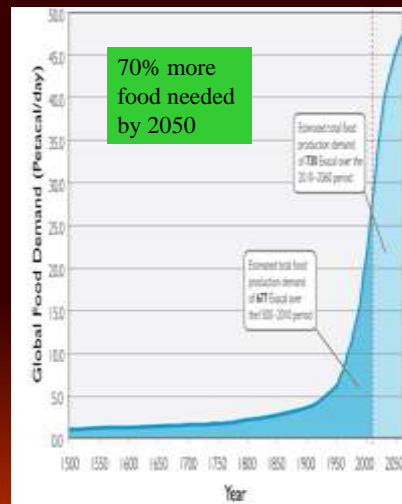
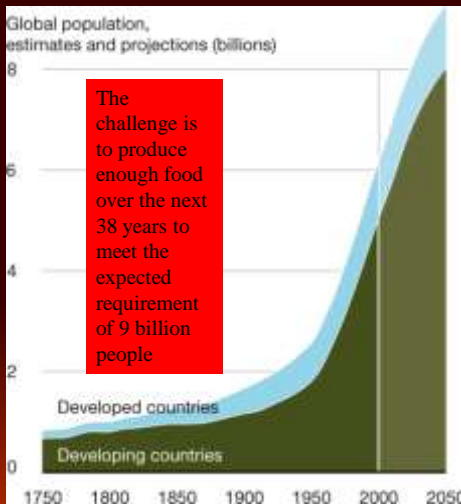
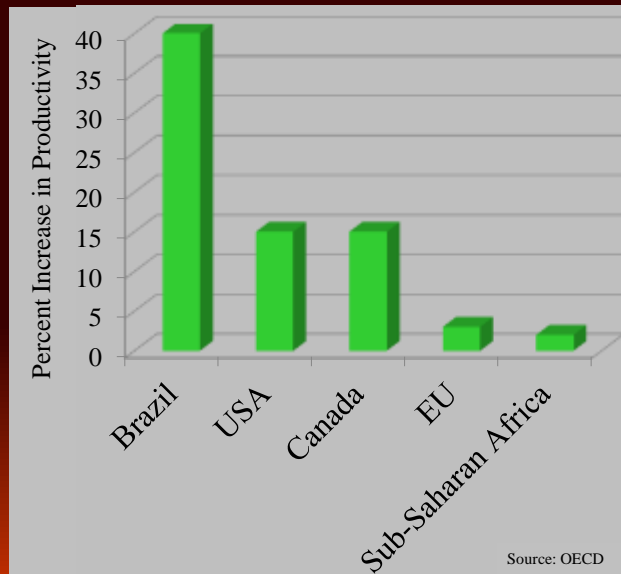


Global Population and Food Demand



Agriculture Production Trends 2010-2019



Food we eat has been genetically modified, through centuries of crosses, both within and between species.

Selective breeding led to higher-yielding varieties.



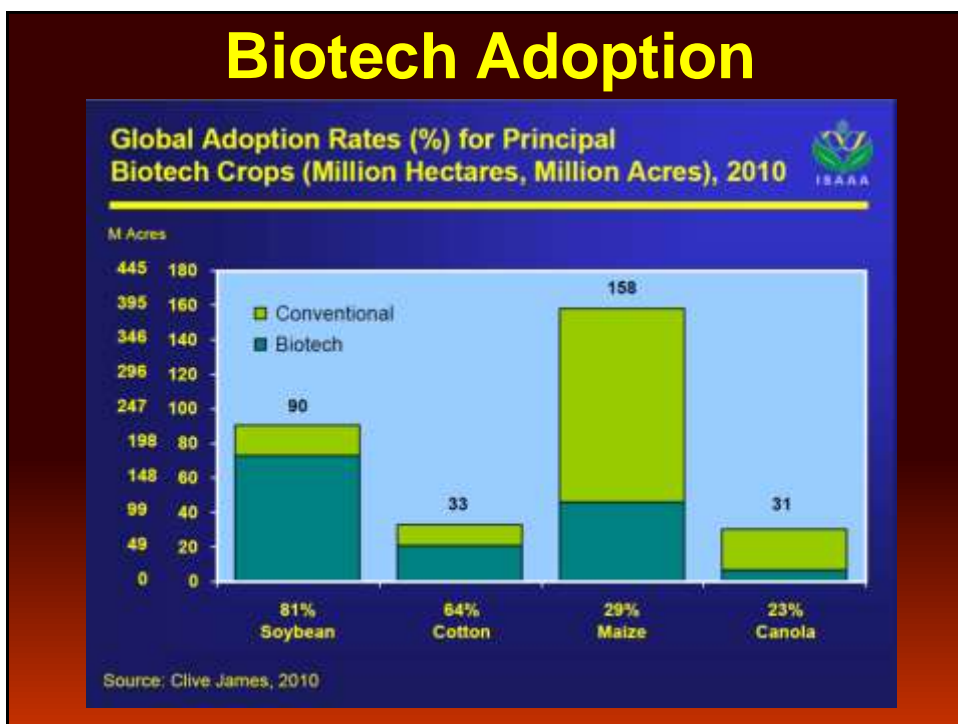
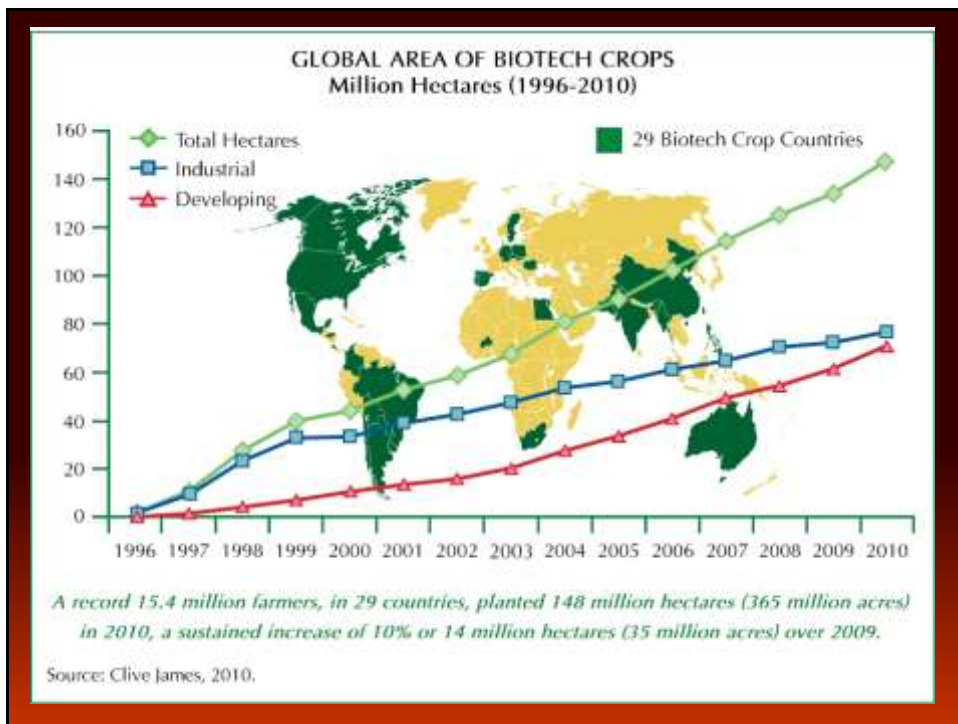
Teosinte



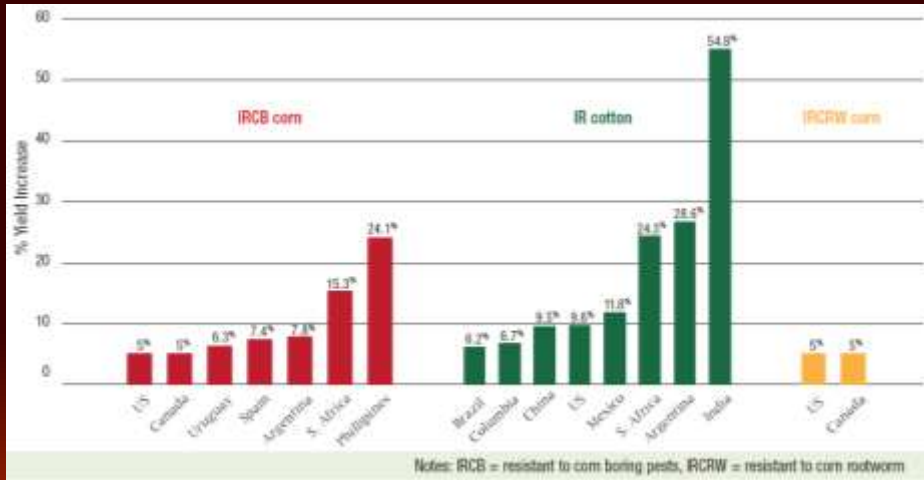
Modern corn

Benefits of Agricultural Biotechnology

- Desirable traits can be introduced without accompanying undesirable traits from e.g., wild plants.
- More beneficial for the environment because:
 - The incorporation of disease or insect resistance decreases the use of toxic pesticides.
 - Higher yields, so less land use.
 - Less soil erosion.
 - Drought tolerant crops now available.



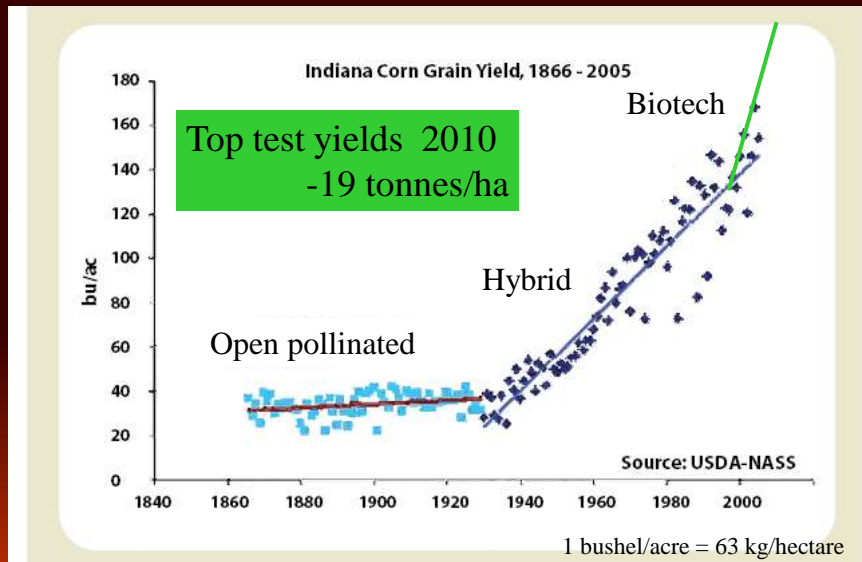
Biotech Crops Increase Productivity and Competitiveness



Biotech crops deliver significant yield increases to farmers

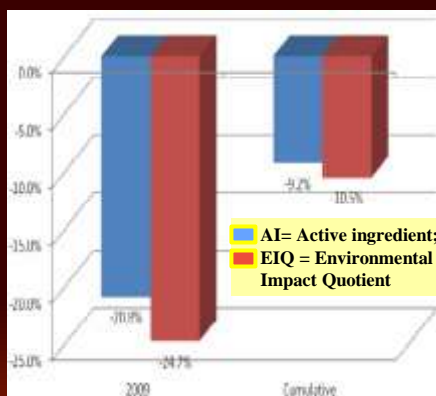
<http://www.pgeconomics.co.uk/pdf/focusonyieldeffects2009.pdf>

Yield Gains: Science Delivers



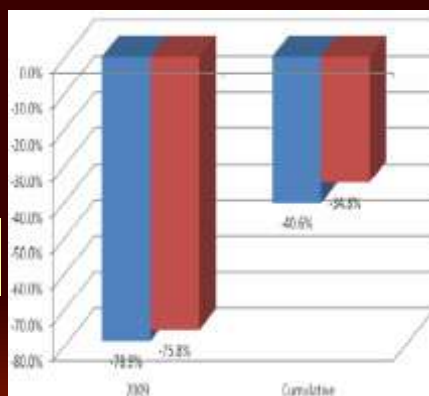
Biotech Crops Need Fewer Inputs

Reduction in Herbicide Use



Reduction in herbicide use and the environmental load from using biotech herbicide tolerant maize in adopting countries 1997-2009

Reduction in Insecticide Use



Reduction in insecticide use and the environmental load from using biotech insect resistant maize in adopting countries 1996-2009

PG Economics Ltd 2011

Biotech Crops Enhance Environmental Sustainability

- Minimized impact on natural resources and environment.
- Higher yields mean less land is needed for agriculture and can be available for wildlife.
- Decreased tillage means less soil erosion.

Land Area Saved for Wildlife by Biotech Crops

Additional conventional area required if biotech not used (m ha)

PG Economics Ltd 2011	2009	1996-2009
Soybeans	3.82	32.75
Maize	5.63	25.02
Cotton	2.58	14.40
Canola	0.34	2.80
Total	12.37	74.97

Biotech Crops Need Less Pesticide

Maize is subject to damage by various insects.



This may also lead to invasion by dangerous mold.



European corn borer damage and resultant fungal infection

Biotech Crops Need Less Pesticide

- The bacterium *Bacillus thuringiensis* (Bt), produces a Bt protein that is lethal to many insects; it inhibits an enzyme in insect gut. Animals are unaffected.
- The gene for Bt has been used to transform crops, so that the tissues contain Bt protein.
- This offers season-long protection against insects, reducing the need to spray for insect control.



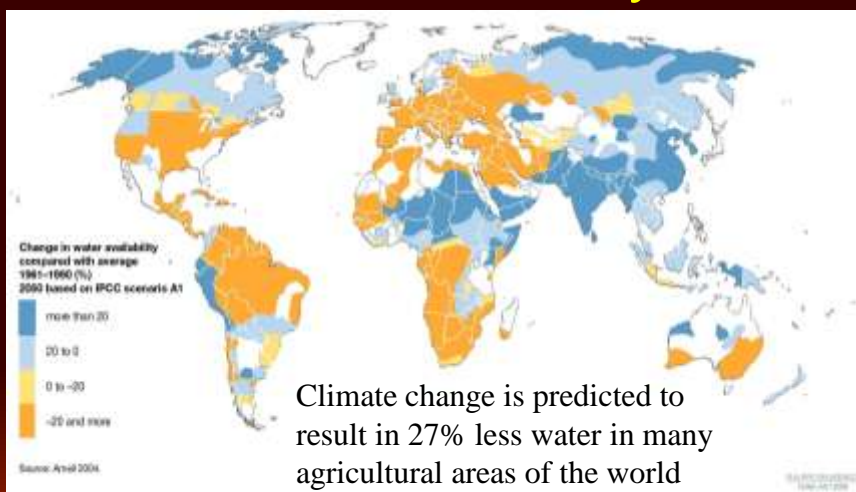
European corn borer damage and fungal infection in non-Bt (left) and Bt hybrids

Biotech Crops Enable Improved Weed Control

- An important biotech character in many biotech crops is herbicide resistance.
- The principal resistance is to glyphosate, a much safer herbicide.
- Glyphosate is safe because it targets a process that is only in plants, and not animals.
- Glyphosate breaks down rapidly in soil.



Water Availability



- New biotech crops can grow in drier areas, enhancing social and economic sustainability.

Biotech Crops Need Fewer Inputs

- Some new biotech crops need less water and allow crops to be grown in dry areas.



New corn drought-tolerant maize (right) needs less water.

Biotech Crops Enhance Food Security Worldwide

Disease-resistant,
insect-resistant
and
drought-tolerant
crops will help us
feed the world!



Papaya with ringspot disease



Biotech papaya resistant to ringspot disease

Papaya – a staple crop in SE Asia



New Biotech Crops with Enhanced Nutrition

Golden Rice

- High in vitamin-A precursor to prevent blindness in developing countries.

New Products Available

- Stacked traits:
 - E.g., Maize with eight added genes instead of just one.
 - The traits included protect against above-ground insects, below-ground insects, and provide broad herbicide tolerance.
- **Build towards biotech's promise of doubling yields by 2030 on the same or less land.**
- Delayed approvals present a problem.

Biotech Crop Benefits to Farm Management

- Biotech crops need fewer inputs.
- No-till farming.
- Fewer miles driven in the fields as fewer pesticide applications.
- Less labor required.

Some Products in the Pipeline

Enhanced nutritional qualities for consumers

- Tomatoes enriched with flavonols
- Soybean and canola oils with higher levels of oleic acid & vitamin E
- Vitamin-enriched rice
- Decaffeinated coffee



Biotech Crops Represent:

- Innovation
 - A more precise method of crop improvement.
- Competitiveness
 - Higher yields with fewer inputs.
- Sustainability
 - Less impact on the environment.



Biotech Myths

- Myth 1: Biotech food harms human health.
 - Thoroughly tested and no ill effects shown.
- Myth 2: Biotech crops harm the environment.
 - Enable *less* pesticide use; Safer herbicides.
 - No more invasive than conventionally bred crops.
- Myth 3: The selection method causes antibiotic resistance.
 - Never found.
 - New selection methods don't rely on antibiotics.

Biotech Myths

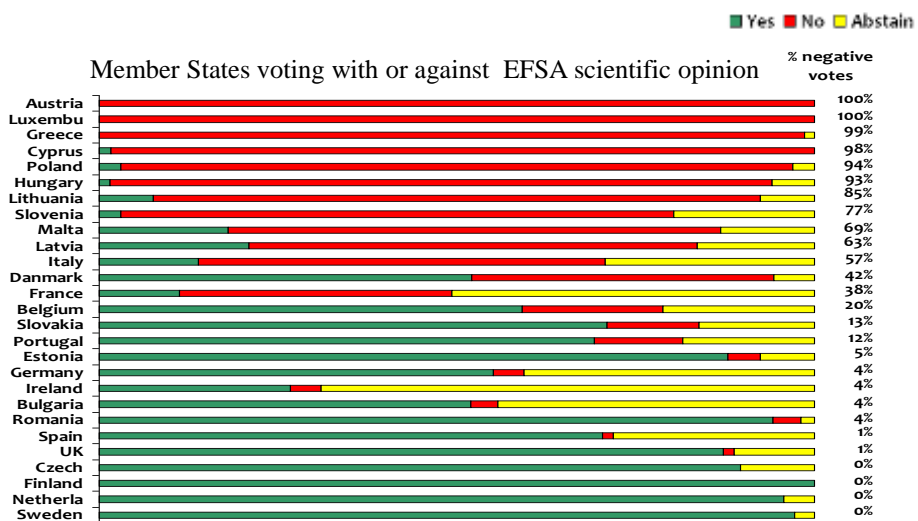
- Myth 4: Biotech crops are uniquely subject to onerous patents.
 - No different from conventionally bred crops and many other farming innovations.
- Myth 5: Opposition targets multinationals.
 - Multinationals are the producers of conventional and organic seeds.
 - Unfounded fears about biotech crops have led to a complex regulatory process that only large multinationals can afford, penalizing small developers of beneficial biotech products, such as universities.

Biotech Crops Are Safe to Grow and Eat

- Biotech crops have been extensively examined by European science and food safety authorities and declared to be totally safe.
- Biotech crops have been consumed by Americans for over 15 years with no ill effects.
- There is not a single documented case of illness or allergy caused by biotech crops.
- The environmental effect of biotech crops is no different from that of traditionally-bred crops of the same species.

Additional slides for answers to any questions

EU biotech crop authorisation voting



The chart shows that over half the countries vote support the EFSA scientific opinion on Biotech crop adoptions most of the time

EuropaBio

Potential Problems: Resistance to GE-related pesticides

Superweeds?:

>> No! Just resistant to the herbicide glyphosate.



Superbugs?:

>> No! Just resistant to one form of Bt.

Both can be prevented by good farming practices:

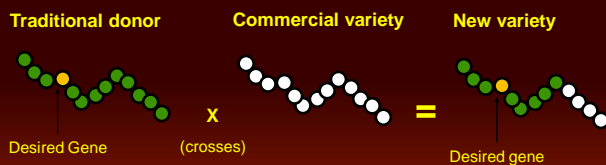
- Rotations of crops and herbicides.
- Interplanting a small % of non-Bt plants with Bt plants.
- Stacked traits (multiple Bt forms) help prevent resistance.

Traditional Breeding

- New varieties were created by crossing or through mutations induced by treating seeds with chemicals or radiation.
- Large numbers of genes of unknown function are transferred or modified to produce new food varieties.
- Then selection is needed to eliminate the undesirable characteristics.
- Only characteristics naturally available in that species can be used.

Traditional Breeding

- Large pieces of chromosome are moved, often bringing in undesirable traits (e.g., poor product quality) with the desirable (e.g., pest resistance).



DNA is a strand of genes, much like a strand of pearls.

Traditional plant breeding moves and combines many genes at once.

Plant Genetic Engineering

- Genetic engineering of plants does what plant breeders have been doing for thousands of years (i.e., moving genes around), but does so much more precisely.

Plant Biotechnology



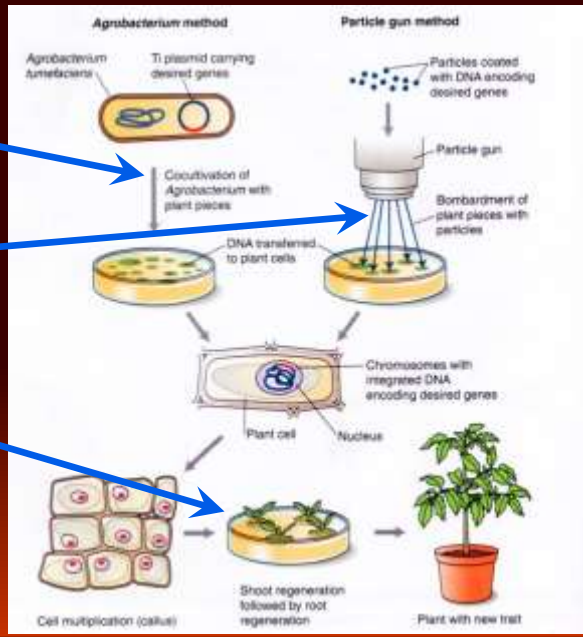
Using plant biotechnology a single gene may be added to the strand.

- *Gene splicing is the most refined, precise and predictable method of genetic modification because the function of the transferred gene or genes is known.*

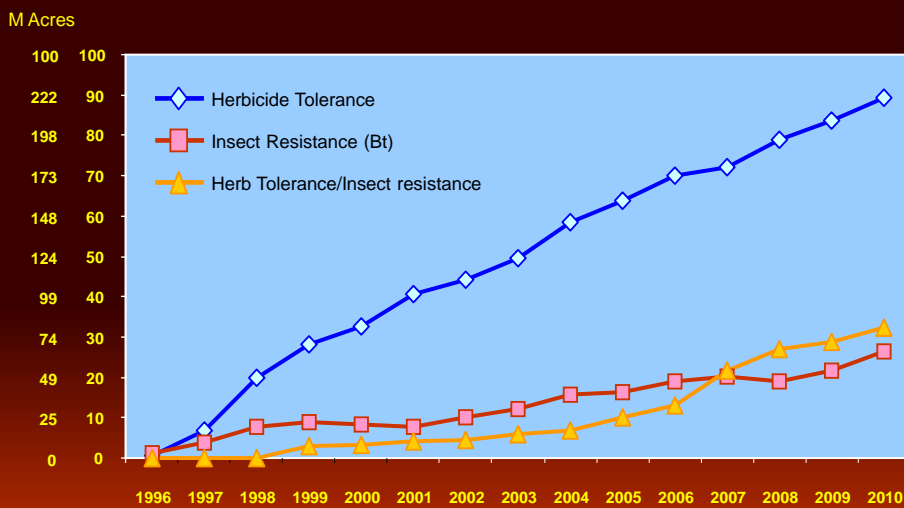
How Biotech Crops are Made

Genes are introduced into plant cells using:
a natural bacterium
or
a gene “gun”.

Then intact plants are generated using tissue culture and reproduced by seed.

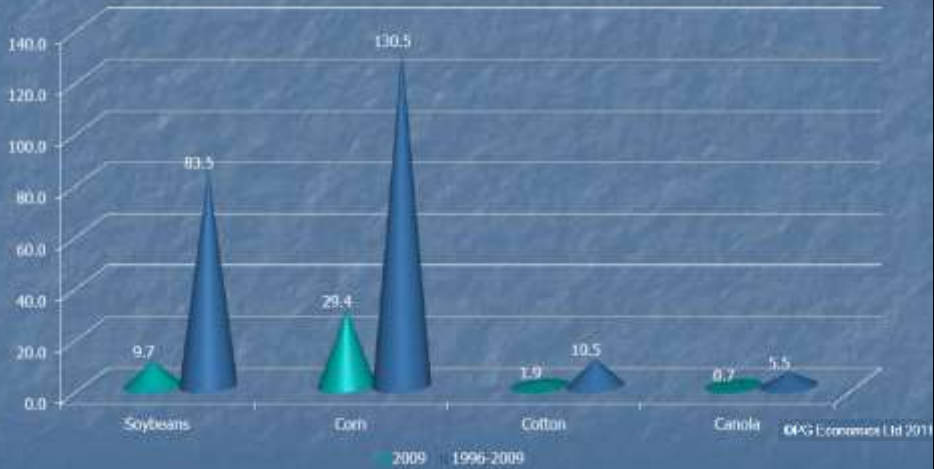


Global Area of Biotech Crops, 1996 to 2010: By Trait (Million Hectares, Million Acres)



Source: Clive James, 2010

Additional crop production arising from positive yield effects of biotech traits 1996-2009 (million tonnes)



Herbicide resistance

- Glyphosate (Roundup) is a herbicide that inhibits the enzyme involved in the biosynthesis of compounds essential for plant growth.
- Animals do not have this enzyme.
- Glyphosate breaks down rapidly in soil.

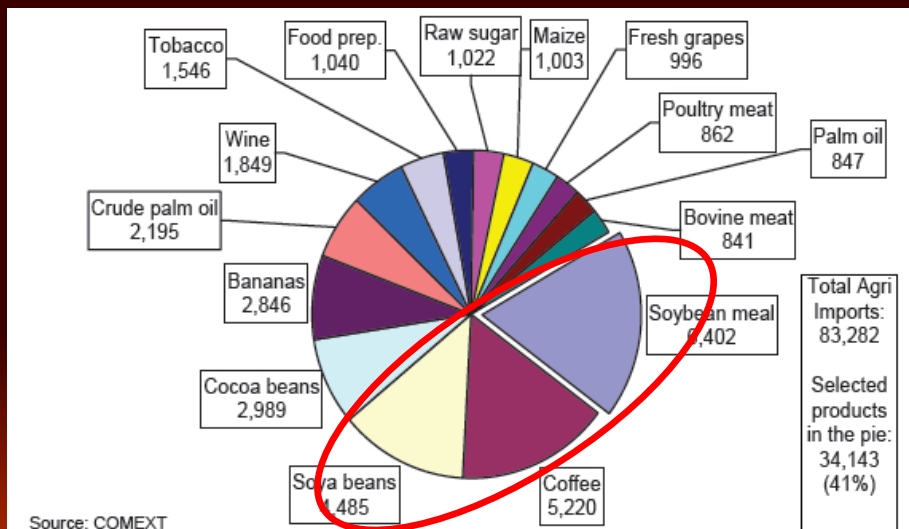


Herbicide resistance

- Glyphosate resistant (Roundup Ready®) crop plants have a single added glyphosate-tolerant enzyme that does the same biochemical syntheses.
- These plants are unaffected by glyphosate.



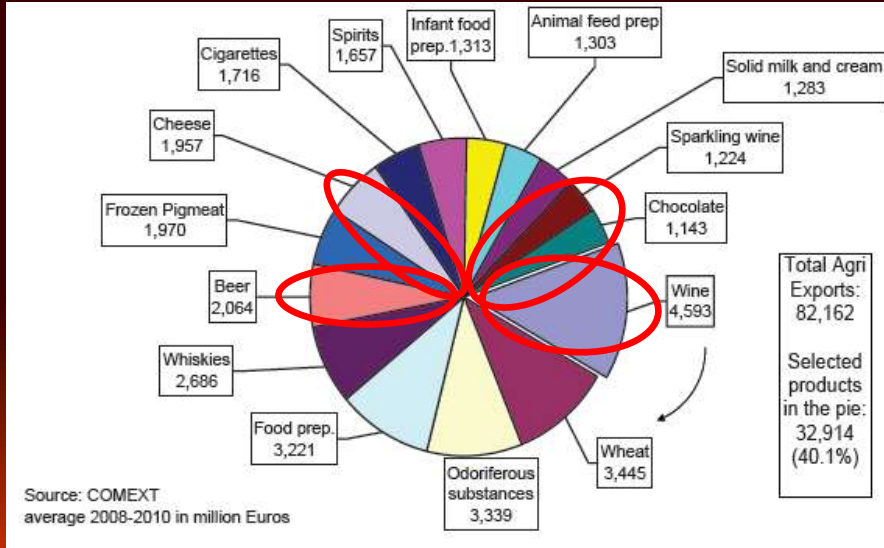
EU Imports



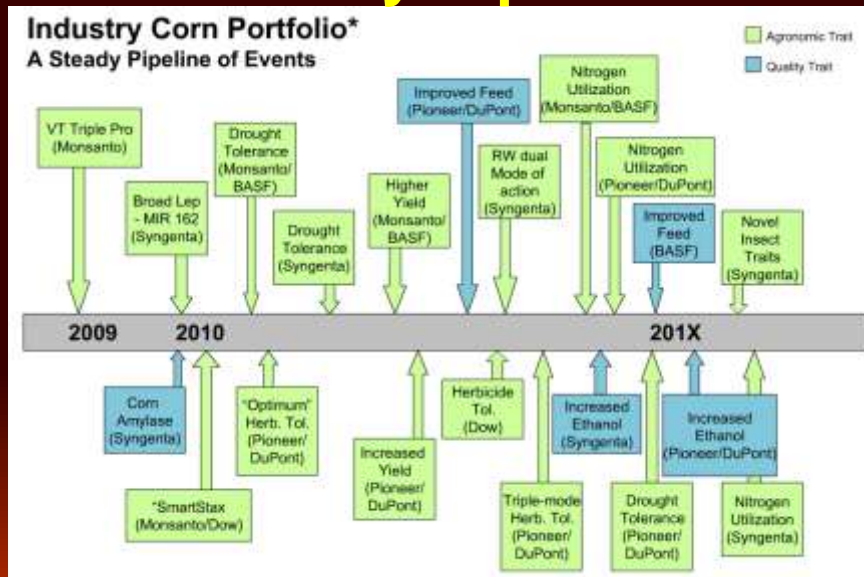
Source: COMEXT
average 2008-2010 in million Euros

Crops that feed the world!

EU Exports



Healthy Pipeline



A Problem: Slow / Broken Regulatory Systems