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Global Food Security: a time-sensitive moving target

Pacific North West Economic Region
Summit

July 18th 2016

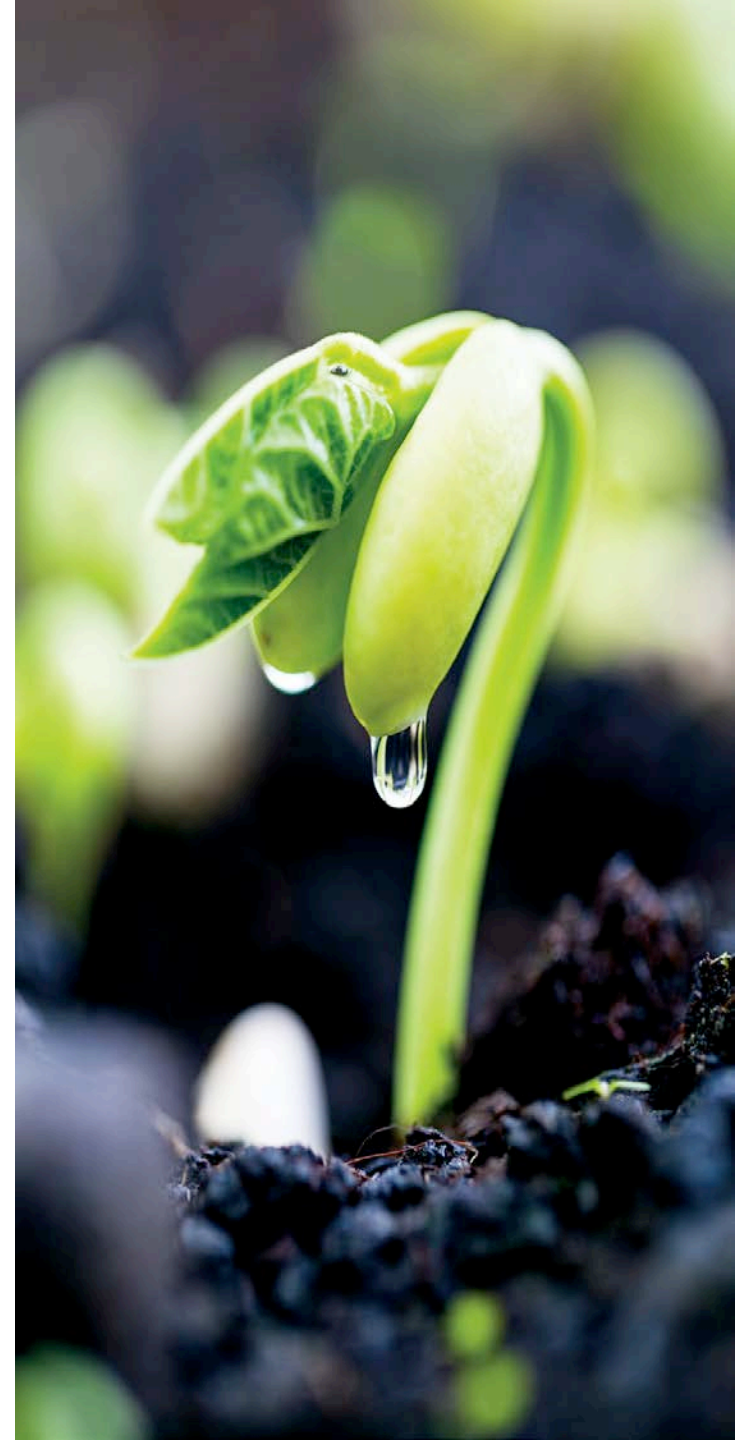
Maurice Moloney Exec. Director and CEO



UNIVERSITY OF
SASKATCHEWAN

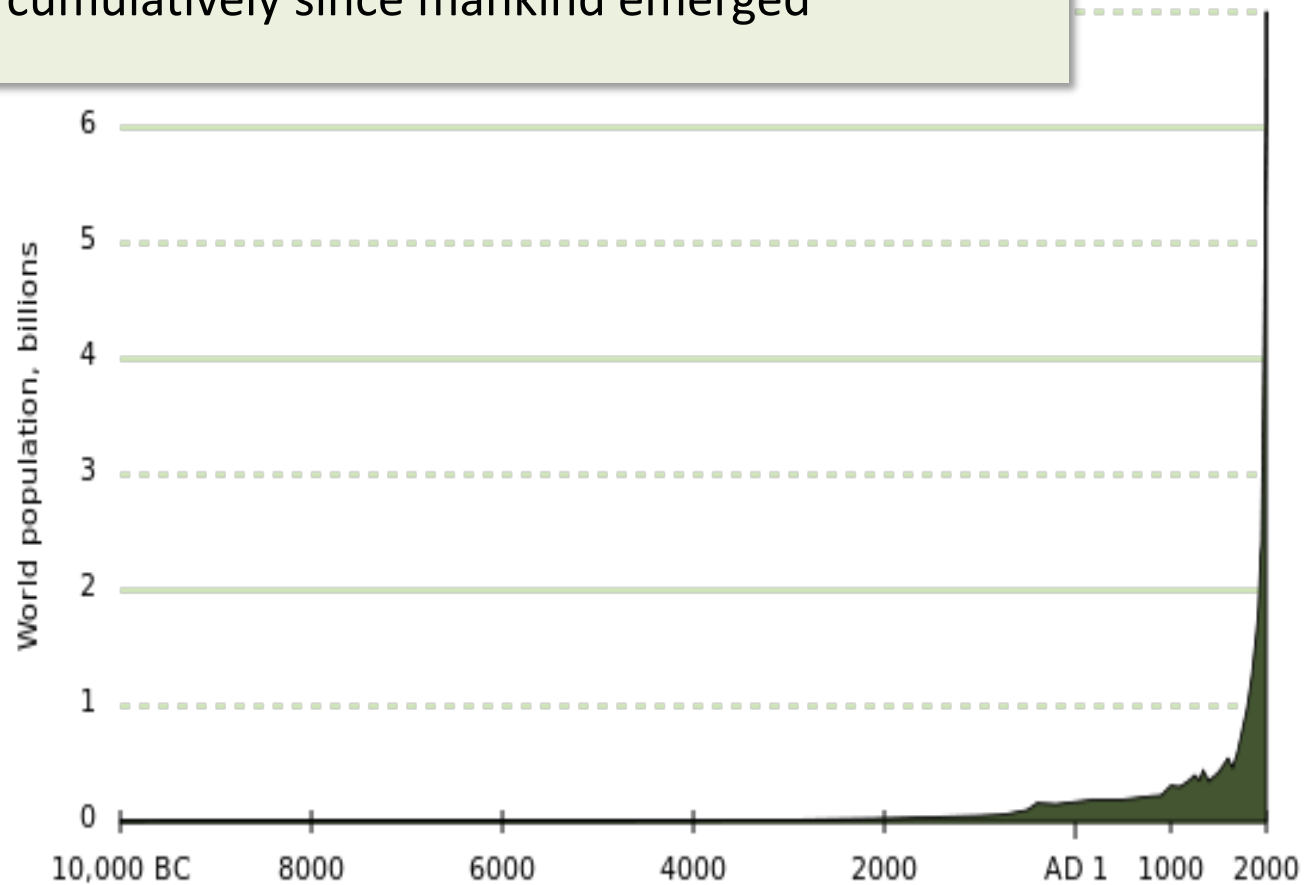


Government
of
Saskatchewan



Feeding a Growing World

- **The Need:** Over the next 50 years we shall need to grow more food than we ever have cumulatively since mankind emerged



The Perfect Storm



- Climate Change
- Water
- Nutrient sources
- Energy



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The Perfect Storm



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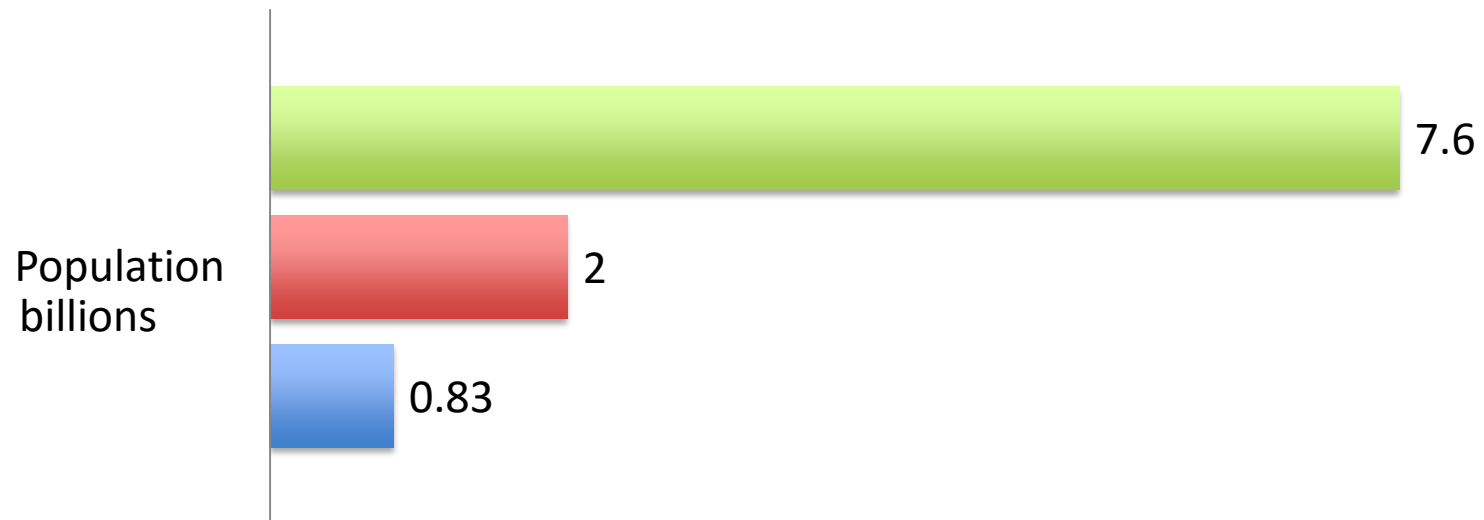
The Food Paradox

In the industrialized world:
Approximately, 2 billion are clinically obese

In the developing world:
Approximately, 830 million are severely undernourished

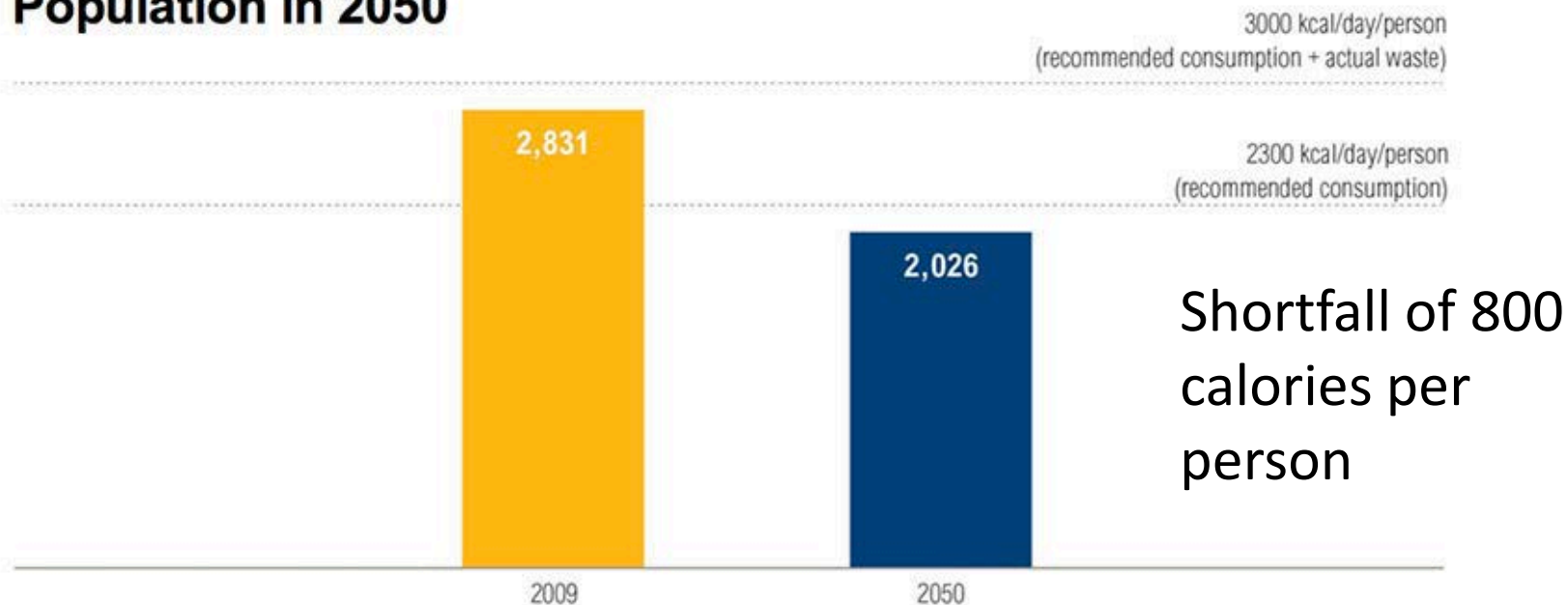
World Population and Malnutrition

■ Total World ■ Obese Pop ■ Severely undernourished



It is Not a Distribution Problem

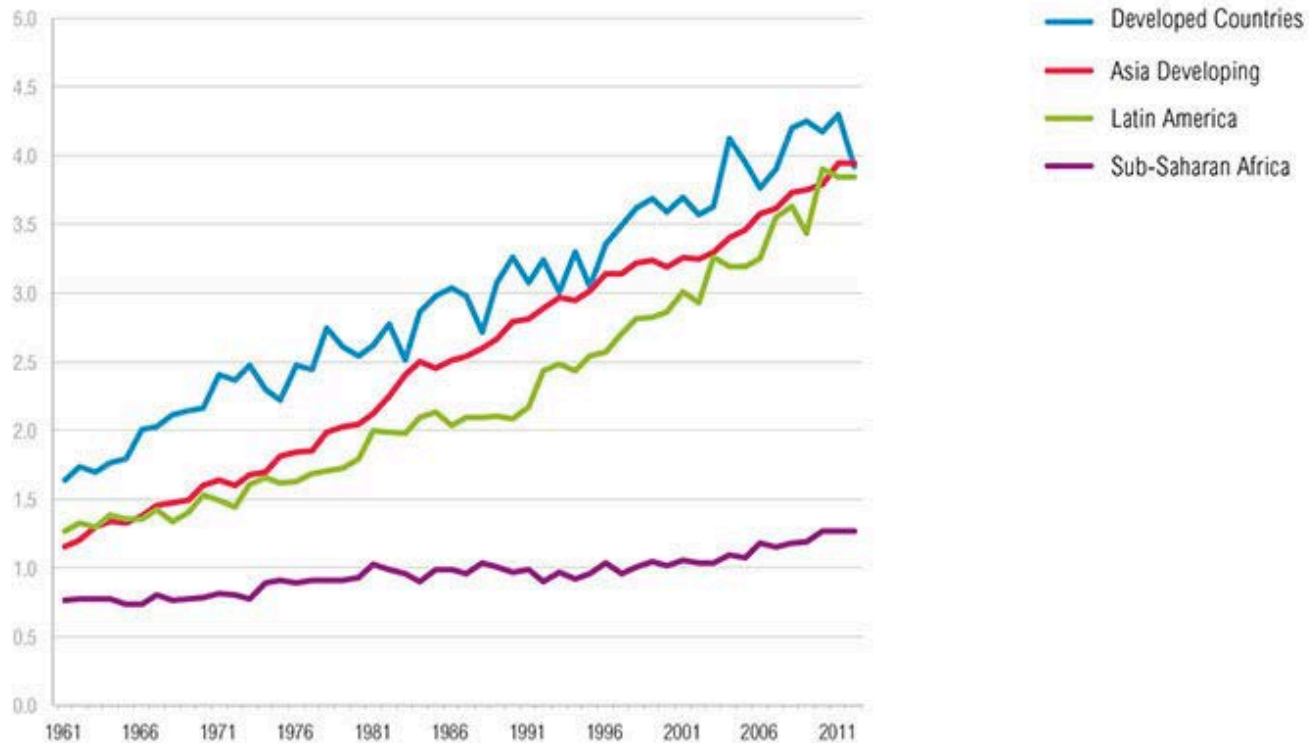
Even Distribution of All Food Produced in 2009 to World Population in 2050



Note: Data reflects food for direct human consumption. It excludes food crops grown for animal feed and biofuels. See endnotes for assumptions used to generate the global average daily energy requirement per person.

The Global Disparity in Crop Yields

Cereal Yields (in metric tons per hectare)



 WORLD RESOURCES INSTITUTE

Sources: <http://ow.ly/rpfMN>

New Technologies needed to produce “smart crops”

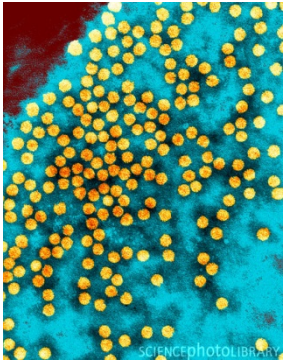


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Agriculture, Food and Technology

The history of agriculture is the history of discovery, innovation and application. Without the vigorous implementation of technology to agriculture and food production, Thomas Malthus would have been proven to be right



A Brief History of Agricultural Technology

1926: First hybrid corn sold by Pioneer

1953: Watson and Crick (DNA structure)

1960s: Norman Borlaug's Green Revolution

1973: First cloned gene (Cohen and Boyer)

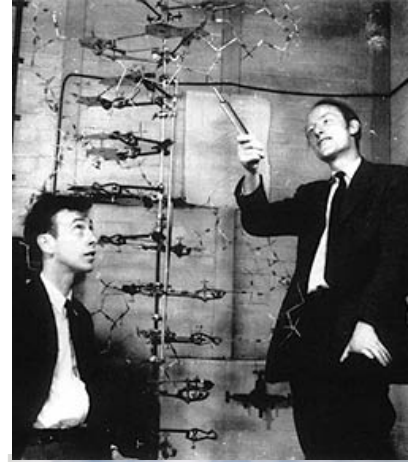
1982: First transgenic plant and animal

1996: First biotech crops approved for food and feed use

2000: First plant genome sequence

2010: 1 billionth hectare of biotech crops

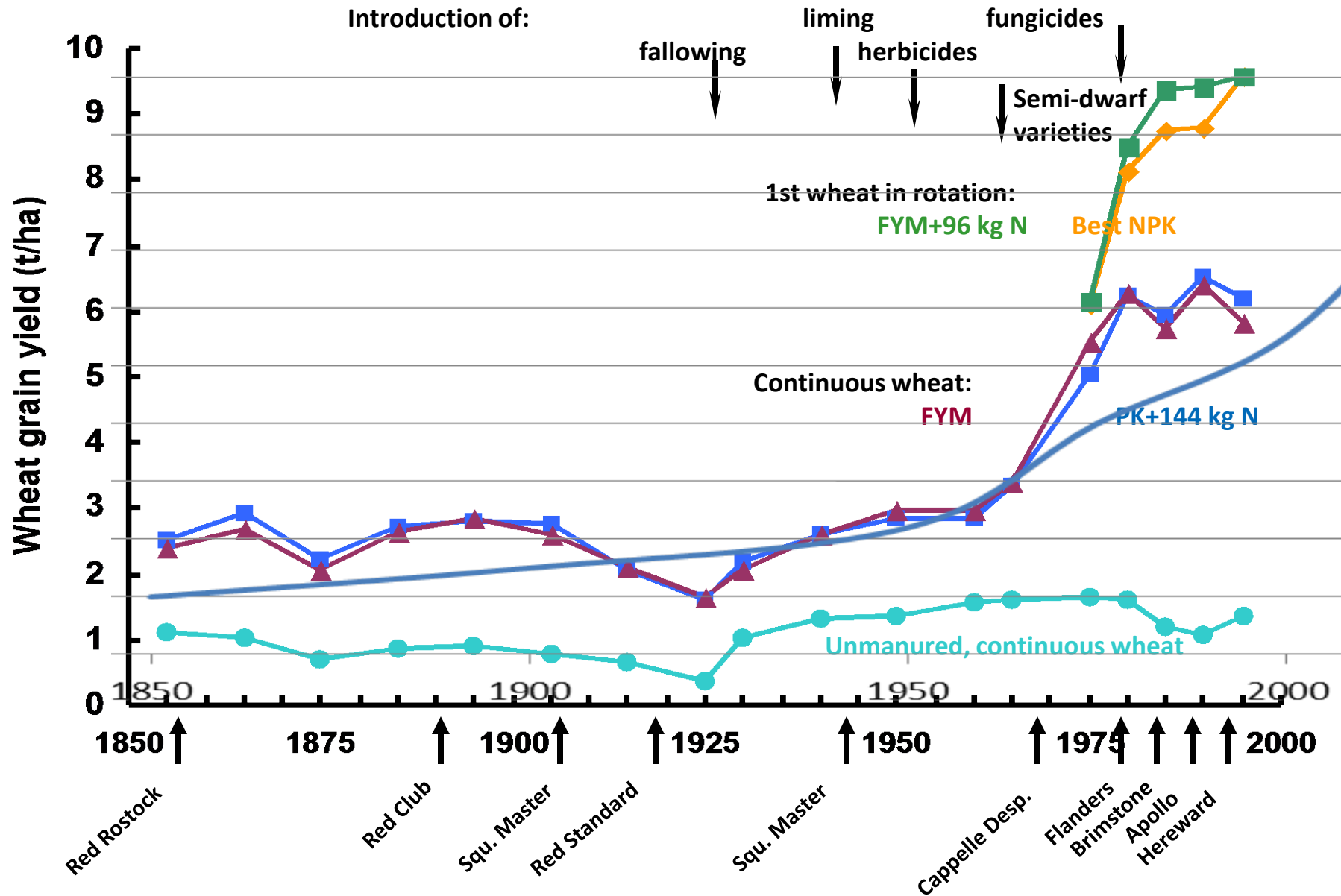
2010: Whole genome sequencing in days



The long-term experiments at Rothamsted: A unique dataset for food security



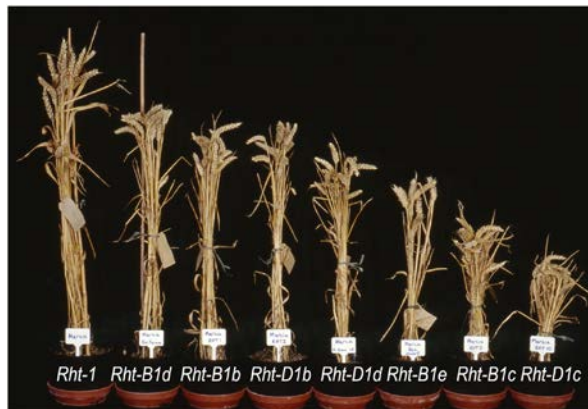
Broadbalk – The World’s Oldest Agricultural Experiment



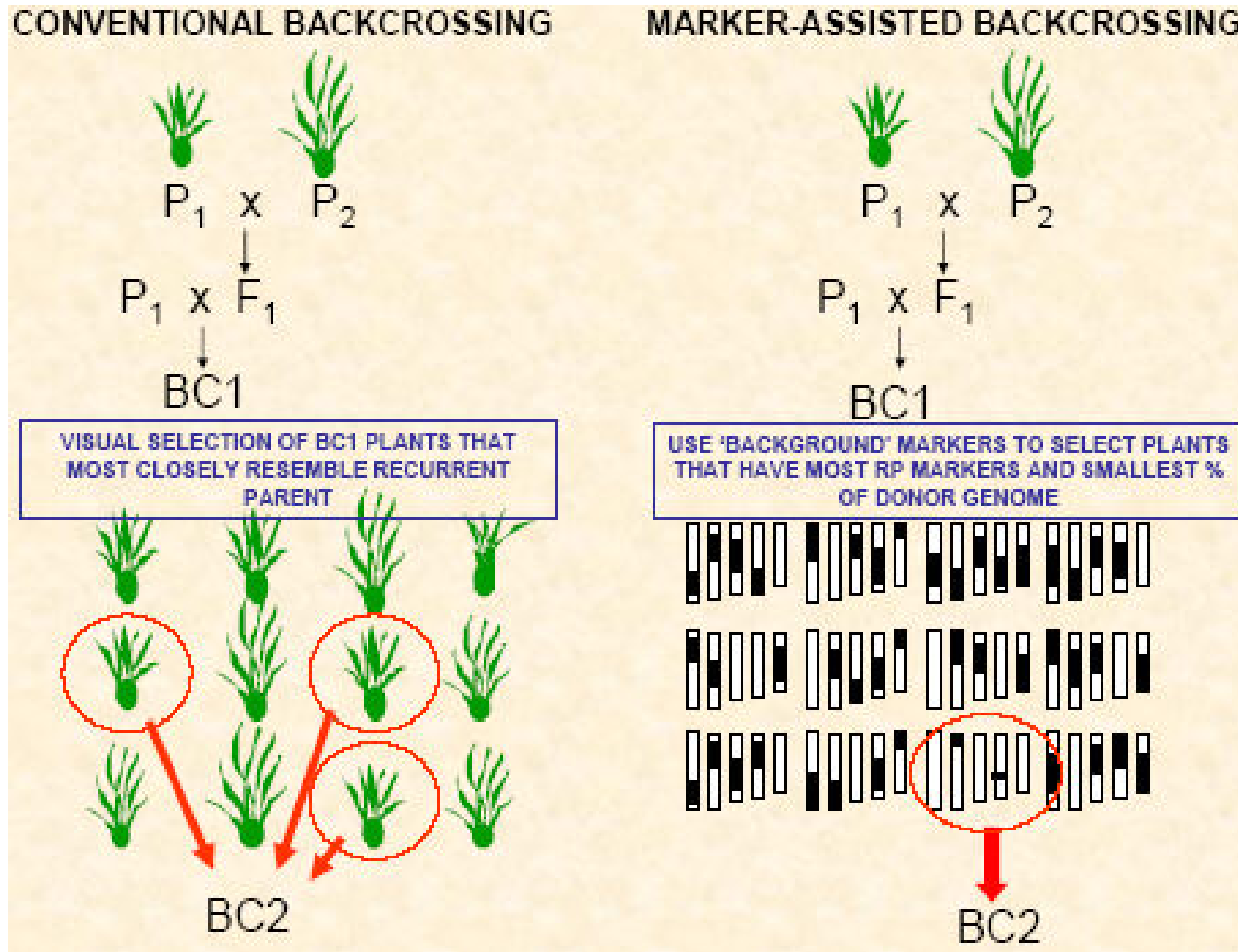
Agricultural Technology for Adaptability

Plant Genetics are Crucial:

- Most of the crop's yield potential is delivered by plant genetics
- Modern genetics is now rooted in DNA technology
- Molecular genetics is essential for speed



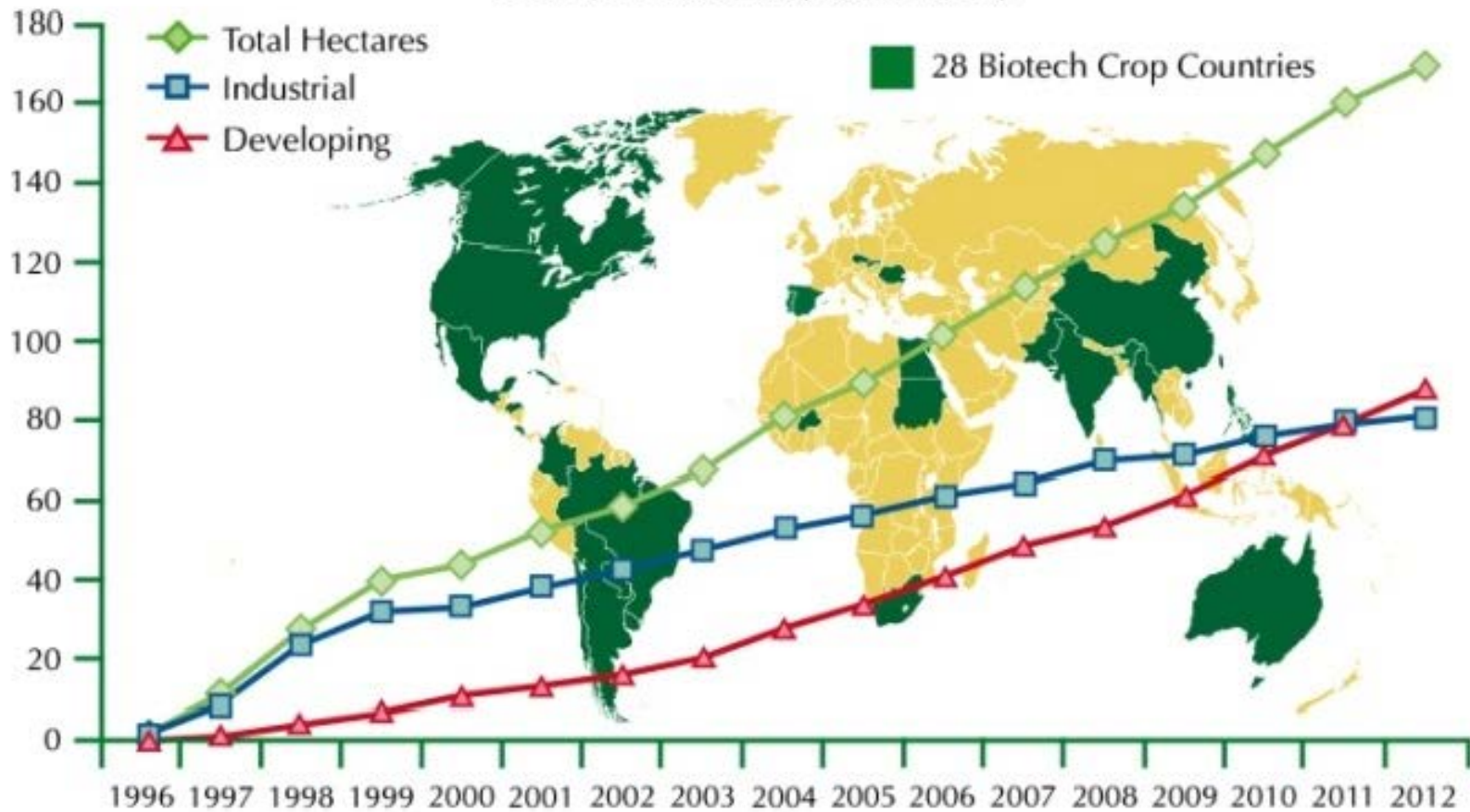
Molecular Breeding is bringing new varieties to the farm



MAB can reduce the breeding cycle by several years

Global Impact of Crop Biotechnology

GLOBAL AREA OF BIOTECH CROPS
Million Hectares (1996-2012)



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Impacts of Agricultural Biotechnology on Agriculture and Environment

- **Reduced chemical use¹**

In the USA alone, adoption of biotech crops resulted in pesticide use reduction of 46.4 million pounds in a single year.

- **No-till agriculture and Soil quality²**

In Canada, the no-tillage canola area increased from 0.8 million ha to 2.6 million ha, which is equal to about half of the total canola area

- **Greenhouse gases reduced²**

GM technology has also significantly reduced the release of greenhouse gas emissions from agriculture, which, in 2005, was ***equivalent to removing 4 million cars from the roads.***

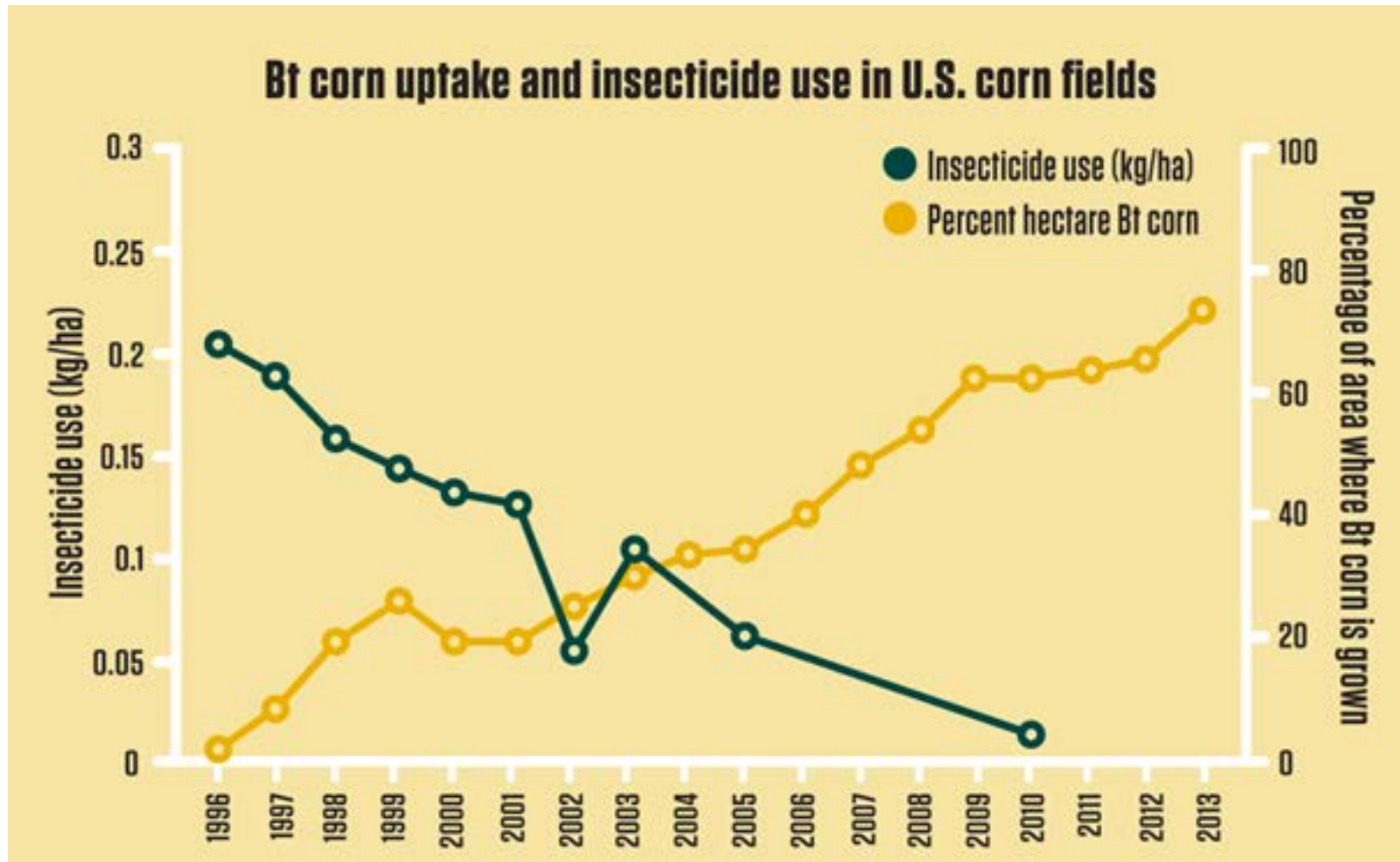
- **Protects against post-harvest spoilage³**

Massive reduction in mycotoxin contamination in maize

1. Sankula, S and E Blumenthal. 2004. Impacts on US agriculture of biotechnology-derived crops planted in 2003 .National Center for Food and Agriculture Policy, Washington, DC, October 2004
2. Graham Brookes and Peter Barfoot (2006) Global Impact of Biotech Crops: Socio-Economic and Environmental Effects in the First Ten Years of Commercial Use *AgBioForum*, 9(3): 139-151. ©2006 AgBioForum.
3. Hammond B, Campbell K. *et al* (2003) Reduction of fumonisin K mycotoxins in Bt corn. *Toxicologist* 72(S-1): 1217



Biotechnology has delivered yield and environmental benefits



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How will we make our crops “smarter”?



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Photosynthesis: a key biological frontier

Substantial improvements in yield are possible by increasing photosynthesis:

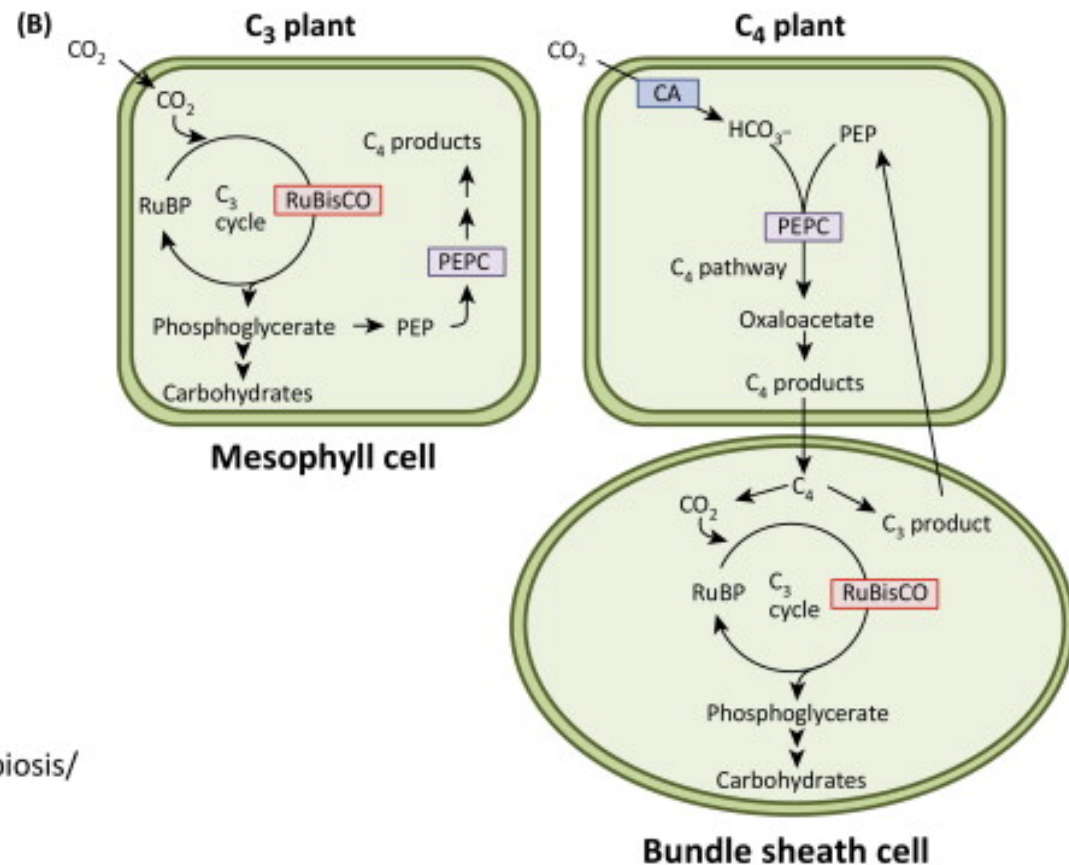
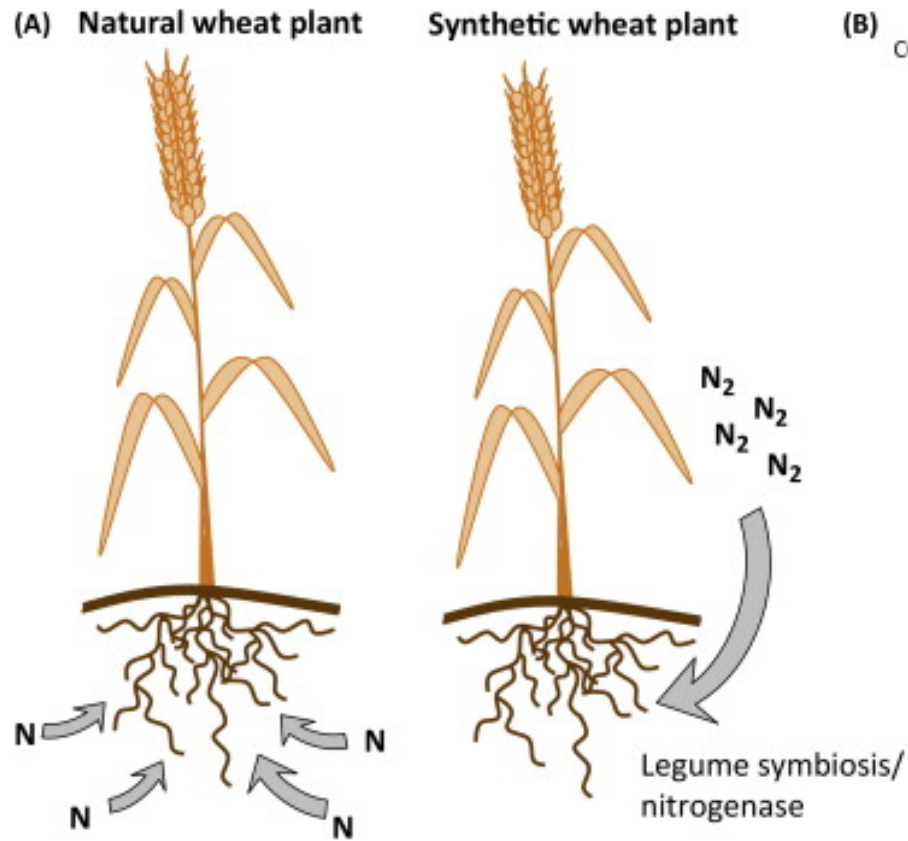
- CO₂ enrichment experiments
- Increase light
- C₄ crops



Synthetic Biology methods are already in the pipeline

Nitrogen

Carbon



Nitrogen Fixation

Photosynthesis

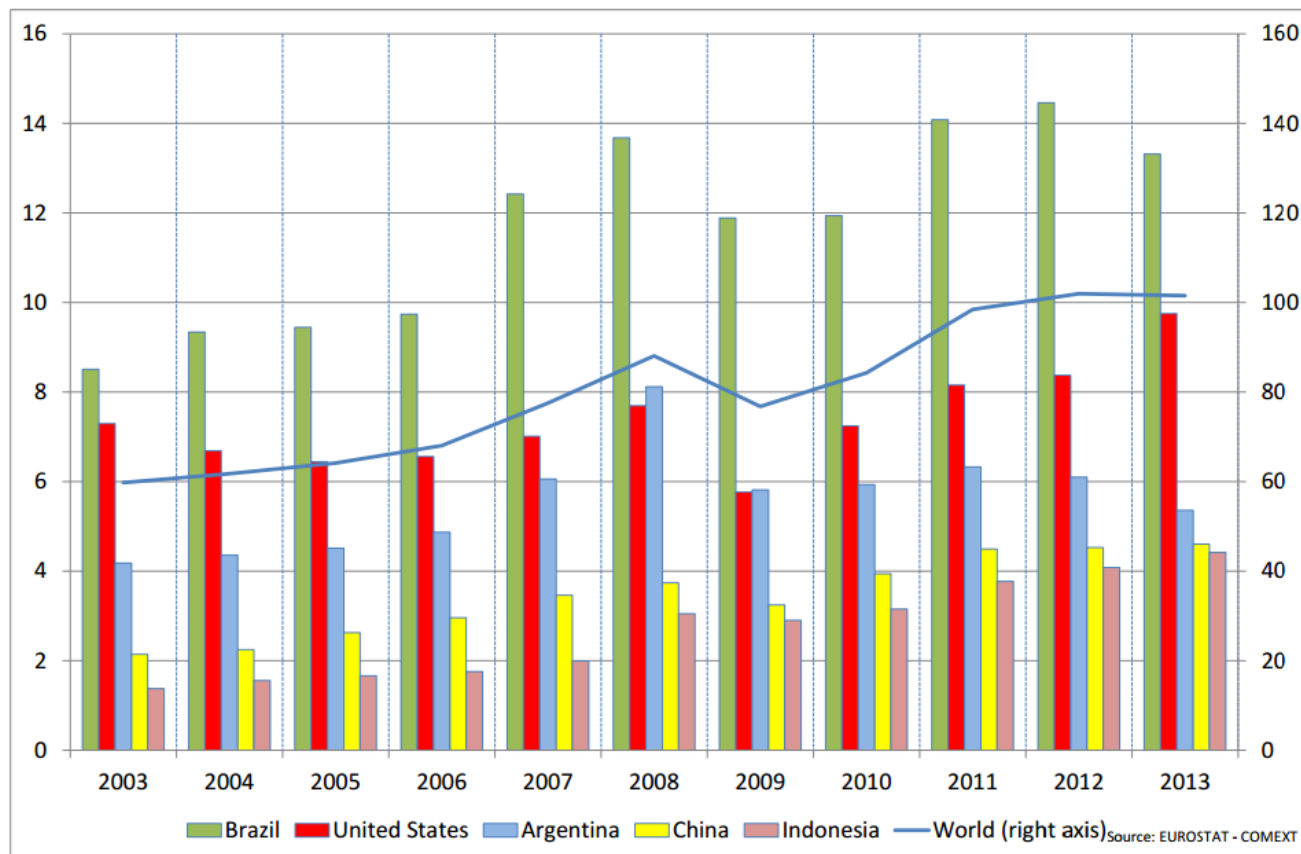
What holds back the use of many advances in crop production?

International trade barriers based on a discordant systems of regulation and approval



Europe continues to import more and more transgenic agricultural products from offshore

EU agricultural imports by origin (€ billion)



http://ec.europa.eu/agriculture/trade-analysis/map/2014-1_en.pdf



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Europe is behind on reducing pesticide use

	EU	USA
Total farmed land (ha x 10 ⁶)	135	450
Total pesticide use (kg x 10 ⁶)	639	512
Pesticide use (kg per hectare)	4.7	1.14
Corrected for yield (UK v US wheat) normalized to US value	1.77	1

UK wheat = 8.6 tonnes/ha; US wheat = 3.2 tonnes/ha

Source: EU Commission EuroStats 2012; USDA Stats 2012



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Can new technologies help to harmonize trading regulations?



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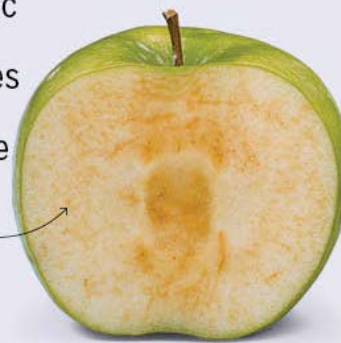
Turning genes off in any cell at any time: RNA interference



The Arctic Apple

TRADITIONAL VS. ARCTIC

An enzymatic process causes apples to brown after they've been cut

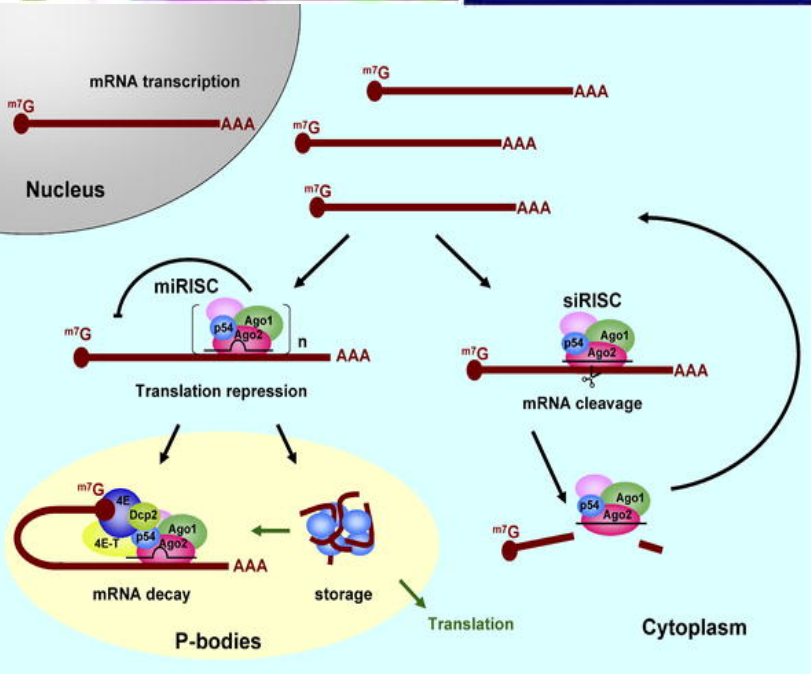


By introducing a gene sequence, this variety 'silences' the process



MACLEAN'S

Chart source: 2013 Statistical Overview of the Canadian Fruit Industry, Agriculture and Agri-Food Canada



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Blight Resistant Potatoes



Cis-genics rather than trans-genics



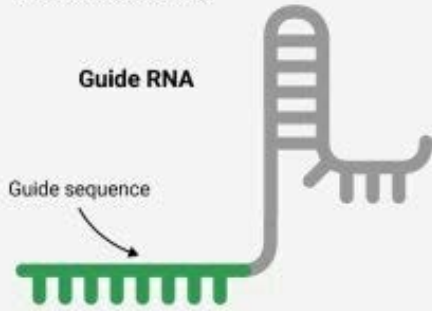
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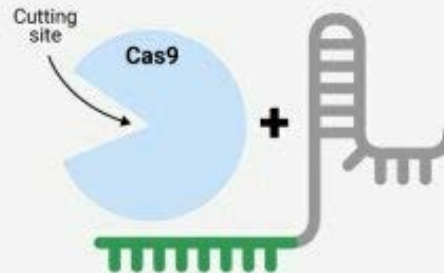
Genome editing

EDITING A GENE USING THE CRISPR/CAS9 TECHNIQUE

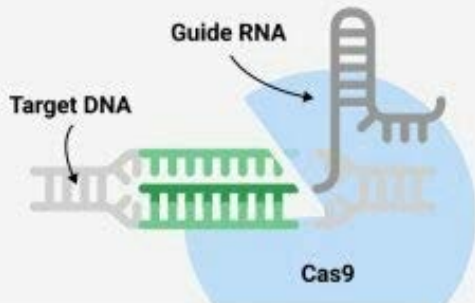
- 1** Scientists create a genetic sequence, called a "guide RNA," that matches the piece of DNA they want to modify.



- 2** This sequence is added to a cell along with a protein called Cas9, which acts like a pair of scissors that cut DNA.



- 3** The guide RNA homes in on the target DNA sequence, and Cas9 cuts it out. Once their job is complete, the guide RNA and Cas9 leave the scene.



- 4** Now, another piece of DNA is swapped into the place of the old DNA, and enzymes repair the cuts. Voilà, you've edited the DNA!



A technology so simple that even high-school students are doing it

<https://www.youtube.com/watch?v=d9IpS3i0-PY>



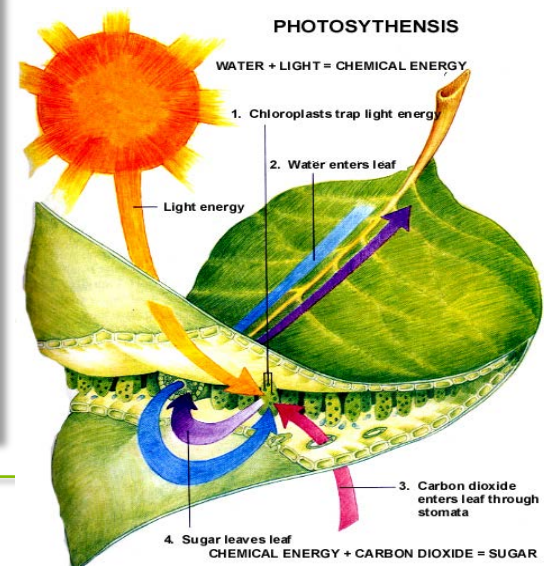
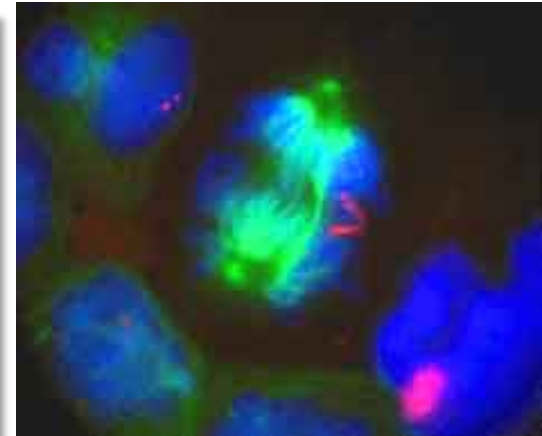
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Will we be allowed to feed 9.6 billion?

Modern crop breeding is now based on molecular genetics

- Over 1000 labs worldwide use molecular genetics and 'GM' technologies to establish gene function
- Biotechnological approaches have above-all the merit of speed and precision, with outstanding results
- Real progress requires global harmonization of regulation and trade rules



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Canada leads the way in approaches to regulate new products based on biotechnology



Canadian Food
Inspection Agency

Plants with novel traits (PNT)

Regulate the ***product*** not the ***process***



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