

*Global Impact of Biotech Crops:
economic & environmental effects
1996-2011*

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Background

- 8th annual review of global GM crop impacts
- Authors of 15 papers on GM crop impacts in peer review journals
- Current review in 2 open access papers in journal GM crops. www.landesbioscience.com/journal/gmcrops
- Full report available at www.pgeconomics.co.uk



Coverage

- Cumulative impact: 1996-2011
- 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

Key Findings

**Pesticide
change 1996-2011**

**474 million kg
reduction in
pesticides &
18.3% cut in
associated
environmental
impact**

**Carbon Emissions
2011**

**cut of 23 billion
kg co2 release;
equal to taking
10.2 million
cars off the
road**

**Global
farm income
1996-2011**

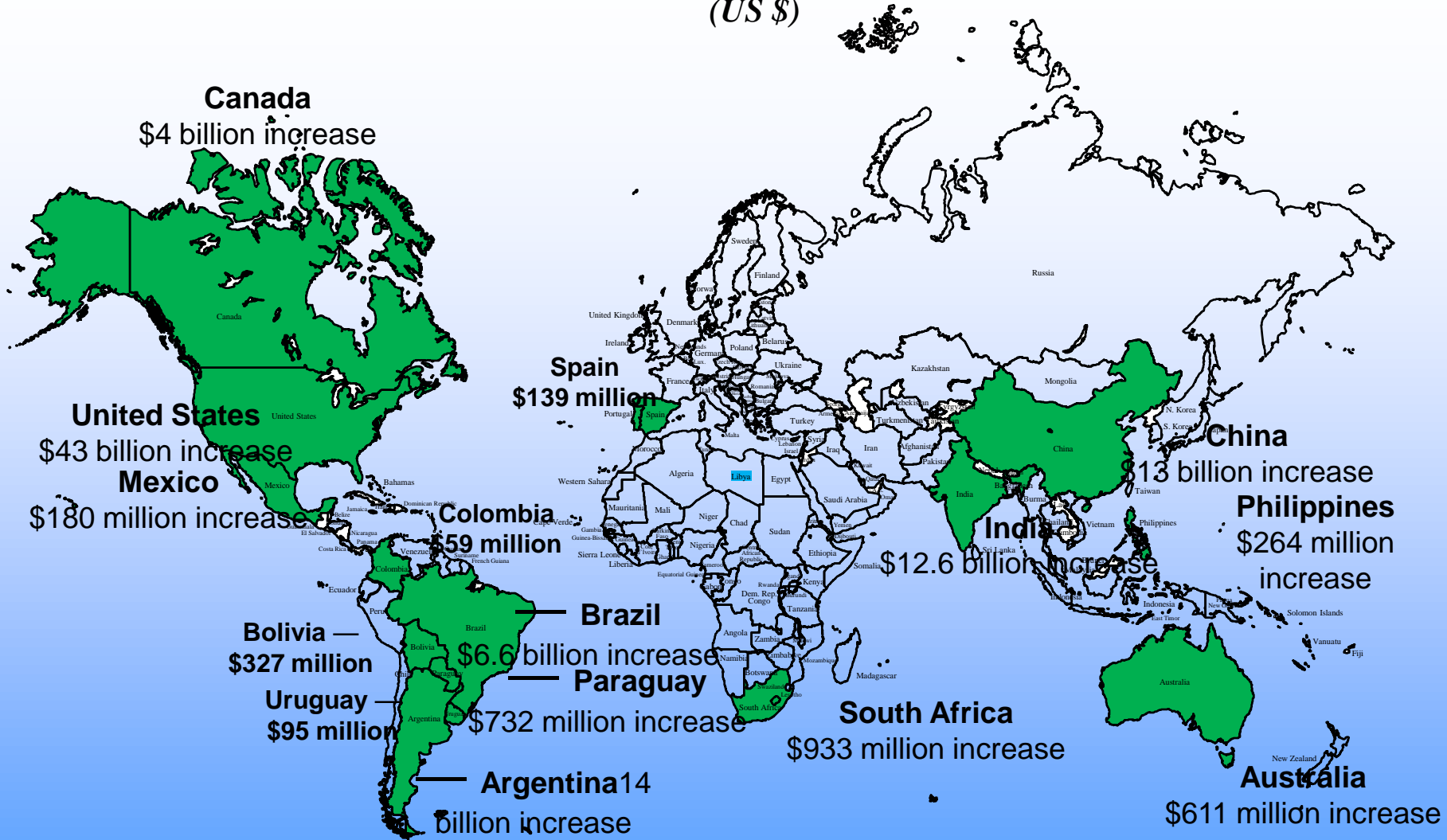
**\$98.2
billion
increase**

Farm income gains 2011: highlights


- Total farm income benefit \$19.8 billion
- Equal to adding value to global production of these four crops of 6.3%
- Average gain/hectare: \$133
- Income share



Farm income gains 1996-2011 by country
(US \$)



Other farm level benefits

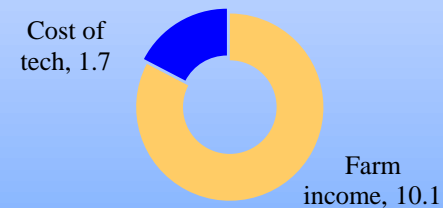
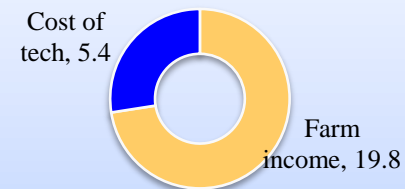
<i>GM HT crops</i>	<i>GM IR crops</i>
Increased management flexibility/convenience	Production risk management tool
Facilitation of no till practices	Machinery & energy cost savings
Cleaner crops = lower harvest cost & quality premia	Yield gains for non GM crops (reduced general pest levels)
Less damage 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 \$9 billion 1996-2011

Cost of accessing the technology (\$ billion) 2011

- Distribution of total trait benefit: all (tech cost 21%)
- Distribution of benefit: developing countries (tech cost 14%)

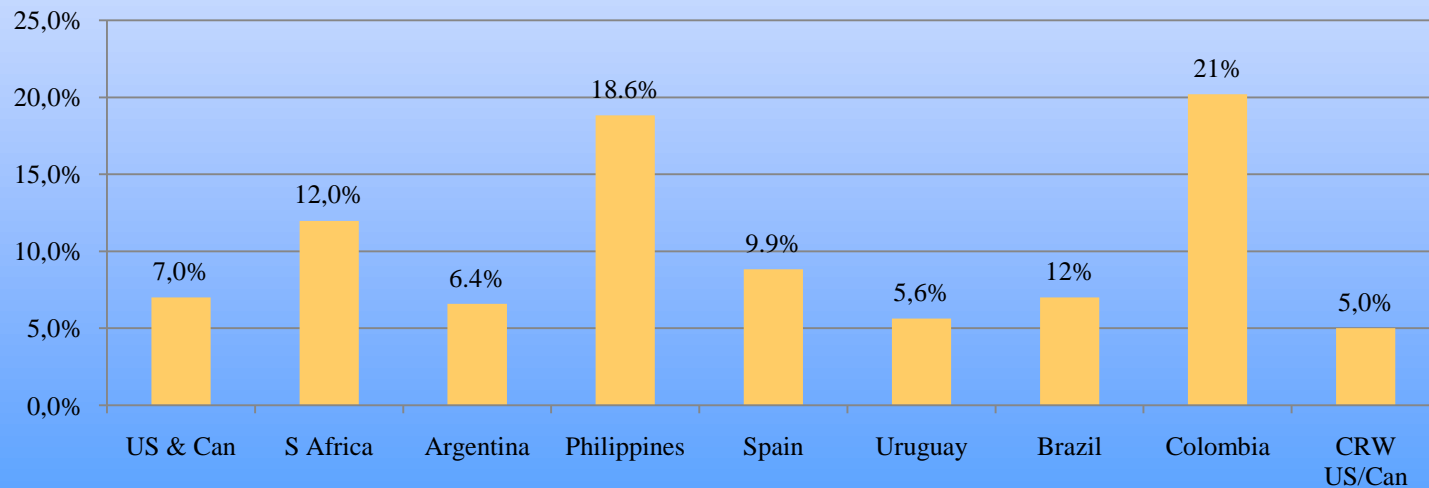


Cost of tech goes to seed supply chain (sellers of seed to farmers, seed multipliers, plant breeders, distributors & tech providers)

Yield gains versus cost savings

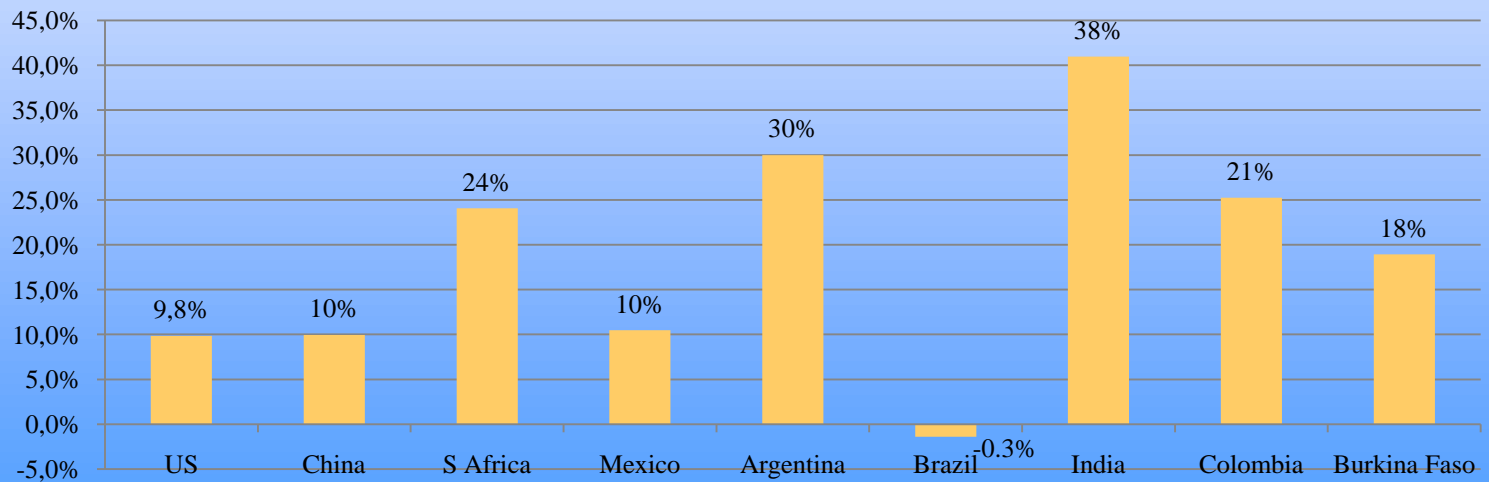
- 49% (\$48 billion) of total farm income gain due to yield gains 1996-2011
- Balance due to cost savings
- Yield gains mainly from GM IR technology & cost savings mainly from GM HT technology
- Yield gains greatest in developing countries & cost savings mainly in developed countries
- HT technology also facilitated no tillage systems – allowed second crops (soy) in the same season in S America

IR corn: average yield increase 1996-2011



Average across all countries:
+10.1%

IR cotton: average yield increase 1996-2011



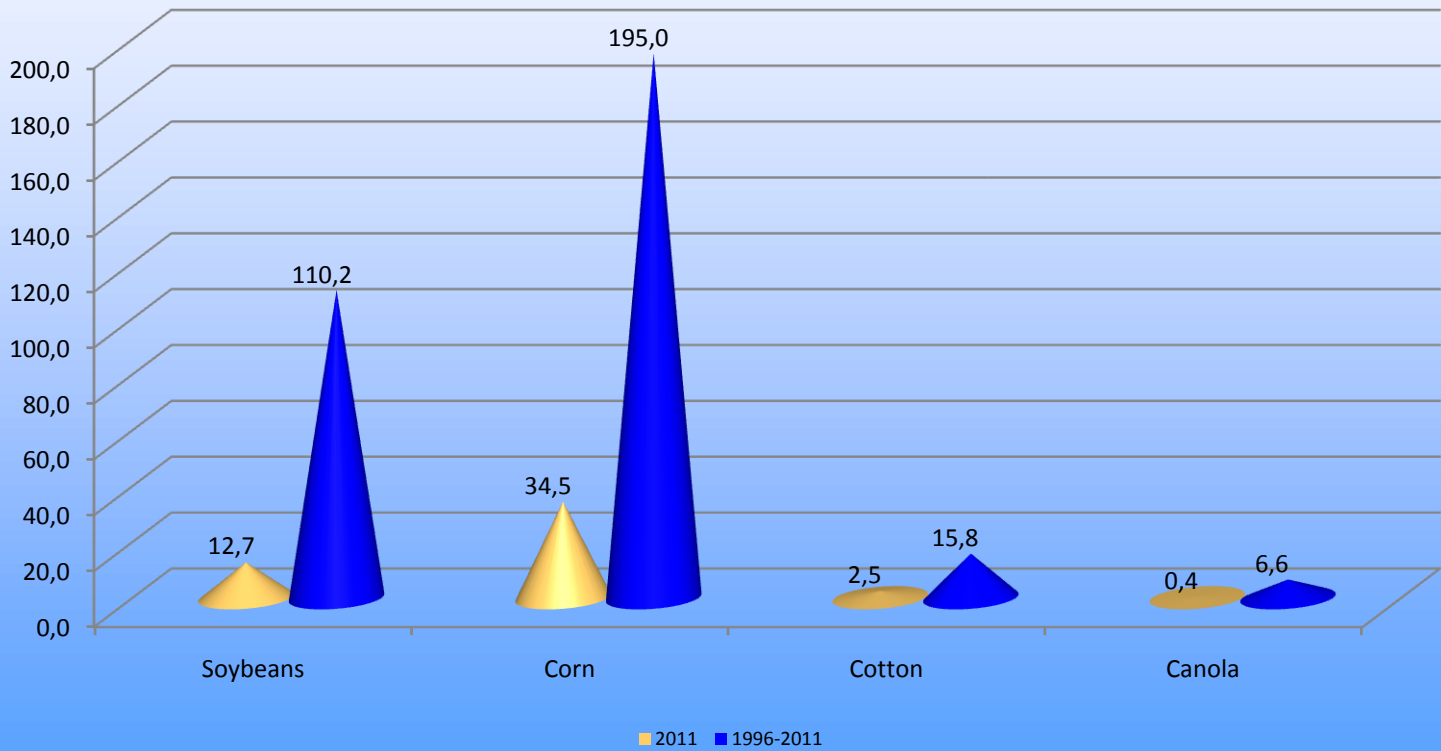
**Average across all countries:
+15.8%**

HT traits: yield and production effects



Trait/country	Yield/production effect
HT soy: Romania, Mexico, Bolivia	+23%, +6% & +15% respectively on yield
HT soy: 2 nd generation: US & Canada	+10% yield
HT soy Argentina & Paraguay	Facilitation of 2 nd crop soy after wheat: equal to +20% and +7% respectively to production level
HT corn: Argentina, Brazil, Philippines	+10%, +3% & +5% respectively on yield
HT cotton: Mexico, Colombia, Brazil	+5%, +4% & +3% respectively on yield
HT canola: US, Canada & Australia	+2.6%, +6.7% & +16% respectively on yield

Additional crop production arising from positive yield effects of biotech traits 1996-2011 (million tonnes)



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

	2011	1996-2010
Soybeans	5.4	47.0
Maize	6.6	37.3
Cotton	3.3	20.9
Canola	0.2	3.5
Total	15.5	105.2

Impact on pesticide use

- Since 1996 use of pesticides down by 474 m kg (-9%) & associated environmental impact -18% - equivalent to 1.7 x total EU (27) pesticide active ingredient use on arable crops in one year
- Largest environmental gains from GM IR cotton: savings of 193 million kg insecticide use & 26% reduction in associated environmental impact of insecticides



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 storage

Reduced GHG emissions: 2011

- Reduced fuel use (less spraying & tillage) = 1.9 billion kg less carbon dioxide =
- Facilitation of no/low till systems = 21.1 billion kg of carbon dioxide not released into atmosphere



Equivalent to removing 10.2 million cars — 36% of cars registered in the United Kingdom — from the road for one year

Reduced GHG emissions: 1996-2011

- less fuel use = 14.6 billion kg co₂ emission saving (6.5 m cars off the road)
- additional soil carbon sequestration = 76 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 16.7 m farmers on 148 m ha in 2011
- Delivered important economic & environmental benefits
- + \$98.1 billion to farm income since 1996
- -474 m kg pesticides & 18.3% reduction in env impact associated with pesticide use since 1996
- Carbon dioxide emissions down by 23 billion kg in 2011: equal to 10.2 m cars off the road for a year

Concluding comments

- GM IR technology: higher yields, less production risk, decreased insecticide use leading to improved productivity and returns and more environmentally farming methods
- 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
- Both technologies have made important contributions to increasing world production levels of soybeans, corn, canola and cotton
- but GM HT technology has seen over reliance on use of glyphosate by some farmers which has contributed to development of weed resistance