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# Review of current and future GM event developments for each cereal species



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# THE CURRENT CROPS\*TRAITS CULTIVATED

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## Herbicide resistance

- Glyphosate resistance
- Glufosinate resistance
- Bromoxynil resistance

## Insect resistance

- Lepidopteran resistance
- Coleopteran resistance

## Virus resistance

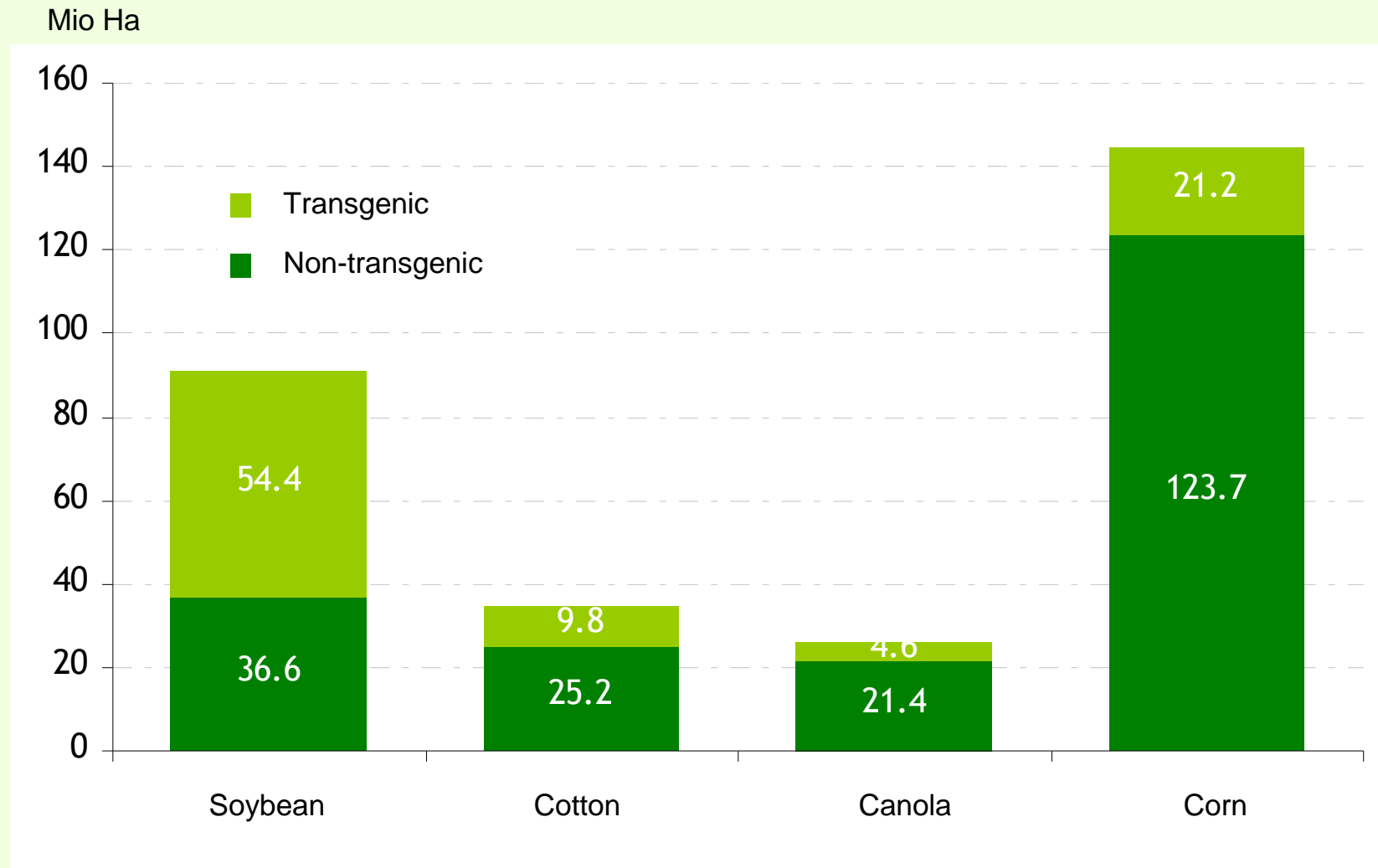
- Different resistance

**and stacking of different genes,**

**on soybean, corn, cotton, canola, papaya, squash, ...**

# A SELECTIVE ADOPTION (1)

Adoption differs considerably according to crops and traits



From ISAAA 2005

# A SELECTIVE ADOPTION, WHY ? (1)

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## **Glyphosate tolerant soybean : a very quick adoption**



- Conventional herbicide treatments are seldom fully successful and RR soybean planting allows :

**simplification of cropping systems**

**herbicides treatments made easier**

**broader treatment slot**

**one single non phytotoxic product**

**reduction of costs of production**

**herbicide cost**

**low or no-tillage production**

**(machinery and fuel costs saving)**

**reduction of environmental impact**

**product profile**

**CO2 emission and carbon sequestration**

...

# A SELECTIVE ADOPTION, WHY ? (2)

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## **Insect resistant corn: a reasoned adoption**



- Insect infestation pressure is variable in year and area : farmer choice is balanced

adoption preferred by « small » farmers in some areas in the US, often as an « insurance » approach

production increase of 5 to 9%

reduction of environmental impact  
around 1000 t/year less insecticide (a.i.)

reduction of mycotoxins accumulation : an economic impact of 17 MUSD

...

# A SELECTIVE ADOPTION, WHY ? (3)

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## **Insect resistant cotton: a multiple criteria adoption**



- Insect infestation pressure is important every year and in every area : insect species are numerous, varieties and fiber qualities are diverse:

**production increase of 5 to 35%**

**increase and stabilization of incomes**

**reduction of environmental impact**

**limited in the US, more important in China**

**reduction of adverse effects on health,**

**increase of fiber quality**

**...**

# THE MAIN PLAYERS IN BIOTECH

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## MONSANTO

- - 32 events (26)
  - Soybean 40-3-2
  - Corn 810, 863, GA21, NK603
  - Cotton 15985, 1445
  - Canola GT73, RT73, GT200
  - Wheat 71800

## PIONEER-DOW

- - 4 events (4)
  - Corn 1507, 59122

## SYNGENTA

- 4 events (4)
  - Corn 176, Bt11
  - Cotton 102

## BAYER CROP SCIENCE

- - 15 events (15)
  - Corn T14, T25
  - Cotton LL25

## Global ranking (seeds)

**1 PIONEER-DOW**

**2 MONSANTO**



**3 SYNGENTA**

...

**7 BAYER CROP SCIENCE**



# WHO SELLS BIOTECH SEEDS ?

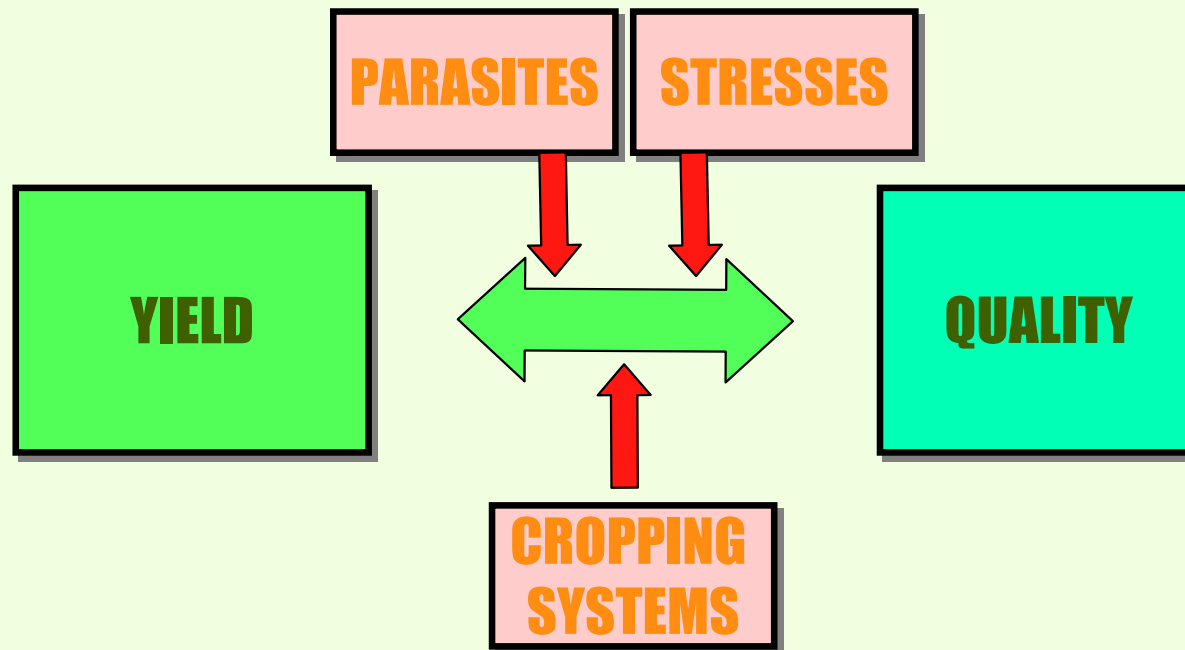
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## In the US and in most countries :

- seed and breeding companies, distributors,  
through licence agreement, paying (and collecting) tech fees  
to technology providers,  
this marketing approach supports innovation spreading  
this generates yearly several MUSD of revenues for the  
leading biotech company !

# BREEDING AND BIOTECH ORIENTATIONS

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Targets for research and new products have to meet with an:

- interest for the farmer,
- interest for the processor (industry),
- interest for the consumer.

# WHERE, FROM THE SITUATION OF 2006 ?

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**First generation traits (HT) are now considered as basic traits**

**farmers want them as a standart**

**many companies are licensees**

**some companies are preparing « me too » and/or  
developping resistance to « new » herbicides**

**traits are present in the breeding germplasm**

# COMING VERY SOON

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## **New herbicide resistance events**

based on broad spectrum herbicide  
(NK603, GA21, 1507, and new soybean events)

## **New insect resistance events**

(88017, new ECB)

for better efficiency (dose, new targets, improved expression, ...)

for IP conflicts, for IP renewal

for regulatory requirements

# AGRONOMIC TRAITS (1)

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## Traits for yield and farmer interest :

**Herbicide resistance (cotton, canola)**

**new events, new resistances**

**Drought tolerance (corn)**

**expression of transcription factors**

**Drought tolerance (soybean, cotton)**

**expression of transcription factors**

**Nitrogen use efficiency (corn)**

**better uptake and utilization**

***Fusarium* resistance (wheat)**

**protected yield and quality**

# AGRONOMIC TRAITS (2)

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## Traits for yield and farmer interest :

*Fusarium* resistance (corn)

protected yield and quality

Insect resistance (soybean)

nematods

Yield (soybean and canola)

improvement

(High lysine corn

feed improvement

Increased phytase

feed improvement )

# QUALITY TRAITS (1)

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## Traits for quality and processor benefit :

**High lysine corn**

**feed improvement**

**Increased phytase**

**feed improvement**

**Feed improvement (corn and soybean)**

**protein balance**

**Extractible starch (wet milling) (corn)**

**get more starch from the same corn  
quantity**

# QUALITY TRAITS (2)

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## Traits for quality and processor benefit:

**Increase of “fermentable” (corn)**

**use whole plant as raw material**

**Starch quality (corn and wheat)**

**high-amylose, “waxy”, etc**

**Food and feed improvement (soybean)**

**protein and fatty acids composition**

# QUALITY TRAITS (3)

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## Traits for quality and consumer benefit:

**Fatty acids profile modification (soybean)**

**several steps low linolenic,**

**high oleic low saturated,**

**omega 3 fatty acids**

**Protein profile modification (soybean)**

**improved taste**

**“Golden” rice**

**enriched in pro-vitamin A**

# NON-FOOD OR -FEED MODIFICATIONS

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## Wide markets for non-food use:

**Biofuels : ethanol (others ?)**

**USA has a leading position**

**Lubricants**

**based on special fatty acids (cyclic, branched, etc)**

**Biodegradable polymers**

**new old projects ?**

## Possible uses on specialized markets:

**High added value**

**bioactive compounds, ...**

# NEW TARGET PLANTS ?

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**Always on “big crops” :**

corn and soybean,

**Adding a new one : rice, coming *via* Iran and China :**

insect resistance, herbicide resistance, disease resistance later

**Wheat will stay apart for acceptability reasons**

herbicide resistance, *Fusarium* resistance, starch quality

# NEW BREEDING STRATEGIES ?

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## A combined approach of genomics, marker-assisted breeding and transgenes insertion



first input traits are present in the germplasm (direct breeding vs. back-crossing)

initial breeding crosses are followed by extensive genotyping

true for complex traits (agronomic and quality improvement)

yield is still the major target ahead of quality

# BOTTLENECKS

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## Technical limitations

fatty acid accumulation

## Marketing costs (regulation)

niche markets are excluded (for long / always ?)

## Public perception, consumers, opponents (European side, notably)

introduce delays, threat for economy, but with a real long-term effect ?

# AND THE FUTURE OF EUROPEAN GMOs (1)?

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## Research and innovation

elsewhere (USA, China, India ... developing countries)

## Agricultural production

still at a high level, but lacks competitiveness and some productions

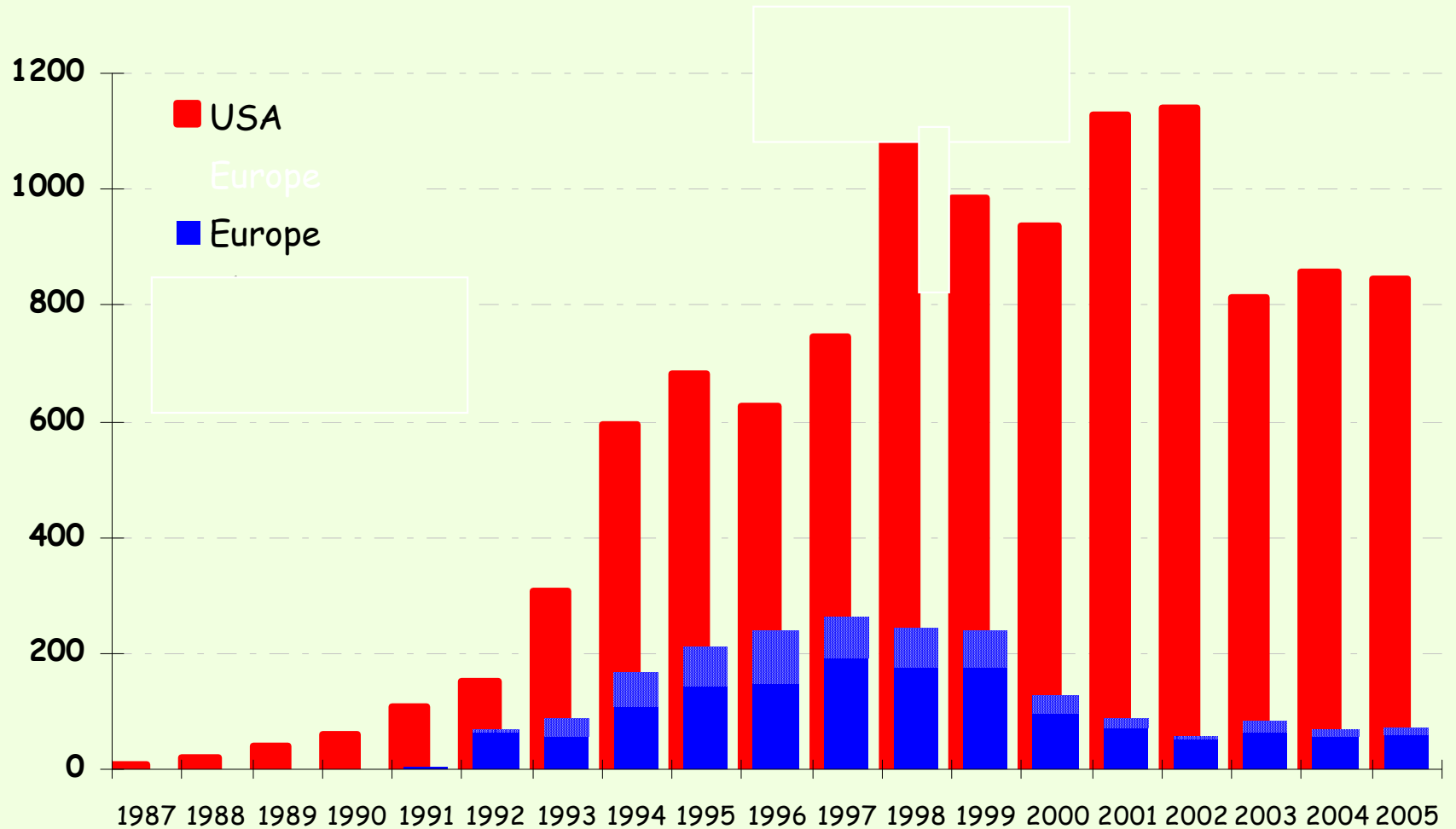
## Political standpoints

a mix of reality (necessity of food quantity and quality) and fantasies

# AND THE FUTURE OF EUROPEAN GMOs (2)?

## Field trials notifications in the US and Europe

A strong reduction of field trials number in Europe :  
- 70%  
between 1998 and 2005



Source : NBIAP, JRC 2005

# AS A CONCLUSION

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- Development of biotech crops (transgenic) is now a part of history ....
- Agronomic traits, with a potential of wide-spreading are favoured and combined through stacking. Quality traits are at first targeted for processing.
- Transgenesis is primarily a research tool whose applications bring new traits and also support genomics and marker-assisted breeding.
- All new plant varieties will not be transgenic but all varieties will be created using knowledge issued from transgenic approaches.
- European situation is strange : favouring imports, prohibiting *de facto* cultivation, disadvantaging both its farmers and its agronomic research .... for a sustainable agriculture.