

Global impact of Biotech crops: economic & environmental effects 1996-2009

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Coverage

- Presenting findings of full report available on www.pgeconomics.co.uk
- Peer review journal versions: economic impact in Int Journal of Biotechnology, environmental impacts in GM Crops journal
- Cumulative impact: 1996-2009
- Farm income & productivity impacts: focuses on farm income, yield, production
- Environmental impact analysis covering pesticide spray changes & associated environmental impact
- Environmental impact analysis: greenhouse gas emissions

Methodology

- Literature review of economic impact in each country – collates & extrapolates existing work
- Uses current prices, exch rates and yields (for each year): gives dynamic element to analysis
- Review of pesticide usage (volumes used) or typical GM versus conventional treatments
- Use of Environmental Impact Quotient (EIQ) indicator
- Review of literature on carbon impacts – fuel changes and soil carbon

Methodology: EIQs

- From Kovach et al (1992)
- Integrates various env impacts of indiv pesticides into a single field value/ha – allows for comparisons between products
- Is consistent and fairly comprehensive
- Compares level of use on GM with conventional crop usage to deliver equal level of efficacy

Key Findings

Pesticide Reduction

393 million kg
reduction in
pesticides &
17.1% cut in
associated
environmental
impact

Carbon Emissions

2009 = cut of
17.7 billion kg
co2 release;
equiv to taking
7.8 million cars
off the road

Global Farm Income

\$64.7
billion
increase

After 14 years of commercialization, biotech crops have yielded a net increase in farm income while significantly reducing environmental impact

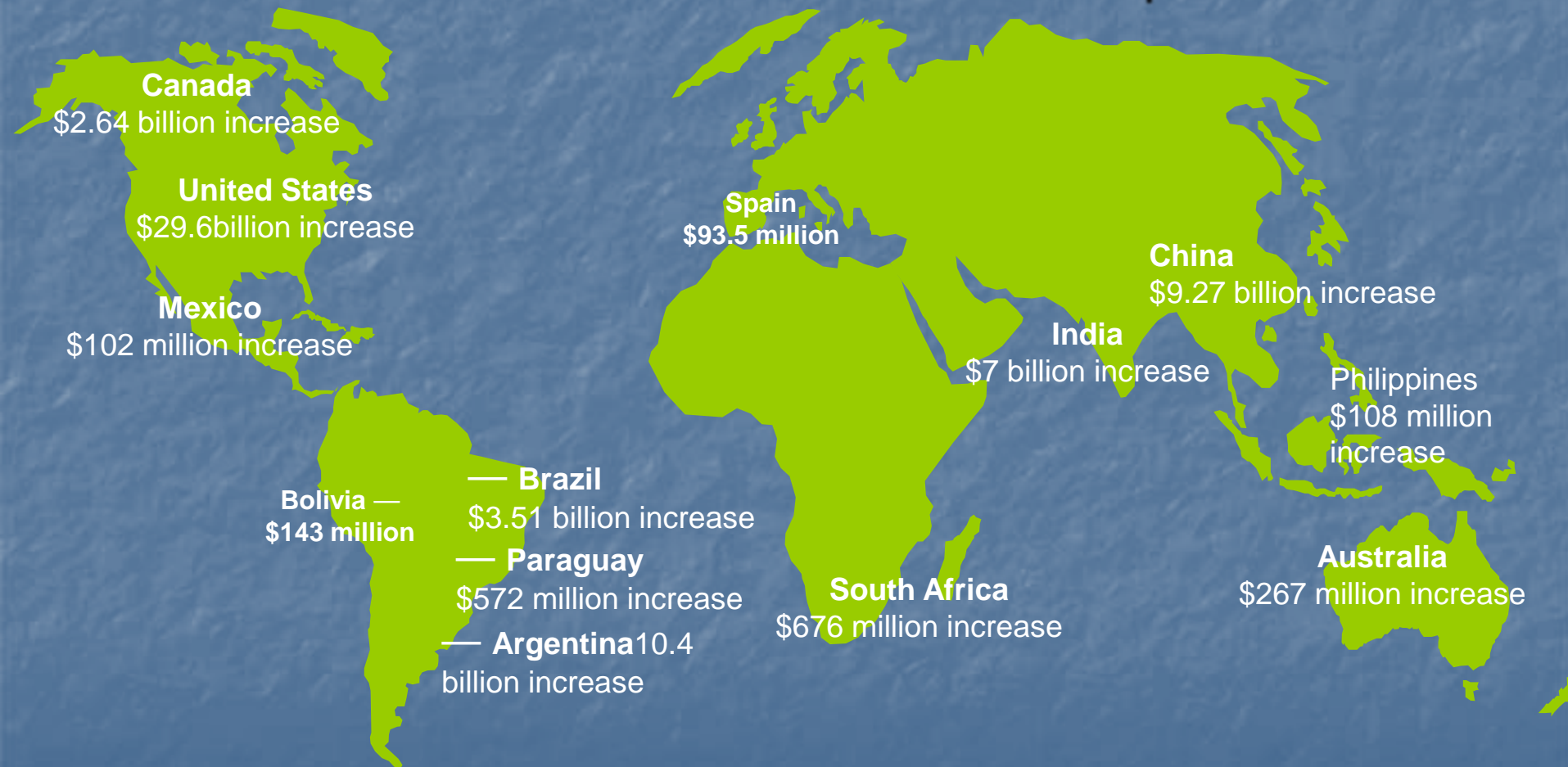
Farm level economic impact

- 2009: farm income benefit \$10.8 billion
- 2009: equiv to adding value to global production of these four crops of 4.1%
- 53% of farm income gain in 2009 to farmers in developing countries (49% 1996-2009)
- Since 1996, farm income gain = \$64.7 billion

Farm income effect: million \$

Trait	Increase in farm income 2009	Increase in farm income 1996-2009	Farm income benefit in 2009 as % of total value of production of these crops in biotech adopting countries	Farm income benefit in 2009 as % of total value of global production of crop
GM herbicide tolerant soybeans	2,068.1	25,076.5	2.7	2.34
GM herbicide tolerant maize	392.1	2,234.9	0.6	0.3
GM herbicide tolerant cotton	38.1	907.8	0.13	0.12
GM herbicide tolerant canola	362.6	2,181.0	7.1	1.59
GM insect resistant maize	3,911.5	14,530.6	5.7	3.5
GM insect resistant cotton	3,912.4	19,578.1	13.3	12.5
Others	84.7	230.4	Not applicable	Not applicable
Totals	10,769.5	64,739.3	5.84	4.1

Farm income gains: by country: 1996-2009 million \$



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Since 1996, biotech crops have increased farm income \$64.74 billion.

Other farm level benefits

GM HT crops	GM IR crops
Increased management flexibility/convenience	Production risk management tool
Facilitation of no till practices	Machinery & energy cost savings
Cleaner crops = lower harvest cost & quality premia	Yield gains for non GM crops (reduced general pest levels)
Less damage in follow on crops	Convenience benefit
	Improved crop quality
	Improved health & safety for farmers/workers

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In US these benefits valued at
\$6.9 billion 1996-2009

Cost of accessing the technology 2009

- Total trait benefit 2009 = \$15.3 billion comprising \$10.8 billion additional farm income plus \$4.5 billion cost of accessing technology
- Cost of tech goes to seed supply chain (sellers of seed to farmers, seed multipliers, plant breeders, distributors & tech providers)
- Overall cost of tech as % of total trait benefits = 30%

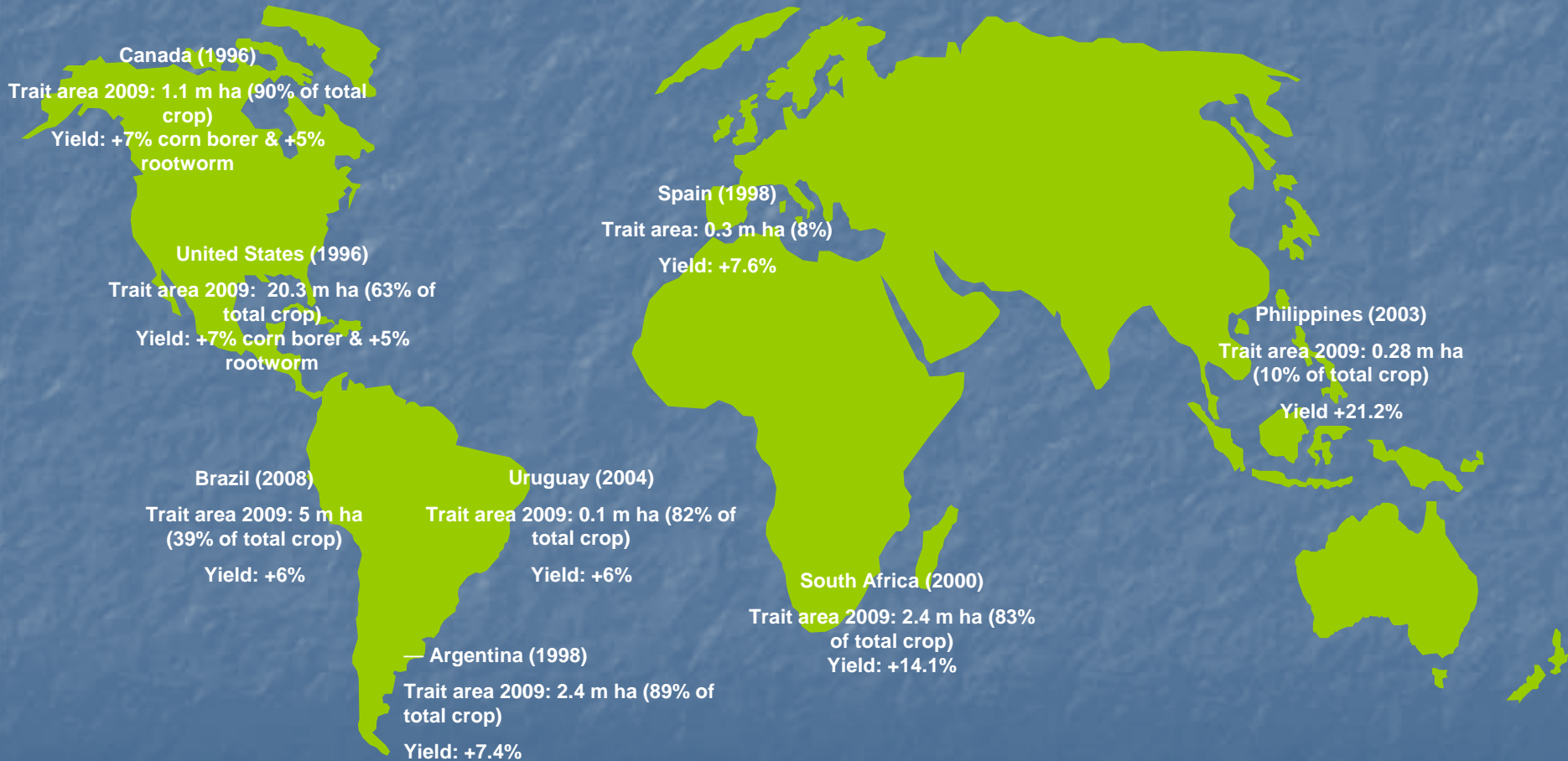
Cost of accessing technology 2009

- Farmers in developing countries: 18% of total trait benefit
- Farmers in developed countries: 39% of total trait benefit
- Higher share of farm income gain as % of total trait benefit in developing countries due to weak provision & enforcement of intellectual property rights & higher average income gains

Yield gains versus cost savings

- 57% (\$36.6 billion) of total farm income gain due to yield gains 1996-2009
- Balance due to cost savings
- Yield gains mainly from GM IR technology & cost savings mainly from GM HT technology
- Yield gains greatest in developing countries & cost savings mainly in developed countries
- HT technology also facilitated no tillage systems
 - allowed second crops (soy) in the same season in S America

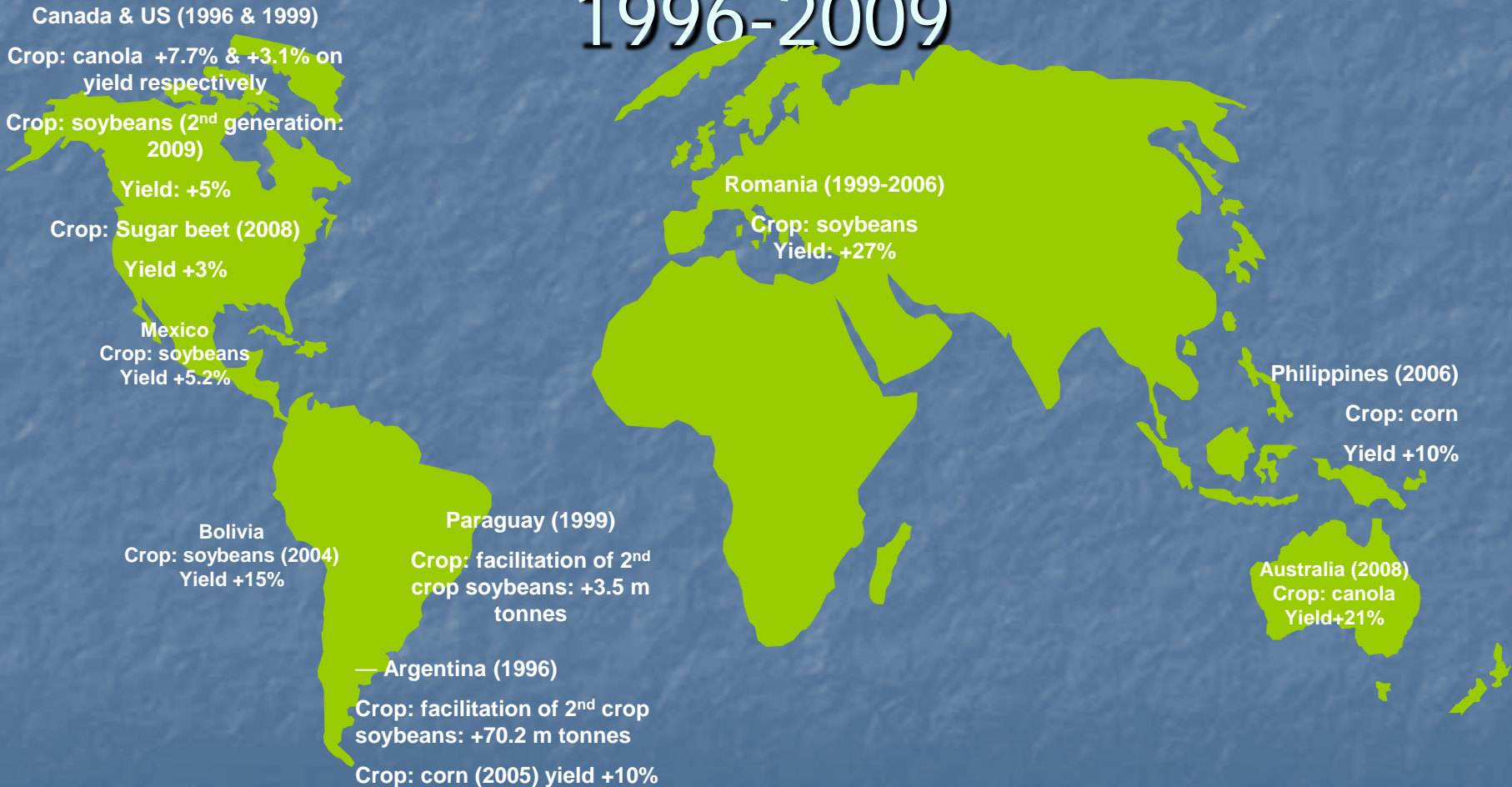
IR corn: yield & production impacts of biotechnology 1996-2009



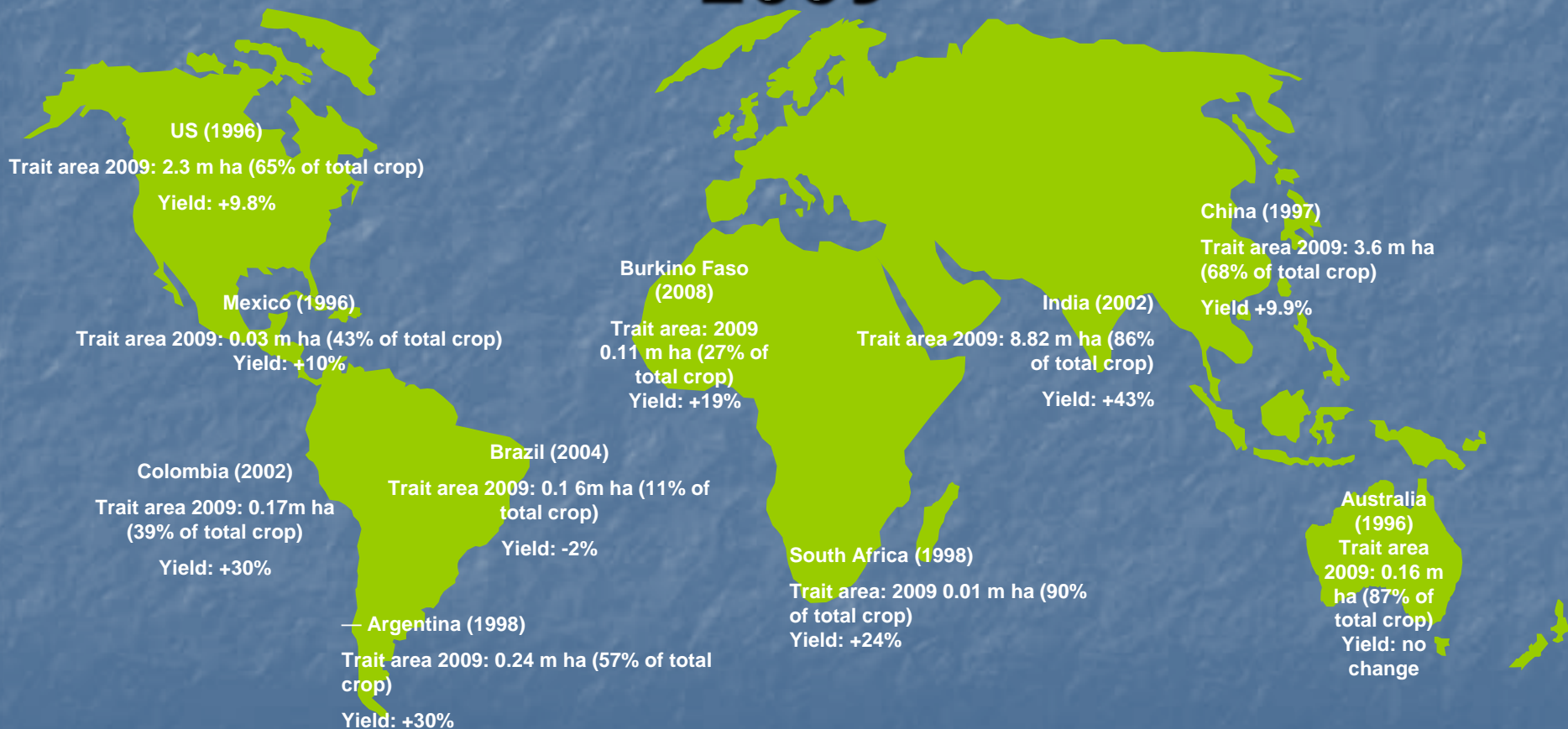
Since 1996, average yield impact +9.7% & +130.4 m tonnes

Herbicide tolerant traits yield & production impacts of biotechnology

1996-2009

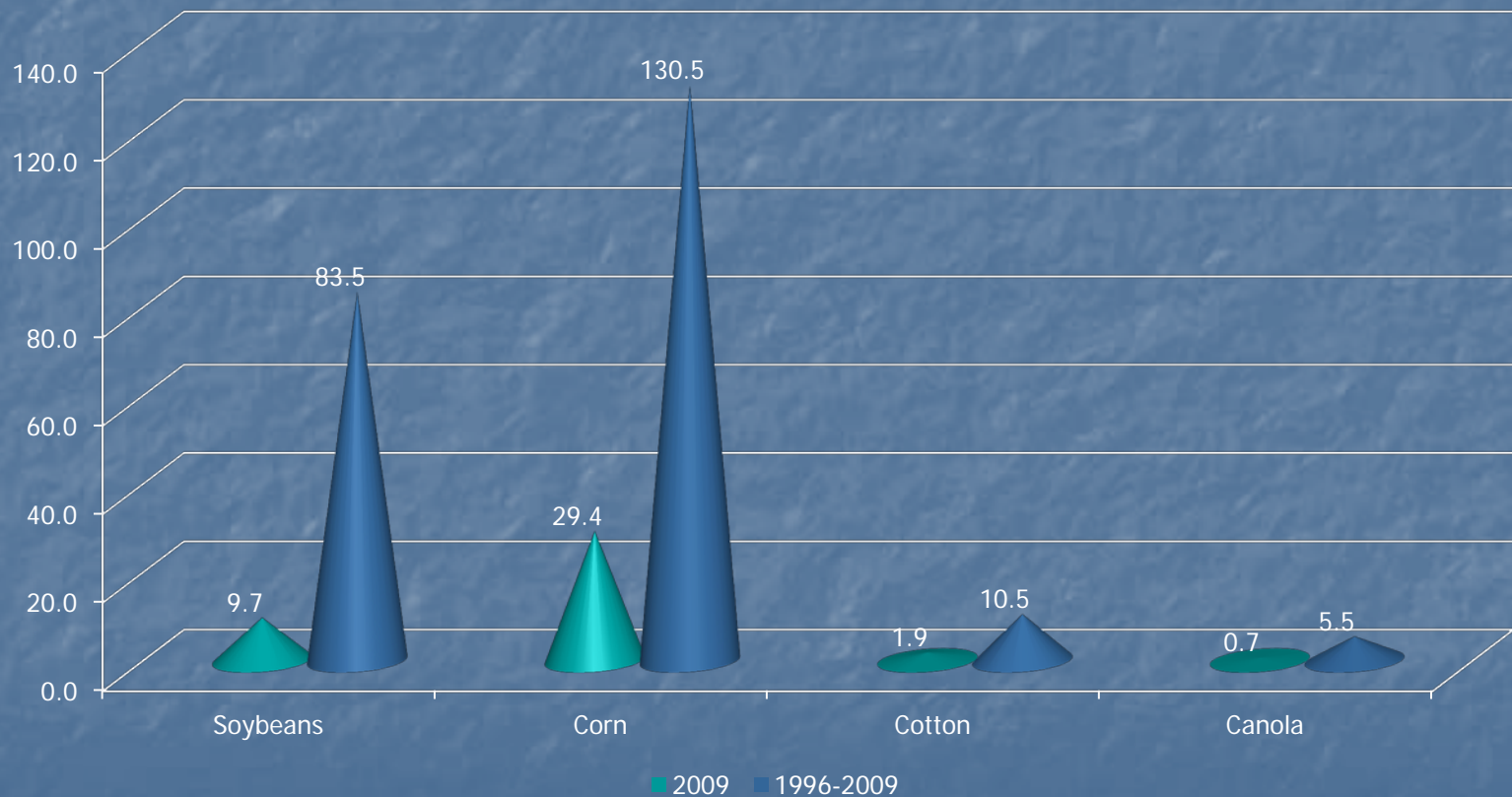


IR cotton: yield & production impacts of biotechnology 1996- 2009



Since 1996, average yield impact +14.1% & +10.5 m tonnes

Additional crop production arising from positive yield effects of biotech traits 1996-2009 (million tonnes)



Additional conventional area required if biotech not used (m ha)

	2009	1996-2009
Soybeans	3.82	32.75
Maize	5.63	25.02
Cotton	2.58	14.40
Canola	0.34	2.80
Total	12.37	74.97

Impact on pesticide use

- Significant reduction in global environmental impact of production agriculture
- Since 1996 use of pesticides down by 393 m kg (-8.7%) & associated environmental impact -17.1% - equivalent to 1.4 x total EU (27) pesticide active ingredient use on arable crops in one year
- Largest environmental gains from GM IR cotton: savings of 153 million kg insecticide use & 25% reduction in associated environmental impact of insecticides

Changes in the use of herbicides & insecticides from growing GM crops globally 1996-2009

Trait	Change in volume of active ingredient used (million kg)	Change in field EIQ impact (in terms of million field EIQ/ha units)	% change in ai use on biotech crops	% change in environmental impact associated with herbicide & insecticide use on biotech crops
GM herbicide tolerant soybeans	-40.85	-5,632.0	-2.2	-16.0
GM herbicide tolerant maize	-140.26	-3,435.4	-9.22	-10.49
GM herbicide tolerant canola	-13.98	-455.8	-16.2	-23.2
GM herbicide tolerant cotton	-8.87	-281.5	-4.0	-6.9
GM insect resistant maize	-36.46	-1,292.3	-40.6	-34.8
GM insect resistant cotton	-152.66	-7,088.0	-21.8	-24.7
GM herbicide tolerant sugar beet	+0.35	-1.0	+18.0	-2.0
Totals	-392.73	-18,184.0	-8.7	-17.1

Impact on greenhouse gas emissions

Lower GHG emissions: 2 main sources:

- Reduced fuel use (less spraying & soil cultivation)
- GM HT crops facilitate no till systems = less soil preparation = additional soil carbon sequestration

Reduced GHG emissions: 2009

- Reduced fuel use (less spraying & tillage) = 1.4 billion kg less carbon dioxide
- Facilitation of no/low till systems = 16.3 billion kg of carbon dioxide not released into atmosphere

=



Equivalent to removing 7.8 million cars — 28% of cars registered in the United Kingdom — from the road for one year

Reduced GHG emissions: 1996-2009

- less fuel use = 9.9 billion kg co₂ emission saving (4.4 m cars off the road)
- additional soil carbon sequestration = 115 billion kg co₂ saving if land retained in permanent no tillage. BUT only a proportion remains in continuous no till so real figure is lower (lack of data means not possible to calculate)

Concluding comments

- Technology used by 14 m farmers on 130 m ha in 2009
- Delivered important economic & environmental benefits
- + \$64.7 billion to farm income since 1996
- -393 m kg pesticides & 17.1% reduction in env impact associated with pesticide use since 1996
- Carbon dioxide emissions down by 17.7 billion kg in 2009: equal to 7.8 m cars off the road for a year

Concluding comments

- GM IR technology: improved profits & env gains from less insecticide use
- GM HT technology: combination of direct benefits (mostly cost reductions) & facilitation of changes in farming systems (no till & use of broad spectrum products) plus major GHG emission gains
- Combination of additional farm income, improved environment, higher production and greater production security = improved sustainability of global agriculture