Old Byzantine Proverb:
‘He who has bread may have troubles
He who lacks it has only one’

PHOTOSYNTHESIS

• Life on earth ultimately depends on energy derived from the sun.
• Photosynthesis by green plants is the only process of biological importance that can capture this energy.
• It provides energy, organic matter and oxygen, and is the only sustainable energy source on our planet.

WE DEPEND TOTALLY ON PLANTS TO SUSTAIN ALL OTHER LIFE FORMS
Agriculture the most important event in human history

Agriculture critical to the future of our planet and humanity

Agriculture is part of the knowledge based bio-economy of the 21st century

2008

The world population has doubled in the last 50 years

Each Year the World’s Population will Grow by about ca. 75 Million People.

10% of the Population Lives on 0.5% of the World’s Income

Developed countries

Developing countries

Industrialized countries
Four innovations brought about change in agriculture in the twentieth century. What are the innovations which will change agriculture in this century?

Mechanisation: Tractors freed up perhaps 25% of extra land to grow human food instead of fodder for draught horses and oxen;

- Fertilisers: Fritz Haber’s 1913 invention of a method of synthesising ammonia transformed agricultural productivity, so that today nearly half the nitrogen atoms in your body were ‘fixed’ from the air in an ammonia factory, not in a soil bacterium;

- Pesticides: Chemicals derived from hydrocarbons enabled farmers to grow high-density crops year after year without severe loss to pests and weeds;

- Genetics: In the 1950s Norman Borlaug crossed a variety of dwarf wheat, originally from Japan, with a different Mexican strain to make dwarf wheats that responded to heavy fertilisation by producing more seeds, not longer stalks. The varieties, imported into India and Pakistan, rapidly replaced the subcontinent’s hunger with surplus in the ‘Green Revolution’.

The effect of these four innovations was to allow more and more food to be produced from less and less land.

What has happened to our planet in the last 100 years?

To feed and resource 6.6 billion people we have already lost.....

- 1/5 of our topsoil (due to erosion, desertification and salinity)
- 1/5 of our agricultural land (overgrazing marginal land)
- 1/3 of our forests

• Plus Today Additionally.....
  - Environmental pollution
  - Climate change, groundwater depletion
  - Depletion of the Ozone layer
  - Massive fossil fuel usage/CO₂ increase by 15% since 1950
  - Species extinction, biodiversity loss
  - Urbanisation → increased meat consumption (India and China etc)
  - Obesity/starvation
  - Zoonotic disease transmission SARS, BSE, F and M, Bird Flu etc

THIS IS UNSUSTAINABLE : DOING NOTHING IS NOT AN OPTION
Models suggest that climate change effects on crop yield are positive or neutral at high latitudes, but negative at low latitudes.

Future Agriculture
To Support Everyone Adequately
Many Improvements Will Be Necessary

- Integrated pest management
- Reduction of chemical use
- Water conservation
- Genetic modification by marker assisted breeding and transgenesis where appropriate
- No-till practices
- Precision agriculture where appropriate
- Conserving genetic diversity
- Orphan Crops and Specialized crops
Global Environmental Challenges

Food → Biodiversity → Climate Change
Food → Biodiversity → Conservation tillage → New Technologies → Biofuels?
Food → Biodiversity → New Technologies → C Sequestration → Renewable Fuels

How can science and technology contribute?

NEW TOOLS FOR CROP IMPROVEMENT

Gene Sequencing

Molecular Breeding

Elite Germplasm

Marker Assisted Breeding

Seed Production

Plant Functional Genomics

Plant Biotech

Trait Development

New Traits

Better Varieties, Faster
Targets for Plant Gene Technology: Finding the genes

**REDUCED STRESSES**
- Biotic and Abiotic
  - Pests and Diseases
  - Weeds
  - Saline or acid soils
  - Increased greenhouse gases

**IMPROVED NUTRITION AND HEALTH**
- Vitamins & Minerals
- Carbohydrates
- Post harvest quality
- Taste
- Proteins
  - Oils

**MORE SUSTAINABLE PRODUCTION**
- Nutrient use efficiency
- Control of flowering
- Plant architecture
- Heterosis
- Yield

**IMPROVED PLANT PERFORMANCE**
- Drought or Flooding
- High or low Temperature
- Phytoremediation

**NEW INDUSTRIES**
- Chemical Feedstocks
- Pharmaceuticals
  - Vaccines
  - Antibodies
  - Diagnostics

**ENVIRONMENT**
- Biodegradable Plastics
- Biofuels

**ADVANCED GENOMICS WILL FURTHER ACCELERATE THE DISCOVERY OF NEW TRAITS AND PRODUCTS**

**Genome** → **Gene map** → **Gene sequence** → **Gene expression** → **Plant traits**

**Bioinformatics**
- Genome → Sequence → Function → Product
The Biotech Pipeline

Plants as factories
- Vitamins
- long-chained fatty acids
- Omega-3-fatty acids
- Enzymes
- Biopolymers
- Color pigments
- Pharmaceuticals
- Fibers

Healthier nutrition and quality
- Amino acids
- Oil
- Starch

Pest protection
- Virus
- Nematode
- Fungi
- Insect

Stress protection
- Cold
- Drought
- Salinity

More efficient agriculture
- Bt-technology
- Herbicide resistance

1997  2005  2015  2025

Increase of 13%, 12 million hectares or 30 million acres, between 2005 and 2006.


100 million Hectares=247 Million Acres
Scientific officials report on transgenic crops safety and benefits:

“...in those countries where transgenic crops have been grown, there have been no verifiable reports of... health or environmental harm.”

-FAO

- World Health Organization
- Food & Agriculture Organization (FAO) of the United Nations
- National Academy of Sciences (USA)
- Royal Society (UK)
- American Medical Association (USA)
- French Academy of Medicine
- European Commission
- U.S. Food & Drug Administration
- Society of Toxicology
- Institute of Food Technologists

Public-Private Partnerships

In the early 21st century 500,000 children per year become blind and 6,000 per day die from vitamin A-malnutrition.

This could be ameliorated with the help of GMO's such as Golden Rice. However, for many in our society GMO's are taboo!

Improved provitamin A accumulation
Public-Private Partnerships

Water-Efficient Maize for Africa (WEMA)

- Multi-party effort to develop drought tolerant maize to Africa
- Begins with adapted germplasm, includes both marker-assisted breeding and Monsanto’s drought tolerance trait

Irrigation as % of cultivated area

http://www.aatf-africa.org/

CSIRO.

Cowpeas Lupins Maize Wheat

Australia 7 660 79 12200
Nigeria 5000 - 4700 67
Niger 3500 - 9 3

Cowpea weevil

Dr T J Higgins-CSIRO Canberra
How Do We Move Forward?

• Given present trends in population, food production, trade, and the environment, the necessary increases in production and income generation in rural areas cannot be achieved simply by expanding cultivated land and using current technologies.

• We must strive to attain global sustainability as a precondition for human progress.

• We must address population, affluence, and technology simultaneously to move toward sustainability.

• While agricultural production must be intensified to meet projected demands for food, feed, fibre and biofuels, intensification strategies must also change to avoid adverse environmental impacts and to reverse the effects of past practices.

We must use all safe, appropriate, socially responsible and sustainable opportunities to increase food supplies locally and also improve ‘orphan crops. This can be achieved by combining the best of conventional plant breeding with the new biotechnologies including marker assisted breeding and genetic modification of crop plants.

DOING NOTHING IS NOT AN OPTION
Finally I would recommend you read a thought provoking new book by Robert Paarlberg: STARVED FOR SCIENCE
How Biotechnology is being kept of Africa

He purports to show how a recent withdrawal of donor support for modern agricultural science in Africa, plus outright opposition to new farm science on the part of some global pressure groups is contributing directly to the continued growth of poverty and hunger…….

He further suggest that low-income, food deficit nations are being advised by governments and pressure groups in privileged nations to reject agricultural, GREEN biotechnology, mostly because this is a technology the rich countries themselves do not at the moment happen to need. When it comes to new applications of medical science, which prosperous countries still need and value, genetic engineering (RED biotechnology) is not seen as a threat..

This is a rich world argument that is hurting the poor.

His concerns are indeed - FOOD FOR THOUGHT!!!

HAVE YOU THANKED THE GREEN PLANT TODAY?
Swift’s dictum:

‘And he gave it for his opinion that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country than the whole race of politicians put together’

Johnathan Swift, Gulliver's Travels, 1726