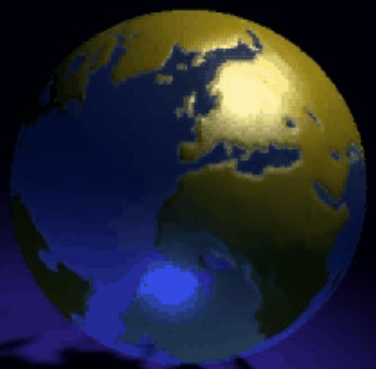
Can Biotechnology Promote Sustainable Agriculture in India?



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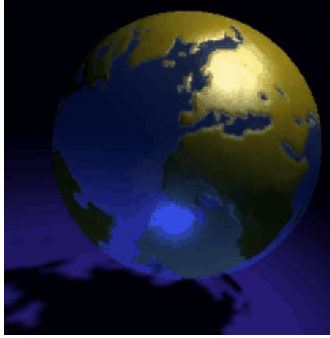
What is Sustainable Farming?

- ***Growing crops productively now without affecting our ability to do so in the future***

- ***Meeting the needs of the present without compromising the ability of future generations to meet their own***

- ***Integrates environmental stewardship with farm profitability***



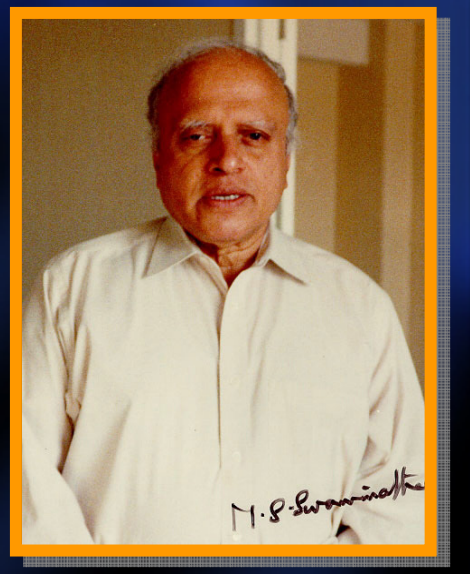
Sustainable Agriculture…

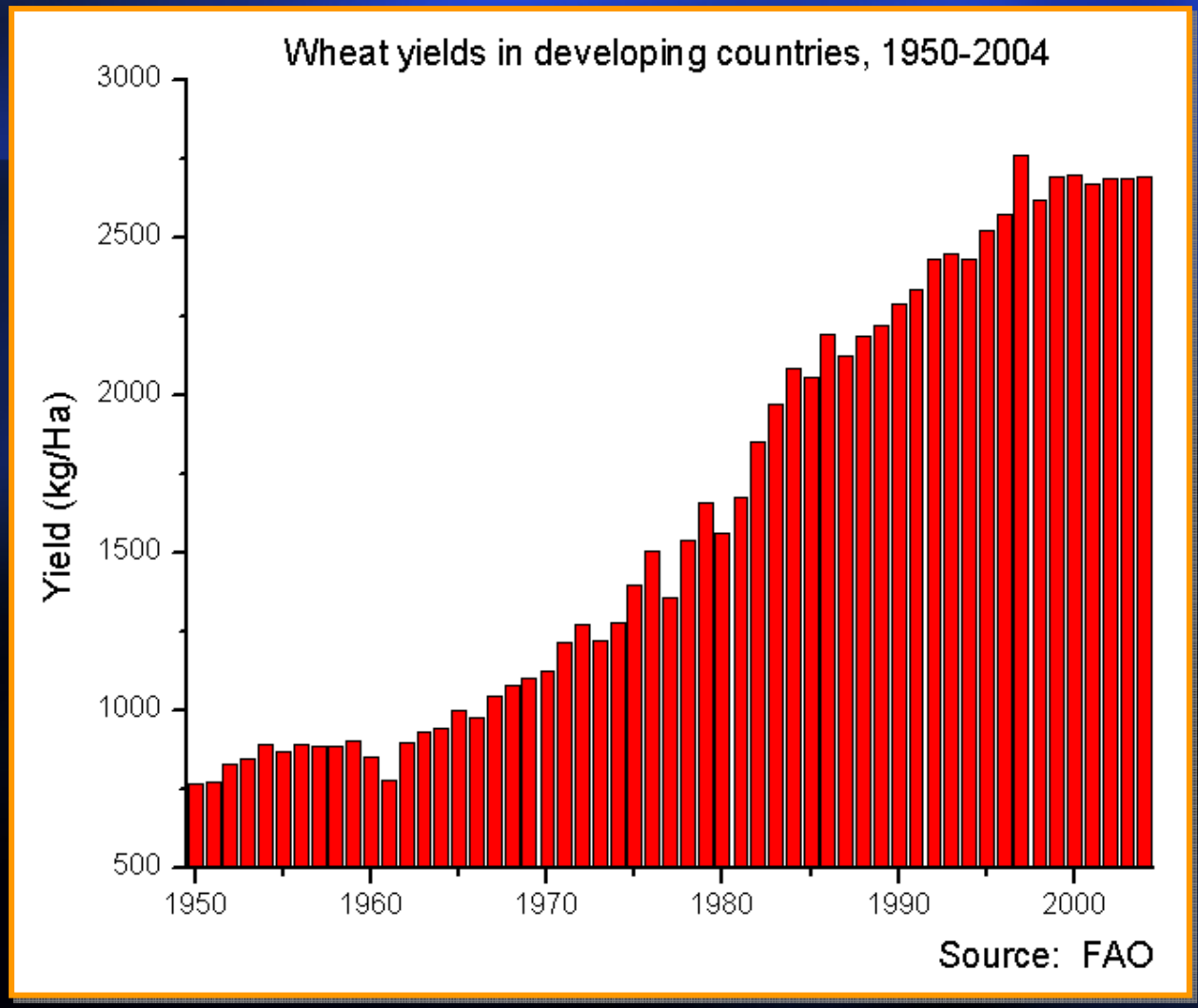
- ***Environmentally friendly farming without damage to ecosystem, including effects on soil, water supplies, biodiversity..***

- ***A way of producing a stable food supply in perpetuity without degrading the natural resources***

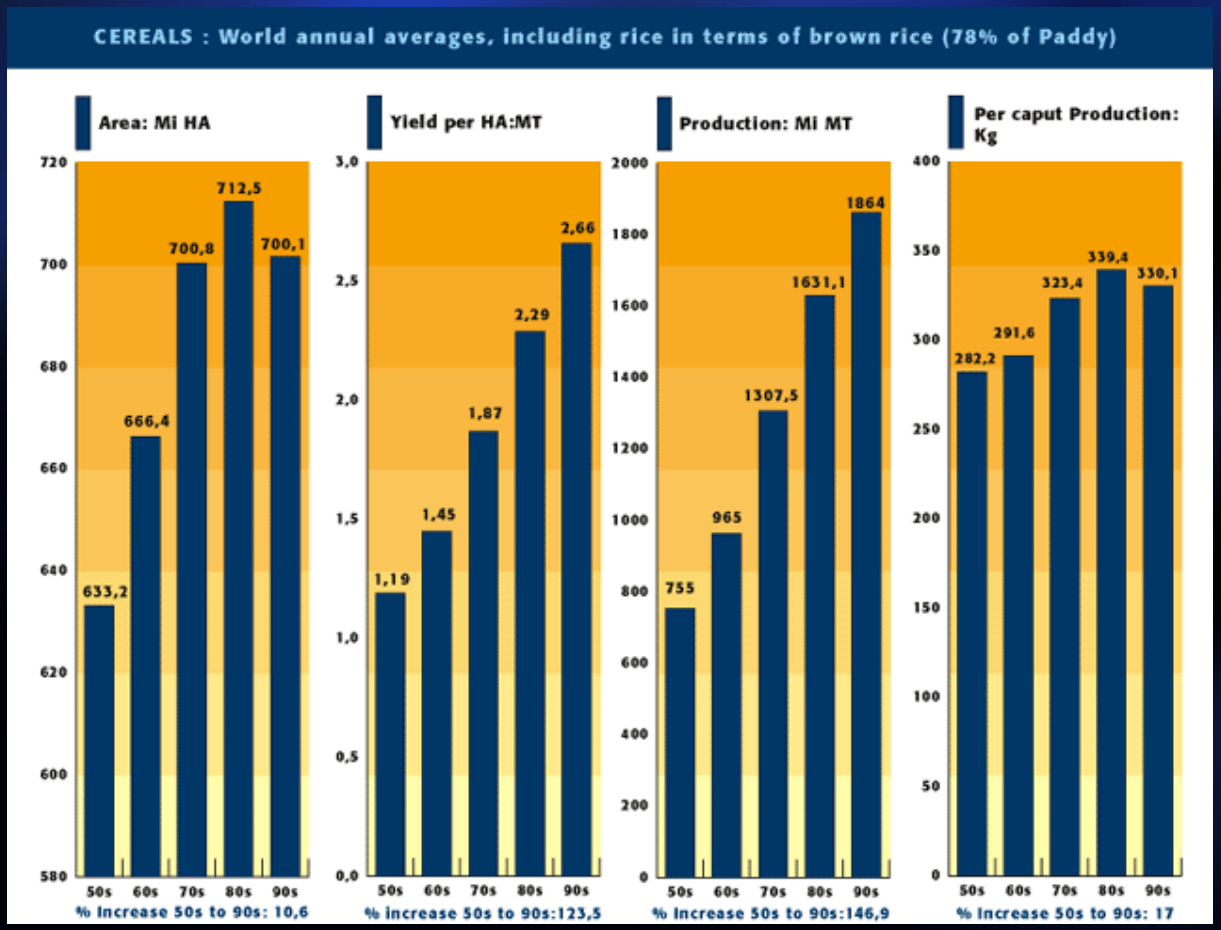
Green Revolution…

- Lifted hundreds of millions Out of Poverty
- Undernourished > from 38% to 19% in past 20 years
- Increase in food consumption per capita
- India: Food production from 50 to 230 mil tons in the past 5 decades. Wheat : from 6 to 90 million tons per year!
- Less starvation and famine
- Increased food self sufficiency




Wheat yields in developing countries, 1950-2004
Yield (kg/Ha)
3000
2500
2000
1500
1000
500
1950
1960
1970
1980
1990
2000
Source: FAO

Cereal trends in the past 50 years…



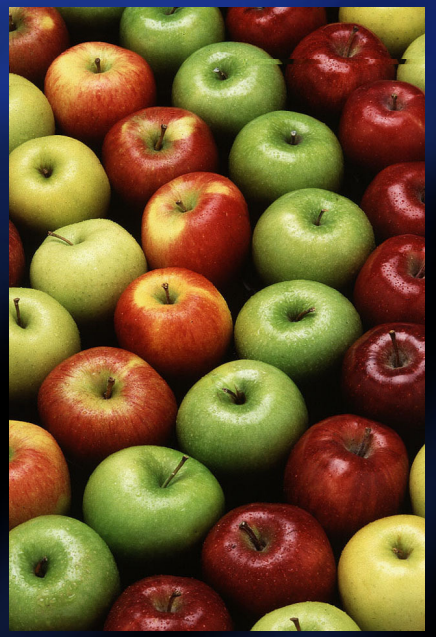
Source: www.fao.org

The Challenge Ahead….

Producing More Food Using Less Land, Less Water, Less Chemicals…?

Improving our Crops –
Farmers and Conventional Breeding

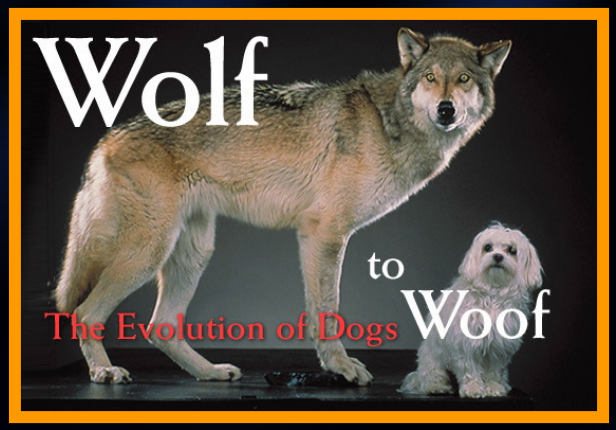
(photos: Dr. Wayne Parrott, Univ of Georgia)



Crop Evolution and Human Civilization

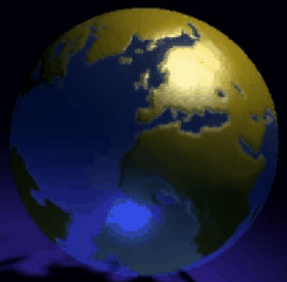
- **Humans have always guided the evolution of crops**
- **A small sample of wild plants were chosen and domesticated**
- **10,000 years of *Selection*.**

- **All crops we grow today were once wild plants. But no crop would survive in the wild any more.**
- **Crops, strains and genes have moved around the globe.**



Teosinte

Maize

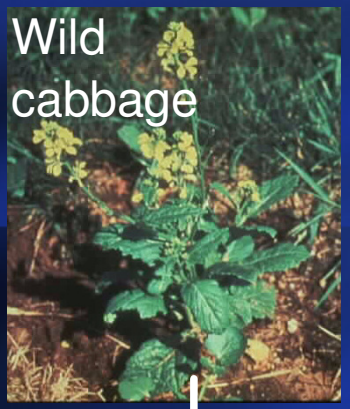


Slide courtesy *Wayne Parrott*, University of Georgia,

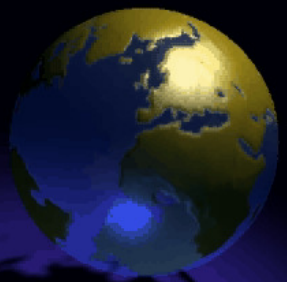
Slide courtesy *Wayne Parrott*, University of Georgia,

Carrot

Slide courtesy *Wayne Parrott*, University of Georgia,



Kohlrabi
Germany, 100 AD



Brussel sprouts
Belgium, 1700's

Many crops never existed in nature

Einkorn x wild wheat

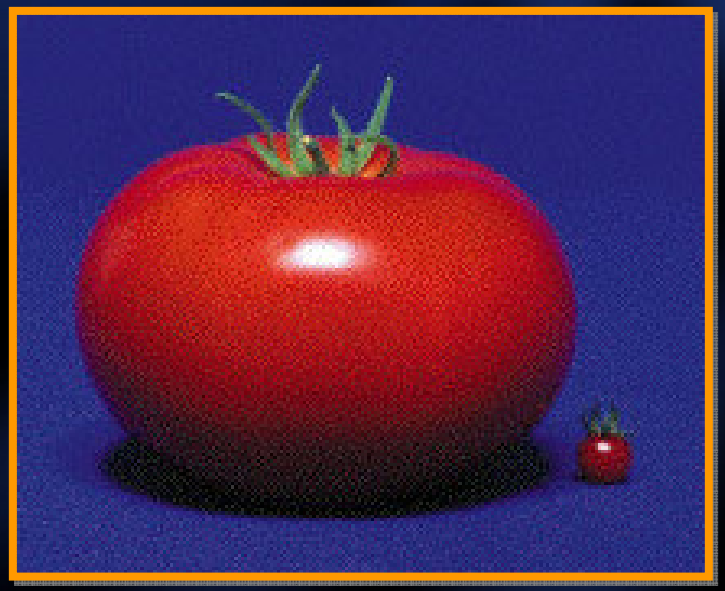
Emmer x goat grass

Bread wheat

www.mpiz-koeln.mpg.de/pr/garten/schau/Triticumaestivum/wheat.html

Improving Our Crop Plants

- Developing Modern Varieties of Crops
  - Hybridization
    - Crosses with Wild Relatives
    - Hybrids
  - Mutation
    - Irradiation
    - Chemicals
  - Cell Culture
    - Embryo Rescue
    - Somaclonal variation

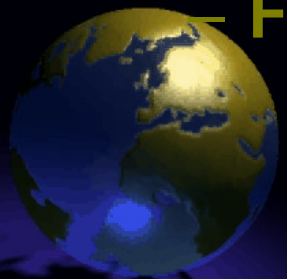


Modern Genetic Modification

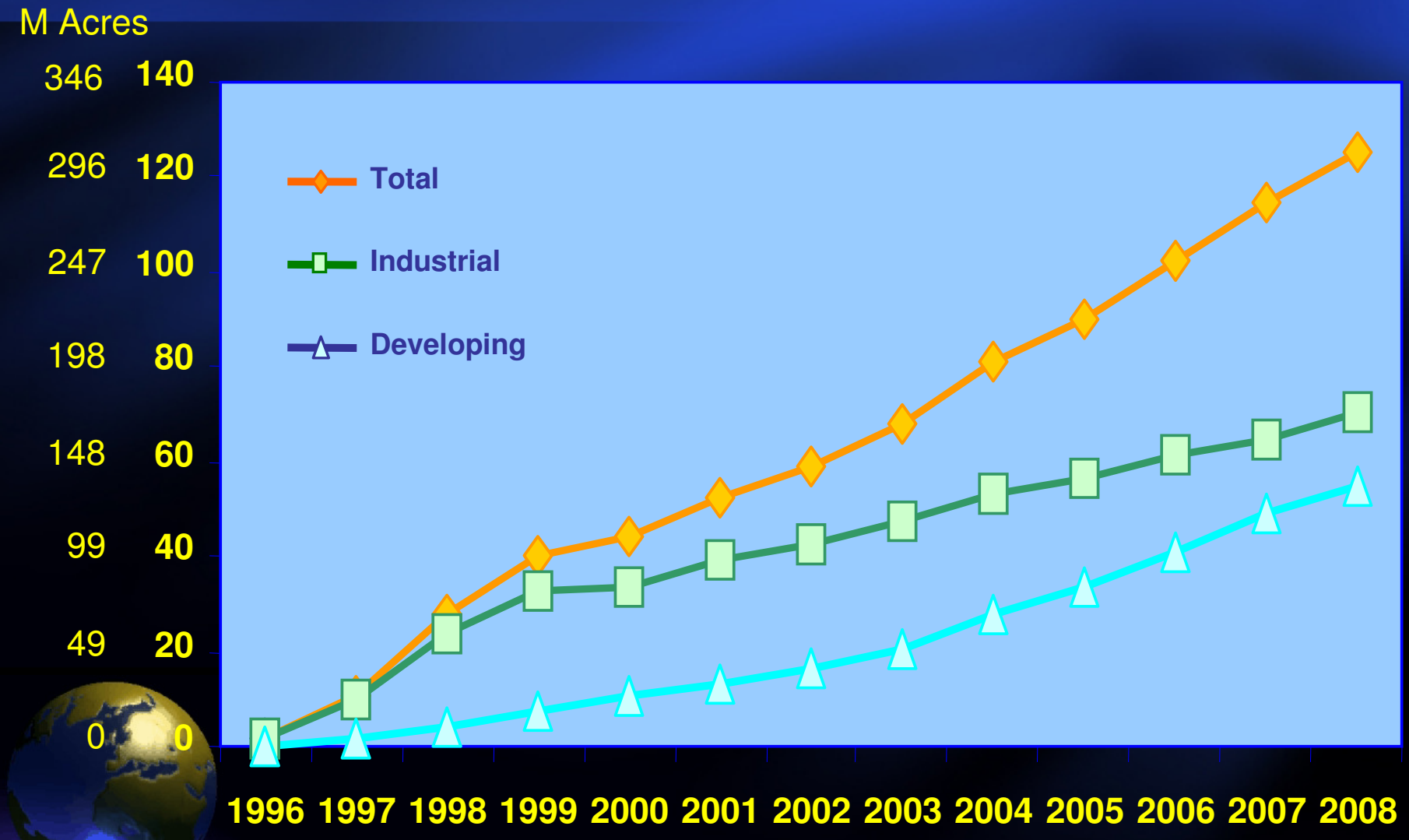
Inserting one or few genes to achieve desired traits.

Transfer of Genes into Crop Plants

- **Relatively Precise and Predictable**
- **Changes are Subtle**
- **Allows Flexibility**
- **Fast**

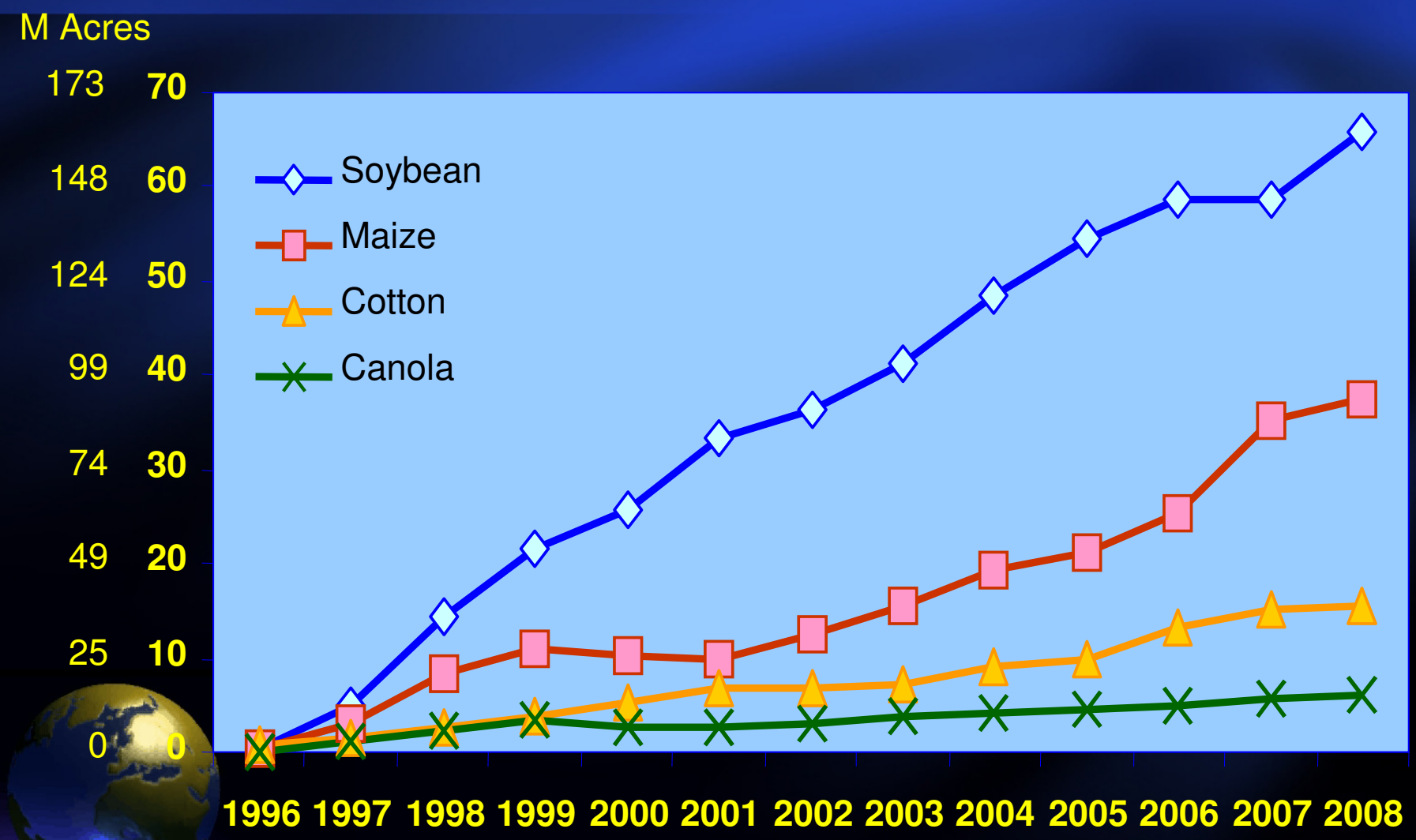


Global Area of Biotech Crops, 1996 to 2008: Industrial and Developing Countries (M Has, M Acres)



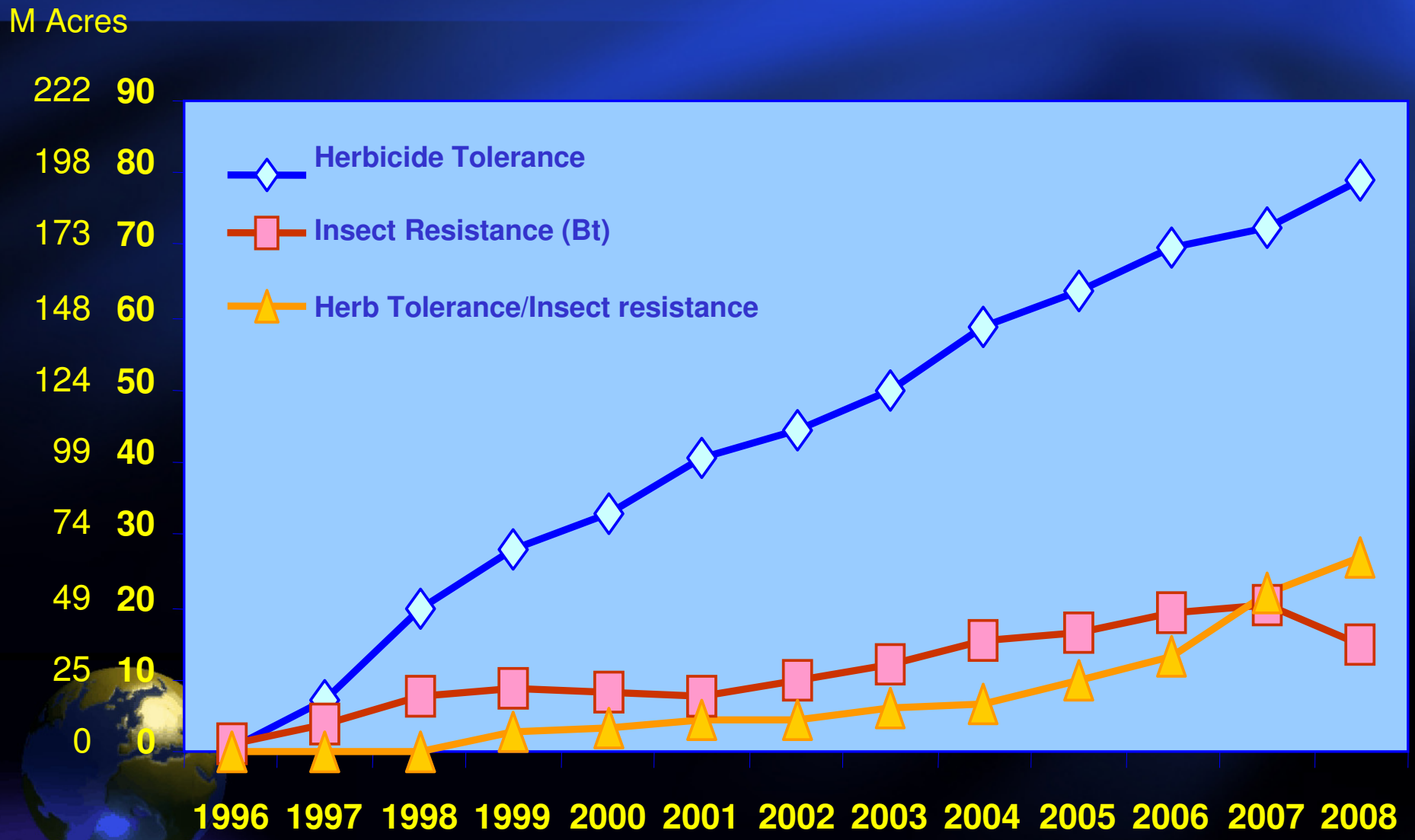
Source: Clive James, 2009

Global Area of Biotech Crops, 1996 to 2008: By Crop (Million Hectares, Million Acres)



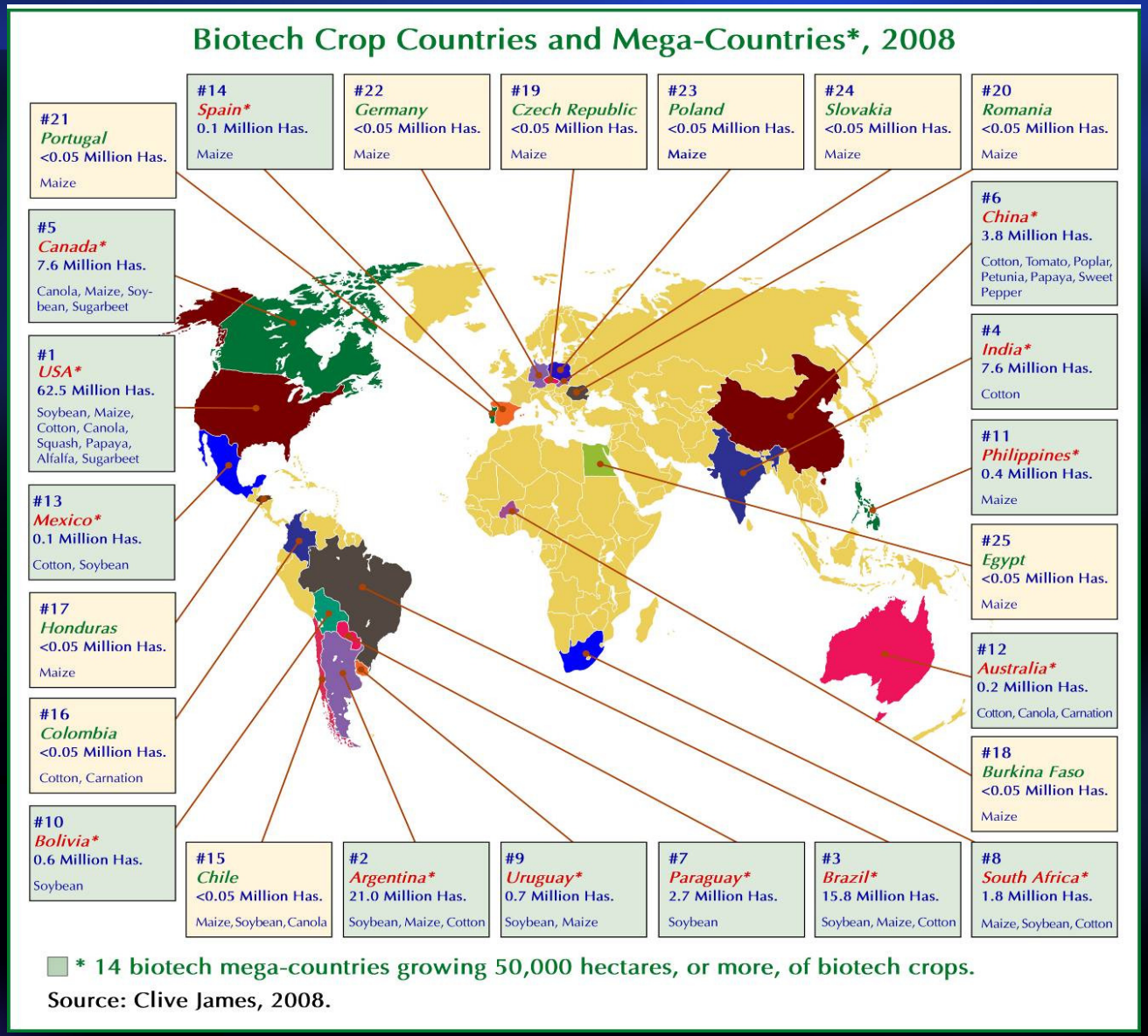
Source: Clive James, 2009

Global Area of Biotech Crops, 1996 to 2008: By Trait (Million Hectares, Million Acres)



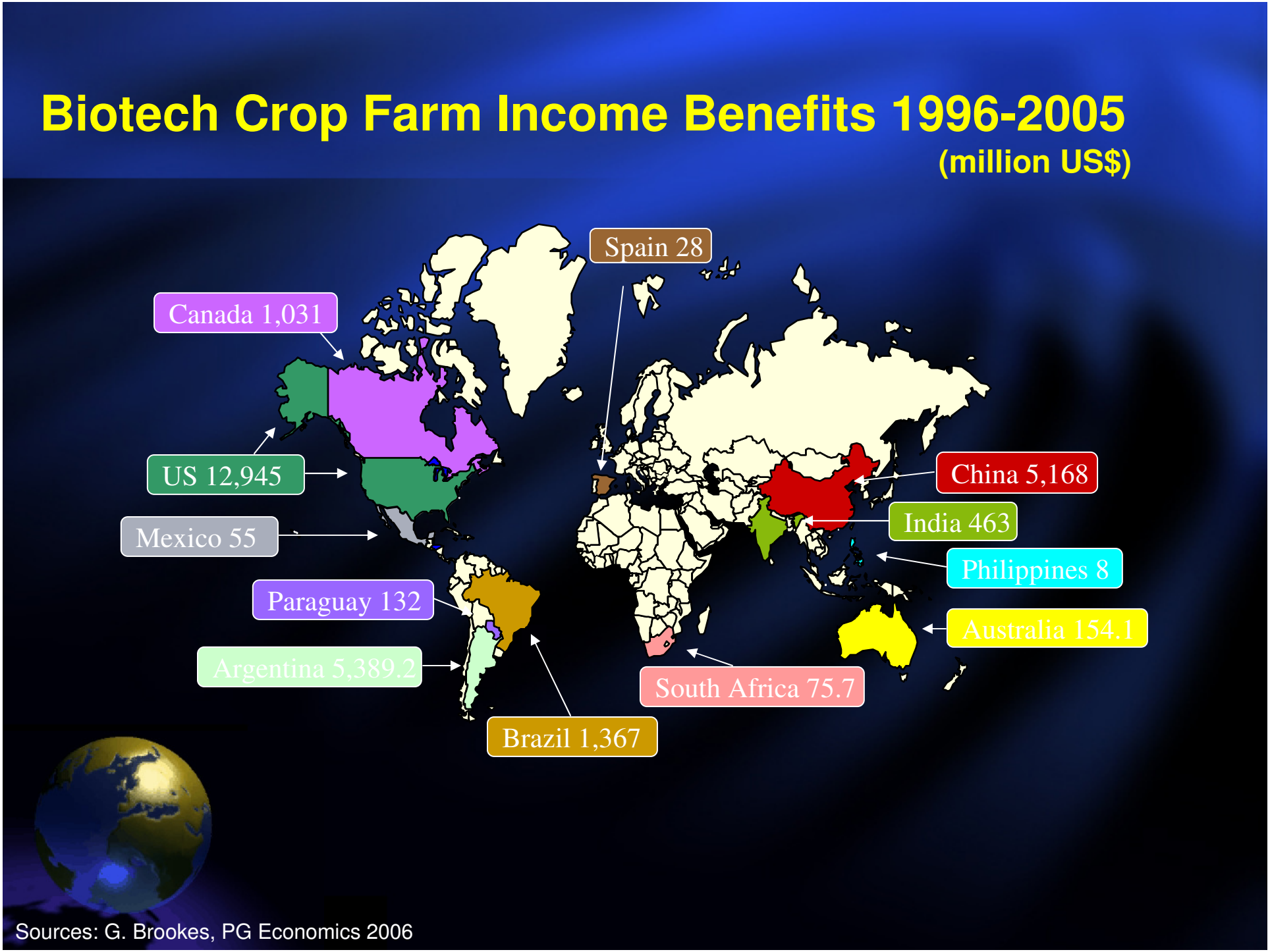
Source: Clive James, 2009

Biotech Crop Countries and Mega-Countries, 2008



Biotech Crop Farm Income Benefits 1996-2005

(million US$)



Sources: G. Brookes, PG Economics 2006

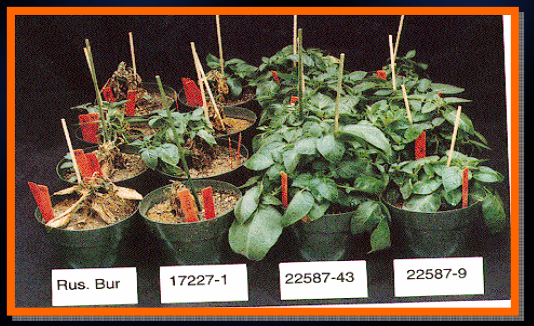
Global Economic Impacts so far..

- $27 billion savings
- Reduced pesticide spraying by 172 million kg
- Environmental Footprint of pesticide down 14%
- Reduced greenhouse gas - removing five million cars from the roads

Source: *GM Crops: The Global Economic and Environmental Impact - The First 9 Years 1996-2004 Graham Brookes and Peter Barfoot* (PG Economics Ltd., UK) AgBioForum.org, v.8 , No. 2 & 3

How Can Biotechnology Bring Sustainability to Indian Agriculture?

- Environmental Impact - Decreased use of pesticides
- Reduce losses from pests and diseases
- Improve nutrient efficiency
- Improve productivity




Preparation for insecticide spray

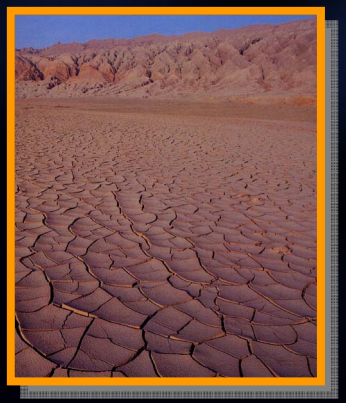

Manual spraying

Bt Corn –Healthier

(Low Mycotoxin)

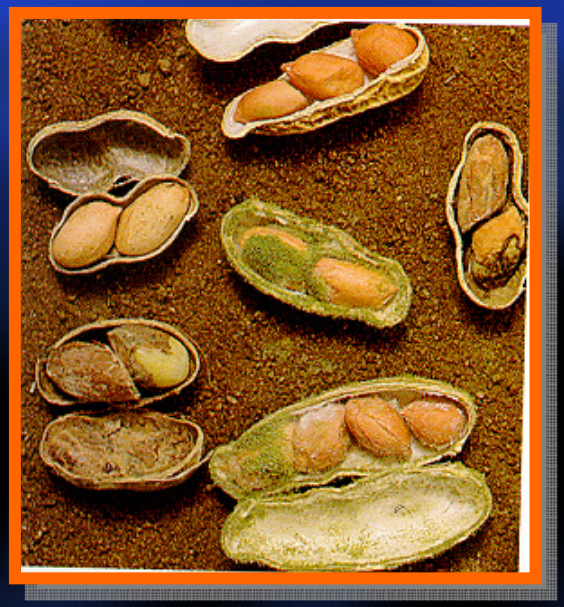
Biotechnology and Sustainability in Farming

- Post Harvest Quality - prolong shelf life of fruits, vegetables and flowers
- Extend crop area and season
- Stress tolerance - drought, acidity, salinity, heat, flooding



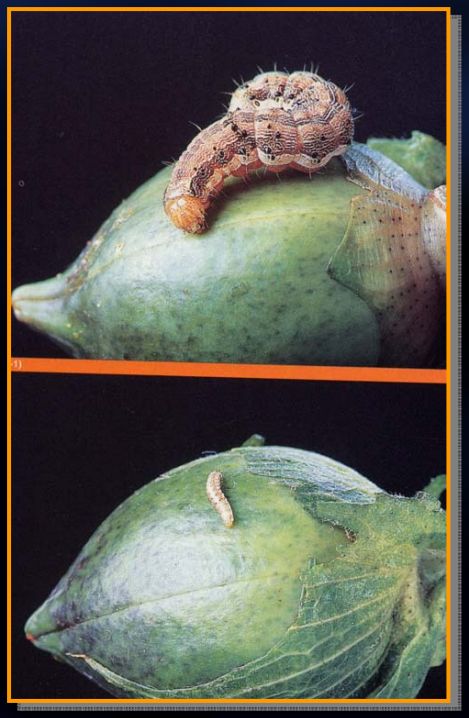
Enhancing Food and Agriculture

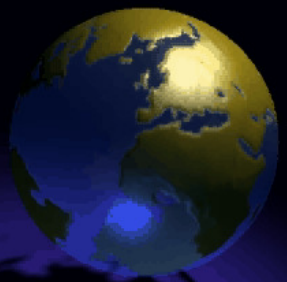
- More Nutritious Food
- Healthy Produce. Low Toxins
- Pharmaceutical Proteins
- Clean Up Environment
- Biofuel - Ethanol, biodiesel
- Industrial Products
- Value-Added Products



Bt Cotton

- Losses due to Bollworm $1 billion
- Cotton - 50% of the total pesticides

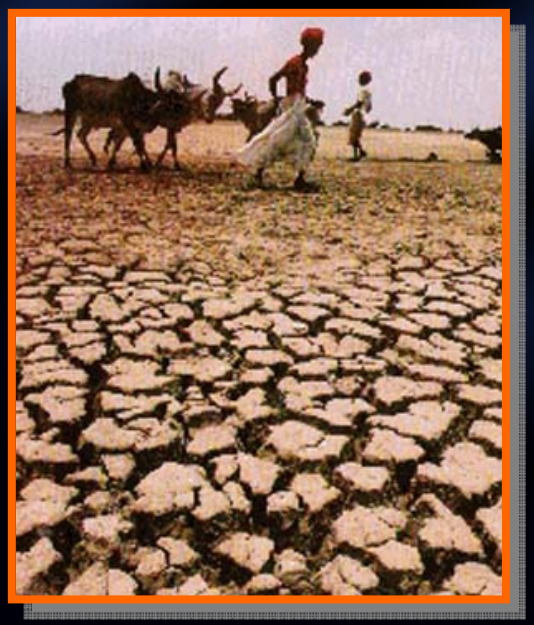




- Bt Cotton - yield increases up to 40%.
- Millions of farmers grew it
- Savings up to $182 per hectare
- Spraying reduced from 12 to 4
- Both private and public sector

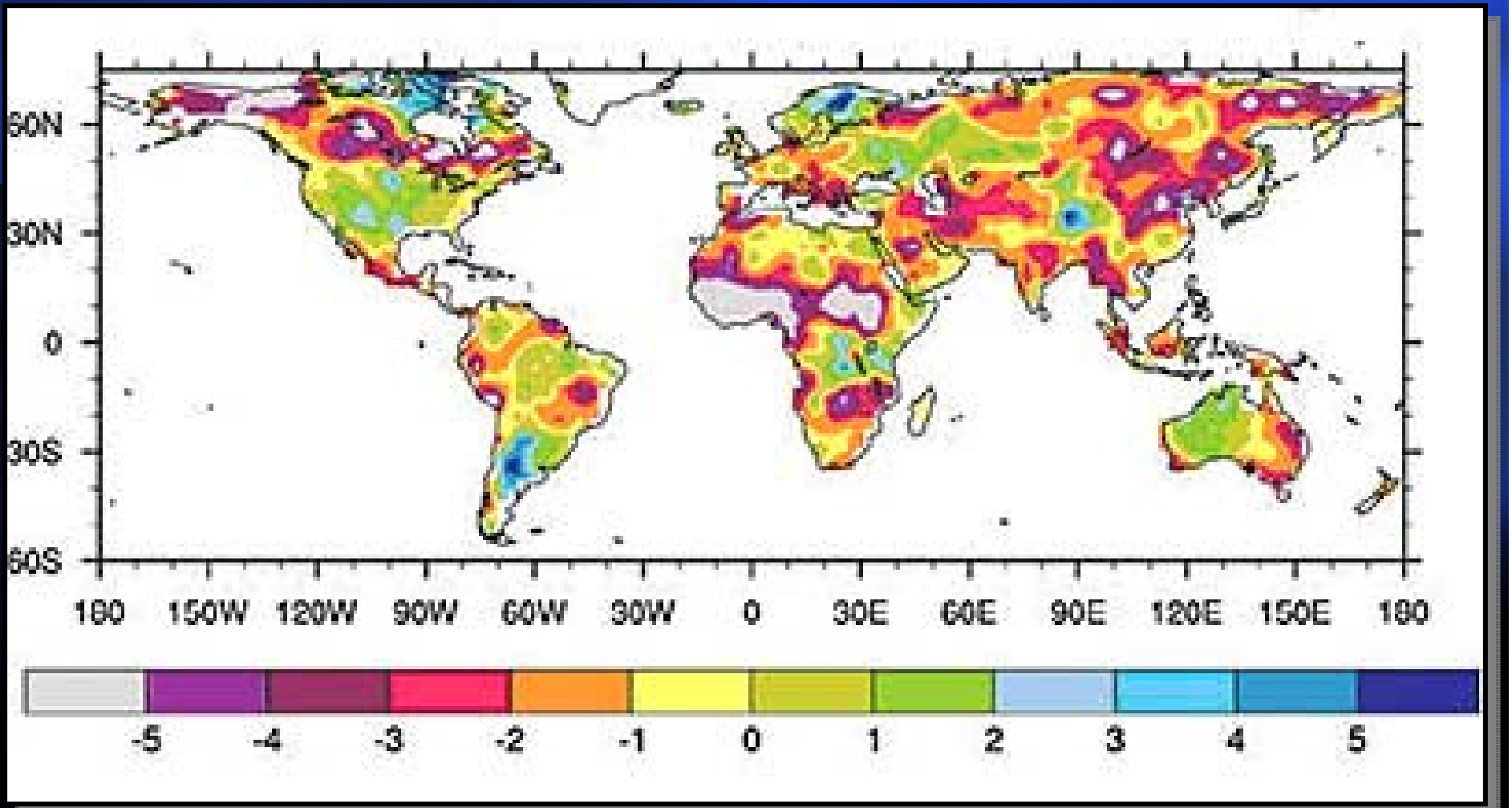
Drought

- Extended period of deficiency in water supply
- Major constraint to farming
- Spurred Green Revolution in India?



Drought and Farming

- *Most important environmental stress on farming*
- *Average 50% crop loss*
- *Agriculture - 85% of freshwater withdrawal*
- *Need more "crop per drop"*

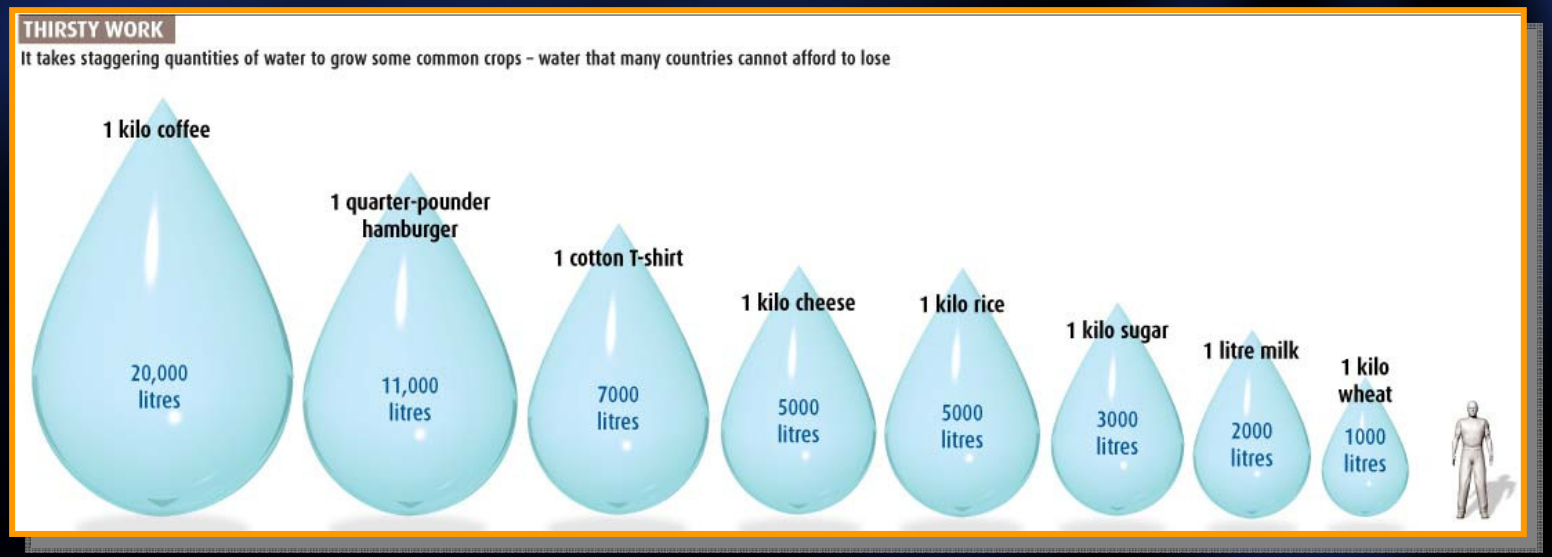


Palmer Drought Severity Index

from 1948 to 2002

Virtual Water

- **Embedded water or hidden water**
- **Water used in the production of a good or service In the context of trade**

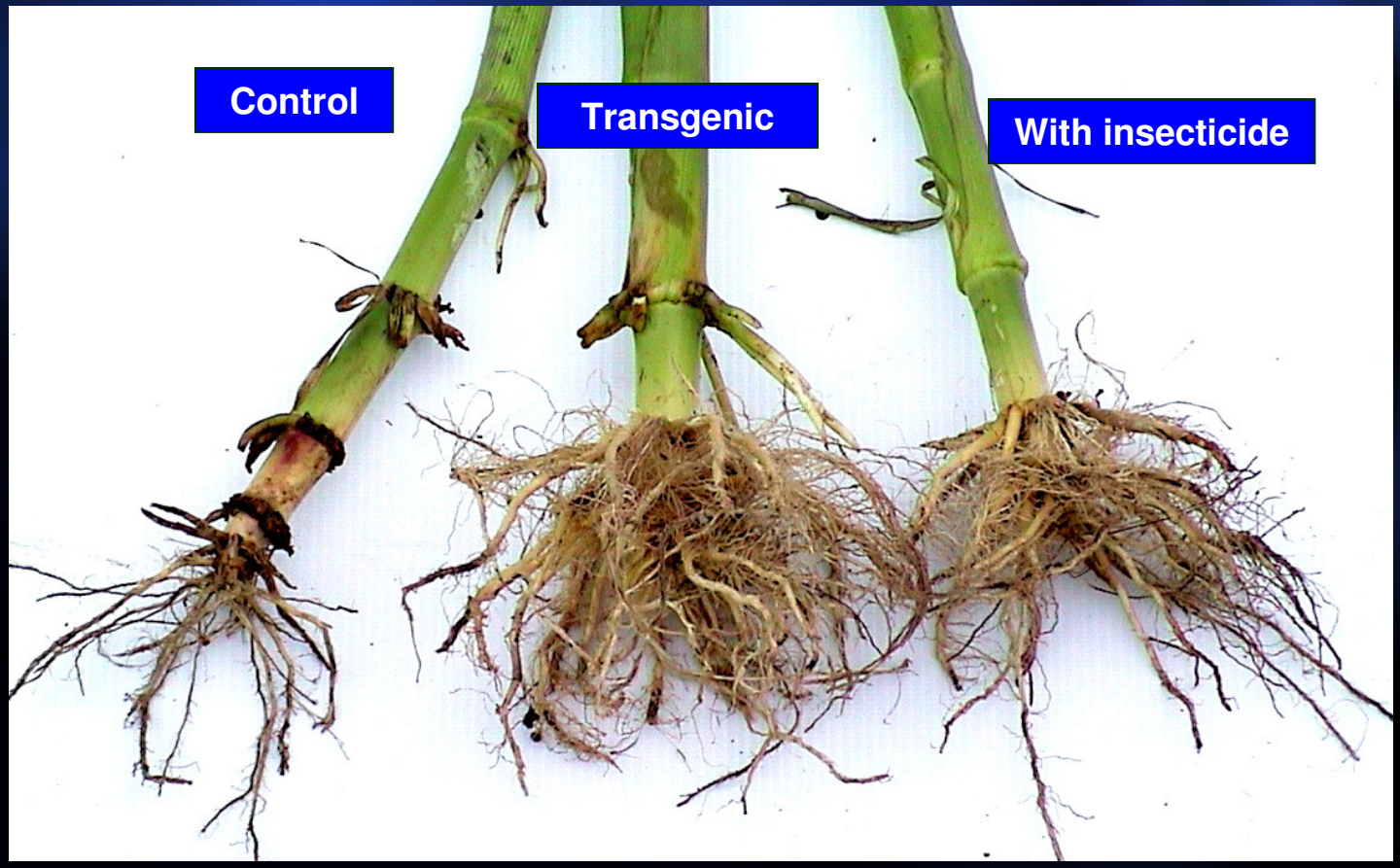


Source: *http://technology.newscientist.com/*

Drought Tolerant Corn

Photo: Monsanto Co.

Rootworm-resistant corn



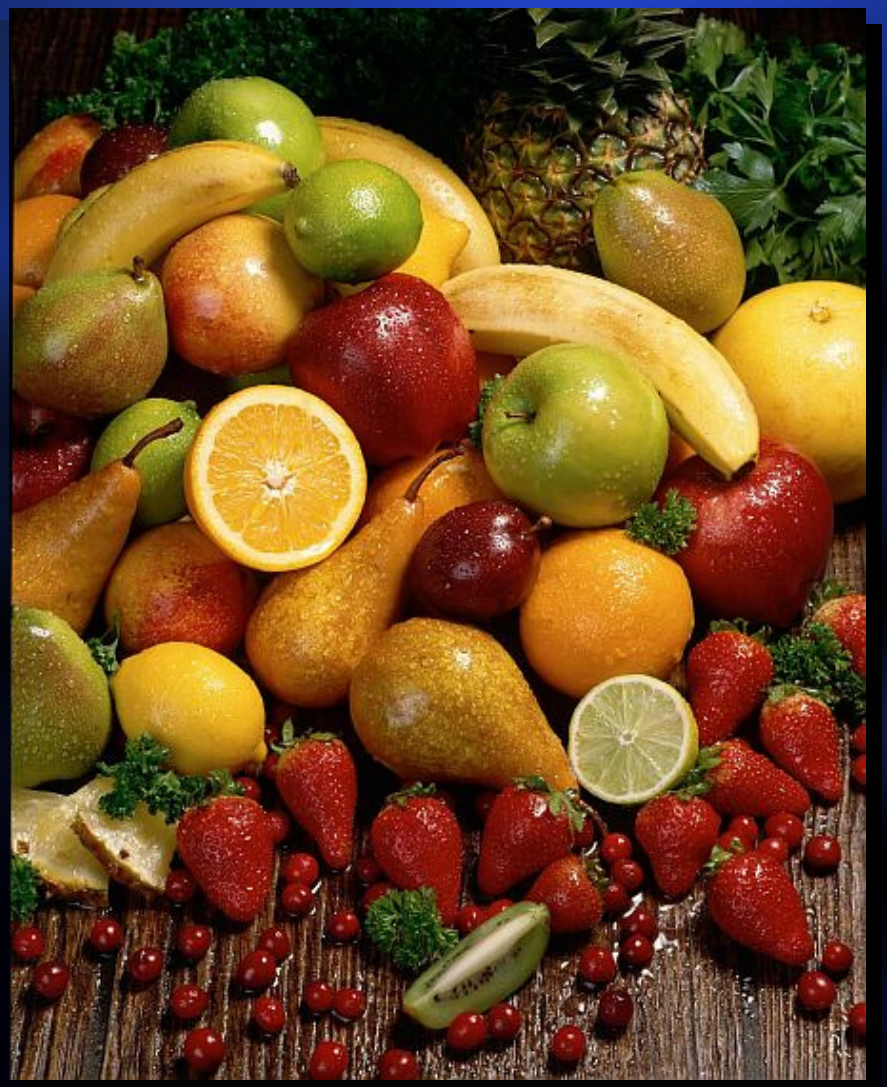
Rootworm-resistant corn under drought conditions

Golden Rice

- Milled rice has no beta-carotene
- Vitamin A deficiency - 200 million children and woman
- About 500,000 children go blind (60 every hour!)
- 2 million children die each year
- Golden Rice may provide one of the many solutions

Vegetables

Fruits

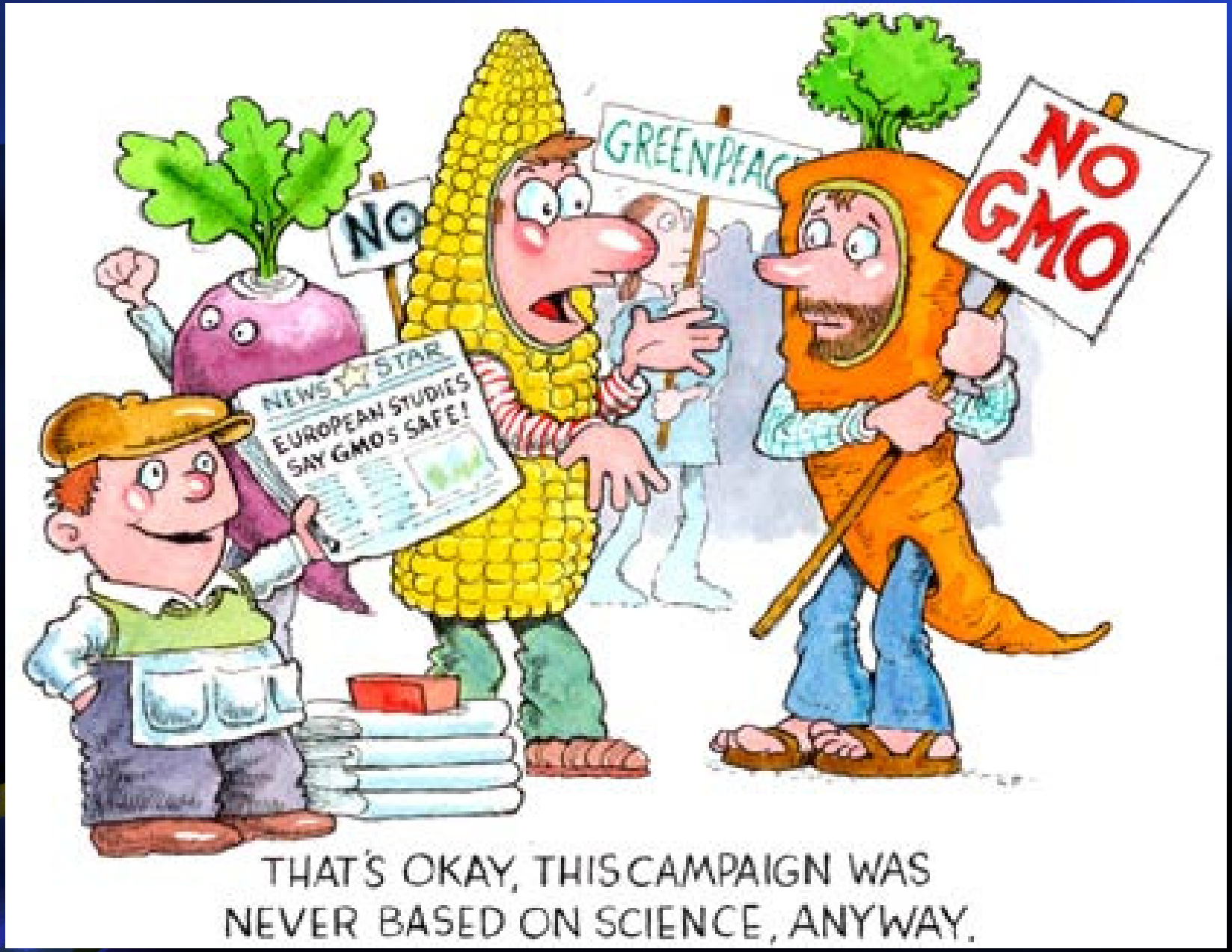


Potato


I WON'T EAT ANYTHING THAT'S GENETICALLY MODIFIED...
IT COULD BE UNHEALTHY...
CHIPS
Rex Babin is on vacation
Anderson / Courier Journa

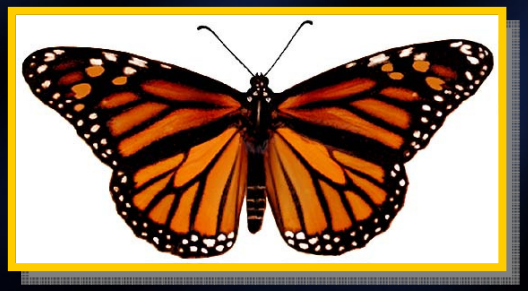
Is Safety an Issue?

- As Safe as Conventional Food
- Subject to High Regulation - FDA, EPA, USDA
- Every Product Tested on Case-by-Case
- Over Billion Acres Grown Since 1996
- More than 10,000 Food Products Contain GM
- Not One Single Instance of Hazard
- Dozens of Scientific Societies Have Endorsed it
- >5,000 Scientists plus 24 Nobel Laureates
- EU Scientific Commission - 'Safer than Conventional Food'


NO
GREENPEACE
NO GMO
NEWS STAR
EUROPEAN STUDIES SAY GMO'S SAFE!
THAT'S OKAY, THIS CAMPAIGN WAS NEVER BASED ON SCIENCE, ANYWAY.

Environmental Issues

- **What are the Ecological Effects of New Crops?**
- **Would Superweeds Emerge?**
- **Does Biotech Affect the Biodiversity ?**
- **Genetic Pollution**
- **Horizontal Transfer…..Will Bacteria or *I* get those genes?**
- **….What about Monarch Butterflies?**



Addressing Environmental Concerns

- Extensive Risk Assessment for the Past 15 years with 5,000 Field Studies; Careful Monitoring
- Evaluate Risk on a Case-by-Case Basis.
- Most Introduced Traits Not Unique to Biotechnology;
- Plant Breeding History - Introducing Novel Genes All the Time

Why Europe Dislikes Biotech Crops?

- Poorly understood science
- Lack of reliable information
- Mistrust of regulators
- Absence of consumer benefits
- Negative media opinion
- Opposition by interest groups
- Mistrust of the globalization and multinational corporations
- Lack of individual control
- Environmental release

Opposition and Hurdles to AgBiotech…

- **Regulatory environment (Precautionary Principle)**
- **Trade barriers (European pressure)**
- **Orchestrated public perception**
- **Imported environmental activism**
- **Negative media portrayal**
- **Food industry and retailers**
- **Organic food industry**

How Can Biotech Help Indian Agriculture?

- Improve Food and Nutritional Security
- Increase Crop Productivity
- Enhance Production Efficiency
- Reduce Crop Damage& Food Loss
- Promote 'Truly' Sustainable Agriculture
- Reduce Environmental Impact
- Empower the Rural Sector
- Reduce Economic Inequity

www.agbioworld.org

Thank you!