

# *Biotechnology, Chemistry, and the Nine Billion*

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“The greatest challenge of the 21<sup>st</sup> century: feeding 9 billion people with a sustainable agricultural production system.”

--Chrispeels, 2000



# GLOBAL DEMOGRAPHY

1999 -- 70% of people grow what they eat

2025 -- 50% will live in cities, will need to be fed through market channels.



“It took some 10,000 years to expand food production to the current level of about 5 billion tons per year.

By 2025, we will have to nearly double current production again.”

--Norman Borlaug, 2000



## FAO Projections...

“...prices above historic equilibrium levels during the next ten years...”  
higher costs for animal feed

demand increase 100% over 40y





*How* can we  
increase production  
by 100% in 40 years?



To double production  
FAO estimates  
gains will come from:

additional farmlands	20%
increased intensity	10%
innovative technologies	70%



## 20<sup>th</sup> Century ~ Chemistry

fertilizers & pesticides (munitions...)

green revolution saved billions  
*through chemistry*

## 21<sup>st</sup> Century ~ Biology

nucleic acids

greater challenges;  
require more complex solutions  
*chemistry will remain indispensable*





Where does chemistry fit in?



“The reports of my death are greatly exaggerated...”

-- Mark Twain



...fertilizers, pesticides and  
transgenes are the best possible  
protectors of the planet.

-----The Economist, “Ears of Plenty:  
The story of man’s staple food”  
24 December 2005.



“A truly extraordinary variety of alternatives to the chemical control of insects is available. All have this in common: They are *biological* solutions, based on understanding of the living organisms they seek to control. ...Some of the most interesting of the recent work is concerned with ways of forging weapons from the insects’ own life processes.”



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--Rachel Carson,  
Silent Spring, 1962





It's *ALL* chemistry...

*chemistry is the keystone.*



Where are we headed?



Green Revolution Solutions = external  
involve topical applications of  
pesticides/herbicides, external apps of  
fertilizers

Doubly Green Revolution Solutions:  
build on GR but add solutions from  
work with *internal* chemistry

*Both are essential and indispensable*

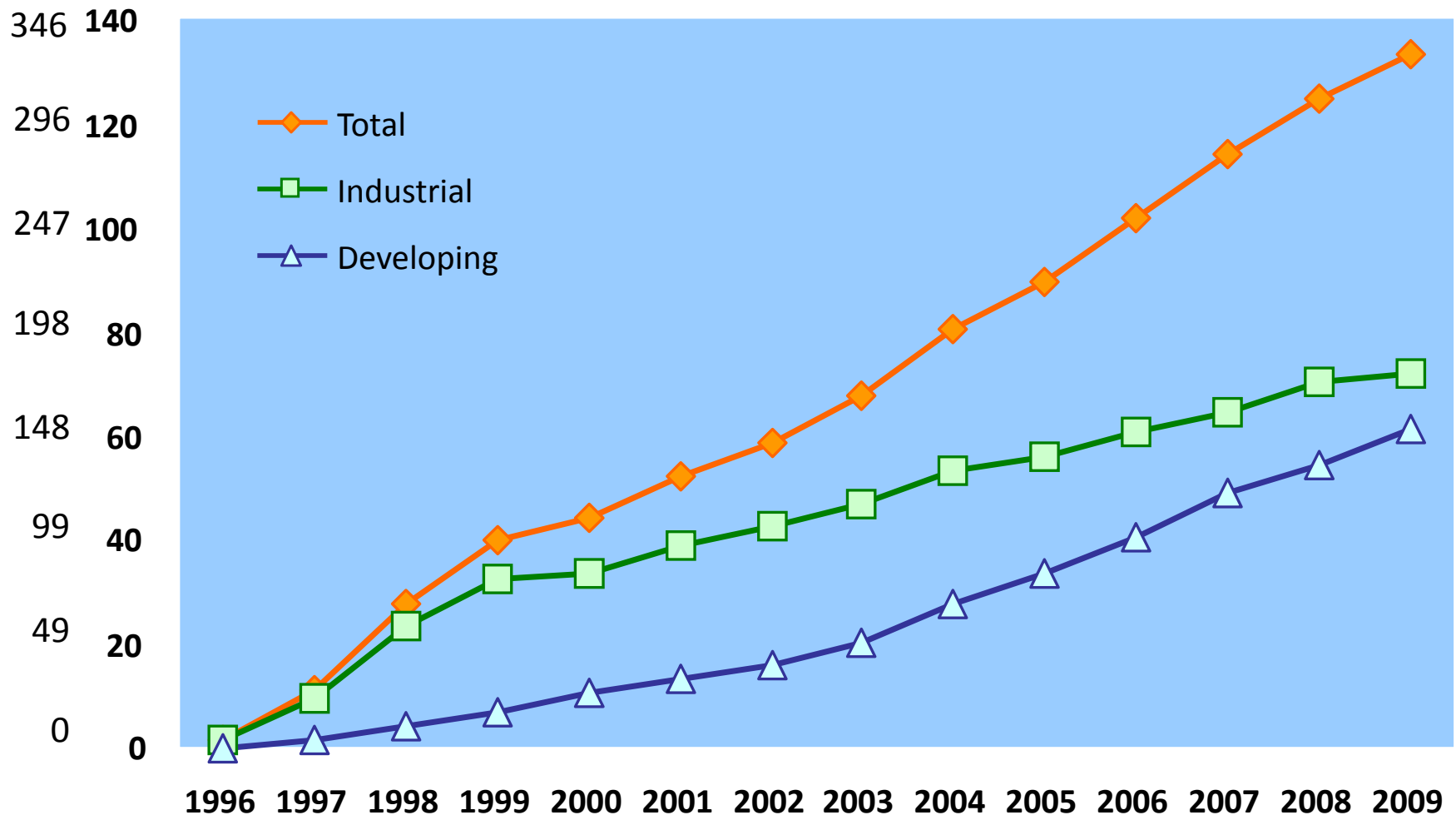


Products of agricultural  
biotechnology are becoming the  
new “conventional” standard



# Global Area of Biotech Crops, 1996 to 2009: Industrial and Developing Countries (M Has, M Acres)

M Acres



Source: Clive James, 2010



# Global Area of Biotech Crops, 1996 to 2009: By Crop (Million Hectares, Million Acres)

M Acres

198 80

173 70

148 60

124 50

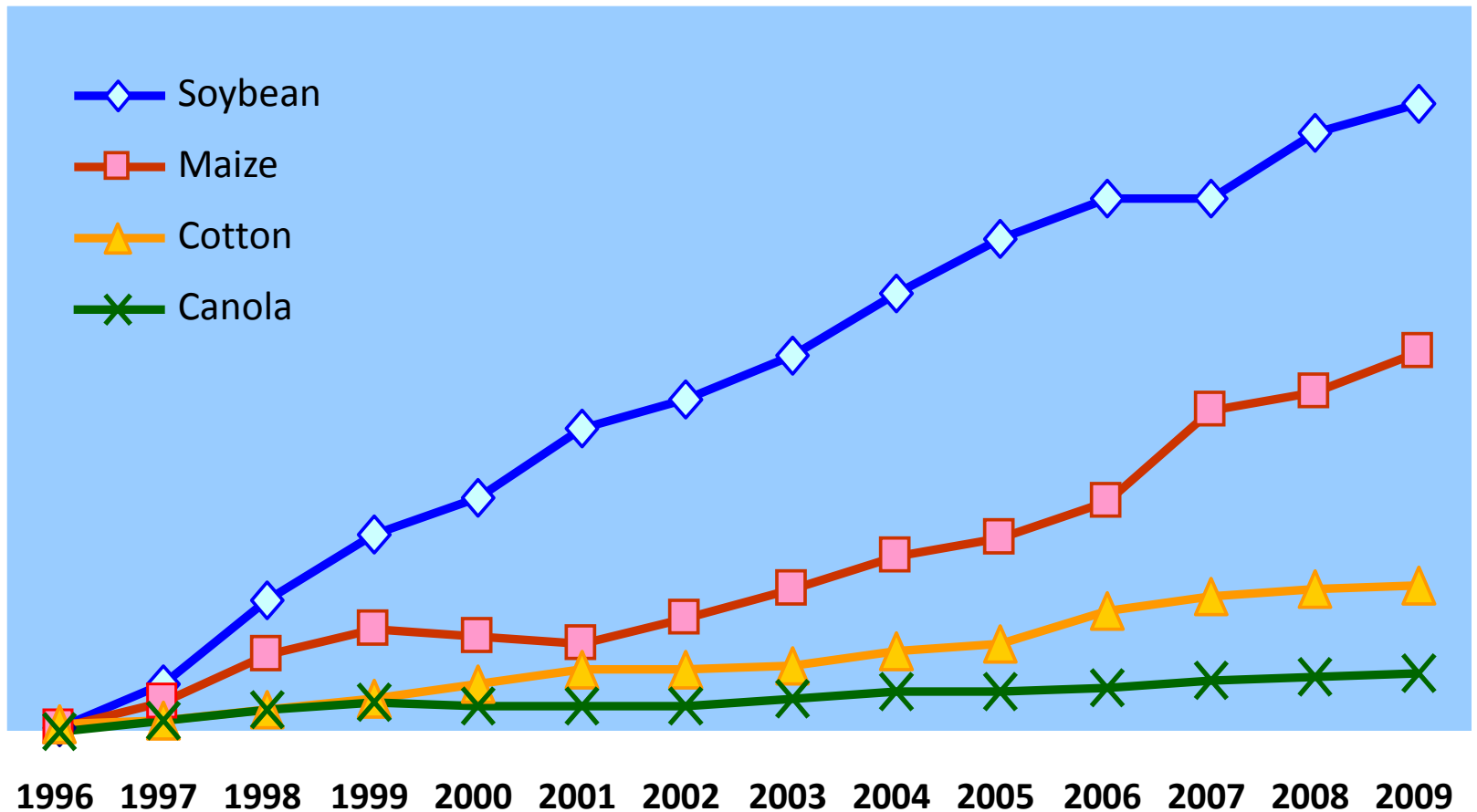
99 40

74 30

49 20

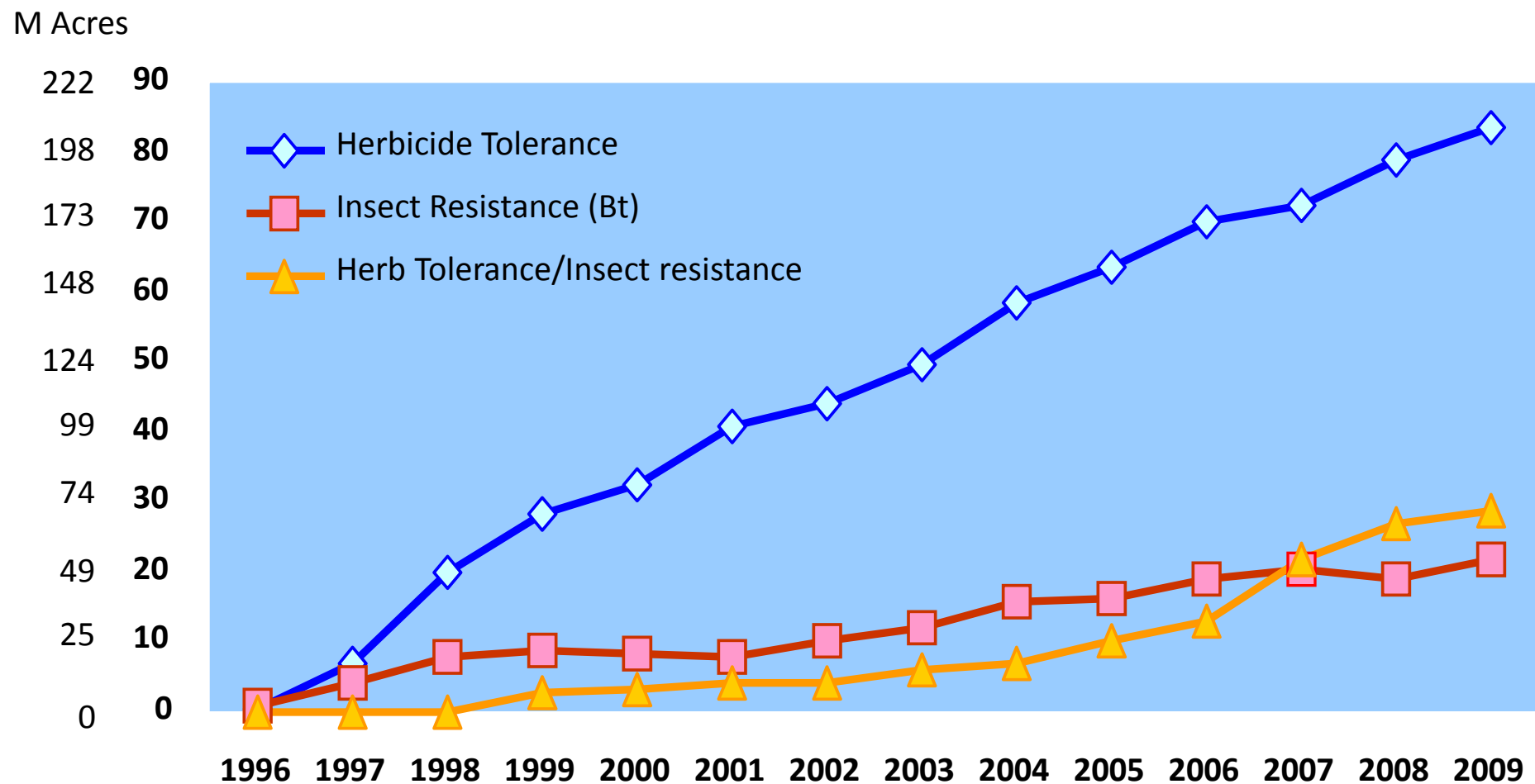
25 10

0 0



Source: Clive James, 2010

# Global Area of Biotech Crops, 1996 to 2009: By Trait (Million Hectares, Million Acres)



Source: Clive James, 2010

# Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2009

M Acres

445 180  
395 160  
346 140  
296 120  
247 100  
198 80  
148 60  
99 40  
49 20  
0 0

■ Conventional  
■ Biotech

90

33

158

31

77%

49%

26%

21%

Soybean

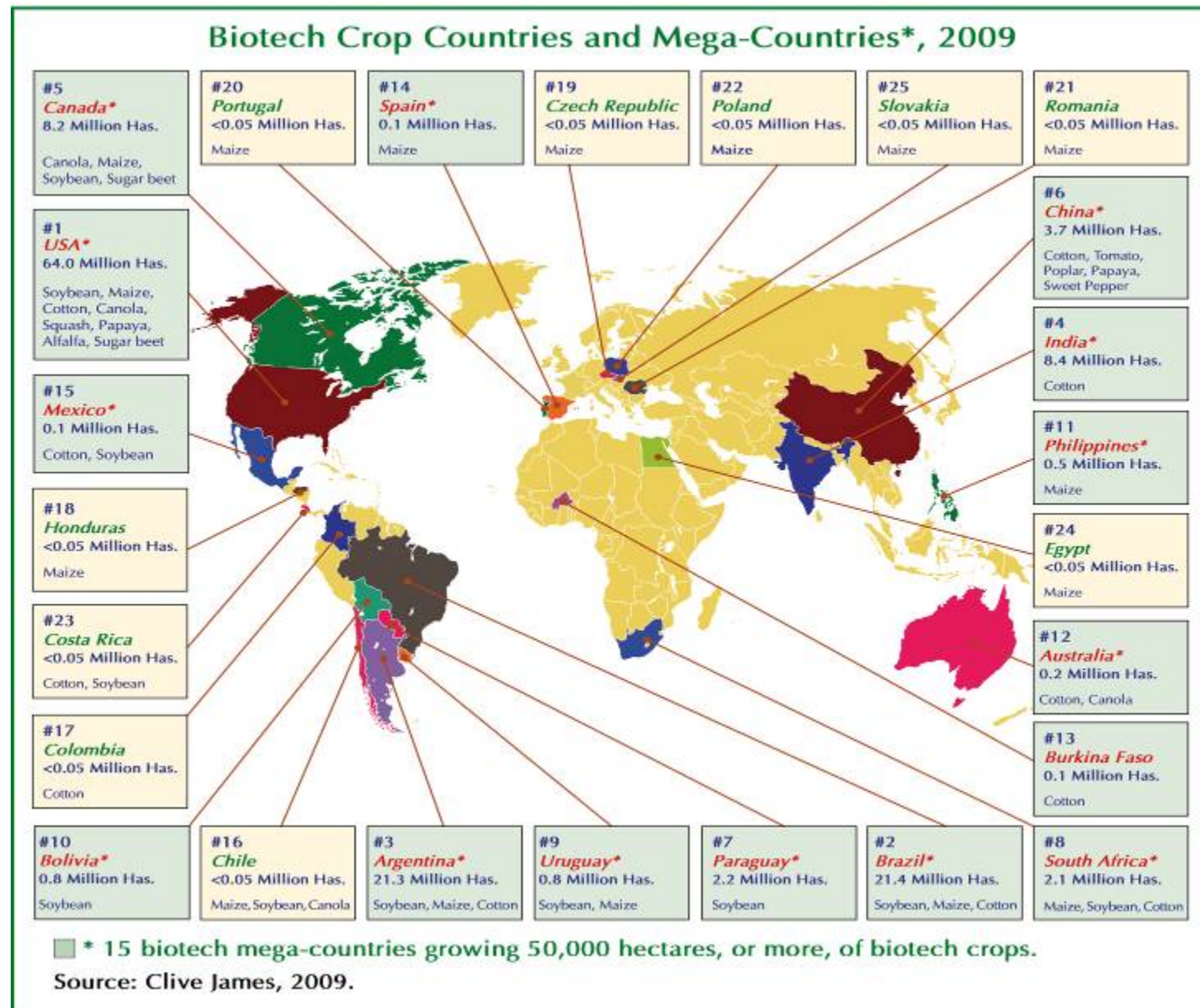
Cotton

Maize

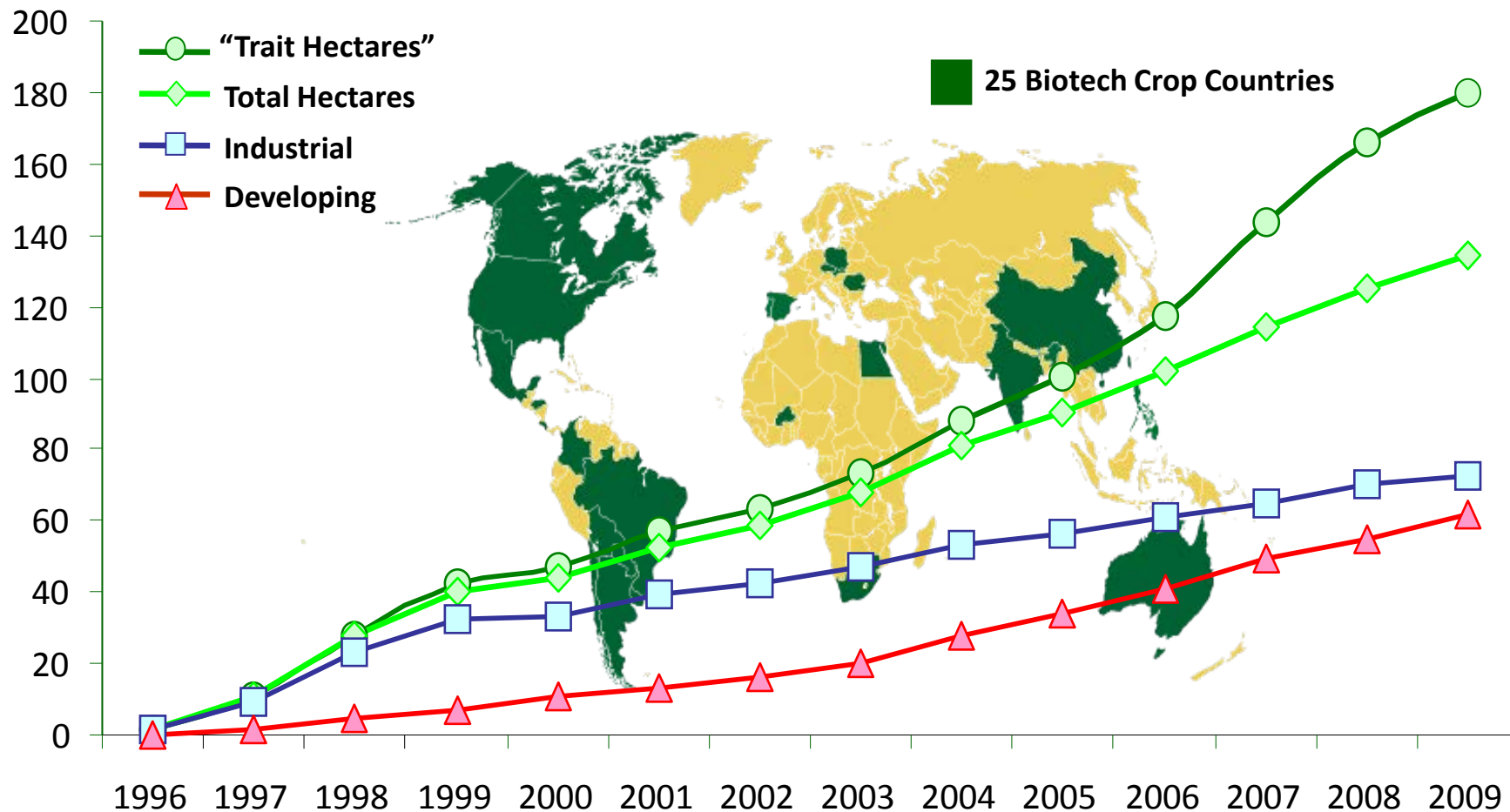
Canola

Source: Clive James, 2010

# Biotech Crop Countries and Mega-Countries, 2009



## GLOBAL AREA OF BIOTECH CROPS Million Hectares (1996 to 2009)



***A record 14 million farmers, in 25 countries, planted 134 million hectares (330 million acres) in 2009, a sustained increase of 7% or 9 million hectares (22 million acres) over 2008.***



Over the next five years,  
we anticipate...

17 new soybean events (currently ~5)

From 9 maize events to 24

From 4 canola to 8

From 12 cotton to 27

From 1\* rice to 15

From 1\* or 2 potatoes to 8

From 7 to 23 minor crops

R&D on *at least* 57 crops in 63 countries



Technology source	Commercialization		Regulatory approval pipeline	Advanced R&D	Projected total by 2015
	<i>current</i>	<i>pending</i>			
USA and EU	24	7	10	26	67
Asia	9	0	11	34	54
Latin America	0	0	2	1	3

1<sup>st</sup> generation = agronomic traits

2<sup>nd</sup> gen = quality/consumer traits

3<sup>rd</sup> gen = GURTS/ inducible traits

4<sup>th</sup> gen = complex, polygenic traits: water metabolism, customized biofuels, N<sub>2</sub> fixation, etc.



“...Societies initially lacking an advantage either acquire it from societies possessing it or (if they fail to do so) are replaced by those other societies.”

--Jared Diamond  
*Guns, Germs and Steel*;  
W.W. Norton, 1998, p. 407

