

History of Plant Improvement

EMBO-EMBL

Food, sustainability and plant science: a global challenge
Heidelberg 6-7 November 2009

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For Developing Countries**

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History of Plant Improvement





Tropical & Subtropical Moist Broadleaf Forests



Tropical & Subtropical Dry Broadleaf Forests



Temperate Broadleaf & Mixed Forests



Montane Grasslands and Shrublands



Tropical & Subtropical Grasslands, Savannas, & Shrublands



Temperate Grasslands, Savannas & Shrublands



Mediterranean Forests, Woodlands, & Shrub



Deserts & Xeric Shrublands



Mangrove

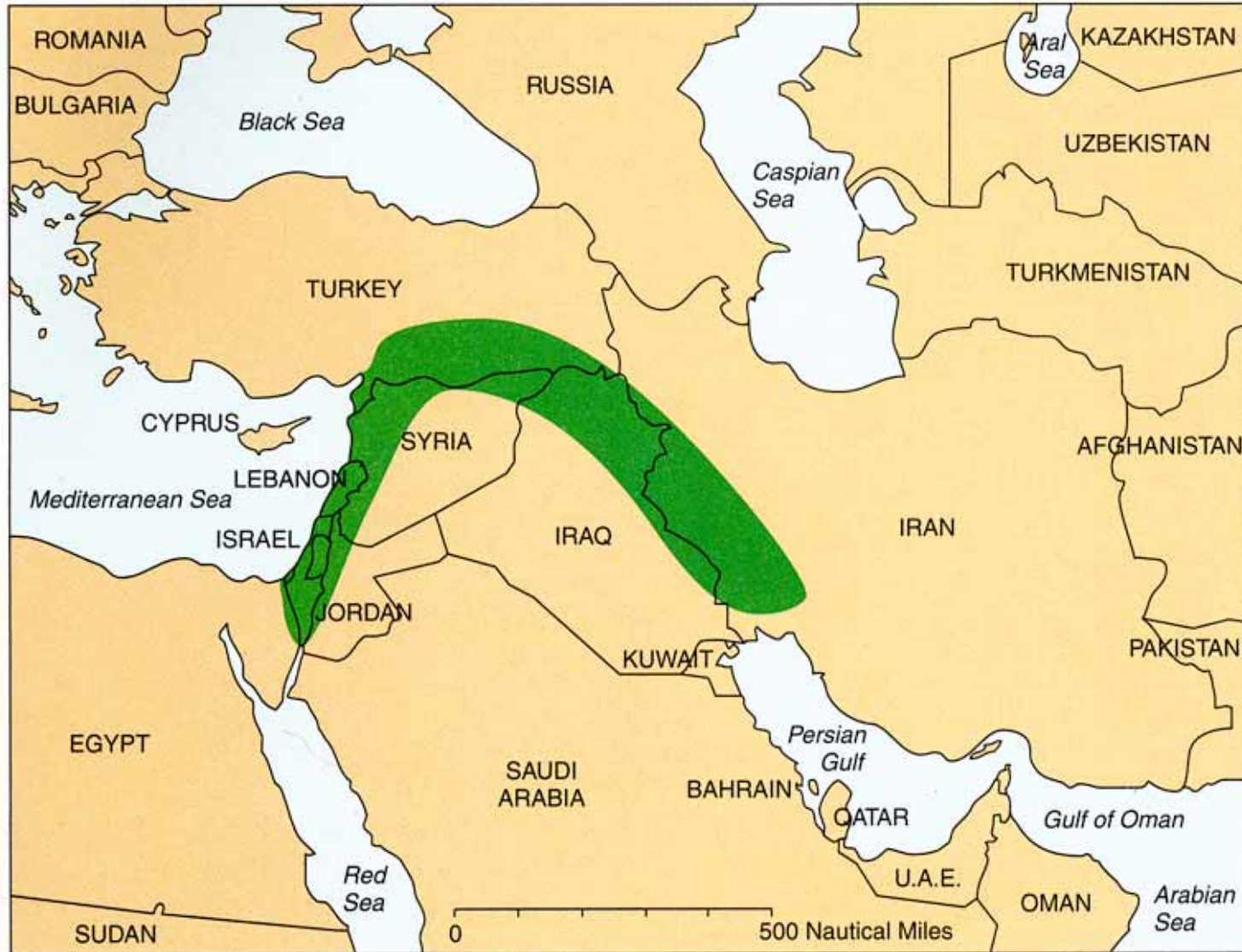
Terrestrial Ecosystems

Ten thousand years of genetically modified plants

- Selection
- Crossing
- Genomic Fusion
- Mutagenesis
- Cloning

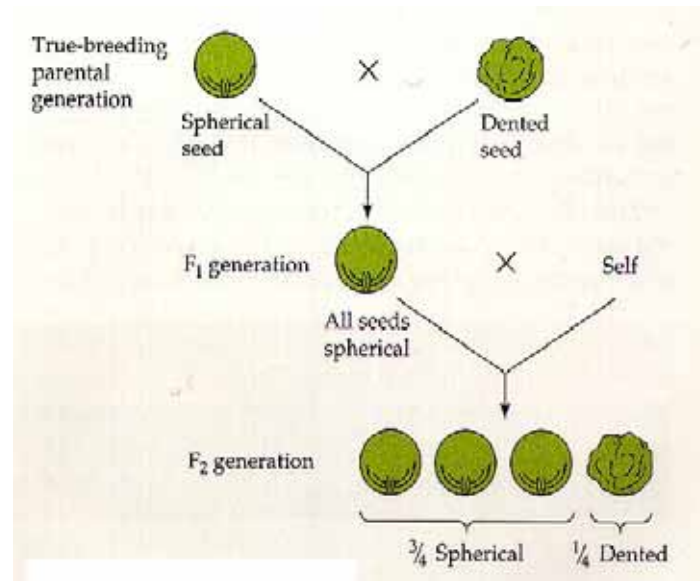


The Origin of Wheat

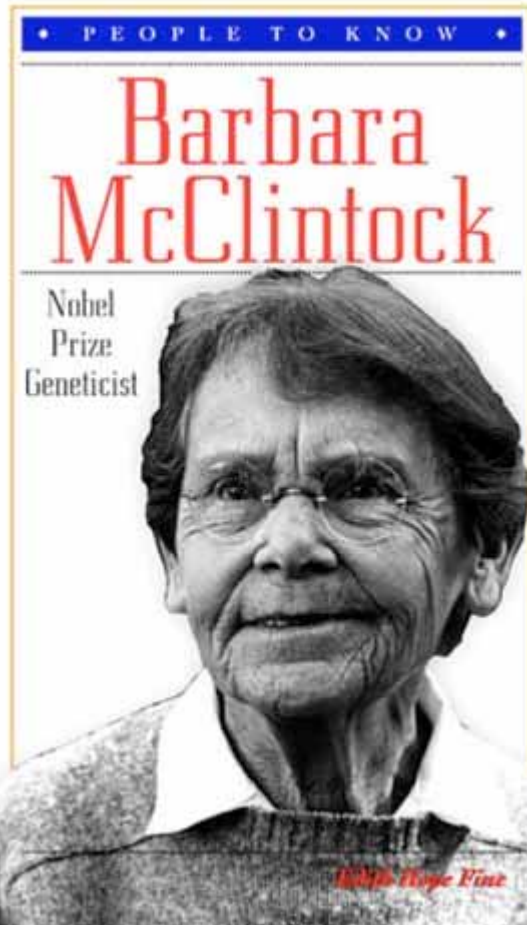




Gregor Mendel : Father of Genetics



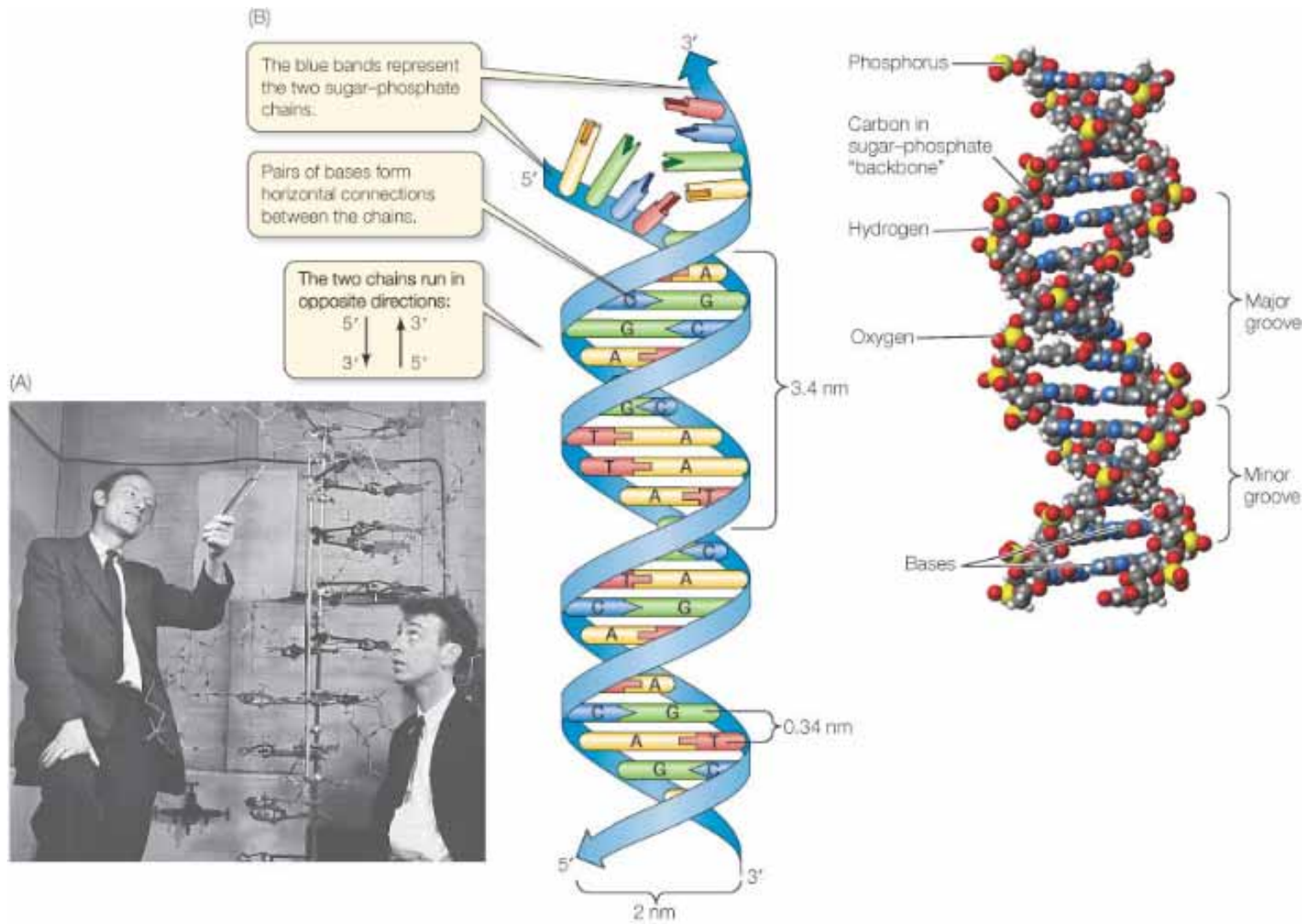
Seminal Contributions of Plant Model Systems to Epigenetic Research



Transposable elements in maize



History of Plant Improvement



THE GREEN REVOLUTION



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

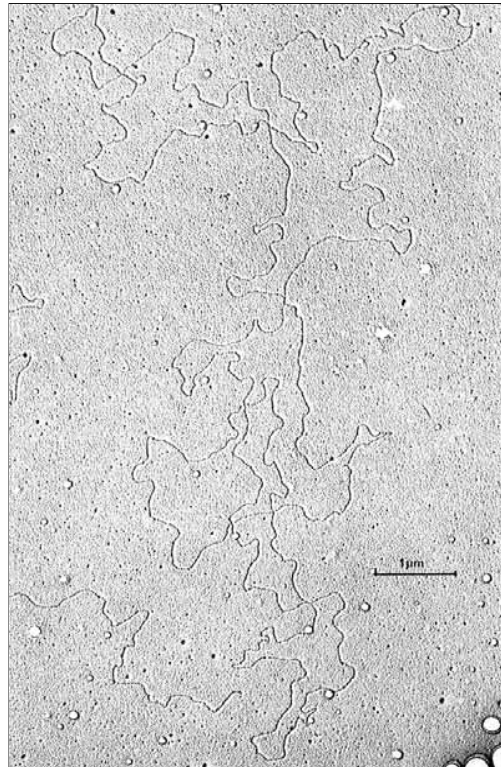


Oil palm plantation, Malaysia

Biotech crop history



1904, *Agrobacterium tumefaciens*



1974, Ti Plasmid, Gent



Arabidopsis thaliana
(thale cress)

1990's genomics



1996 Commercial launch



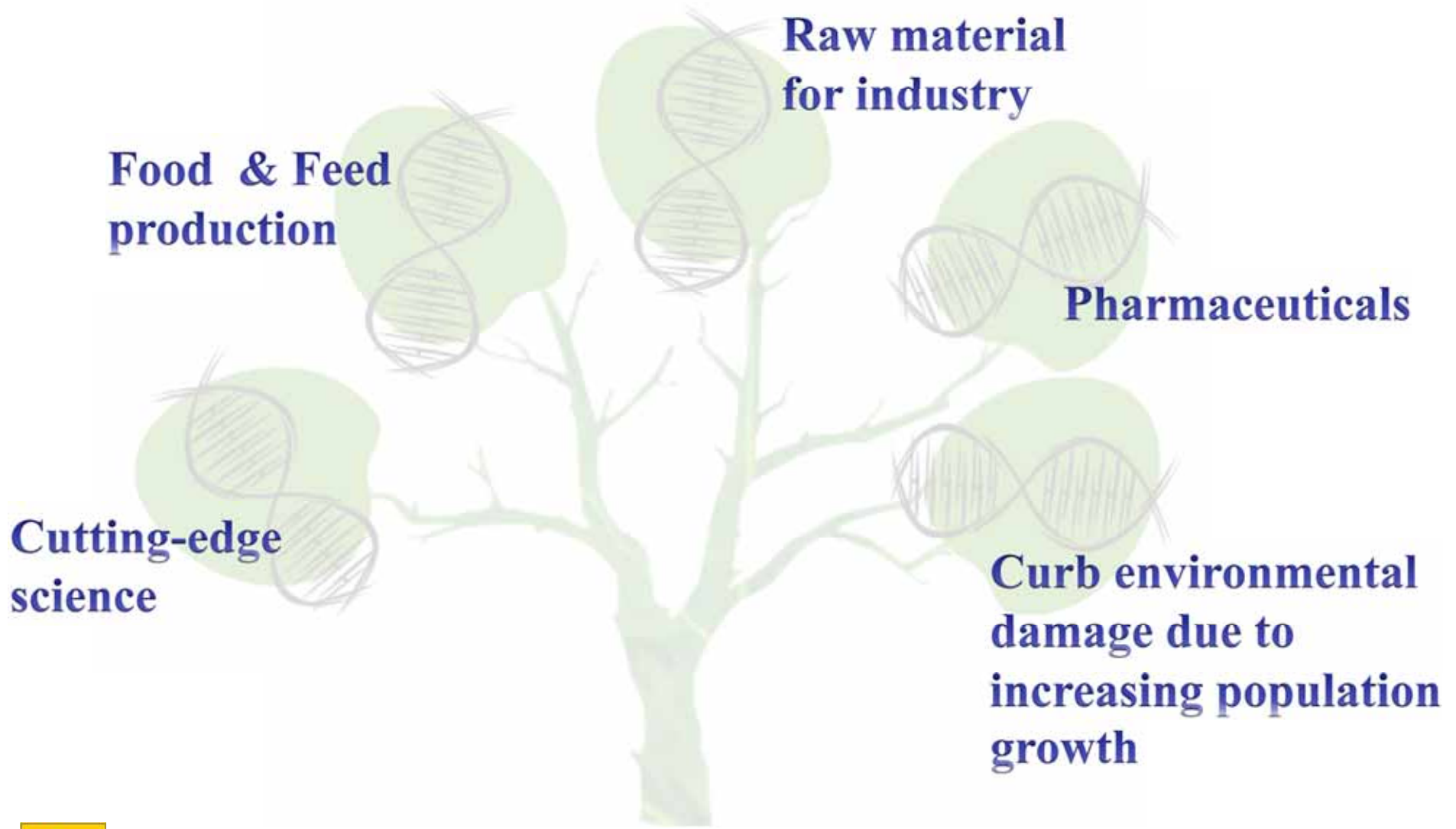
Seminal Contributions of Plant Model Systems to Epigenetic Research



Transgenic technology :
homology-dependent gene
silent (**cosuppression**)



Plant Biotechnology

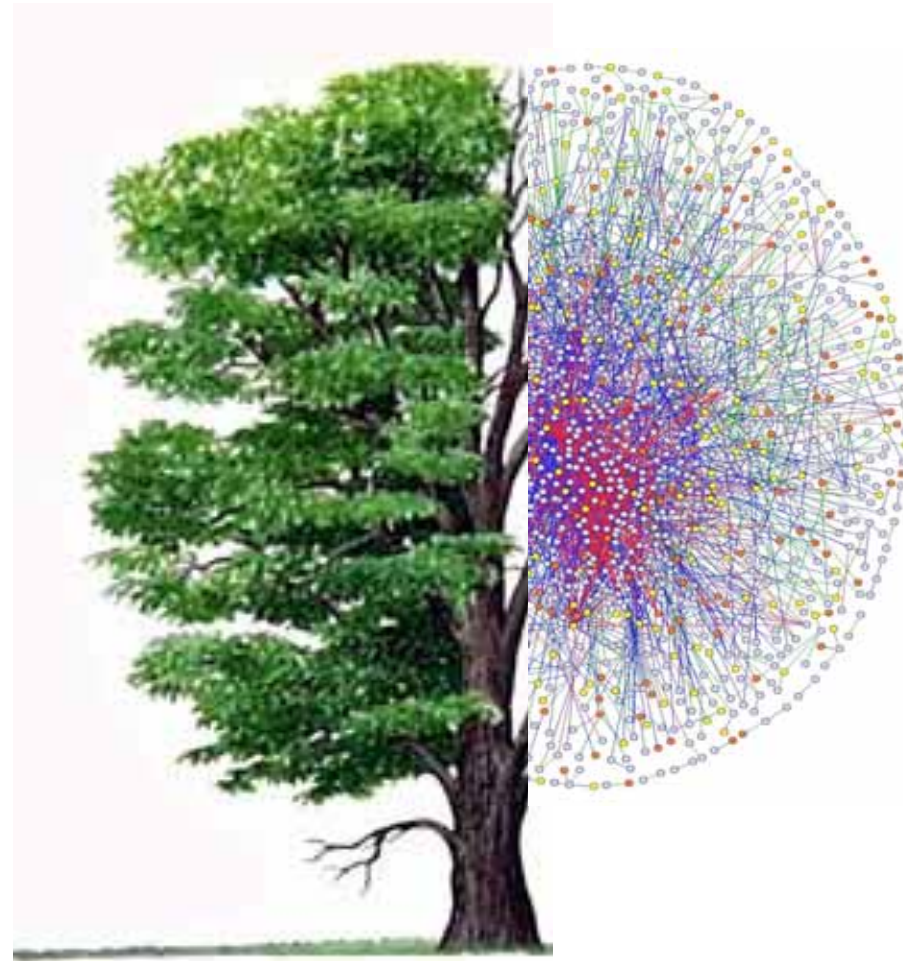


Success of Plant Biotechnology

Relies on efficient interaction between fundamental, strategic and applied research

Making the products our planet needs depends on:





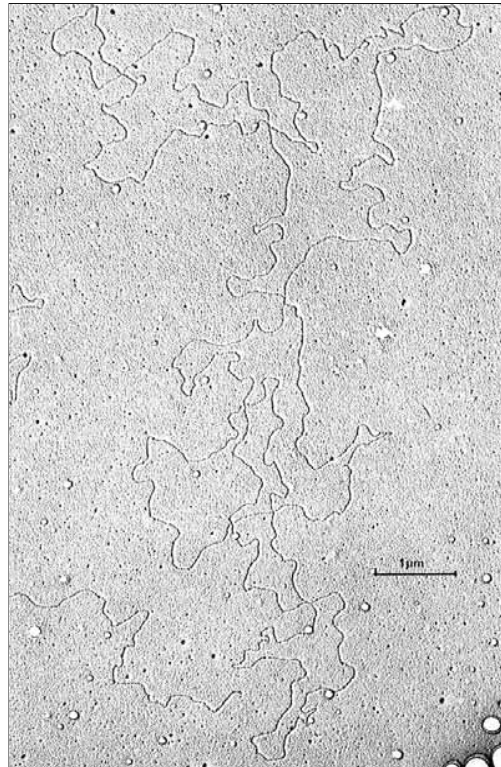
Plants for Knowledge



Biotech crop history



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Insect resistance: a tool for reducing pesticide use



Drivers for chronic food insecurity

(von Braun 2007; Conway 2009)

- Increasing population;
- Changing and converging consumption patterns;
- Increasing per capita incomes, leading to increased resource consumption;
- Growing demand for livestock products (meat and dairy), particularly those fed on grain;
- Growing demand for biofuels;
- Increasing water and land scarcity;
- Adverse impacts of climate change;
- Slowing of increases in agricultural productivity.

(<http://royalsociety.org/document.asp?tip=0&id=8825>)





Thomas Malthus:

(13 February 1766 – 23 December 1834)

The rise in human population will outrun the growth in food supplies.





Population growth



1945

2 billion

1998

6 billion

2008

6.7 billion

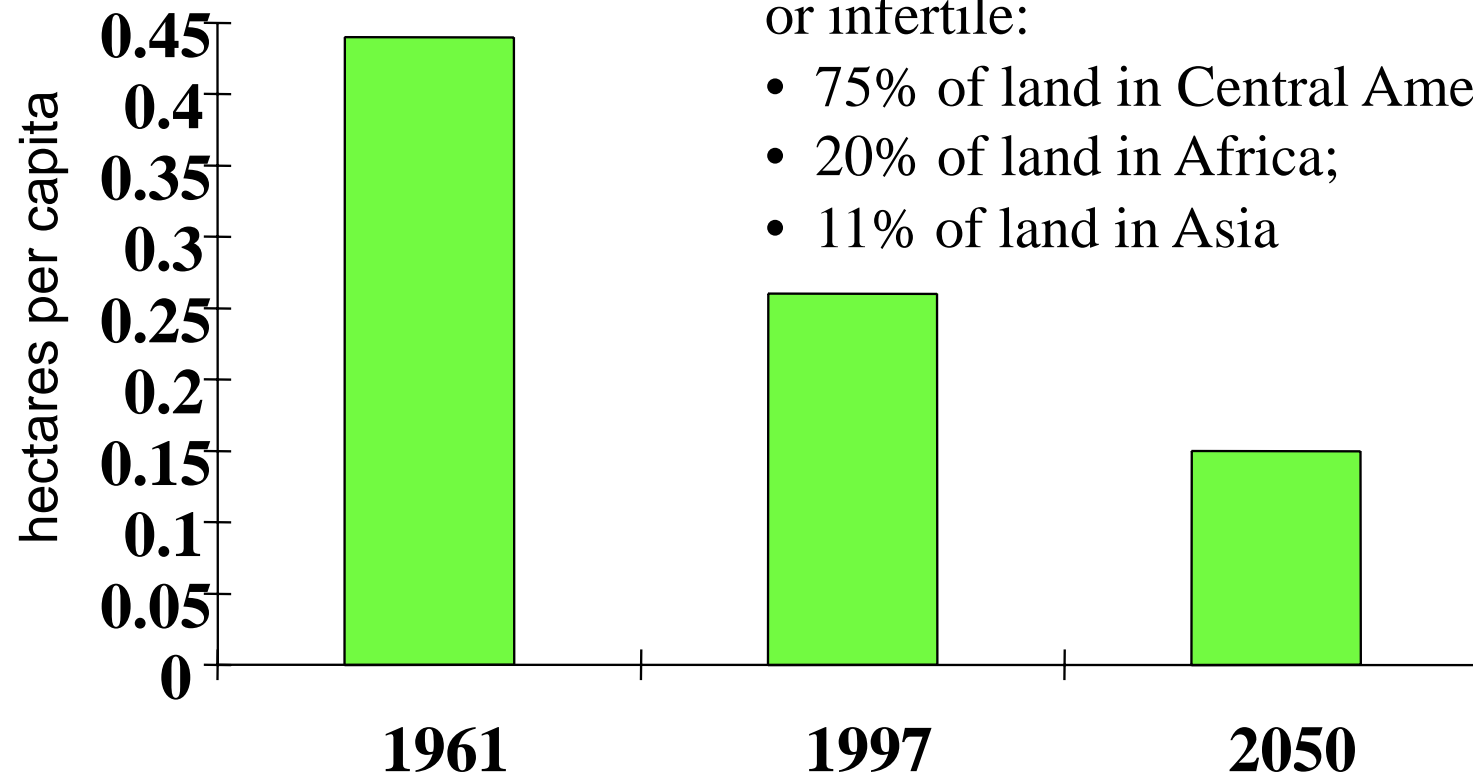
Urban Population exceeds rural population

2050

9-10 billion



Resources for food production: arable land availability



40% of arable land is seriously degraded or infertile:

- 75% of land in Central America;
- 20% of land in Africa;
- 11% of land in Asia

Source: UN Millennium Ecosystem Assessment



Challenges for agriculture

Tackle food security issues & environmental constraints on productivity.



Reduce the environmental footprint of industry.



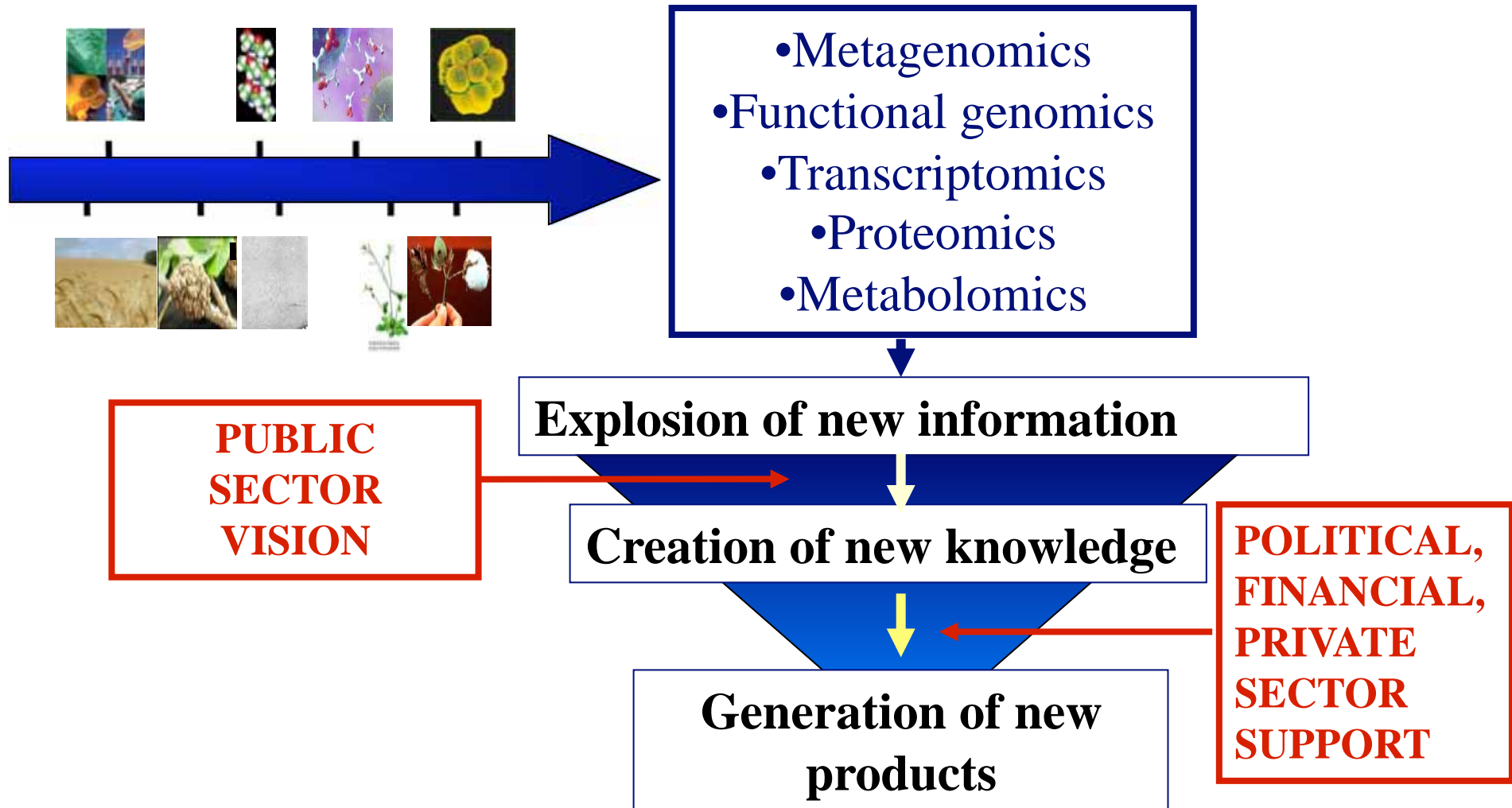
Plants for fuels and the chemical industry.



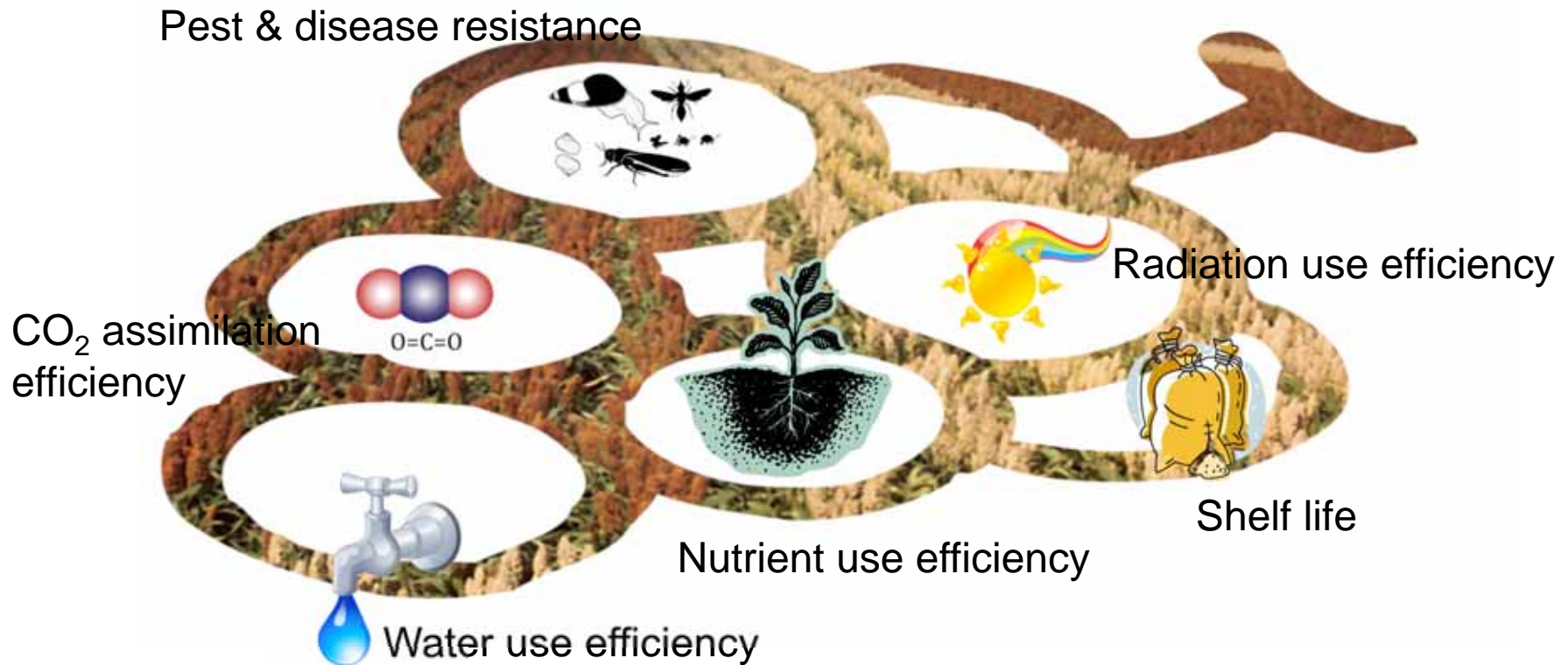
Biotechnology as a coherent answer to these challenges.



Systems Biology: Outstanding Developments



Crop Productivity – A Complex Trait



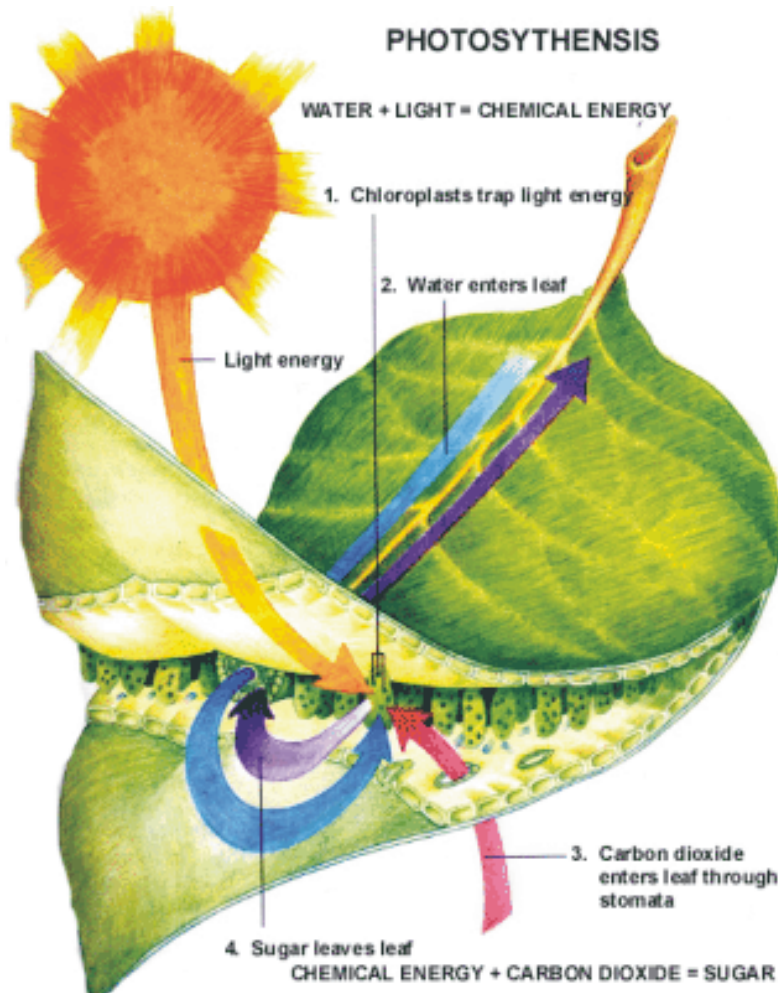
Photosynthesis

The ultimate source
of cell biological
energy

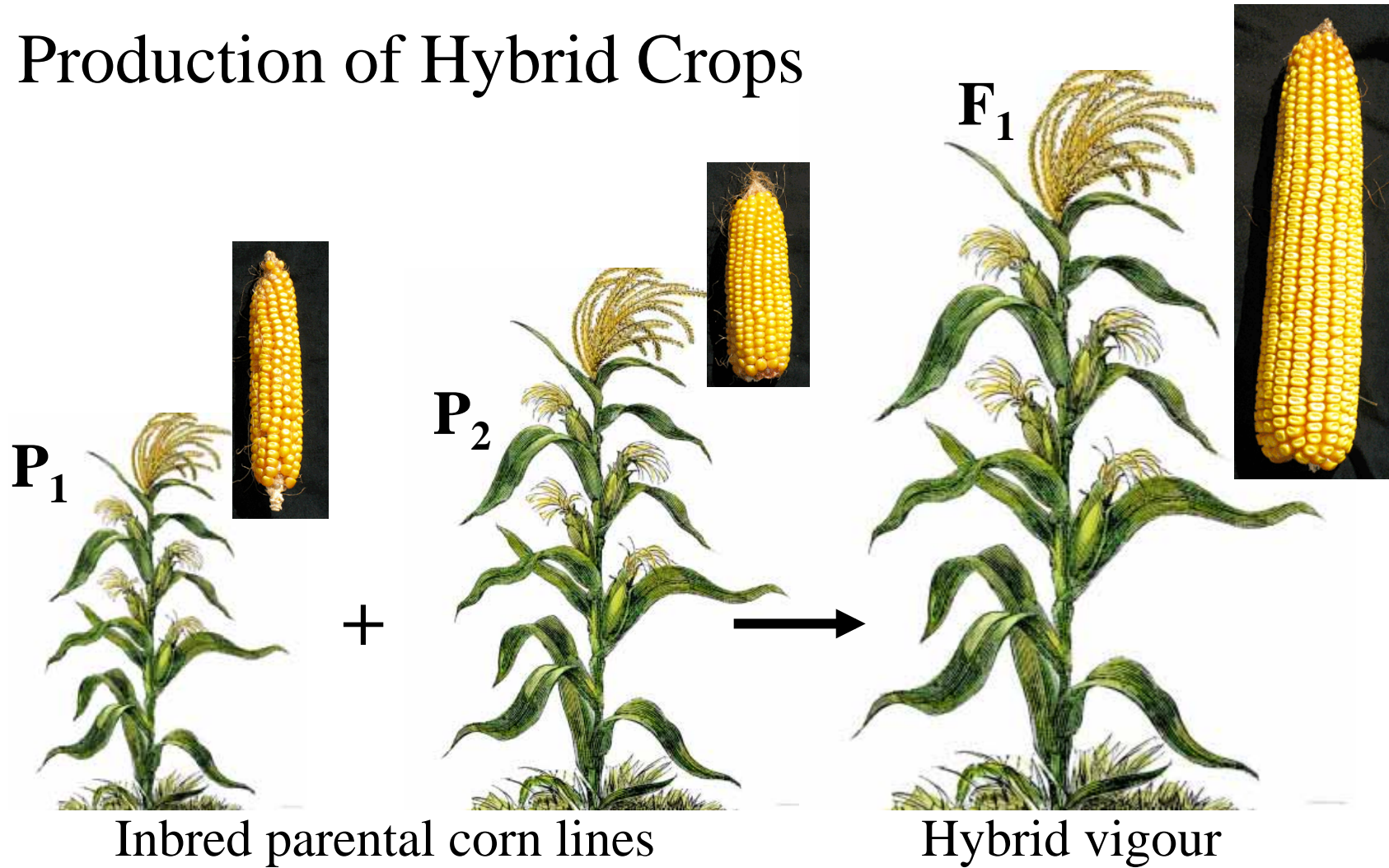
Carbon Credit \Rightarrow Plant Yield

Leaf area index: interception of
sunlight and conversion to fixed
carbon

Plant productivity depends on carbon fixation by photosynthesis



Production of Hybrid Crops



Nuclear Male Sterility: a tool for increasing yield

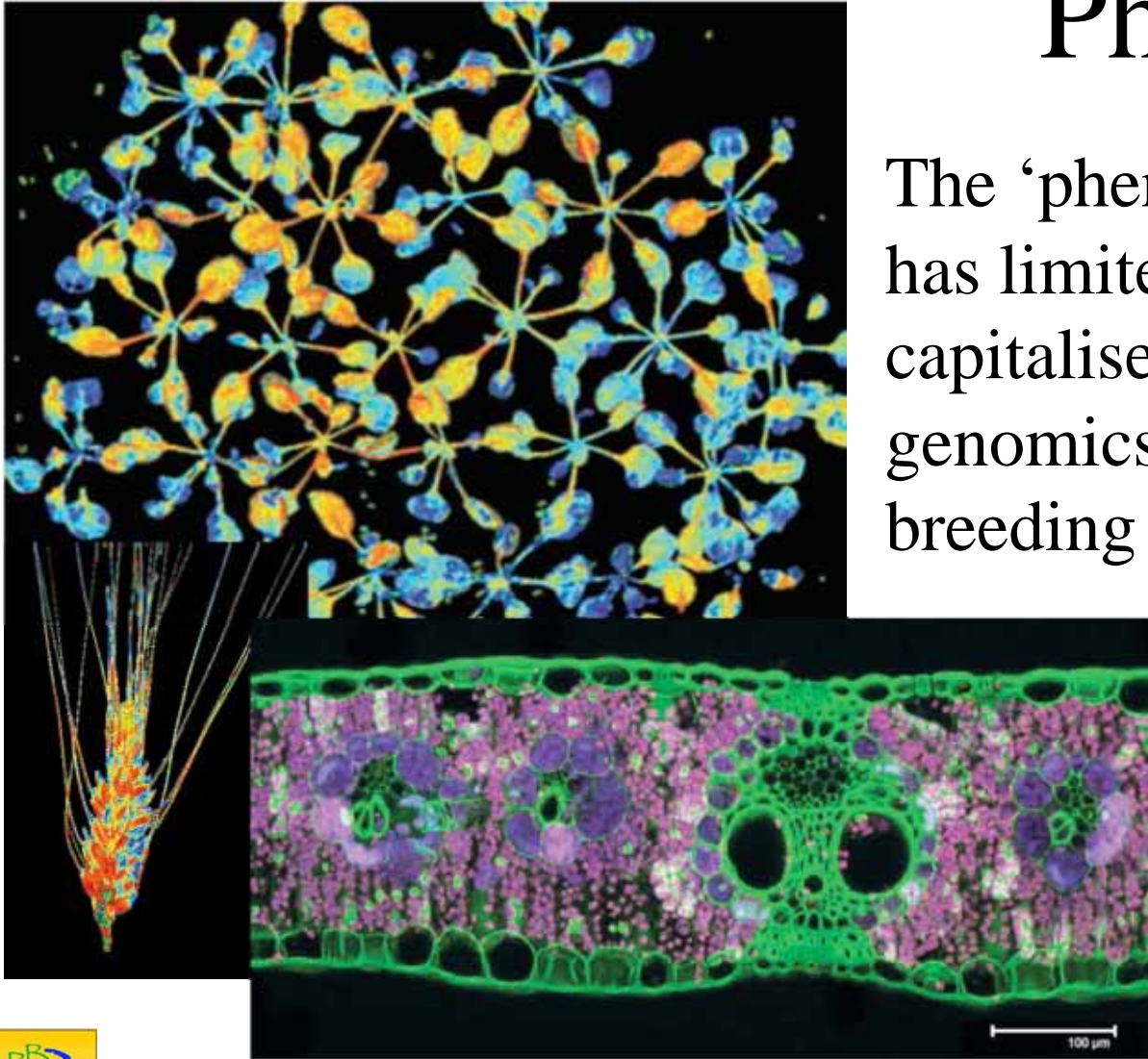


SMEs traditionally fill the application gap



Phenomics

The ‘phenotyping bottleneck’ has limited our ability to capitalise on plant functional genomics and modern breeding technologies



Chlorophyll fluorescence, and photosystem II activity
Science, August 8, 2009



Drought & salinity will be the most significant constraints on productivity

Existing practices are unsustainable



Solutions to ensure future productivity must be designed to meet an increasingly harsh environment

Scientific solutions:

Crop improvement:

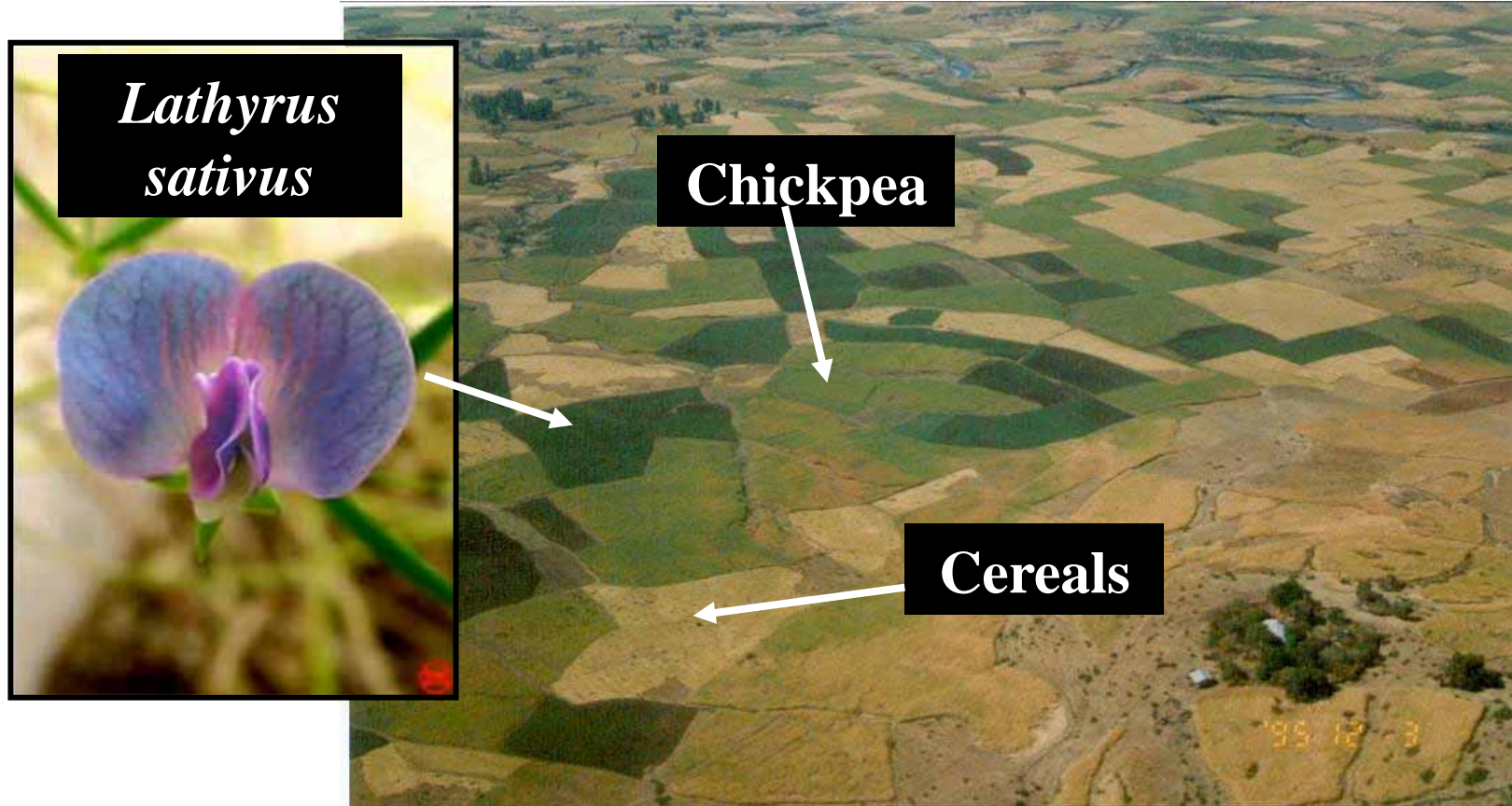
- GM crops
- MAS breeding

Crop choices:

- Sorghum
- Lathyrus
- Pearl Millet



Alternative crops:

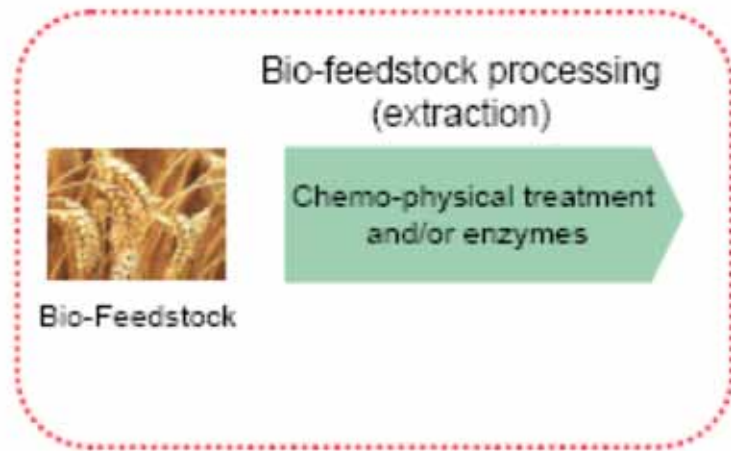


Drought in Ethiopia

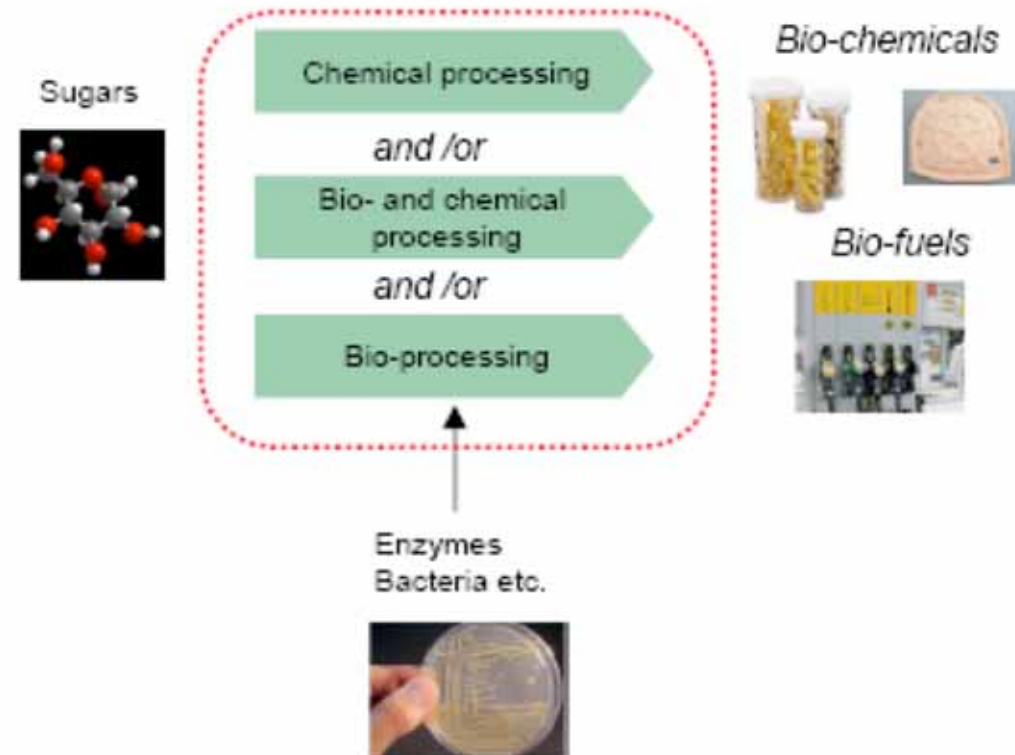


The emerging bio-economy is built on green and white biotechnology

Green biotechnology



White biotechnology

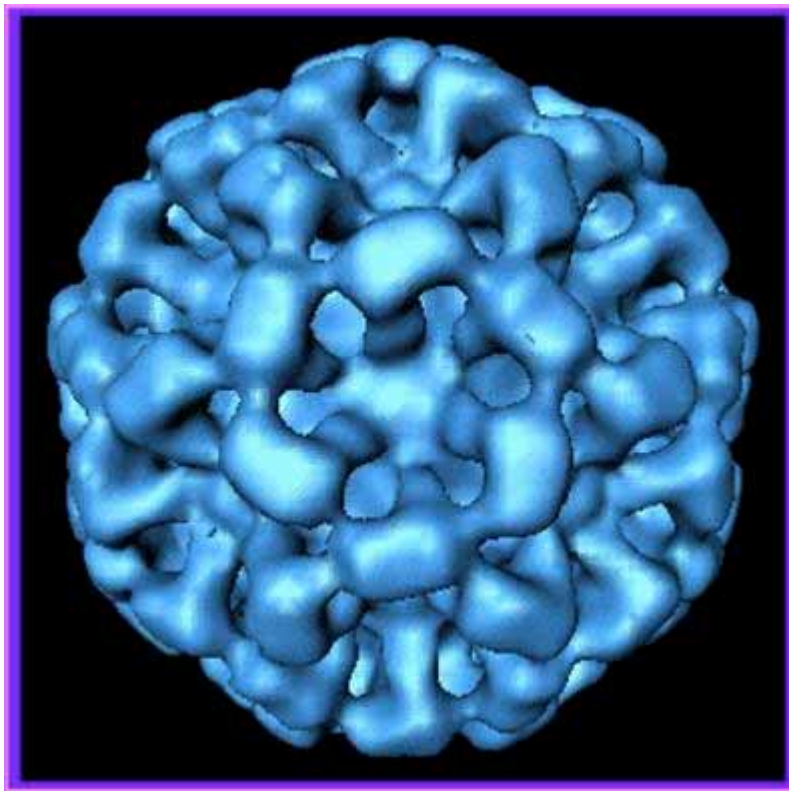


A photograph of a dense tropical rainforest. The image shows several large, thick tree trunks and roots, some of which are covered in moss or lichen. The forest floor is dark and appears to be covered in fallen leaves and branches. The lighting is somewhat dim, suggesting a deep forest environment. The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

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

Vaccines for Medicine and Husbandry

vaccine production against rapidly mutating virus is slow and costly



Alternative solution: Nanoparticle vaccine

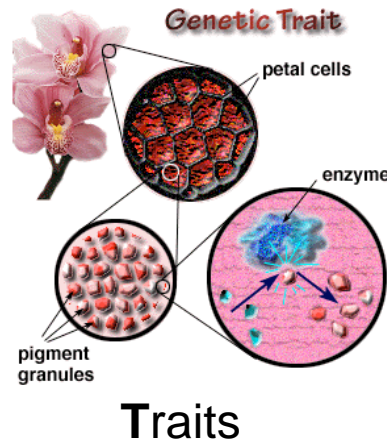
production of high levels of specially designed “virus-like” nanoparticles in tobacco plants

Advantages: less costly, time saving, easier purification, safer....



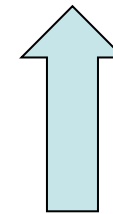
Charles Arntzen , 238th ACS 92009

Key Elements in Crop Development



Technology

- PVP/IP protection
- Acceptance of the new technology



Trade

