

# Plants for the future

OECD, Prague, April, 2009

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<http://www.efb-central.org>  
<http://www.pubresreg.org>

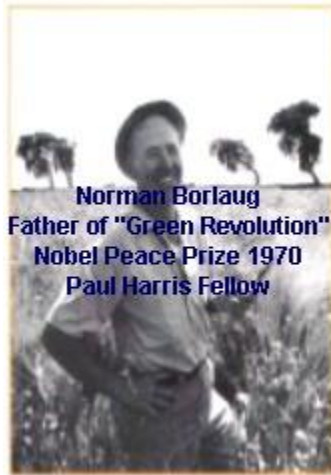
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# Ten thousand years of genetically modified plants

- Selection
- Crossing
- Genomic Fusion
- Mutagenesis
- Cloning



# THE GREEN REVOLUTION



# Green Revolution: promises and Constraints

- The Green Revolution demonstrated the power of Plant Breeding
- Tripling World Population created the need for intensive agriculture
- The extensive use of irrigation, soil fertilization and chemical pest control brought many sustainability problems



Soy field with Brazil Nut tree, Amazon



# Intensive Agriculture Under Pressure



- Agronomic techniques, drip irrigation, less polluting agrochemicals were a partial answer
- Intensive breeding and high quality seed companies brought also important yield increase
- But it remained difficult to limit the need for even more arable acreage
- The use of plants for industrial production (rubber, oil palm ) brought a major destruction of tropical forest



Oil palm plantation, Malaysia

# Impact of the green revolution in Asia

	<b>Irrigation</b> Million Ha	<b>Fertilizer</b> <b>consumption</b> million tonnes	<b>Tractors</b> millions
<b>1961</b>	87	2	0.2
<b>1970</b>	106	10	0.5
<b>1980</b>	129	29	2.0
<b>1990</b>	158	54	3.4
<b>1998</b>	176	70	4.6

Source: Norman Borlaug. (2002) The green revolution revisited and the road ahead



# Food Security

## *Human Footprint*



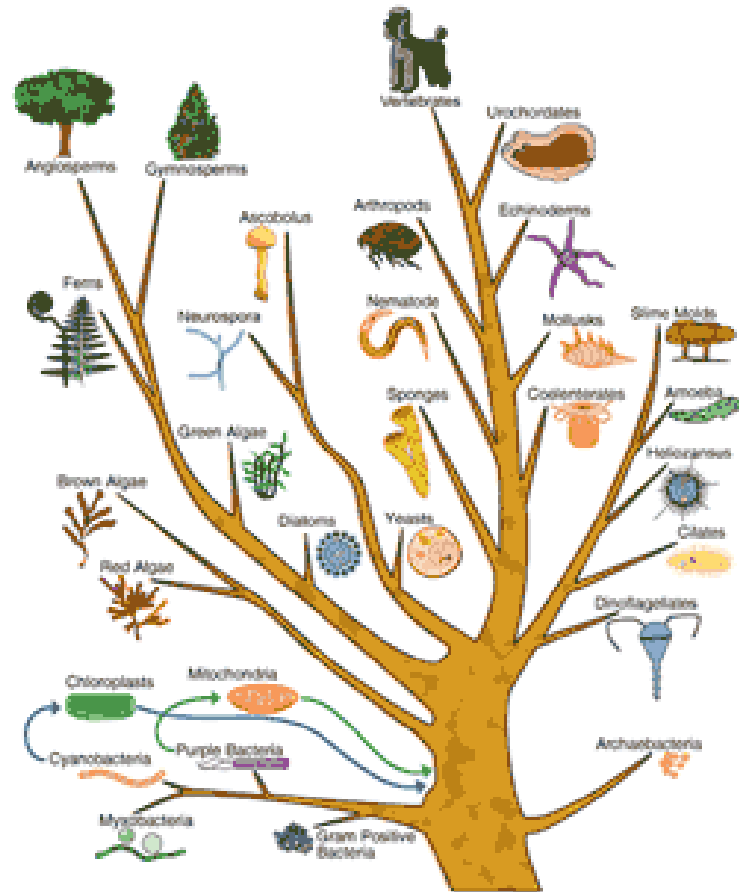
### Human Population

1900.....	1.0 Billion
1945.....	2.0 Billion
2000.....	6.0 Billion
2010.....	6.8 Billion
2025.....	8.0 Billion



# Lessons from Molecular Evolution

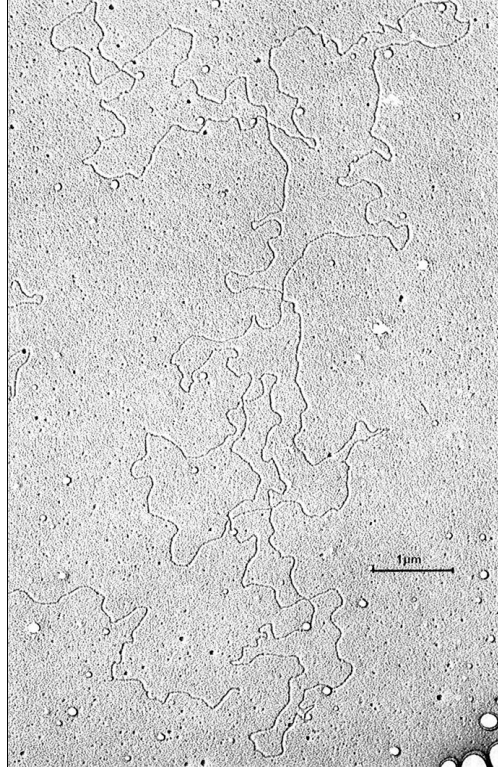
- The living world is one large gene-pool of functional and pseudogenes
- This gene-pool is permanently evolving, this is the base of evolution
- Nature is one big genetic laboratory
- It is very misleading to talk about human gene, pig gene, rat gene etc.



# Biotech crop history



**1904, *Agrobacterium tumefaciens***



**1974, Ti Plasmid, Gent**



*Arabidopsis thaliana*  
(Acker-Schmalwand)

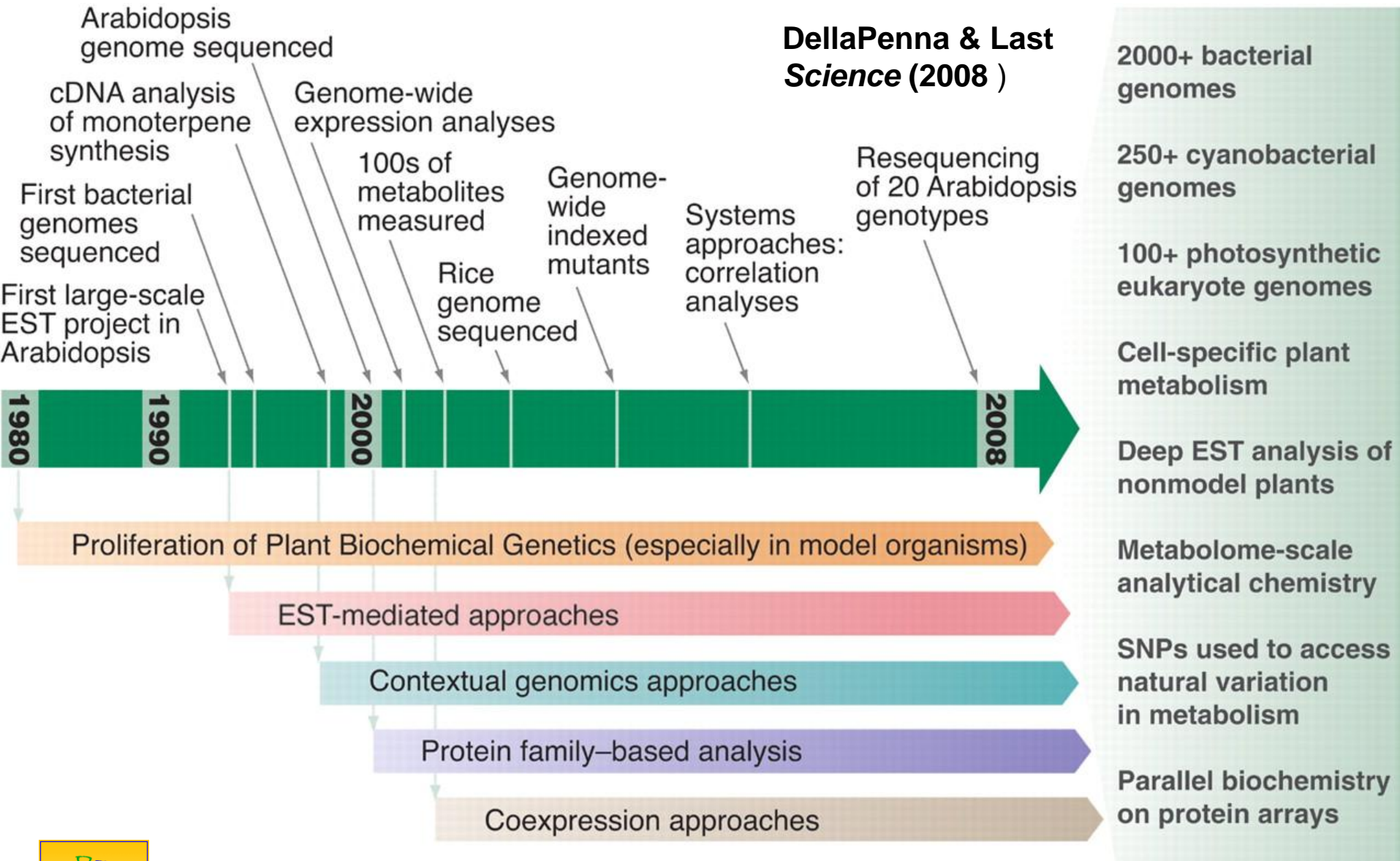
**1990's genomics**



**1996 Commercial launch**



# Plants for the future



# Challenges for agriculture

Tackle food security issues & environmental constraints on productivity.



Reduce the environmental footprint of industry & Agriculture



Plants for fuels and the chemical industry.

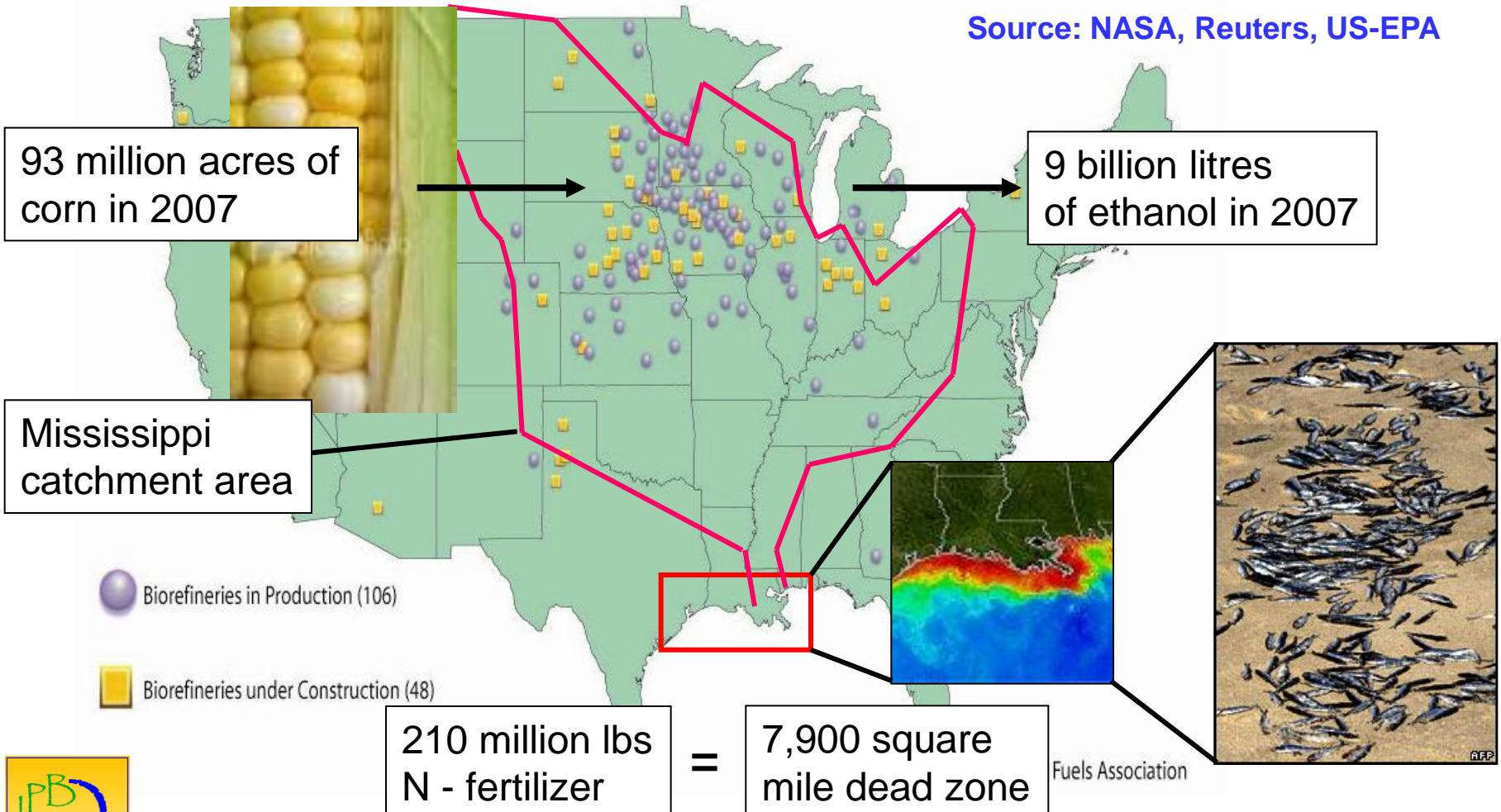


Biotechnology as a coherent answer to these challenges.

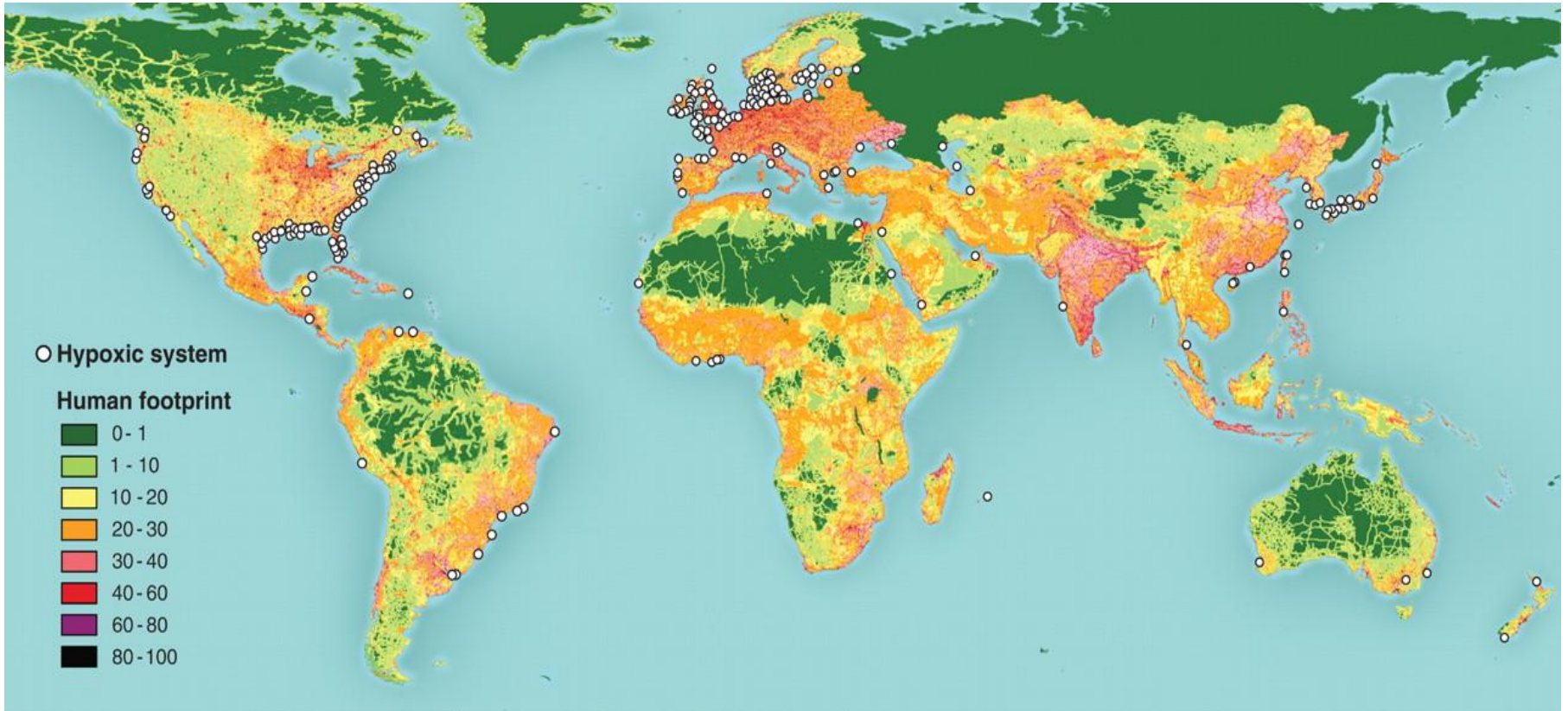


# Environmental challenges of intensive agriculture: the example of corn-ethanol

Source: NASA, Reuters, US-EPA



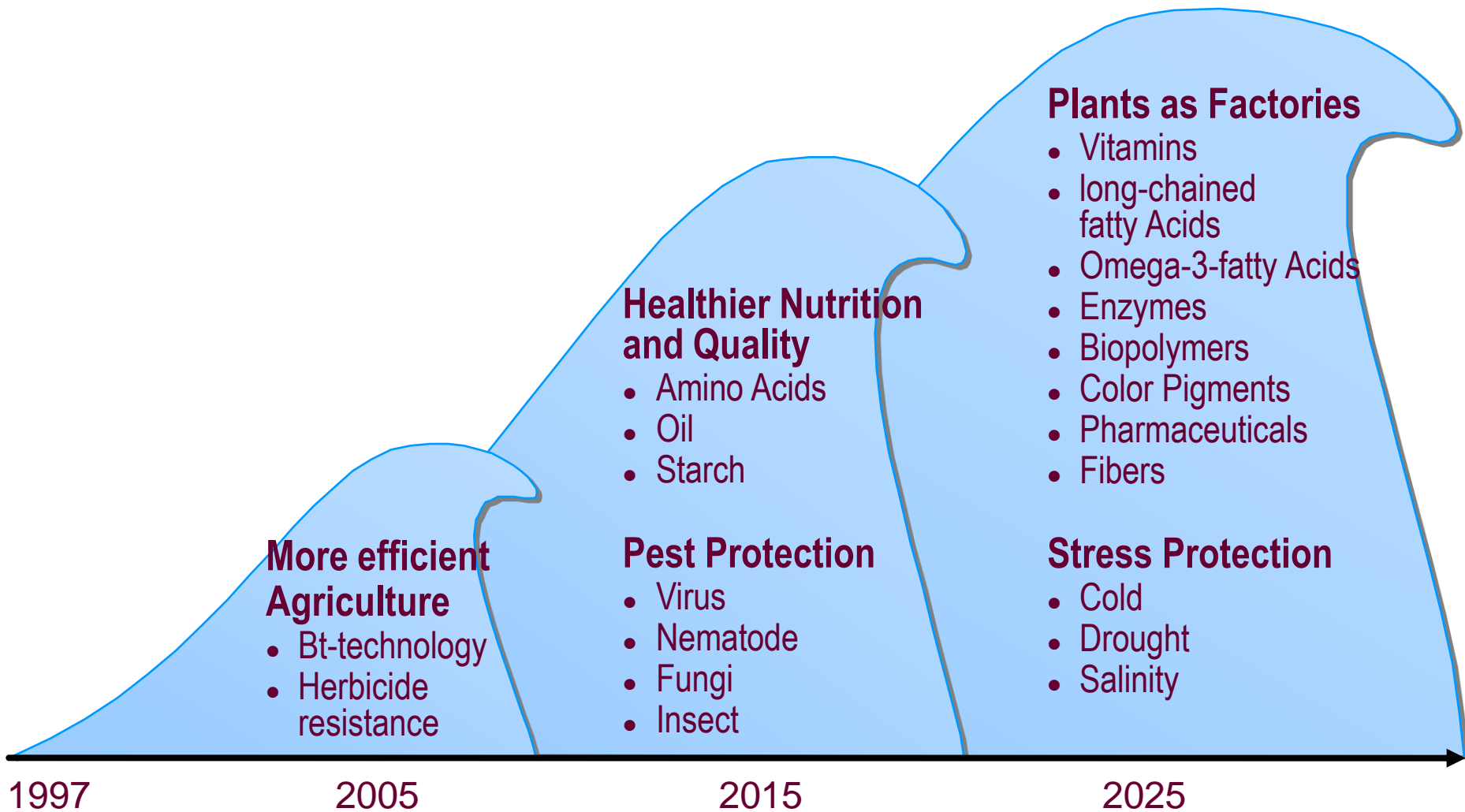
# Environmental degradation is a global problem



Source: Diaz & Rosenberg (2008), Science; 321: 926-929

OECD, Challenges for Agricultural Research, April 2009

# The future – benefits for consumers



# The search for yield improvement



cropdesign



# Necessities: Invest in non-food crop improvement – gene silencing approaches

*Jatropha curcas*



*Ricinus communis*



# Explore the potential of non-food crops



Miscanthus



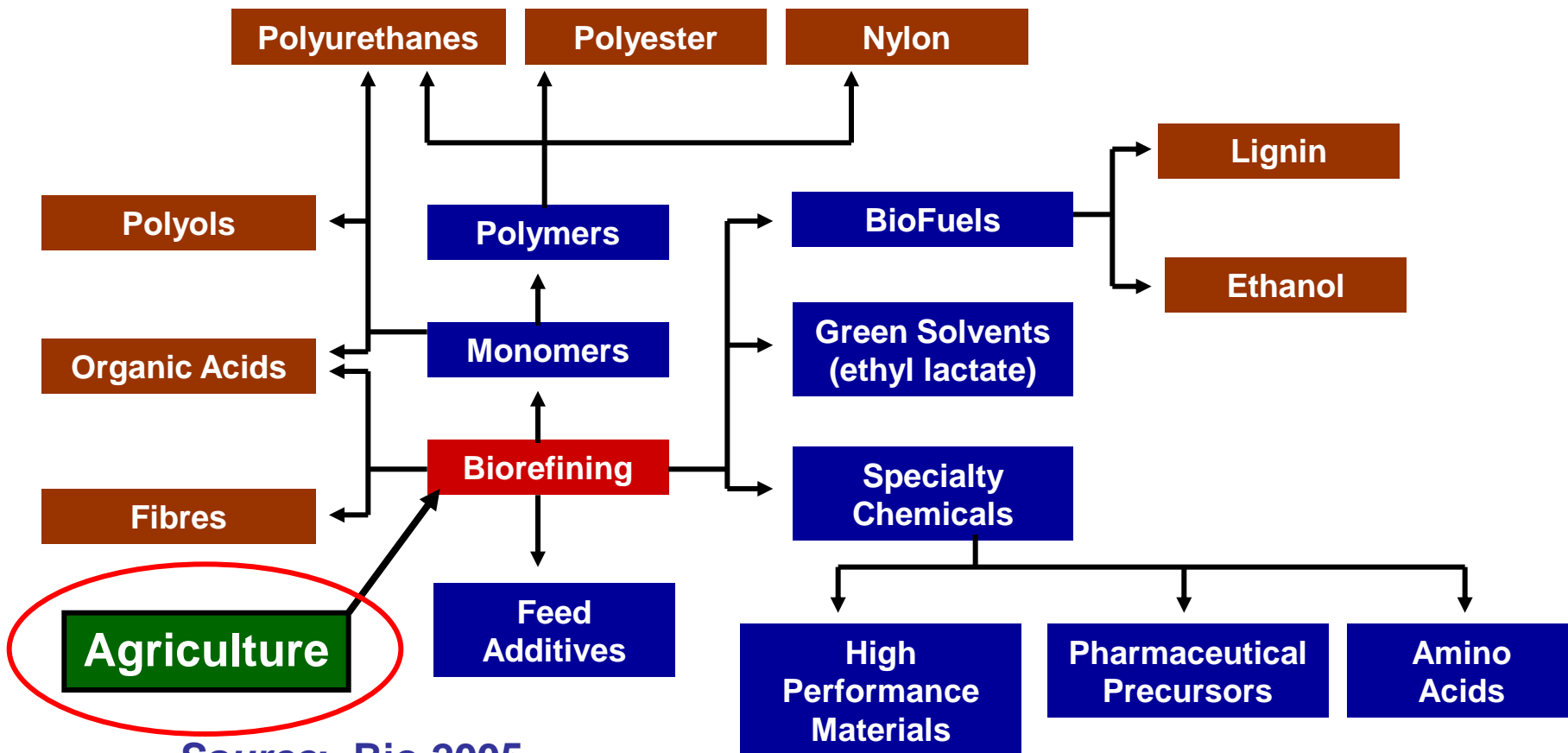
Sweet sorghum



Castor bean



# The Biorefinery platform using agricultural feedstocks

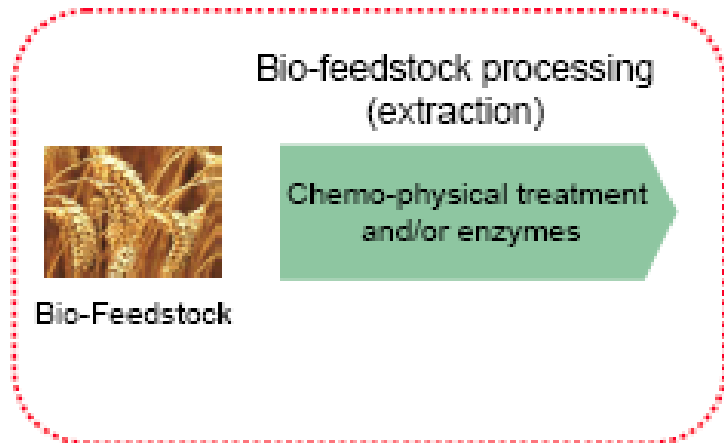


Source: Bio 2005

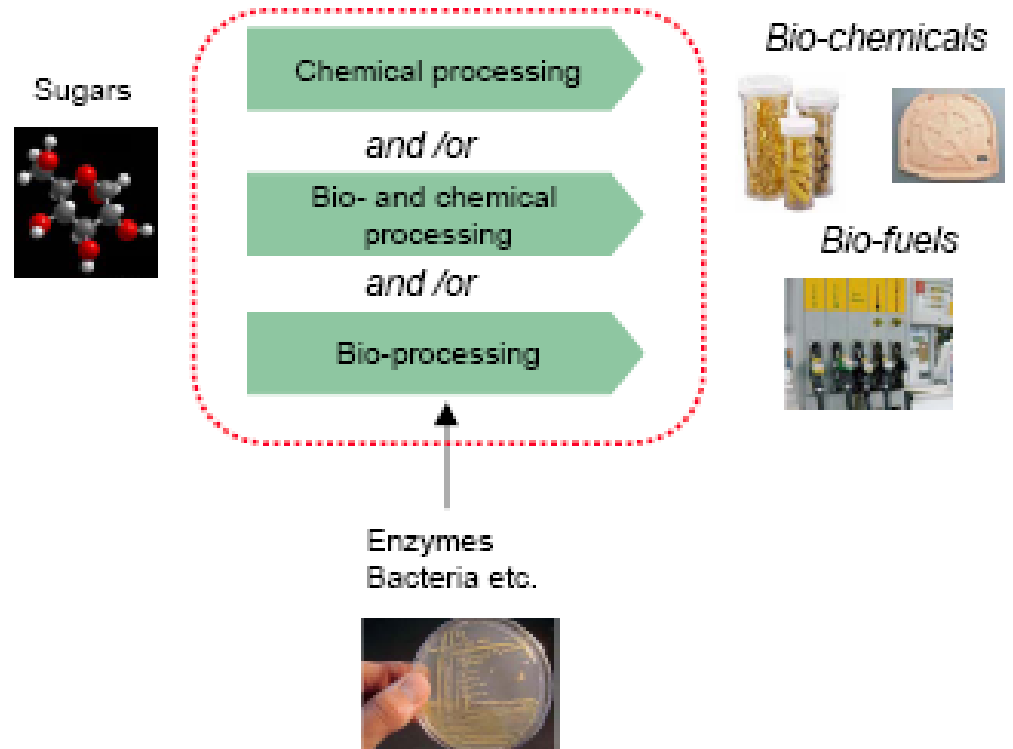


# The emerging bio-economy is built on green and white biotechnology

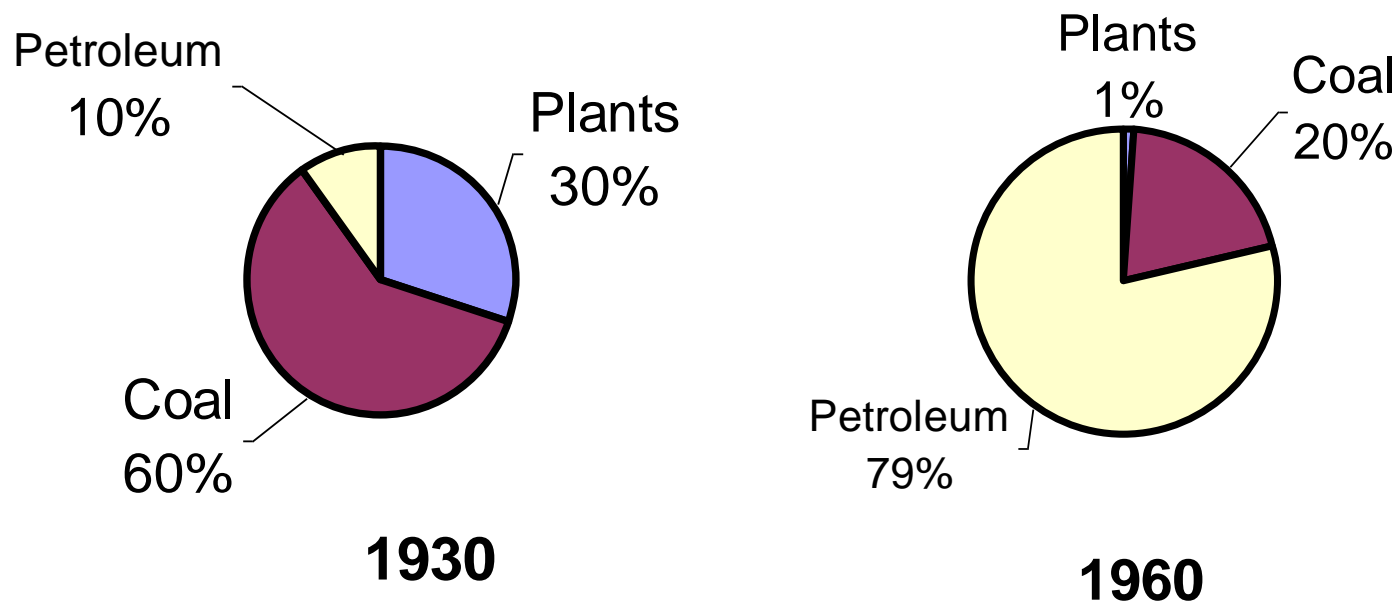
## Green biotechnology



## White biotechnology



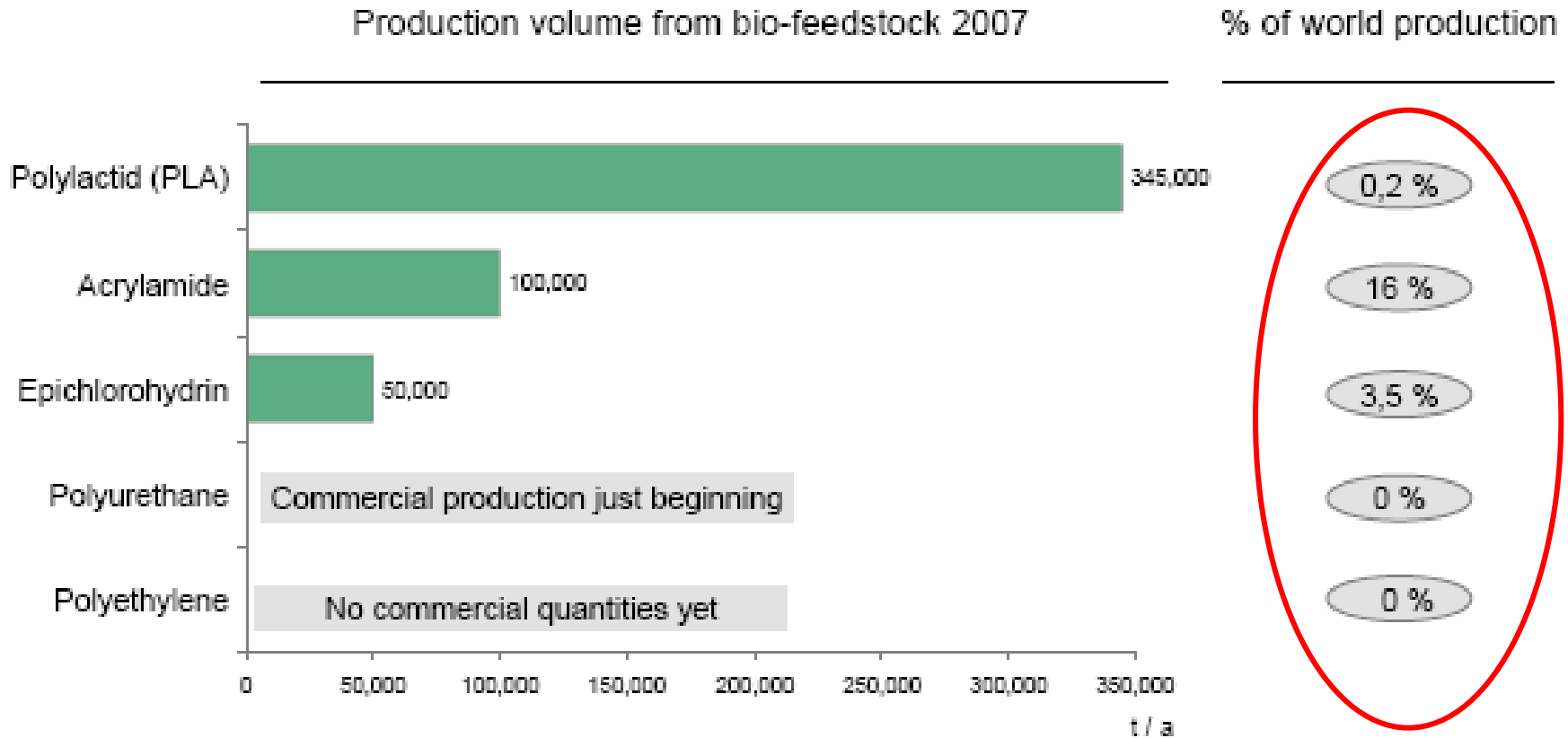
# Plant-based feedstocks in industry are not new



Source: UNIDO



# ....but production capacity of bio-chemicals is still rather low



Overall, less than 10 % of global chemicals from bio-feedstock...  
... why?



# Other applications are emerging



**1930's: soy-based car components (Ford)**



**21<sup>st</sup> Century: kenaf-based car components**



**21<sup>st</sup> Century: soy-based car components (Ford-Dupont)**

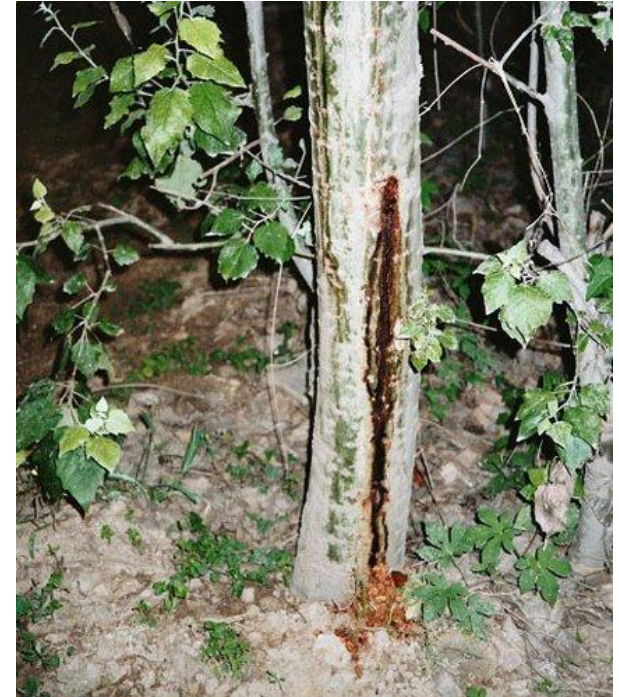


# Short rotation plantations for fuel and fibre

- Wood producing plants e.g. poplar
- CO<sub>2</sub> captation in cell walls



# Insect resistant poplars in China



- arid land regeneration
- Asian longhorn beetle resistance



# Mountain pine beetle – could Bt be the cure for this environmental disaster?




British Columbia 2008



270 mega tonnes of carbon emission by 2020

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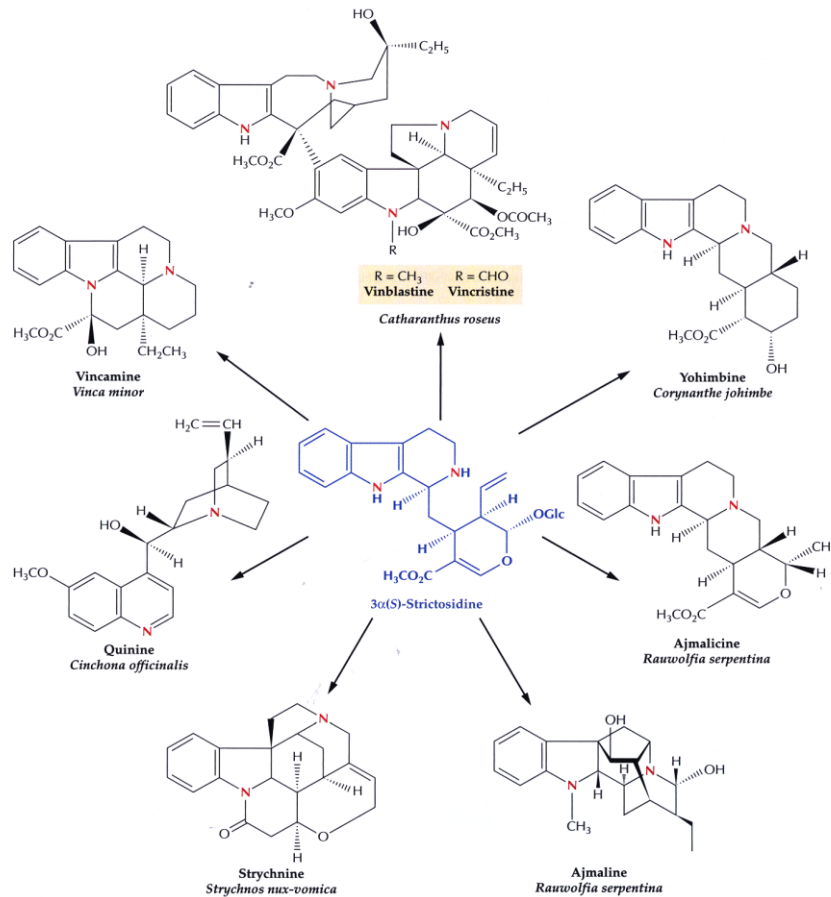
OECD, Challenges for Agricultural Research, April 2009

A photograph of a dense tropical rainforest. The image shows several large, thick tree trunks and roots, some of which are covered in moss. The forest floor is dark and appears to be covered in fallen leaves and other organic matter. The lighting is somewhat dim, suggesting a shaded forest environment. The overall color palette is dominated by various shades of green and brown.

**Molecular tools  
for capturing the value  
of the tropical rain forest**



# Metabolic engineering



- *Catharanthus roseus* produces vinblastine & vincristine
- Use: Hodgkin's disease, acute leukemia, breast cancer
- Content in plants: In leaves ~ 0.0003 % (500 kg plant material is needed to obtain 1 g vincristine)
- Price: ~13 000 € / g



Rischer et al., PNAS (2006)

OECD, Challenges for Agricultural Research, April 2009

# The GM Controversy



Neolithic farming in Europe

- Will Europe be
  - importer only?
  - active producer of GM crops?

# Major public concerns

## Safety Issues

- **Human and Animal Health**
  - No adverse effect reported with the approved GM-crops (WHO, EFSA, JRC)
- **Environmental**
  - Already a long list of beneficial effects
  - No alarming scenario was confirmed
  - Long term ecological effects can be lower than those of traditional agriculture



# Price Tag for Introducing GM Plants

Overregulation and unnecessary testing make that

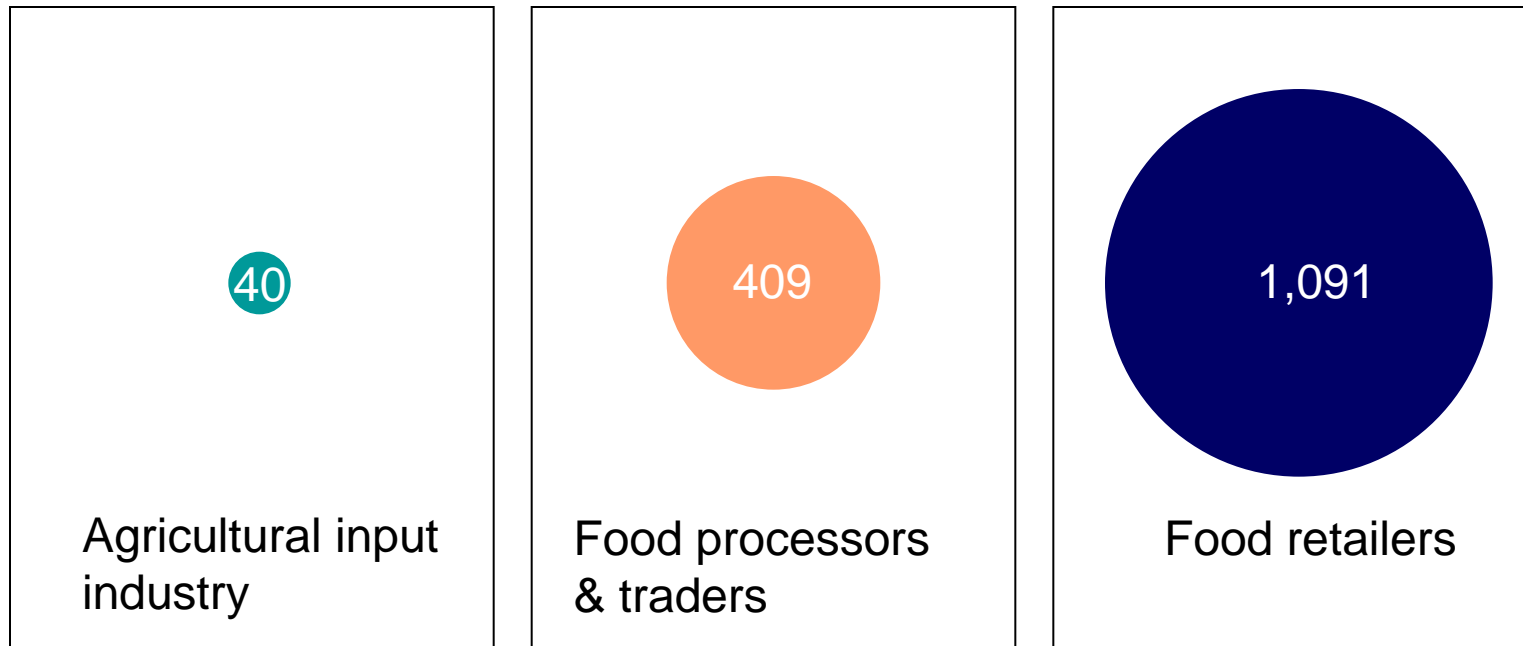
- no Small Medium Enterprise
- no Third World country

can afford to introduce a GM crop.

Only multinationals can proceed.



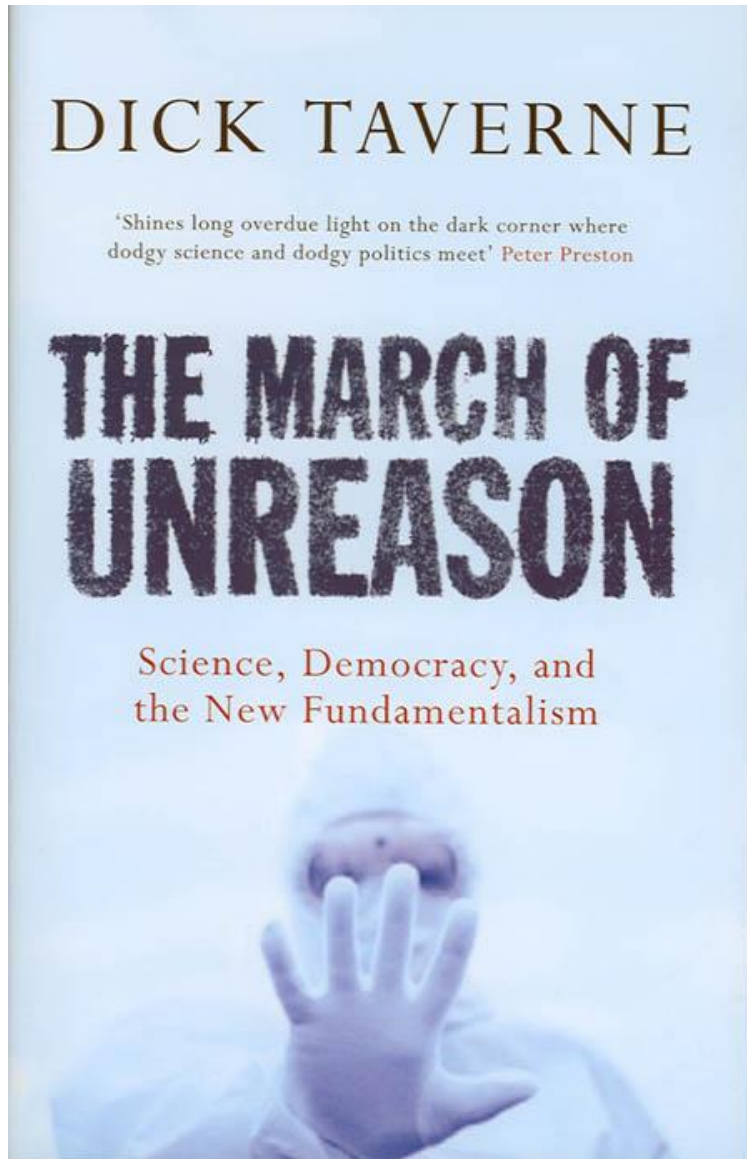
# Agrochemical companies do not control the food chain – contrary to popular belief



Sales of top 10 companies (in billions of USD) 2006

Source Von Braun, IFPRI, The World food situation 2007





Oxford University Press

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# STARVED FOR SCIENCE

**HOW BIOTECHNOLOGY IS BEING  
KEPT OUT OF  
AFRICA**

Robert Paarlberg

With a Foreword by Norman E. Borlaug and Jimmy Carter

Harvard University Press

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ISBN-13: 978-0674029736



# Actions

- Improve science education and awareness of the importance of science in decision making.
- But move from “educating the public” to engaging with the public.
- Discuss new products with consumer organisations.
- Explain the consequences of not using GM plants.



# Policy framework priorities

## **Enable knowledge Infrastructure:**

- Promote science education;
- Invest in global R&D systems;
- Harmonise intellectual property regimes;
- Harmonise regulatory regimes;
- Promote technology transfer;
- Support innovative firms and entrepreneurs;
- Encourage financial systems that promote investment in high risk ventures;
- Ensure international collaboration for sharing of resources and best practice;
- Harmonise international market and trade structures





# 21<sup>st</sup> Century Plants will be GM-Plants



In a better Environment