

# Overview of the global pipeline of GM crops and 2020 outlook

Claudia PARISI  
EC-JRC-IPTS



[www.jrc.ec.europa.eu](http://www.jrc.ec.europa.eu)

*Serving society*

*Stimulating innovation*

*Supporting legislation*

**GMCC-15** Amsterdam

19<sup>th</sup> November 2015

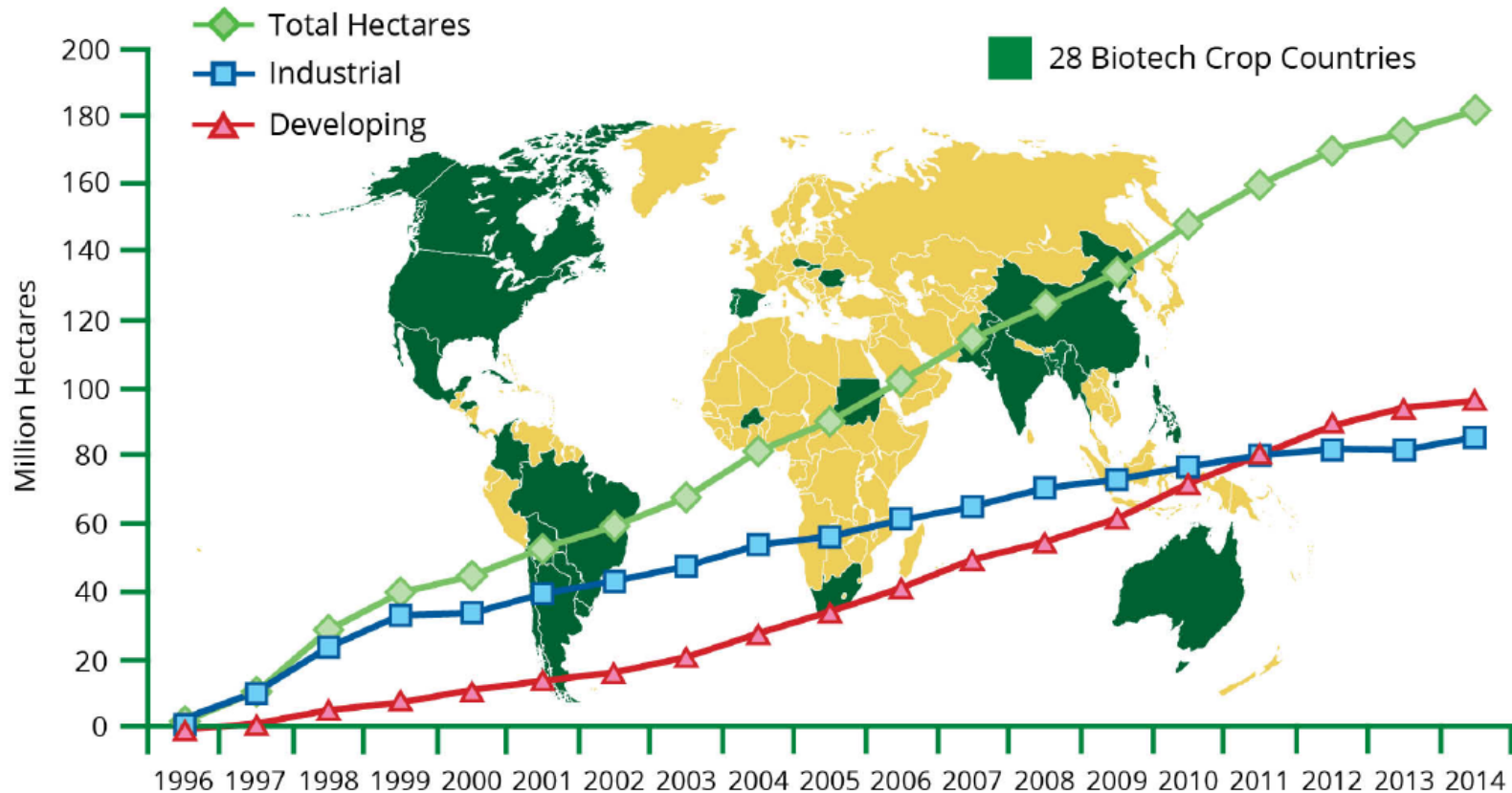
# OUTLINE

- **The global pipeline of GM crops**
  - 2008 study
  - 2014 study: methodology and results
- **Low Level Presence Implications**
- **Conclusions**
- **Future Trends in Biotechnology**



# Global Status of Commercialized GM Crops: 2014

*181.5 million hectares GM crops in 28 countries*



# GM crop pipeline: 2008 Study

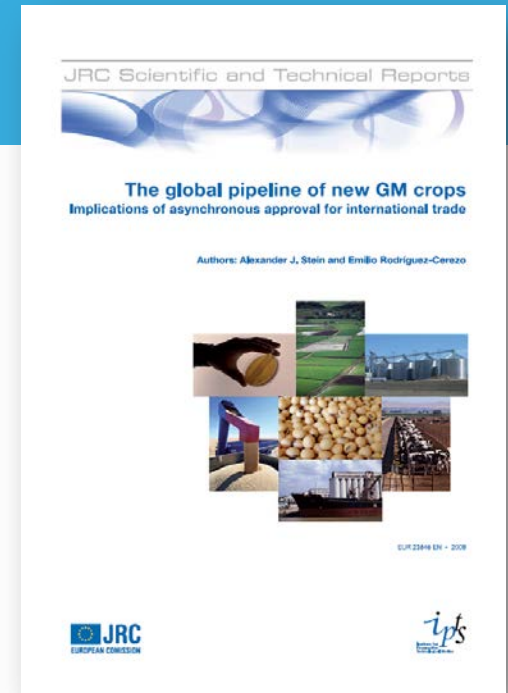


**Context of the study:** first incidents of GM crop  
Low Level Presence (LLP) and trade disruption.

**Main objective:** to assess the likelihood of future  
LLP incidents of unapproved GM material in crop  
shipments and to understand related impacts on  
global trade.

## **Main results:**

- 42 GM events authorised in at least one country, of which 33 cultivated
- Main GM crops: Cotton, Maize, Soybean, Oilseed rape
- Main traits: Insect resistance, Herbicide tolerance
- Main developers: US- and Europe-based Multinational Companies
- Projections 2014:
  - 103 GM events on the market (higher LLP risk)
  - Half of new GM events brought to the market by players from developing countries
  - Quality traits slowly emerging



# GM crop pipeline: 2014 Study

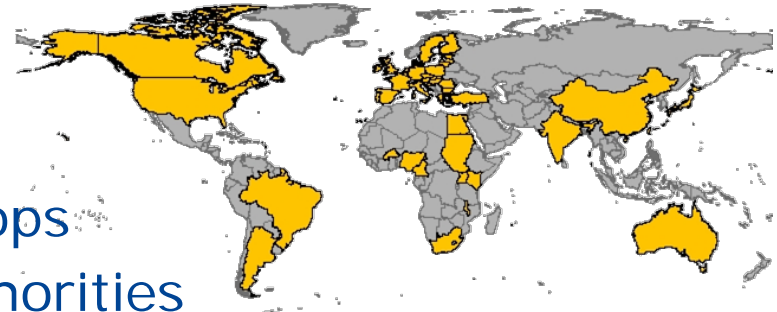


**Objectives:** to depict the orientation taken by biotechnology innovations in agriculture and its consequences for many players in the commodity supply chain and regulatory/authorization bodies.

**Methodology:** build a database of GM crops in the following development stages:

<b>Commercial cultivation</b>	GM events that are currently cultivated and commercialized in at least one country worldwide
<b>Pre-commercial stage</b>	GM events that are authorized for cultivation in at least one country worldwide but not yet marketed
<b>Regulatory stage</b>	GM events that are under assessment for authorization in at least one country worldwide
<b>Advanced R&amp;D stage</b>	GM events not yet in the regulatory process but at late stages of development.
<b>Early R&amp;D stage</b>	GM events for which a proof of concept has been obtained.

# GM crop pipeline: 2014 Study



## Sources of information:

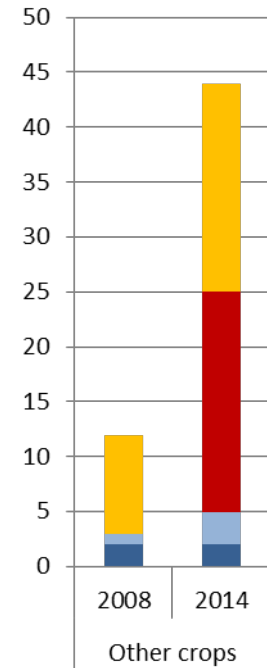
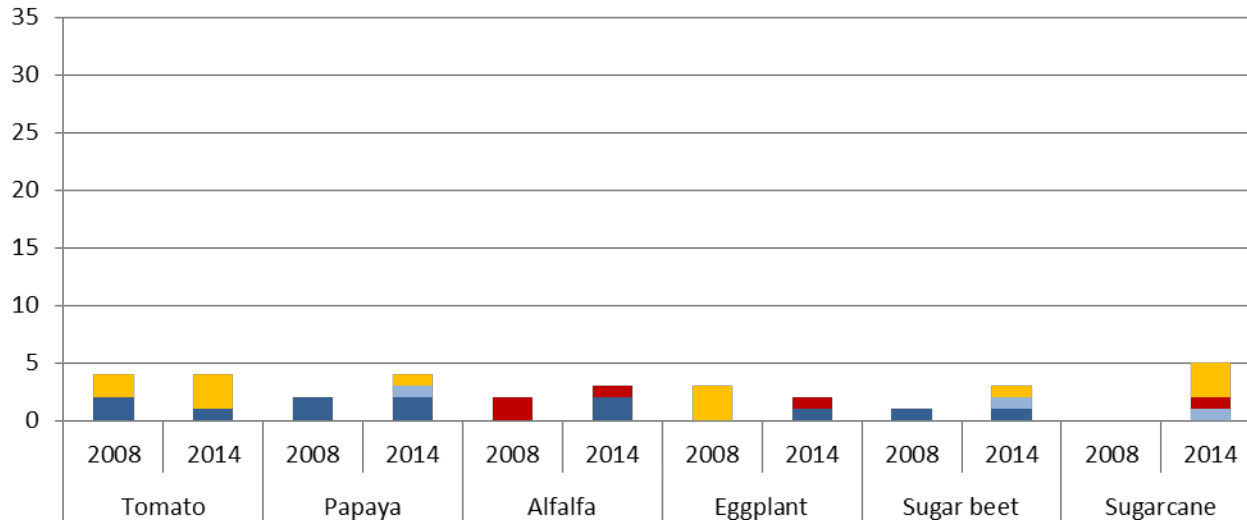
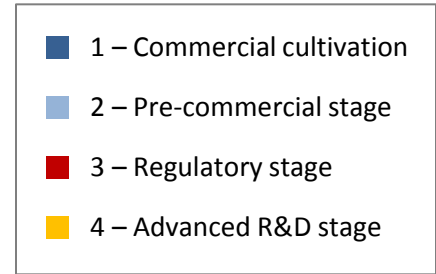
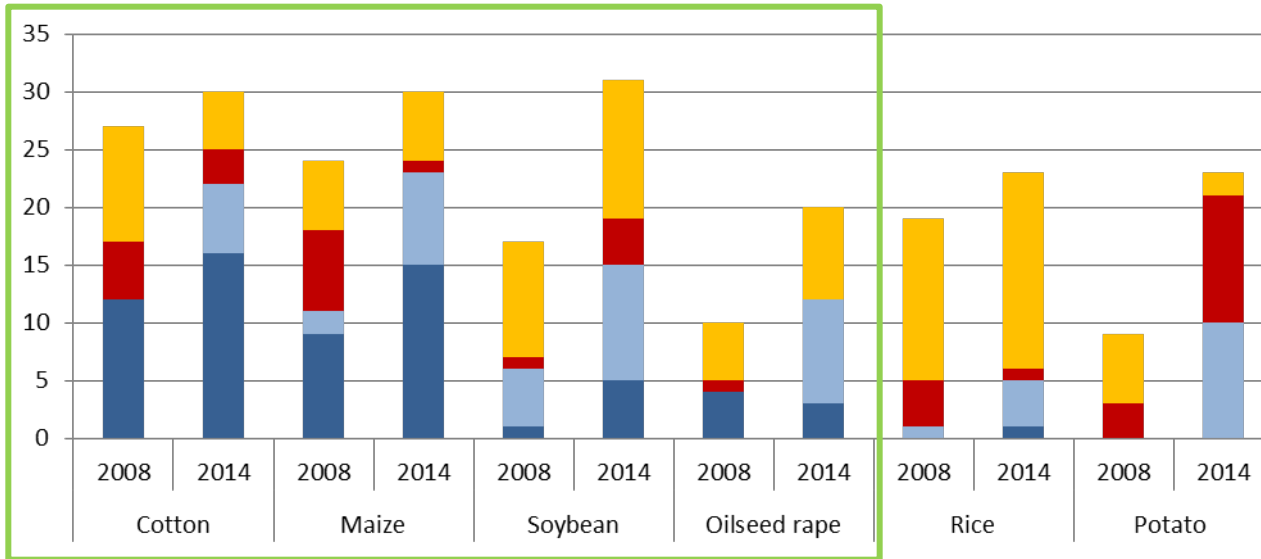
- Public databases of approved GM crops
- Databases of the national public authorities
- Information available online on the GM crops pipeline of private companies
- **International workshop** (11-12 June 2014 at JRC-IPTS):
  - National regulators from the EU, the US, Canada, Brazil, China, India, Turkey, Australia and Africa.
  - The Food and Agriculture Organization (FAO)
  - The main private technology providers of GMOs
  - Public Technology Providers and Public-Private Partnerships in the field of GM crops development
  - Stakeholders from the food/feed supply chain

# GM crop pipeline: 2014 Study



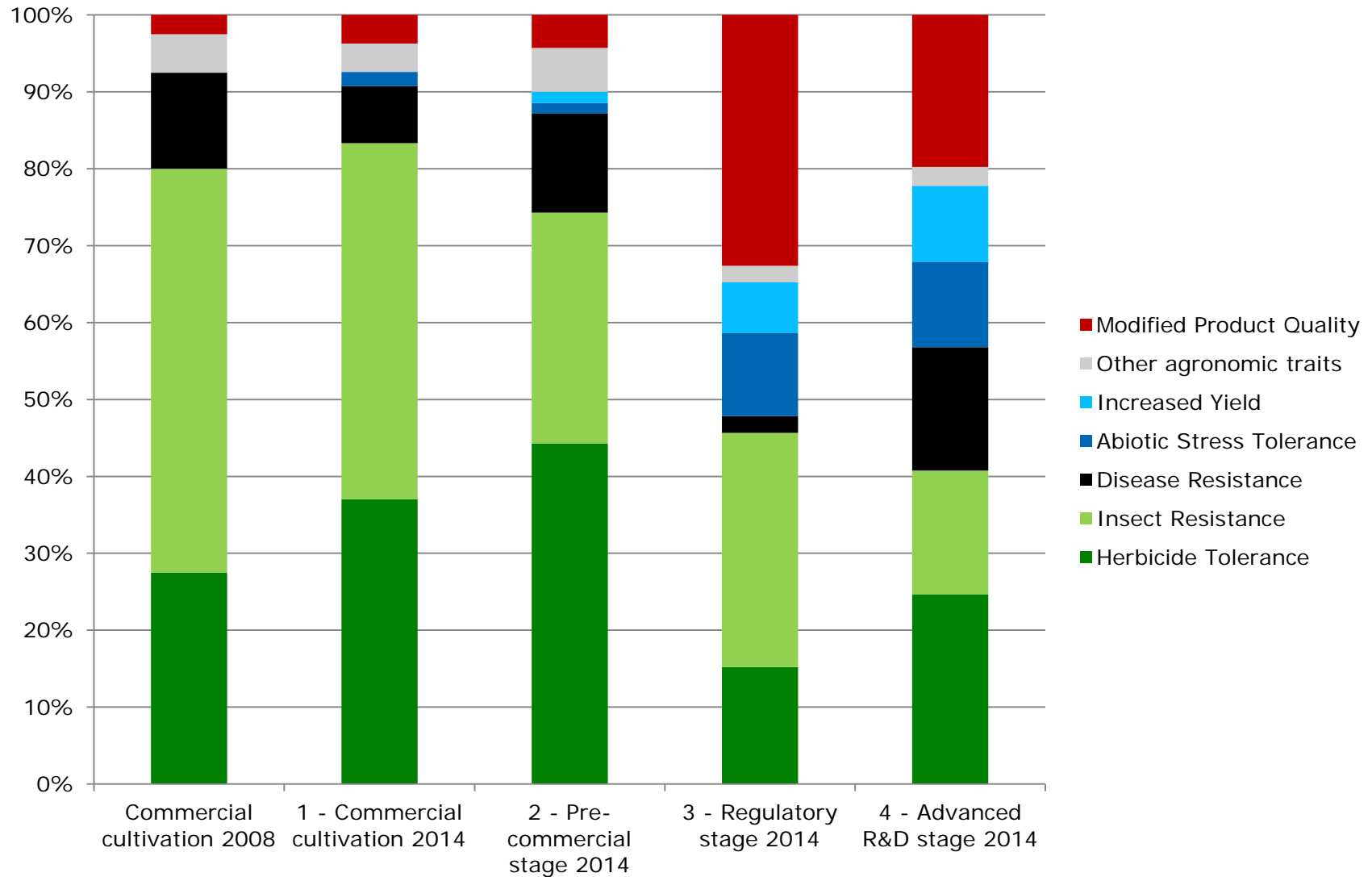
2008	2008-2014 evolution			+ New crops	2014 totals	2020 totals
Marketed crops <b>33</b>	30	90.9%	Marketed crops	+ 7	<b>49</b>	<b>96</b>
	3	9.1%	Removed from the market			
Pre-commercial stage <b>9</b>	4	44.4%	Marketed crops	+ 38	<b>53</b>	<b>123</b>
	3	33.3%	Pre-commercial stage			
	2	22.2%	Removed from the pipeline			
Regulatory stage <b>23</b>	7	30.4%	Marketed crops	+ 38	<b>43</b>	At least 52
	5	21.7%	Pre-commercial stage			
	0	0%	Regulatory stage			
	2	8.7%	Removed from the pipeline			
	9	39.1%	No info available			
Advanced R&D stage <b>65</b>	1	1.5%	Marketed crops	+ 64	<b>77</b>	At least 89
	7	10.8%	Pre-commercial stage			
	5	7.7%	Regulatory stage			
	13	20.0%	Advanced R&D stage			
	3	4.6%	Removed from the pipeline			
	36	55.4%	No info available			

# GM crop pipeline: Crops





# GM crop pipeline: Traits





## New traits emerging

### Agronomic traits



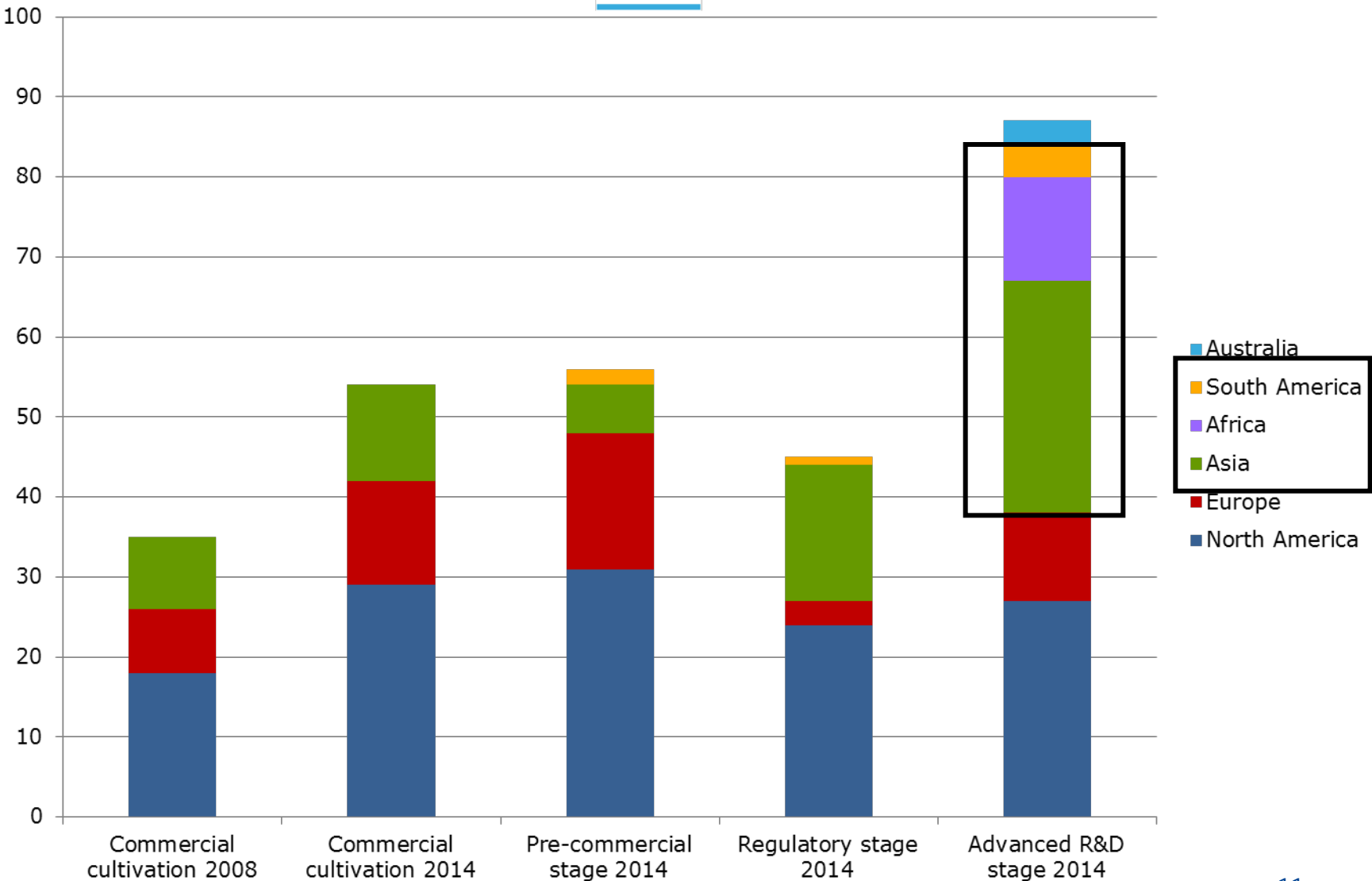
- Tolerance to new herbicides, beyond glyphosate and glufosinate: e.g. sulfunylurea, 2,4-D, Dicamba, Isoxaflutole and Oxynil (pre-commercial stage)
- Alternative approaches to defeat pests, employing new Bt genes

### Quality traits

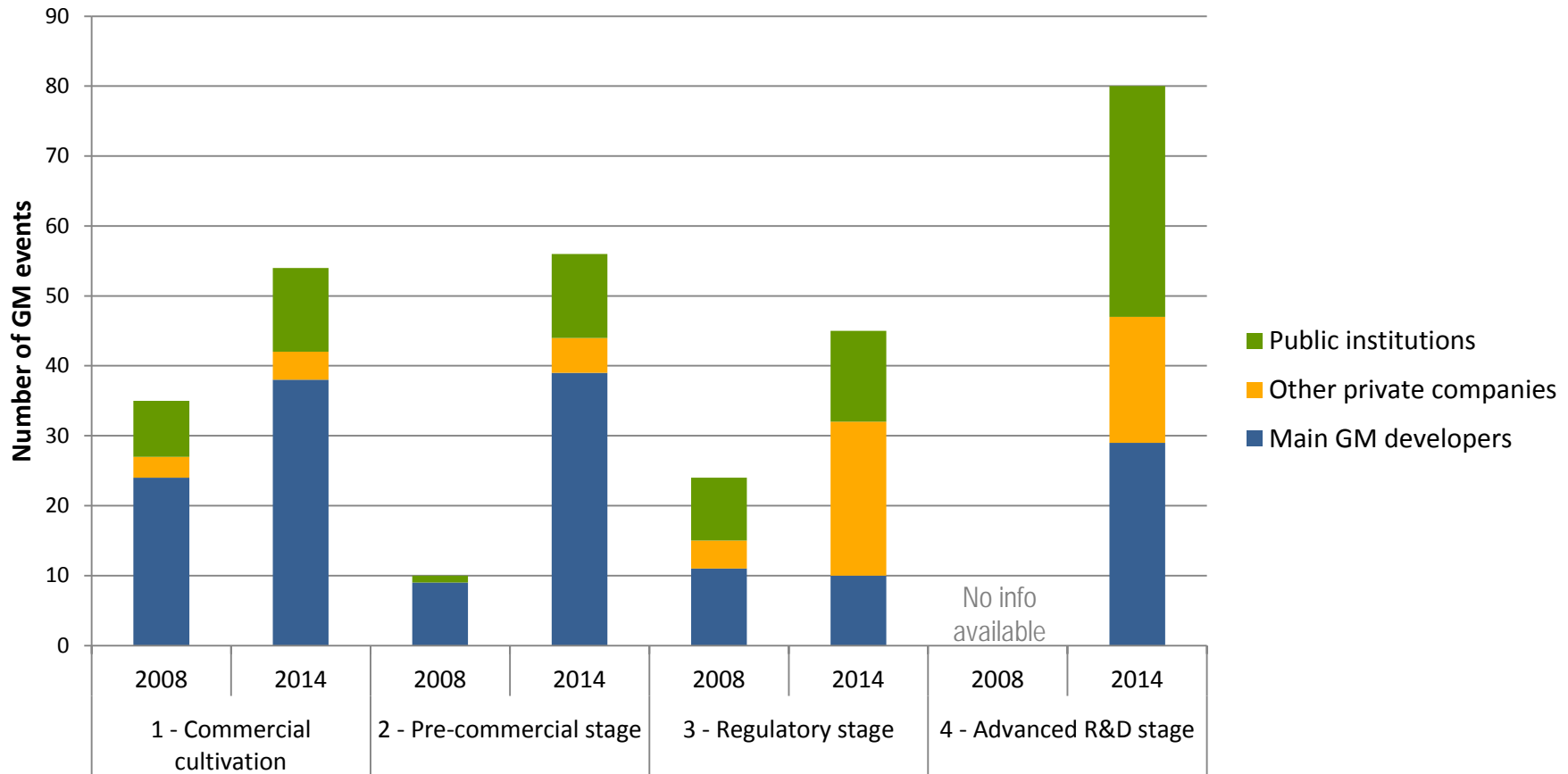


- Biofortified food: modified oil composition (omega-3), increased micro-nutrients (vitamins, amino acids, etc.)
- Industrial use: better sources of biomass for liquid fuels and industrial products (e.g. amylase maize)

# GM crop pipeline: Developers



# GM crop pipeline: Developers

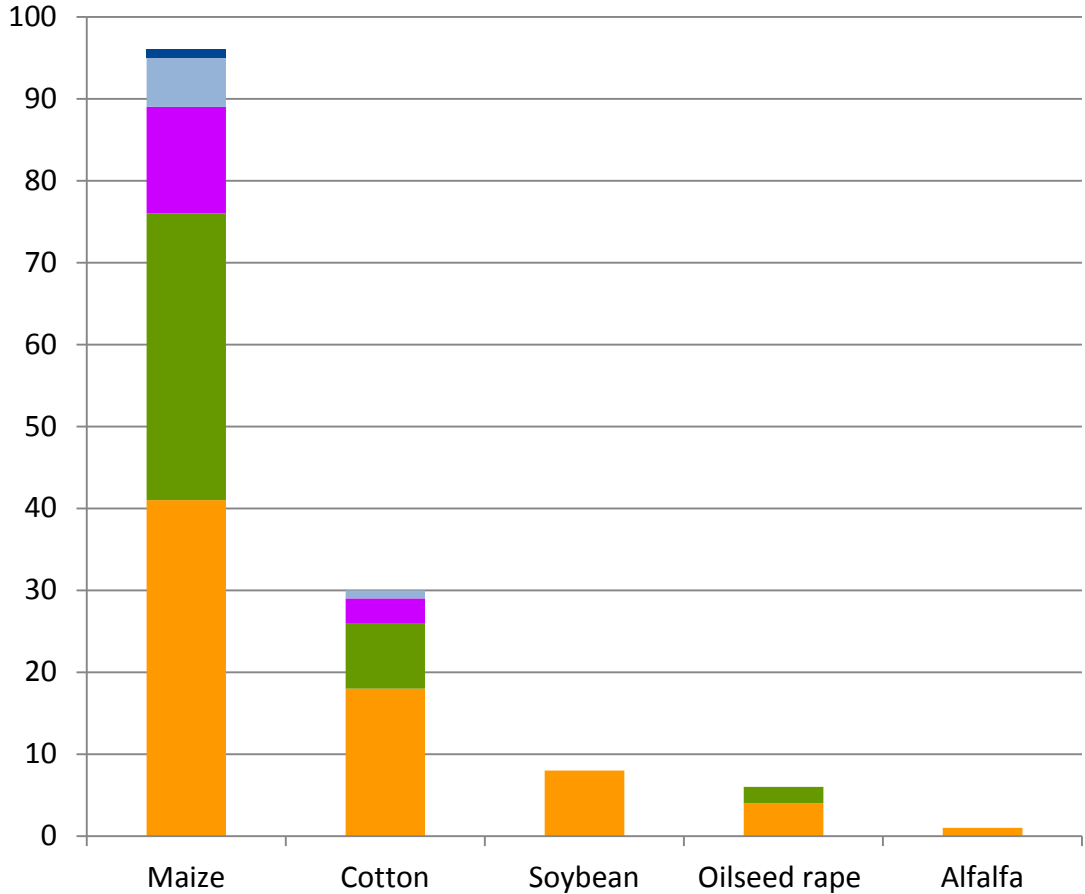


"Main GM developers" include BASF, Bayer CropScience, Cargill, Dow AgroSciences, DuPont Pioneer, Monsanto and Syngenta.

# GM crop pipeline: GM stacks



**Commercial or hybrid stack:** commercial GM varieties obtained through conventional breeding (crossing) involving two or more plant lines with GM events



Stages represented:

- Marketed crops
- Pre-commercial stage
- Regulatory stage

- 6 Sextuple
- 5 Quintuple
- 4 Quadruple
- 3 Triple
- 2 Double

# Low Level Presence Implications



Increasing number of GM crops worldwide



Export-orientation of the largest GM crop growing countries



Growing number of commercial GM stacks



Disparities in the GM crops authorisation process



**Intensification of LLP incidents worldwide**



Different authorisation times

Different commercial strategies

GM crops for domestic use only

2013-2014

FAO Technical Survey and Technical Consultation on trade LLP incidents

# Conclusions



- The global GM crop pipeline has shown an evolution since 2008:
  - The number of GM events at the commercial cultivation, pre-commercial or regulatory stages has more than doubled
  - There is a nascent growth in quality traits, with a strong focus on biofortified food and industrial applications
  - More specialty crops are being introduced into the pipeline: bean, rice, potatoes and sugarcane may be cultivated by 2020
- New technology developers are emerging beyond the usual biotech companies, especially in developing countries
- GM developers/breeders continue the trend of combining several traits by commercial stacking, which are becoming one of the dominant form of GM crops cultivated worldwide.
- The growing number of GM events, together with the increasing asymmetry in the authorization of GM events, is causing an intensification of LLP incidents worldwide.



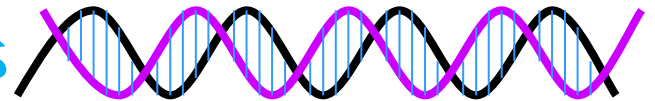
## Intellectual Property



**Expiry of patents** of broadly cultivated and exported GM crops:

- November 2014: MON810 maize
- March 2015: 40-3-2 soybean

## Technological developments



**RNA interference** increasingly used to obtain a stable gene silencing effect in transgenic plants. The R&D is very active and some products are at an advanced stage.

## New Plant Breeding Techniques (NPBT)

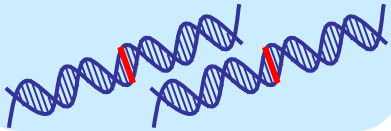


# New Plant Breeding Techniques

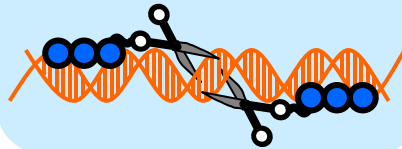


## TARGETED MUTAGENESIS TECHNIQUES

OLIGONUCLEOTIDE DIRECTED MUTAGENESIS



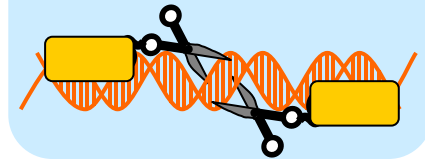
ZINC FINGER NUCLEASE TECHNIQUE



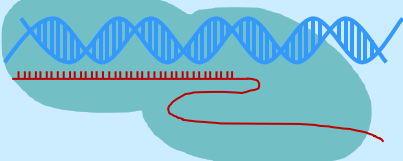
MEGANUCLEASE TECHNIQUE



TALEN TECHNIQUE

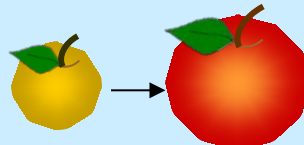


CRISPR-Cas SYSTEM

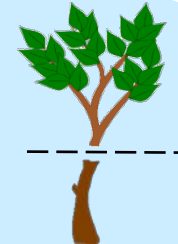


## VARIANTS OF PLANT TRANSFORMATION TECHNIQUES

CISGENESIS AND INTRAGENESIS

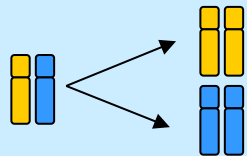


GRAFTING ON GM ROOTSTOCK

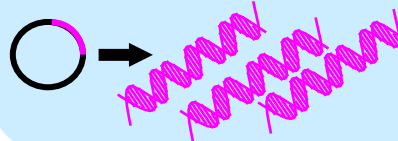


## TECHNIQUES RESULTING IN "NEGATIVE SEGREGANTS"

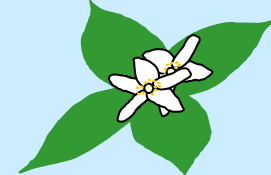
REVERSE BREEDING



RNA DIRECTED DNA METHYLATION



EARLY FLOWERING-accelerated breeding





# Thank you for your attention

For more information:

[Claudia.PARISI@ec.europa.eu](mailto:Claudia.PARISI@ec.europa.eu)

[Emilio.RODRIGUEZ-CEREZO@ec.europa.eu](mailto:Emilio.RODRIGUEZ-CEREZO@ec.europa.eu)