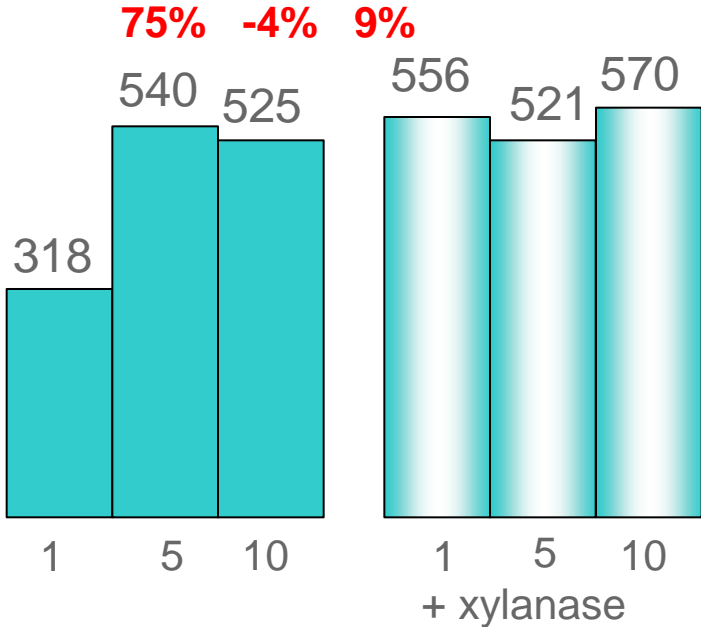
Daily gain (g)

FCR: 1.38 1.27 1.14 1.19 1.17 1.19

Improvement with xylanase : 103% 5% 4%



Feed intake (g/day)



Wheat variety

Xylanase effects:
 Daily gain P<0.001 Feed intake P<0.001 FCR NS
 Wheat x Xylanase P <0.001

Source : Choct et al (1999)

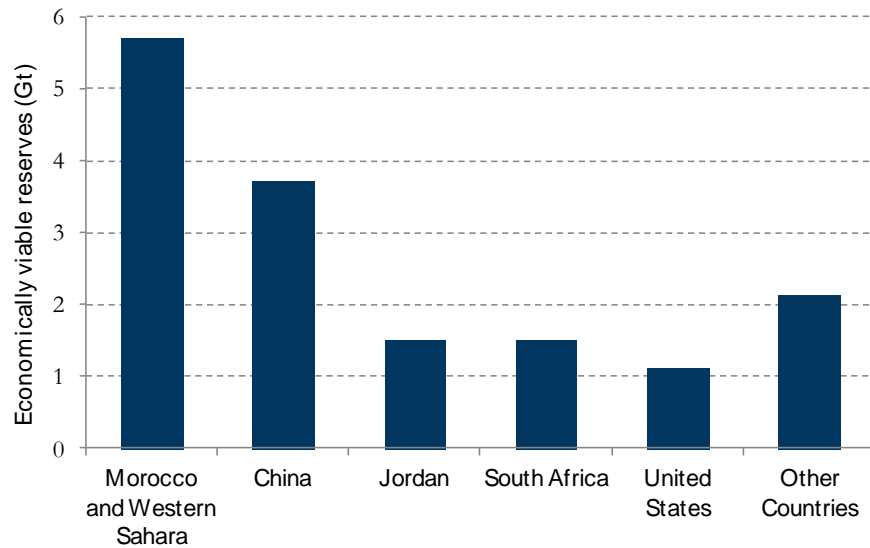
Inorganic Phosphorus: A Non-Substitutable and Finite Resource



Inorganic Phosphorus: A Non-Substitutable and Finite Resource

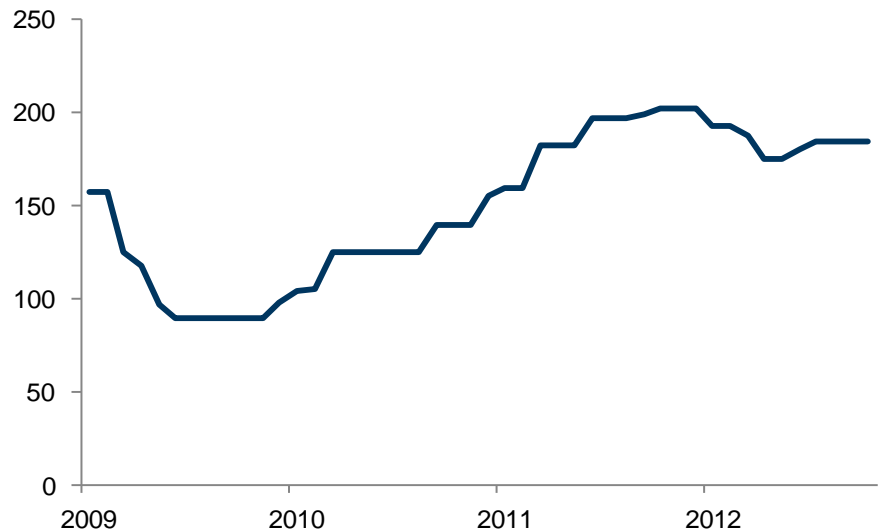
- There are no substitutes for phosphorus in agriculture
- As world phosphate demand grows, both for animal feed and fertilisers, increasing price pressures will continue

Global Inorganic Phosphate Reserves



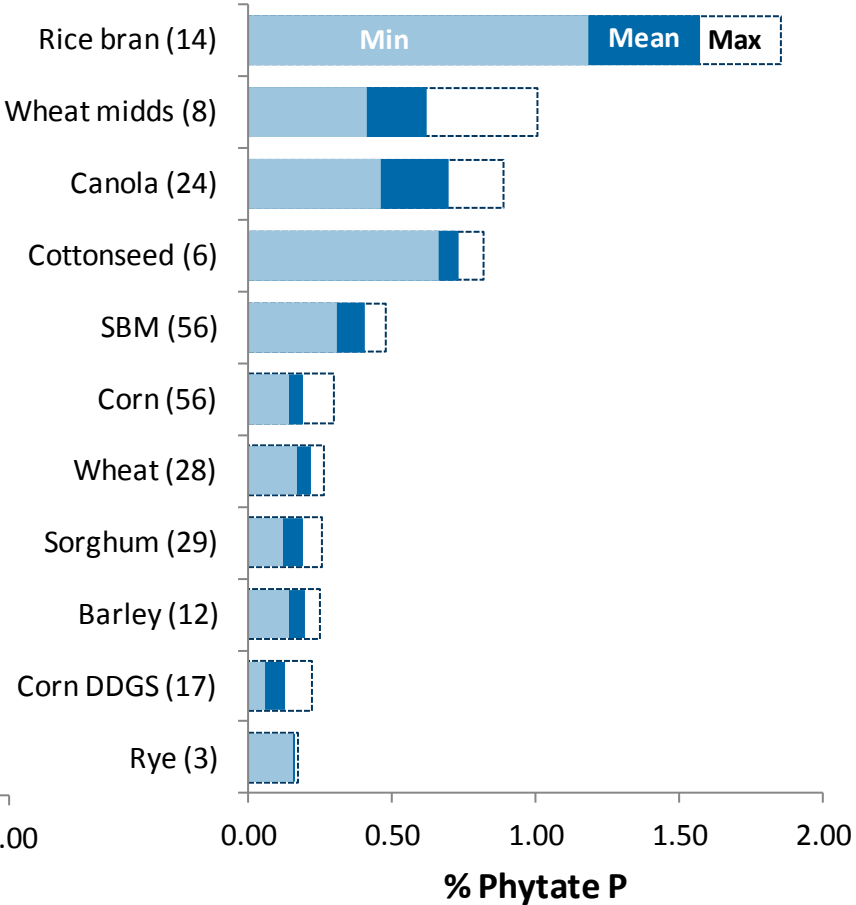
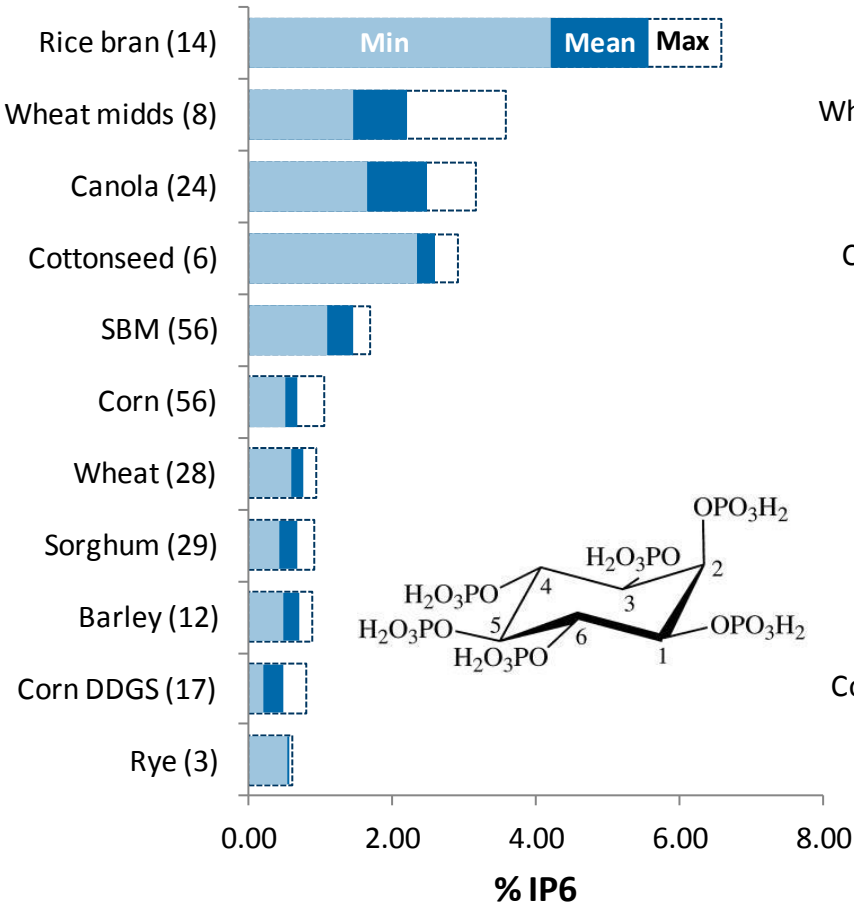
(U.S. Geological survey, 2010)

Monthly rock phosphate prices (\$/MT)

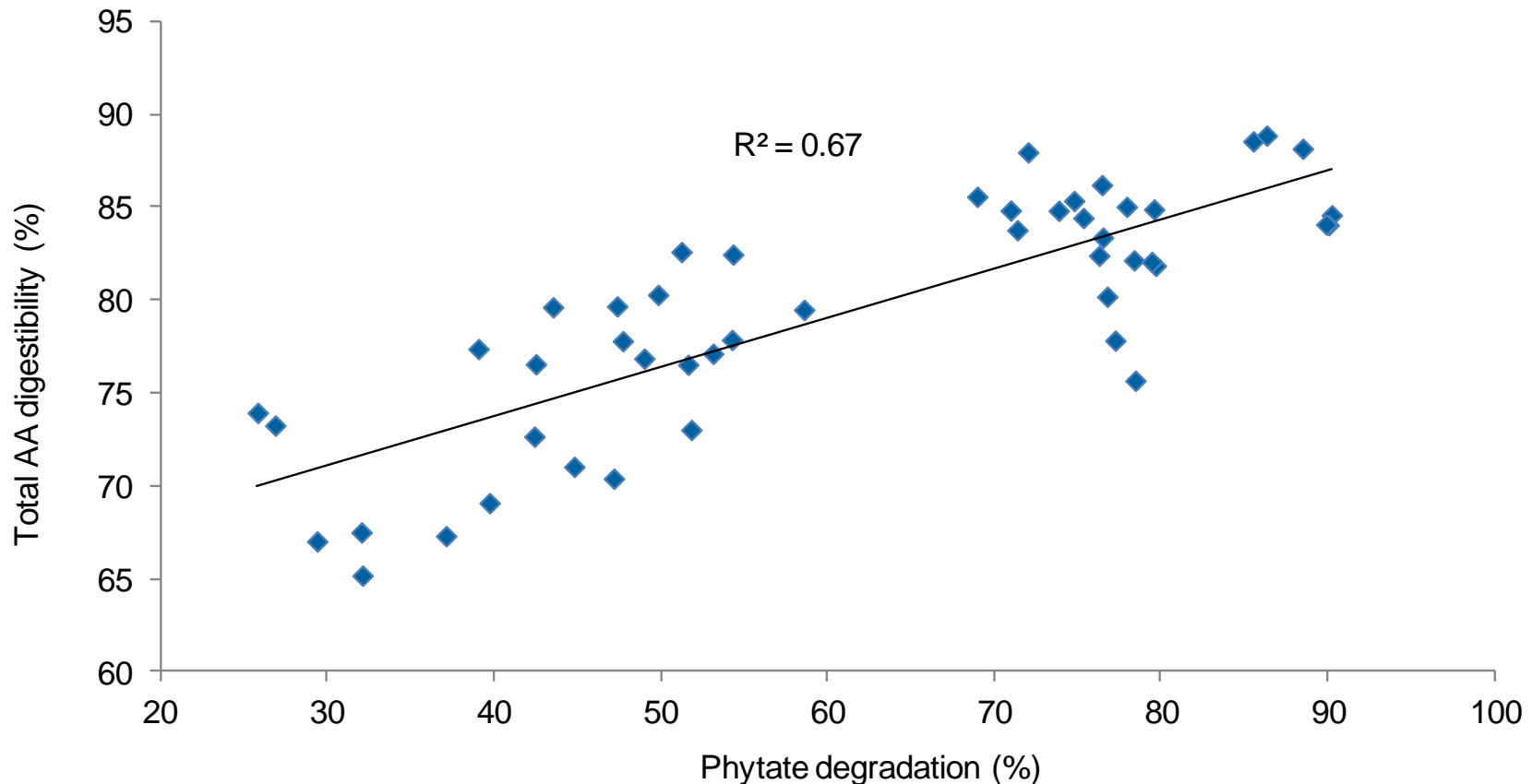


(World Bank, 2012)

Phytate - Also Known As IP6 - Is The Natural Store Of Phosphorus In Plants But The Content Is Variable

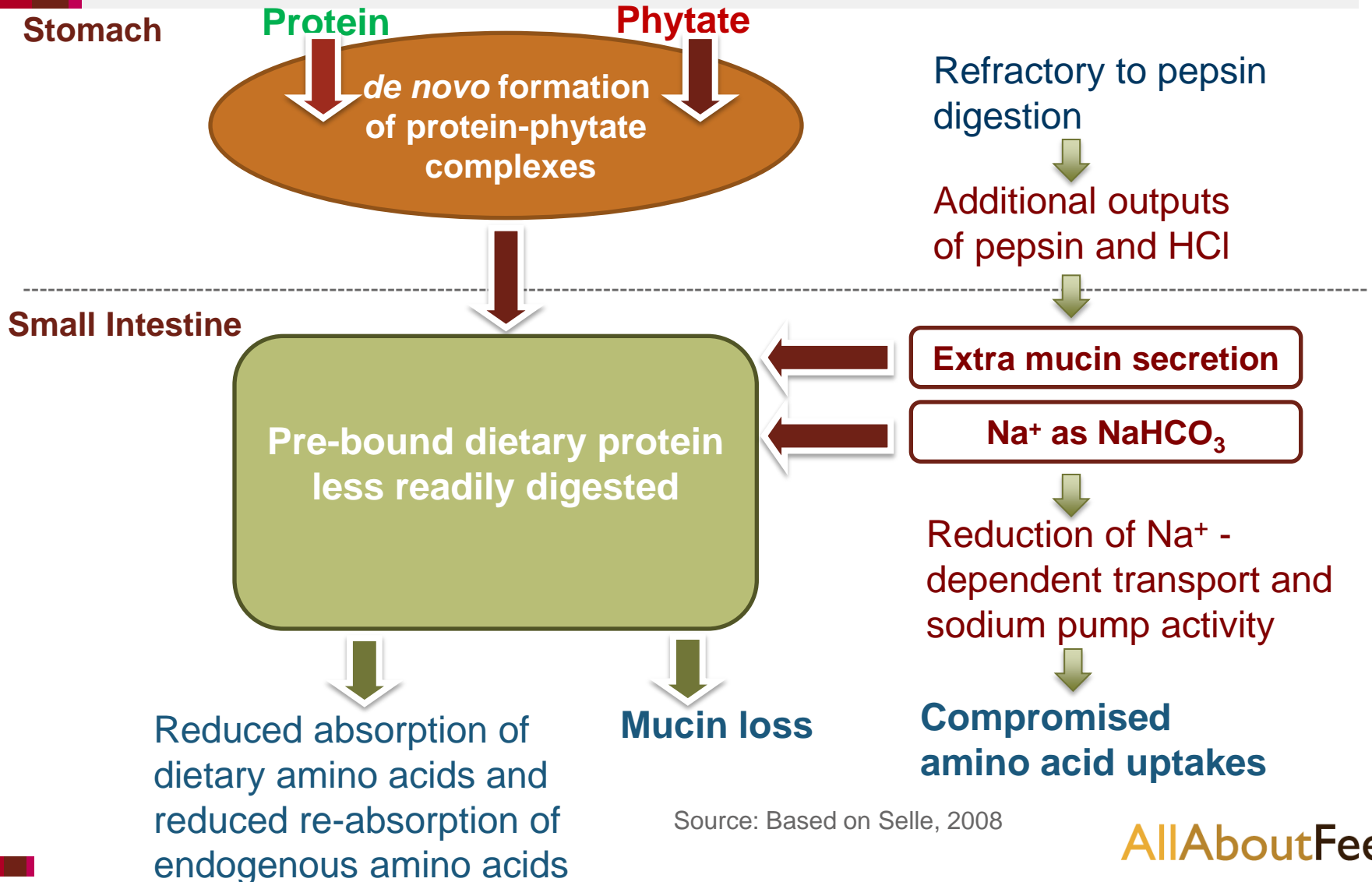


Phytate Degradation by Phytase Increases Protein Digestibility



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

Phytate Increases Costly Endogenous Secretions



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

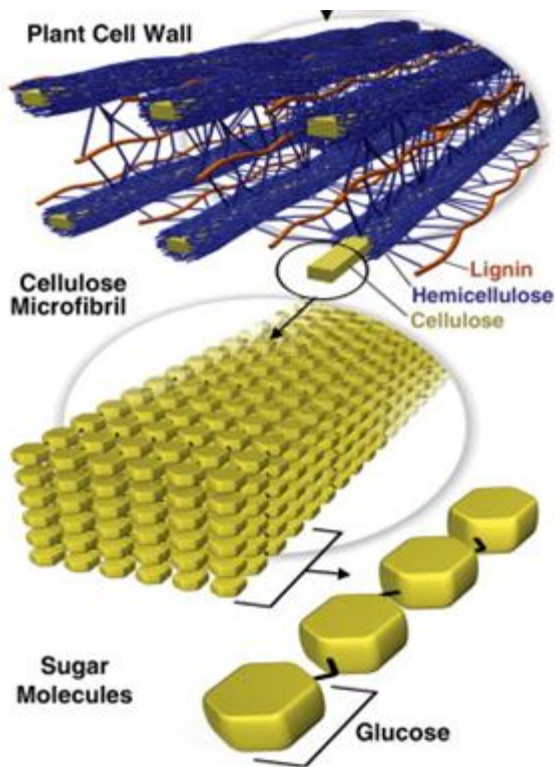
Food for a Sustainable Planet

ARNOLD VAN HARE, HENK VAN GURT, THE HAREEL-DICAR



Biomass Challenge

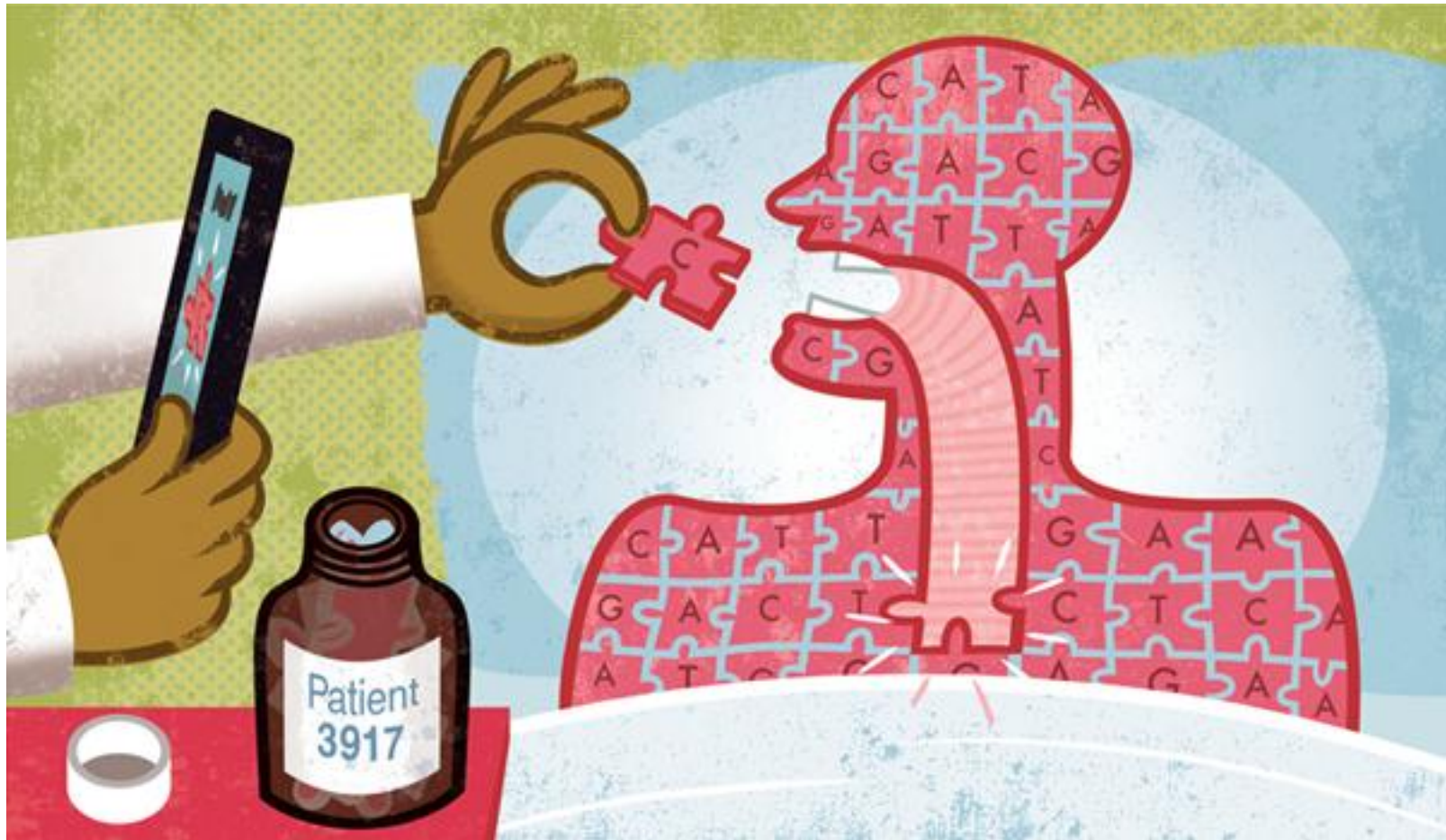
- 1. Hemicellulose: broken down with exogenous enzymes eg. Xylanase
- 2. Cellulose: Crystalline structure, difficult for enzymes to access
- 3. Lignin: non-fermentable, no energetic value for animals



Sannigrahi et al., 2010



Personalised Nutrition/Medicine



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

Summary

- Dupont is committed to Food Security
- Enzymes gives
 - » Increased animal production efficiency
 - » More sustainable production
 - » Healthier better performing animals
- The future
 - » New alternative non-food feedstocks
 - » New technologies applied to animal production



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.
 BRAIN STORM.
 INCREASE SHELF LIFE.
 INSPIRE ONE ANOTHER.

COLLABORATE.
 PROVIDE FOOD WHERE IT'S NEEDED.
 DISCOVER.
 MAXIMIZE YIELDS.

BE PART OF A COMMUNITY OF SOWERS.
 GIVE HOPE TO THE HUNGRY.
THINK GLOBALLY.

SOLVE

Welcome to The Global Collaboratory.™

BREAK NEW GROUND. **HARVEST SOLUTIONS.**
INNOVATE.
 REALIZE A CROP'S POTENTIAL.
 PLANT NEW THOUGHTS.
 SHARE A VISION.

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