Potential Technological Breakthroughs Concerning Productivity

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European Commission

Potential Technological Breakthroughs Concerning Productivity

Agricultural Biotechnology

www.jrc.ec.europa.eu

Emilio Rodriguez-Cerezo

Serving society
Stimulating innovation
Supporting legislation

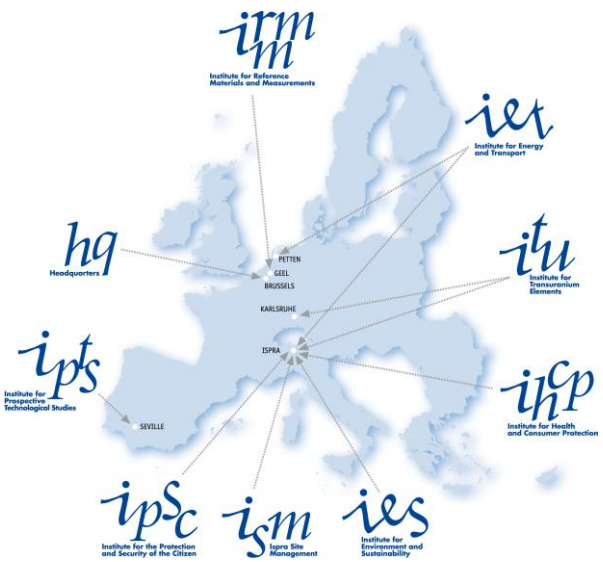
Who are we and what do we do?

JRC is the European Commission's in-house science service. It provides the science for policy decisions, with a view to ensuring that the EU achieves its Europe 2020 goals for a productive economy as well as a safe, secure and sustainable future.

The JRC plays a key role in the European Research Area and reinforces its multi-disciplinarity by networking extensively with leading scientific organizations in the Member States, Associated Countries and worldwide.

Established 1957

- 7 institutes in 5 countries: Italy, Belgium, Germany, The Netherlands, Spain
- 2,845 permanent and temporary staff in 2010
- 1,398 scientific publications in 2010
- 125 instances of support to the EU policy-maker annually
- Budget: €356 million annually, plus €62 million earned income



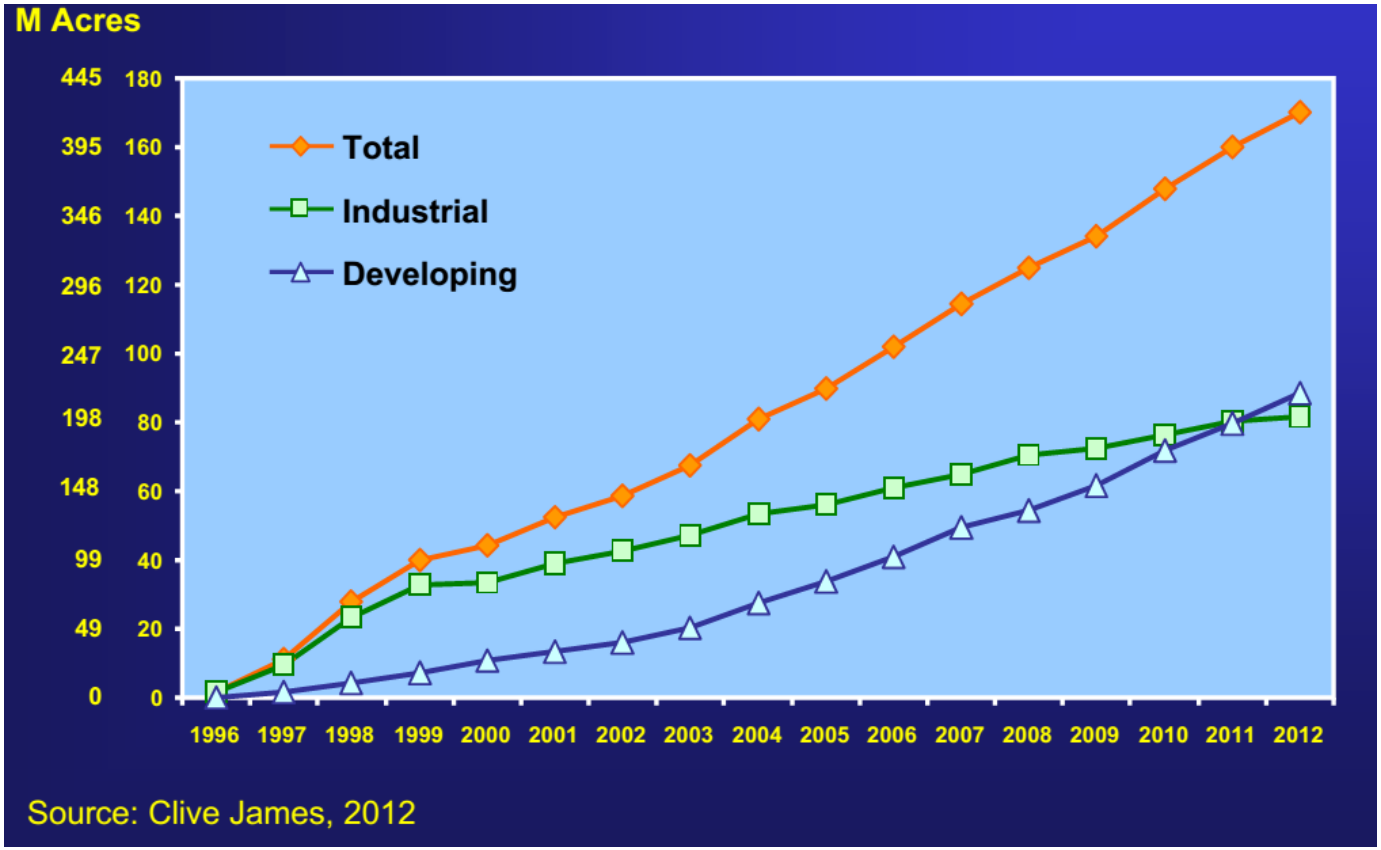
Where you can find us

- **Corporate Services** – *Brussels*
- **IRMM** – *Geel, Belgium*
  Institute for Reference Materials and Measurements
- **ITU** – *Karlsruhe, Germany and Ispra, Italy*
  Institute for Transuranium Elements
- **IE** – *Petten, The Netherlands and Ispra, Italy*
  Institute for Energy
- **IPSC** – *Ispra, Italy*
  Institute for the Protection and Security of the Citizen
- **IES** – *Ispra, Italy*
  Institute for Environment and Sustainability
- **IHCP** – *Ispra, Italy*
  Institute for Health and Consumer Protection
- **IPTS** – *Seville, Spain*
  Institute for Prospective Technological Studies

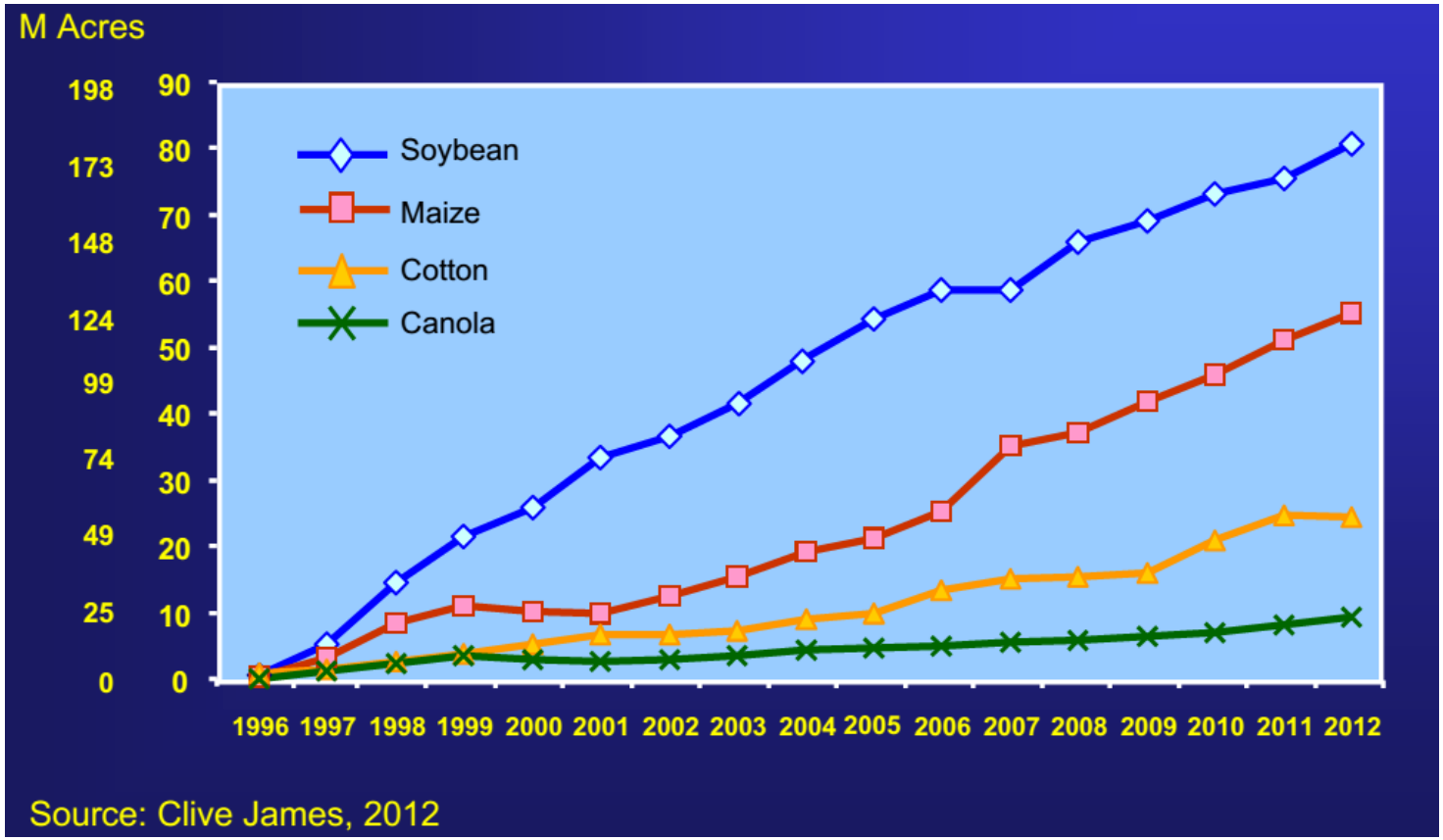
Agricultural Biotechnology: GM crops

- Status
- Lessons learned
- Outlook

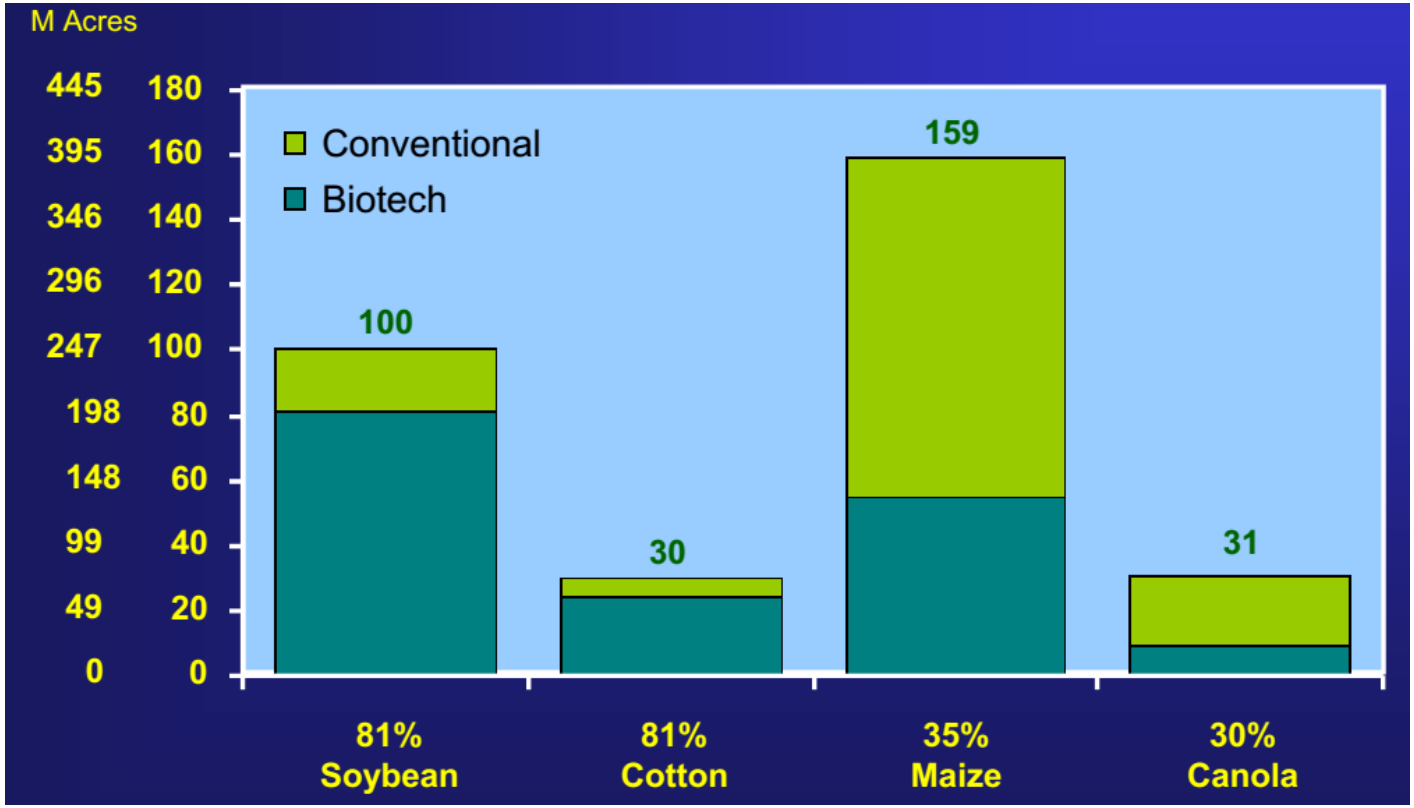
Status


M Acres
445 180
395 160
346 140
296 120
247 100
198 80
148 60
99 40
49 20
0 0
Total
Industrial
Developing
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Source: Clive James, 2012

Status


M Acres
198
173
148
124
99
74
49
25
0
90
80
70
60
50
40
30
20
10
0
Soybean
Maize
Cotton
Canola
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Source: Clive James, 2012

Status



USA, Brazil and Argentina constitute 76% of the adopted area

Agricultural Biotechnology

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Lessons learned

Herbicide tolerance

- Broad spectrum herbicide application
- Easier management and increased flexibility
- Maize, soybean, oilseed rape, sugar beet

Insect resistance

- Protection against insect damage
- Less pesticides needed
- Maize, cotton

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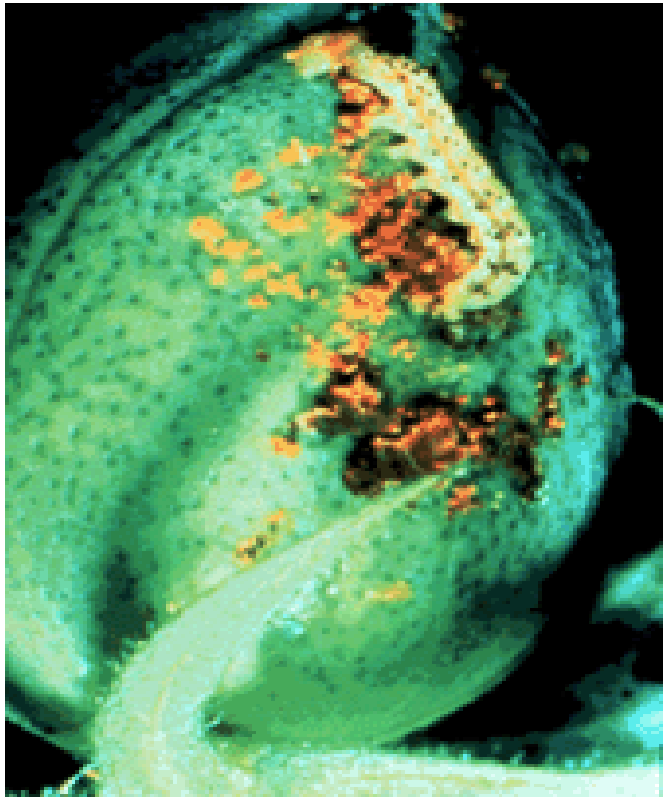
Bt cotton case studies farm level



China, India, South Africa, Argentina, México, USA and Australia…

Joint Research Centre

European Commission

Bt maize
South Africa/Spain/USA

Joint Research Centre

Farm level productivity impacts (Bt cotton, Bt maize)

- Increase yield by protecting plants from pest
- Adopted by small and industrial farmers alike
- Reduce pesticide use (direct health impact)
- Positive impact on income (seed pricing strategy)
- Regional and temporal variability impact high
- Sustainability of positive effects (management of refuges, resistance, education)

Conclusions IFPRI-CGIAR 2009 report

"*Rising adoption rates of Bt cotton and Bt maize among smallholders in developing countries are a fact*"

"*The evidence is generally conclusive that Bt crops reduces pest damage and insecticide use and increases yields, but the magnitude of profit is highly variable*"

Example: variability of farm level impacts Bt cotton in India (2004-2009)

Insecticide sprays	-29 to -70%
Yield	+11 to +86%
Seed Costs	+166 to +224%
Insecticide Costs	-24% to -92%
Total costs	+8 to +32%
Net income	+58 to +144 %

Adapted from T. Raney and I. Matuschke (FAO): authors
Analysed peer-reviewed papers on performance of Bt cotton in India published between 2004 and 2009

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Bt maize productivity impacts in Spain JRC survey 2009

- Yield differences significant for Bt maize (av. 11.4 %)
- No difference in harvest price for farmers (14 euro/ton)
- Technology fee for Bt seed small (9 euro/ha)
- Reduced pesticide cost and use
- Higher gross margin (av. 195 euros/ha/year for Bt)

Joint Research Centre

HT soybeans

The largest GM crop in area world wide

Novel weed control (using non-selective herbicides)

A “Western” crop (90 % adoption in the USA)

98 % adopción in Argentina, increasing in Brazil

EU: imported since 1996 (grown in Romania before accesion)

HT crops: farm level conclusions

Western countries, low adoption in developing world

Neutral with respect to yields in most cases (exceptions of yield increase when poor weed control)

Reduces costs (fuel, weed control, labour)

Allows double cropping (Argentina)

Easy of management, conservation tillage and higher off farm income

Lessons learned

- Focused on early adopters which might have different characteristics
- Data from field trials instead of farm conditions
- Self- selection of the farmers
- Counterfactual not well chosen (e.g. Underlying pest pressure)
- Approach through company extension program
- Limited assessment of markets and policies

- **Bt crops have increased yields, particularly in developing countries**
- **HT crops yield neutral (except double cropping)**
- **GM varieties limited to feed/industrial crops and few traits**
- **Extension to minor crops: regulatory costs very high, licensing**
- **Extension to large food crops: consumer acceptance, coexistence, segregation**

  - **Feed crops vs feed crops e.g.**
    - **Potato in the USA**
    - **Wheat in the USA**
    - **Rice in China**

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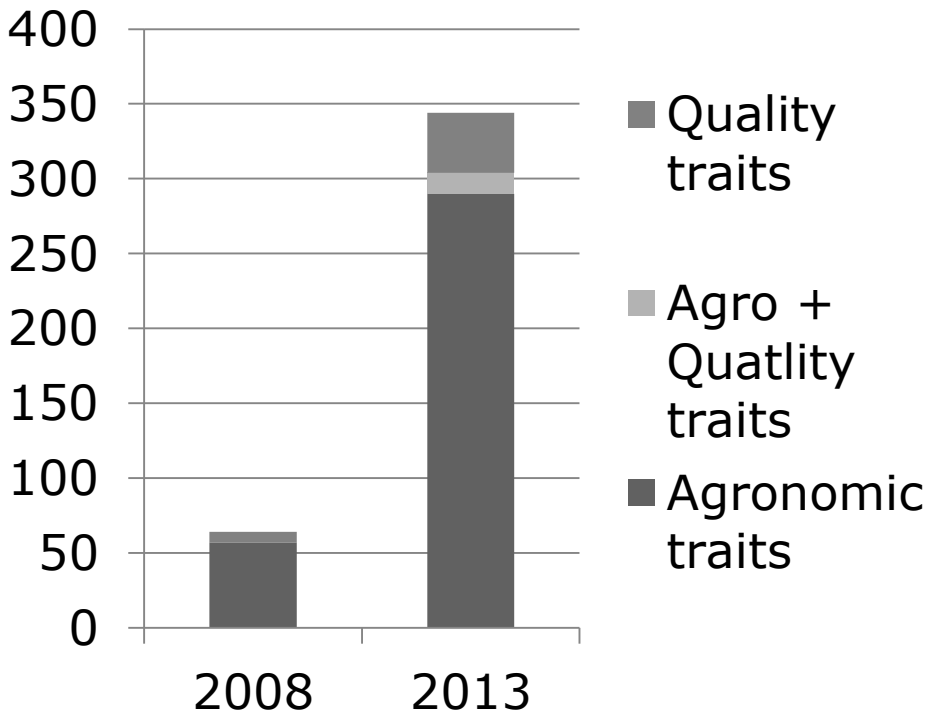
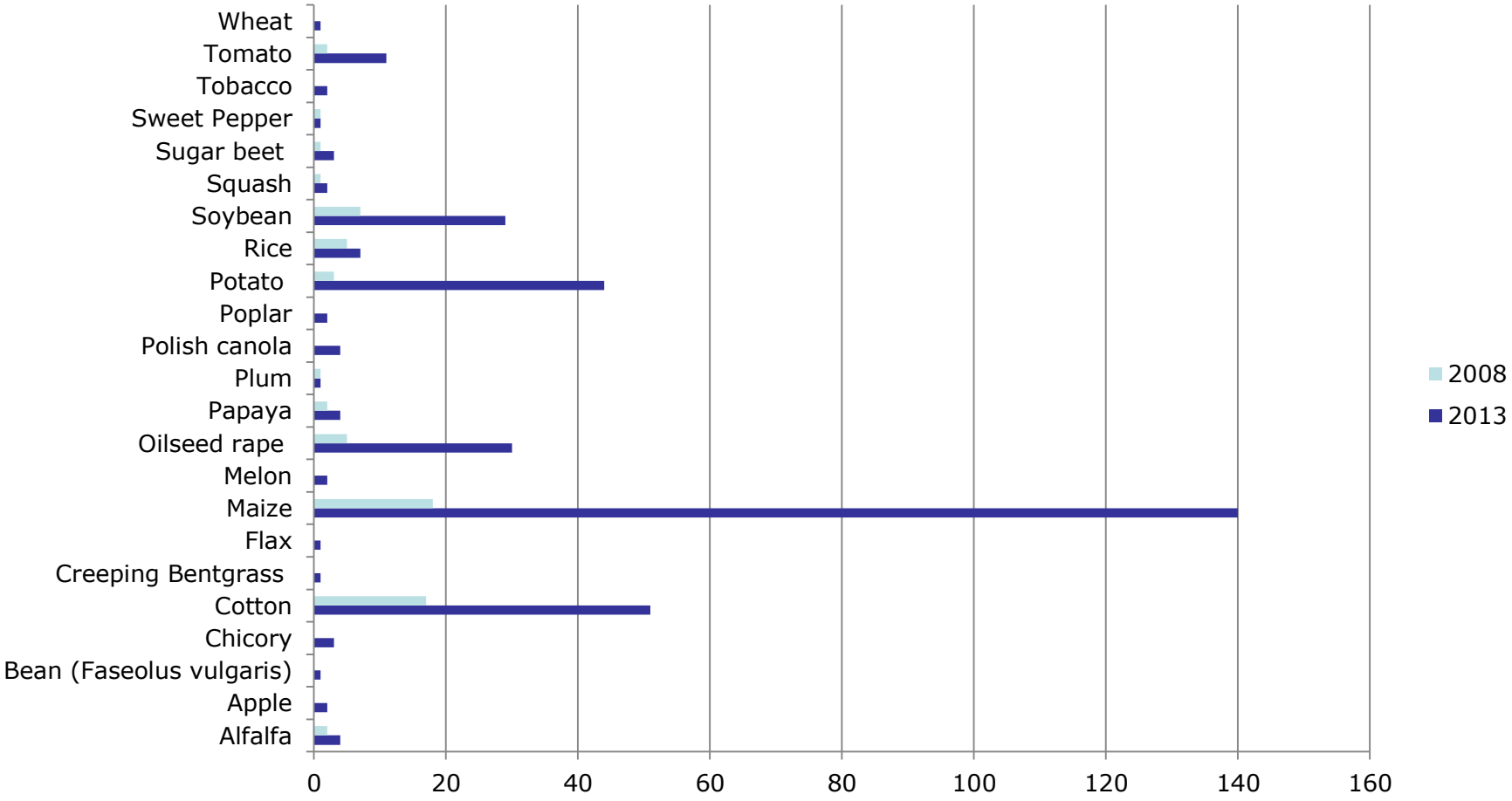
Outlook

Regulatory approval continues and will explode in upcoming years



Outlook


Wheat
Tomato
Tobacco
Sweet Pepper
Sugar beet
Squash
Soybean
Rice
Potato
Poplar
Polish canola
Plum
Papaya
Oilseed rape
Melon
Maize
Flax
Creeping Bentgrass
Cotton
Chicory
Bean (Faseolus vulgaris)
Apple
Alfalfa
0
20
40
60
80
100
120
140
160
2008
2013

New agronomic traits in the pipeline

- Abiotic Stress Tolerance
  - **Commercial pipeline:** Drought tolerance maize (MON87460)
  - **Research pipeline:** Drought (cotton, second generation maize), salt tolerance (canola, rice, cotton and tomatoes)

- High-yield crops
  - **Regulatory pipeline:** Increased yield soybean in regulatory pipeline (MON87712)
  - **Research pipeline**:(maize, soybean, wheat, alfalfa)

- Nitrogen-utilization efficiency
  - **Research pipeline:** maize, canola and rice

- Disease Resistant crops
  - **Commercial pipeline**: Gold Mosaic Virus resistance bean developed in Brazil
  - **Regulatory pipeline**: Late blight resistance potato

Pipeline: quality traits for human & animal nutrition

- Modified oil profile
  - **First commercial crop:** High oleic soybean (DP305423) first grown in 2013
  - **Commercial pipeline:** low-linolenic (MON87705) & high-SDA (MON87769) soybean
  - **Research pipeline:** 1 high-SDA rapeseed, 3 other SDA soybean events
- Low-Phytate crops
  - **Commercial pipeline:** 1 phytase maize event in China
  - **Research pipeline:** 2 barley & 1 maize events in advanced development, at least 12 other in early development
- Low-lignin
  - **Regulatory pipeline:** low-lignin alfalfa since 2013
  - **Research pipeline:** research on alfalfa, maize, sorghum, tall fescue, ryegrass,…
- Essential amino-acid (EAA) rich crops
  - One event removed from **commercial pipeline** (LY038), but…
  - **Research pipeline** with about 30 different events, numerous crops and EAA

Thanks for your attention

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