Global impact of Biotech crops: economic & environmental effects 1996-2006

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Coverage

- Presenting findings of full report available on www.pgeconomics.co.uk
- In peer reviewed scientific journal: AgbioForum (2008) 11, (1) 21-38 www.agbioforum.org
- 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

286 million kg

reduction in pesticides & 15.4% cut in associated environmental impact

Carbon Emissions

2006 = cut of 14.8 billion kg co2 release; equiv to taking 6.6 million cars off the road

Global Farm Income

$33.8 billion increase

After 11 years of commercialization, biotech crops have yielded a net increase in farm income while significantly reducing environmental impact.

Farm level economic impact

- 2006: farm income benefit $6.9 billion
- 2006: equiv to adding value to global production of these four crops of 3.8%
- 53% of farm income gain in 2006 to farmers in developing countries (49% 1996-2006)
- Since 1996, farm income gain = $33.8 billion

Farm income effect: million $

Trait	Increase in farm income 2006	Increase in farm income 1996-2006	Farm income benefit in 2006 as % of total value of production of these crops in GM adopting countries	Farm income benefit in 2006 as % of total value of global production of these crops
GM HT soybeans	3,091	17,455	6.74	5.58
GM HT maize	296	1,111	0.64	0.35
GM HT cotton	21	814	0.13	0.08
GM HT canola	227	1,096	8.55	1.49
GM IR maize	1,131	3,634	2.47	1.35
GM IR cotton	2,149	9,567	13.15	7.85
Others	26	93	n/a	n/a
Totals	**6,941**	**33,770**	**6.2**	**3.8**

Farm income gains: by country: 1996-2006 million $

Since 1996, biotech crops have increased farm income $33.8 billion.

Farm income benefit; IR cotton: India (update)

	2007	Cumulative 1996-2007
Farm income gain (Billion $)	1.95	3.25
Average gain/ha ($/ha)	$333	$280
Average yield impact		+50%
Additional lint/fibre production (million tonnes)	1.26 (32% of total production)	2.25
Area planted to trait (million ha)	5.87 (63% of crop) – 2008 = 6.97 (77% of crop)	

Other farm level benefits

GM HT crops	GM IR crops
Increased management flexibility/convenience	Production risk management tool
Facilitation of no till practices	Energy cost savings
Cleaner crops = lower harvest cost & quality premia	Machinery use savings
Less damage in follow on crops	Convenience benefit
	Improved crop quality
	Improved health & safety for farmers/workers

Cost of accessing the technology 2006

- Historically normal practice in seed and pesticide sectors is technology priced to deliver one third to supply chain and two thirds to farmers
- Total trait benefit 2006 = $6.91 billion extra farm income plus $2.7 billion extra cost of seed
- Means 73% of total benefit goes to farmers and 27% to supply chain (sellers of seed to farmers, seed multipliers, plant breeders, distributors & tech providers) = better than historic average benefit for farmers

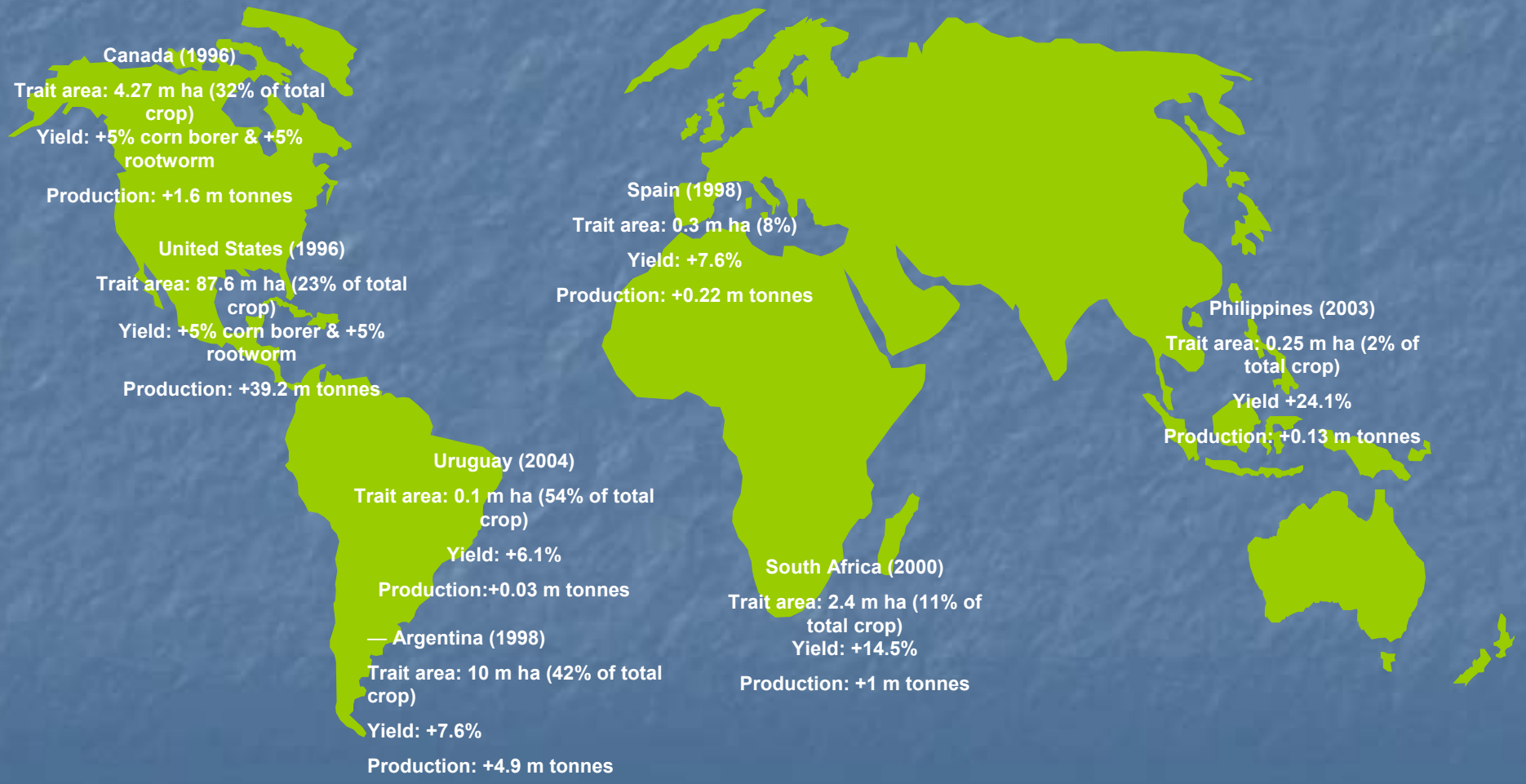
Cost of accessing technology 2006

- Farmers in developing countries: 17% of total trait benefit
- Farmers in developed countries: 38% of total trait benefit
- Higher share of farm income gain as % of total trait benefit in developing countries due to combination of higher average benefits per hectare in developing countries and weaker enforcement of intellectual property rights

Yield gains versus cost savings

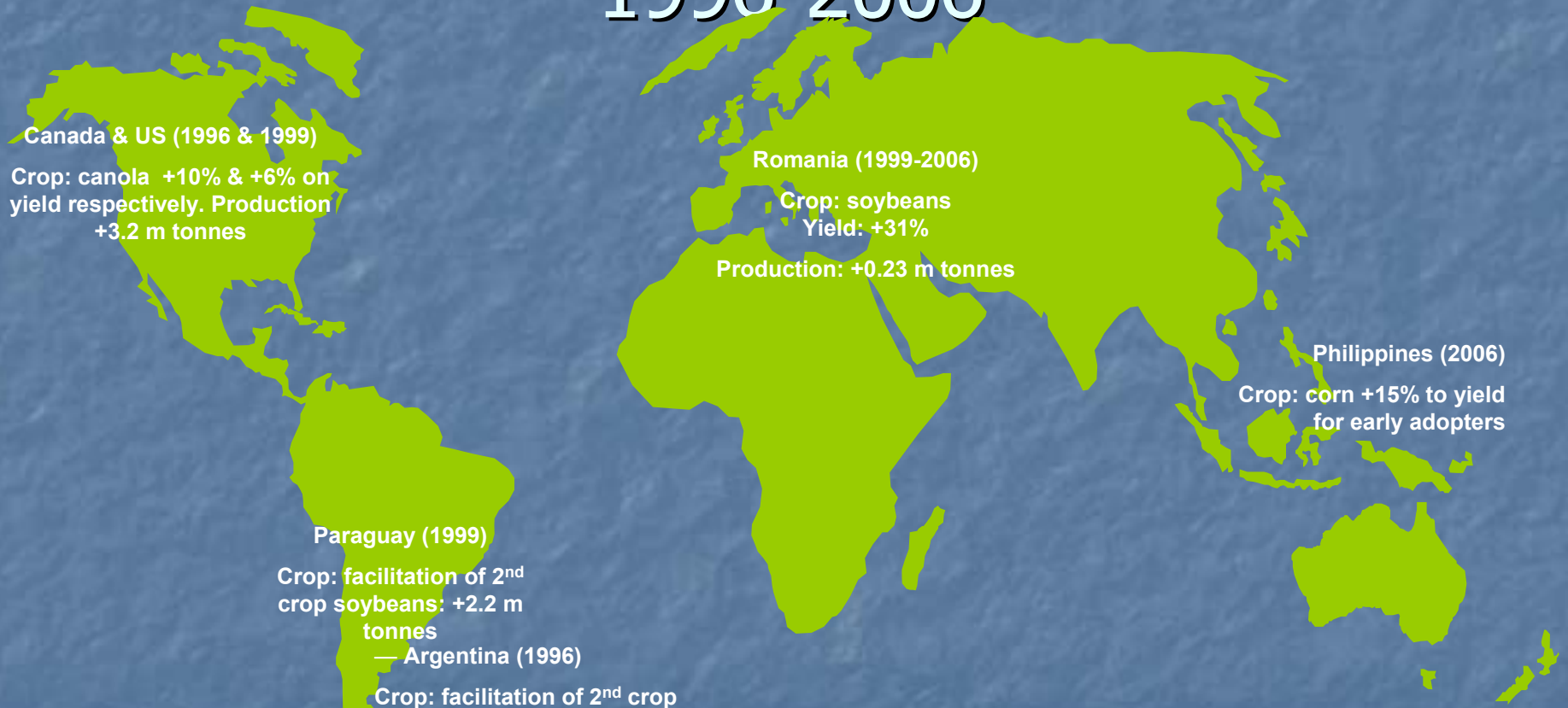
- 43% ($14.54 billion) of total farm income gain due to yield gains 1996-2006
- 57% due to cost savings
- Yield gains mainly from GM IR technology & cost savings mainly from GM HT technology
- Yield gains greatest in developing countries & cost savings mainly in developed countries
- HT technology also facilitated no tillage systems – allowed second crops (soy) in the same season in S America

IR corn: yield & production impacts of biotechnology 1996-2006

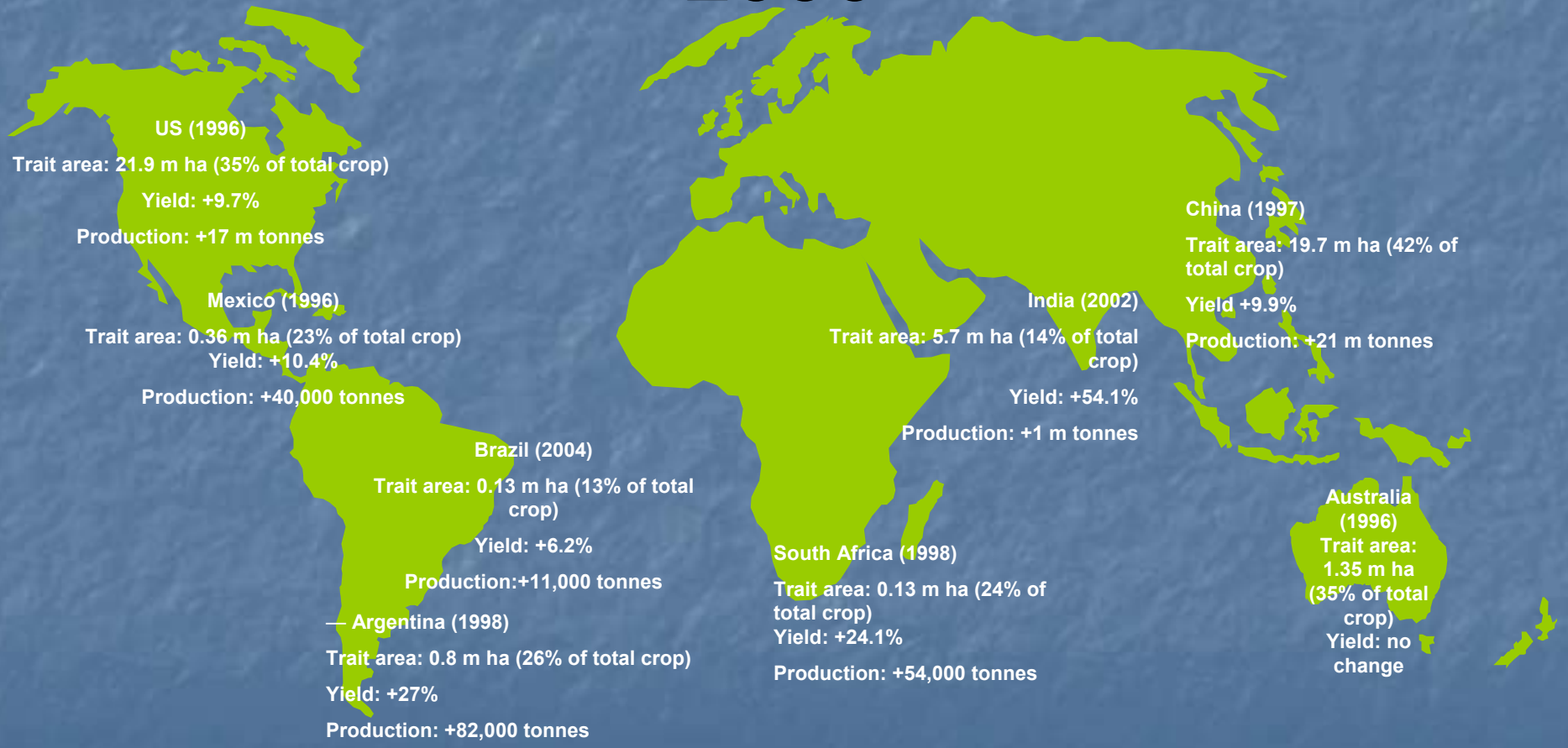


Since 1996, average yield impact +5.7% & +47.1 m tonnes

Herbicide tolerant traits yield & production impacts of biotechnology 1996-2006

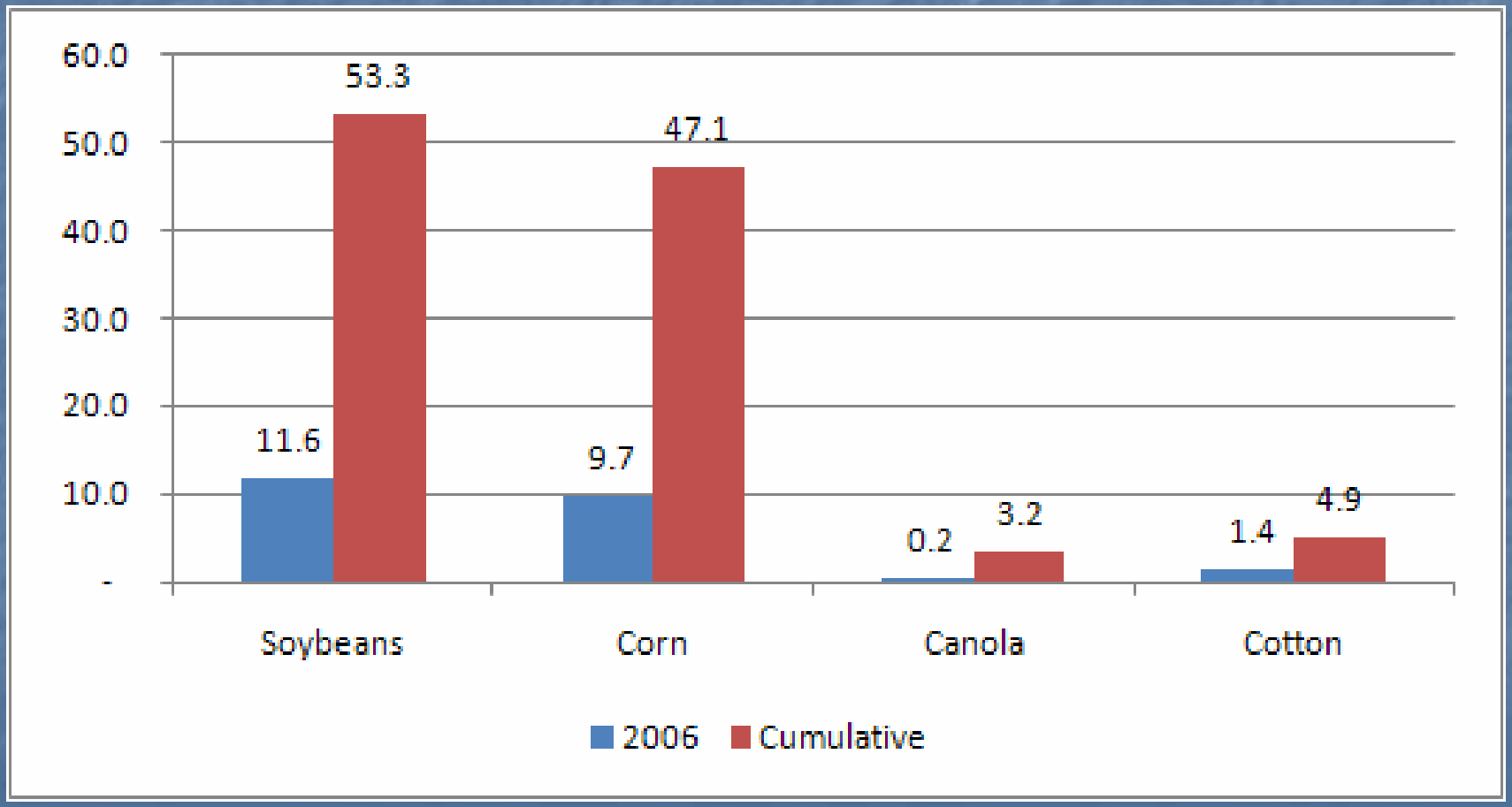


IR cotton: yield & production impacts of biotechnology 1996-2006



Since 1996, average yield impact +11.1% & +4.9 m tonnes

Additional crop production arising from positive yield effects of biotech traits 1996-2006 (million tonnes)



Contribution to food security

- 2006: additional production = (after conversion to livestock production, where applicable) meets energy requirement of 65 million people for one year
- 1996-2006 = energy requirement to feed 310 million people for a year

Impact on pesticide use

- Since 1996 use of pesticides on biotech crop area down by 286 m kg (-7.9%) - equivalent to total EU (27) pesticide active ingredient use on arable crops in one year
- Environmental impact as measured by EIQ indicator down -15.4%

Changes in the use of herbicides & insecticides from growing GM crops globally 1996-2006

Trait	Change in volume of active ingredient used (million kg)	Change in field EIQ 'foot print' (in terms of million field EIQ/ha units)	% change in ai use in GM growing countries	% change in environmental 'foot print' in GM growing countries
GM HT soybeans	-62.4	-5,536	-4.4	-20.4
GM HT maize	-46.7	-1,172	-3.9	-4.6
GM HT cotton	-32.1	-616	-14.3	-14.5
GM HT canola	-7.9	-372	-12.6	-24.2
GM IR maize	-8.2	-452	-5.0	-5.3
GM IR cotton	-128.4	-5,628	-22.9	-24.6
Totals	**-285.7**	**-13,776**	**-7.9**	**-15.4**

IR Cotton India: reduction in insecticide use & environmental impact

	2007	Cumulative 1996-2007
Insecticide active ingredient reduction (million kg)	-9.5 (-29%)	-18.9 (-10.4%)
Field EIQ reduction (%)	-27%	-9.7%

Impact on greenhouse gas emissions

Lower GHG emissions: 2 main sources:

- Less spraying and less ploughing = less fuel use
- GM HT crops help farmers go from plough to no till systems = less soil preparation = soil carbon no longer released into atmosphere

Reduced GHG emissions: 2006

- Reduced fuel use (less spraying & tillage) = 1.2 billion kg less carbon dioxide
- Facilitation of no/low till systems = 13.5 billion kg of carbon dioxide not released into atmosphere

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Equivalent to removing 6.56 million cars — 25% of cars registered in the United Kingdom — from the road for one year

Reduced GHG emissions: 1996-2006

- less fuel use = 5.8 billion kg co2 emission saving (2.6 m cars off the road)
- additional soil carbon sequestration = 63.9 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 over 10 m farmers on 100 m ha (2006) – 12 m farmers on 114 m ha in 2007
- Delivered important economic & environmental benefits
- + $33.8 billion to farm income since 1996
- -286 m kg pesticides & 15.4% reduction in env impact associated with pesticide use since 1996
- Carbon dioxide emissions down by 14.76 billion kg in 2006: equal to 6.56 m cars off the road for a year

Concluding comments

- GM IR technology: higher farm income mainly from higher yields & environmental gains mainly from less insecticide use
- GM HT technology: farm income gains mostly from cost savings (also second cropping in South America). Environment gains mostly lower GHG saving from switch to no tillage
- Higher production = more trade on world markets = world prices would be higher if technology had not been used – positive impact on cost of food at a time of high world prices for grains and oilseeds

Concluding comments: India

- Major improvement in farm income (+$3.3 billion)
- Improved farm/household incomes = better able to feed families and higher standard of living
- Extra spending = improvements to local/rural economies (contributes to new employment generation)
- India now a cotton exporter – improved export earnings
- Improved health = less exposure to insecticides
- Better environment from less insecticide spraying