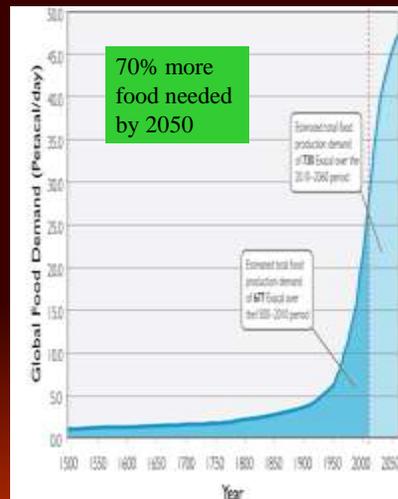
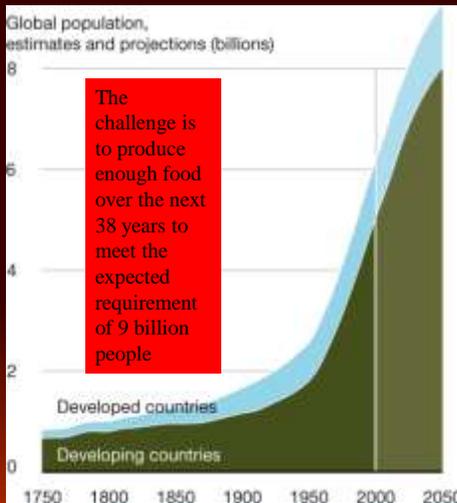
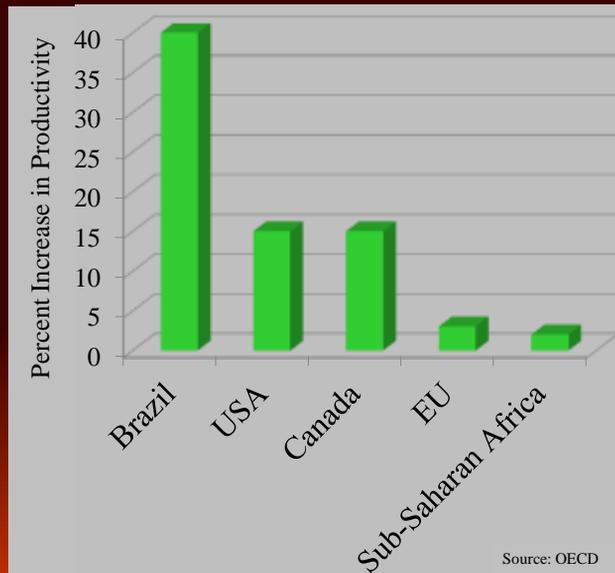


## Global Population and Food Demand



## 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.



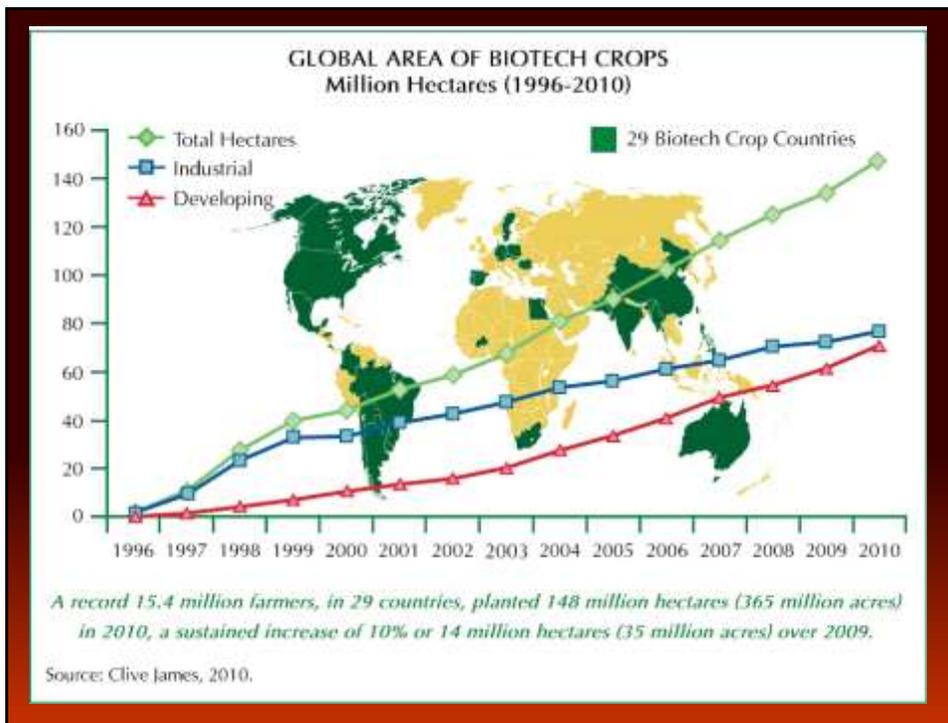
Teosinte



Modern corn

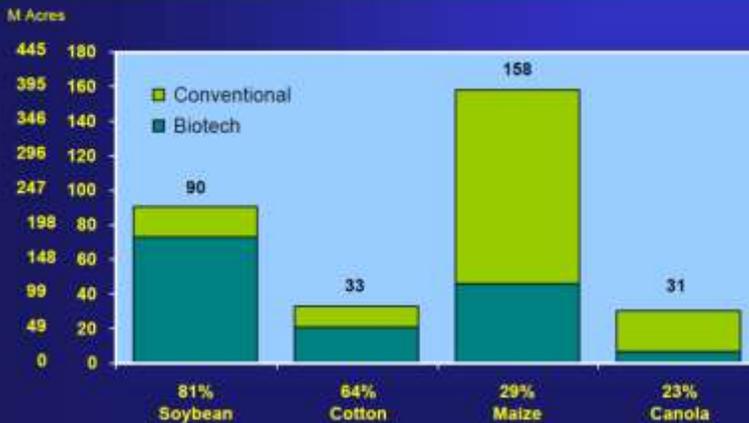
## Benefits of Agricultural Biotechnology

- 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.



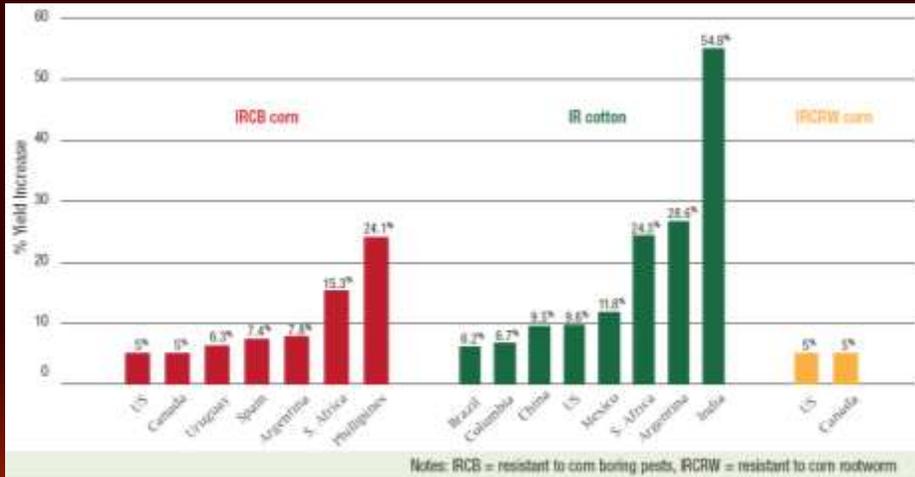
## Biotech Adoption

**Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2010**



Source: Clive James, 2010

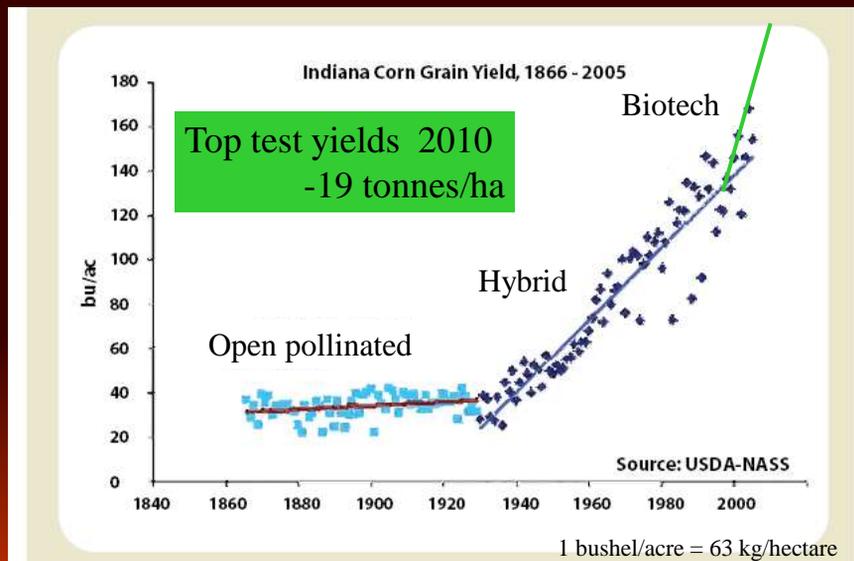
## Biotech Crops Increase Productivity and Competitiveness



Biotech crops deliver significant yield increases to farmers

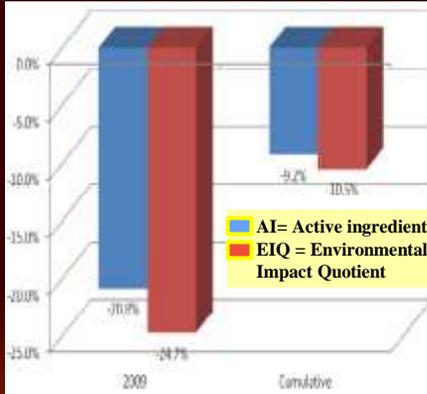
<http://www.pgeconomics.co.uk/pdf/focusonyieldeffects2009.pdf>

## Yield Gains: Science Delivers



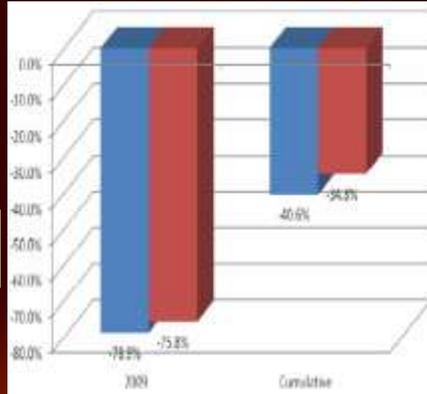
# Biotech Crops Need Fewer Inputs

## 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
<b>Total</b>	<b>12.37</b>	<b>74.97</b>

## 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.



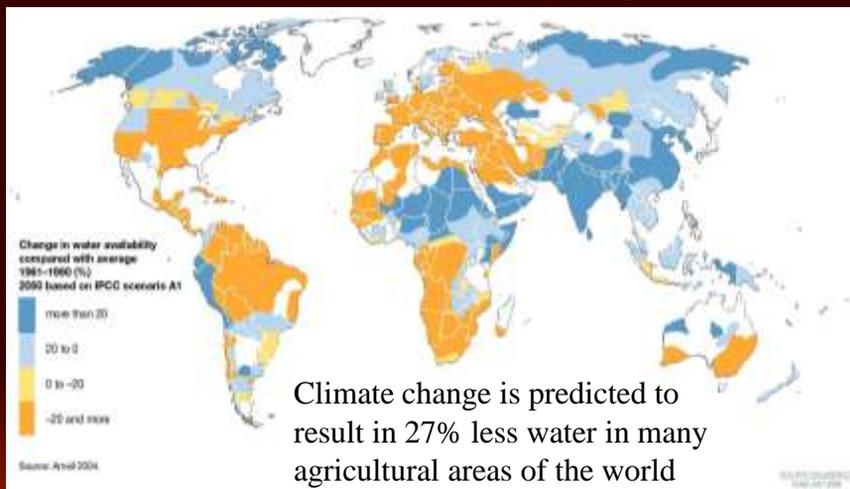
European corn borer damage and fungal infection in non-Bt (left) and Bt hybrids

## 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

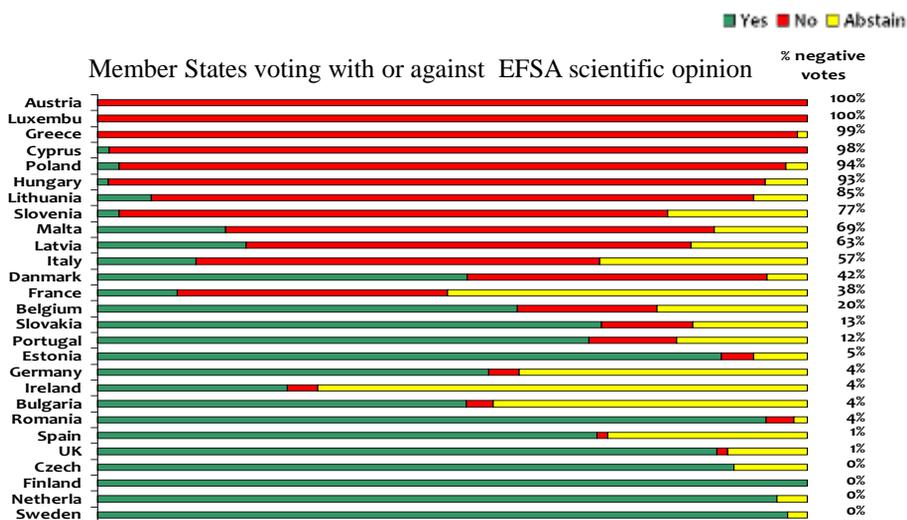
- Myth 4: Biotech crops are uniquely subject to onerous patents.
  - No different from conventionally bred crops and many other farming innovations.
- Myth 5: Opposition targets multinationals.
  - Multinationals are the producers of conventional and organic seeds.
  - Unfounded fears about biotech crops 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:

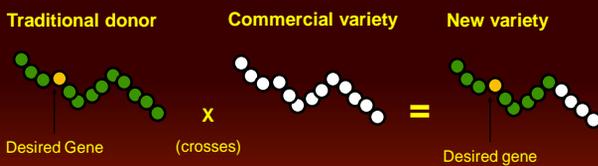
- Rotations of crops and herbicides.
- Interplanting a small % of non-Bt plants with Bt plants.
- Stacked traits (multiple Bt forms) help prevent resistance.

## 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



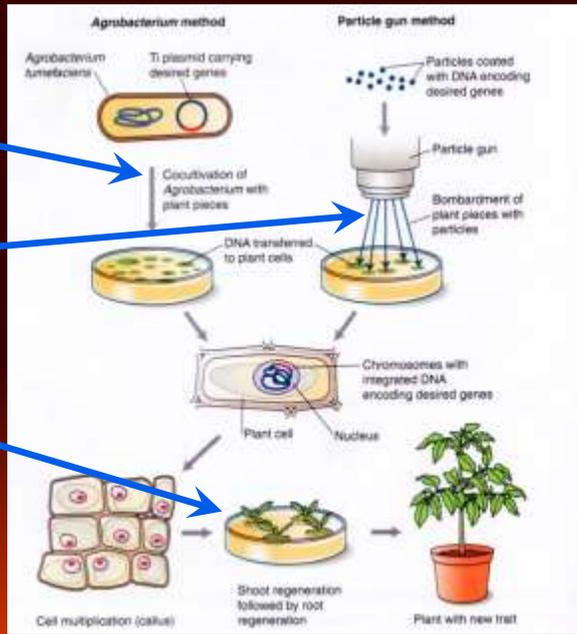
Using plant biotechnology a single gene may be added to the strand.

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

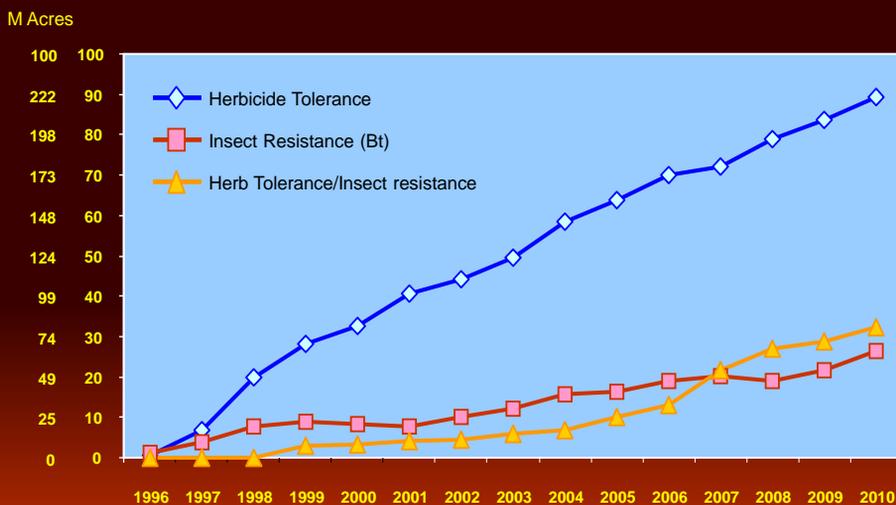
# How Biotech Crops are Made

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.

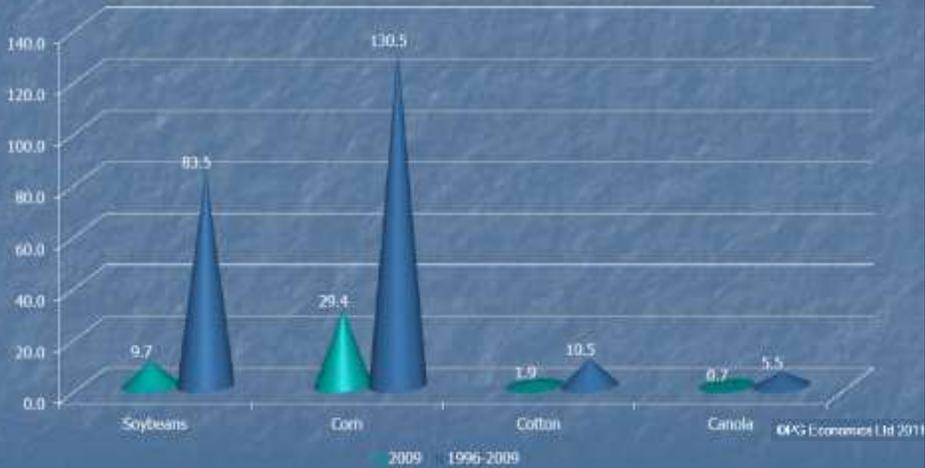


## Global Area of Biotech Crops, 1996 to 2010: By Trait (Million Hectares, Million Acres)



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.

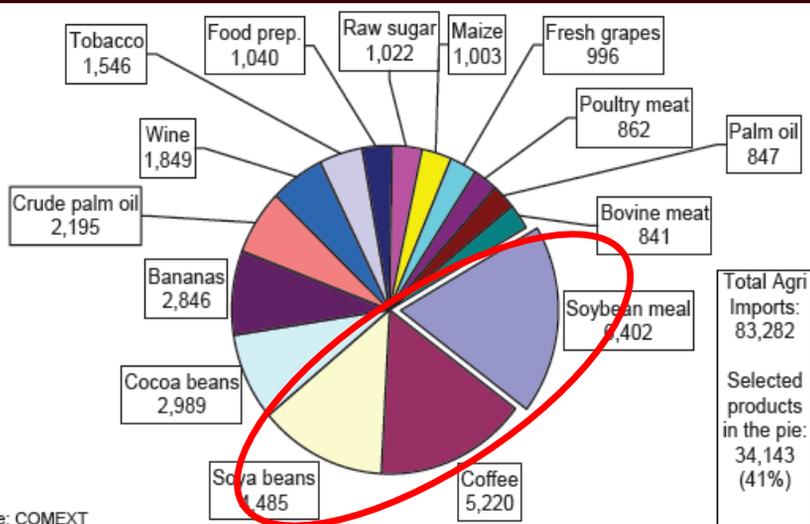


# Herbicide resistance

- 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.



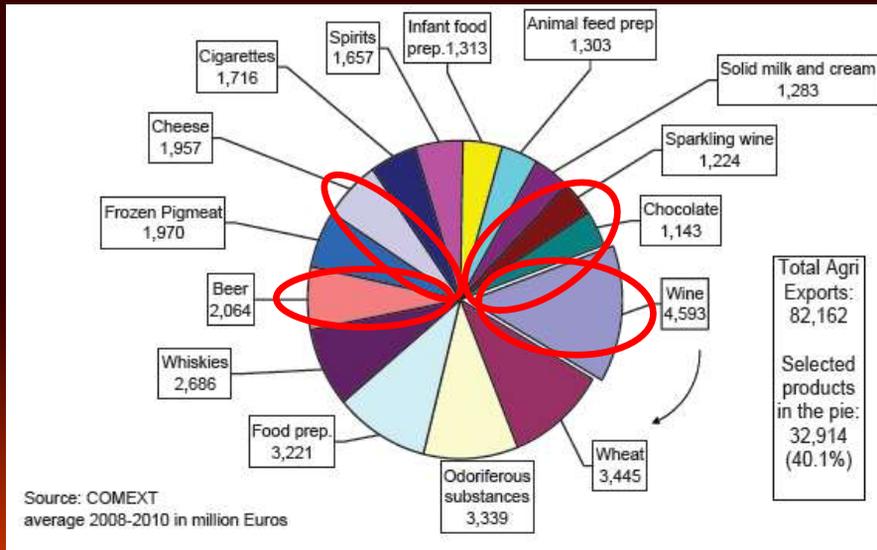
# EU Imports



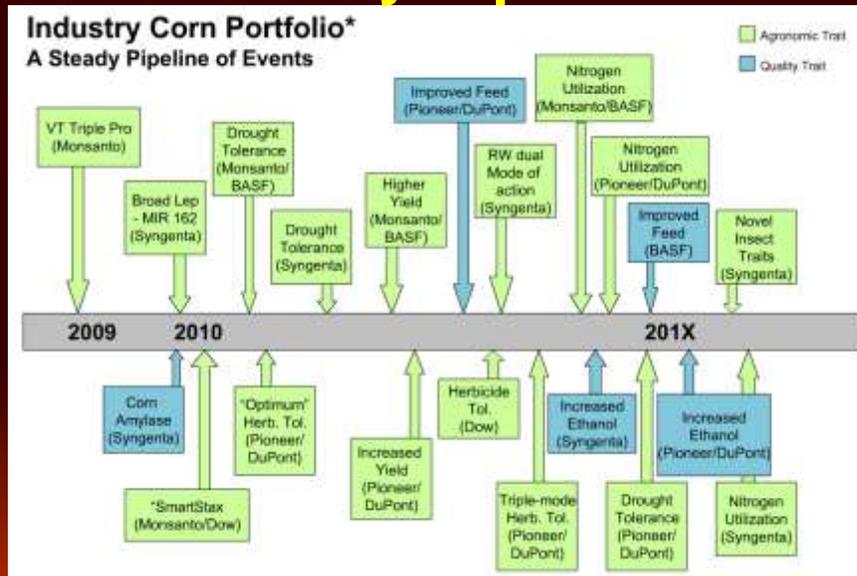
Source: COMEXT  
average 2008-2010 in million Euros

Crops that feed the world!

# EU Exports



# Healthy Pipeline



A Problem: Slow / Broken Regulatory Systems