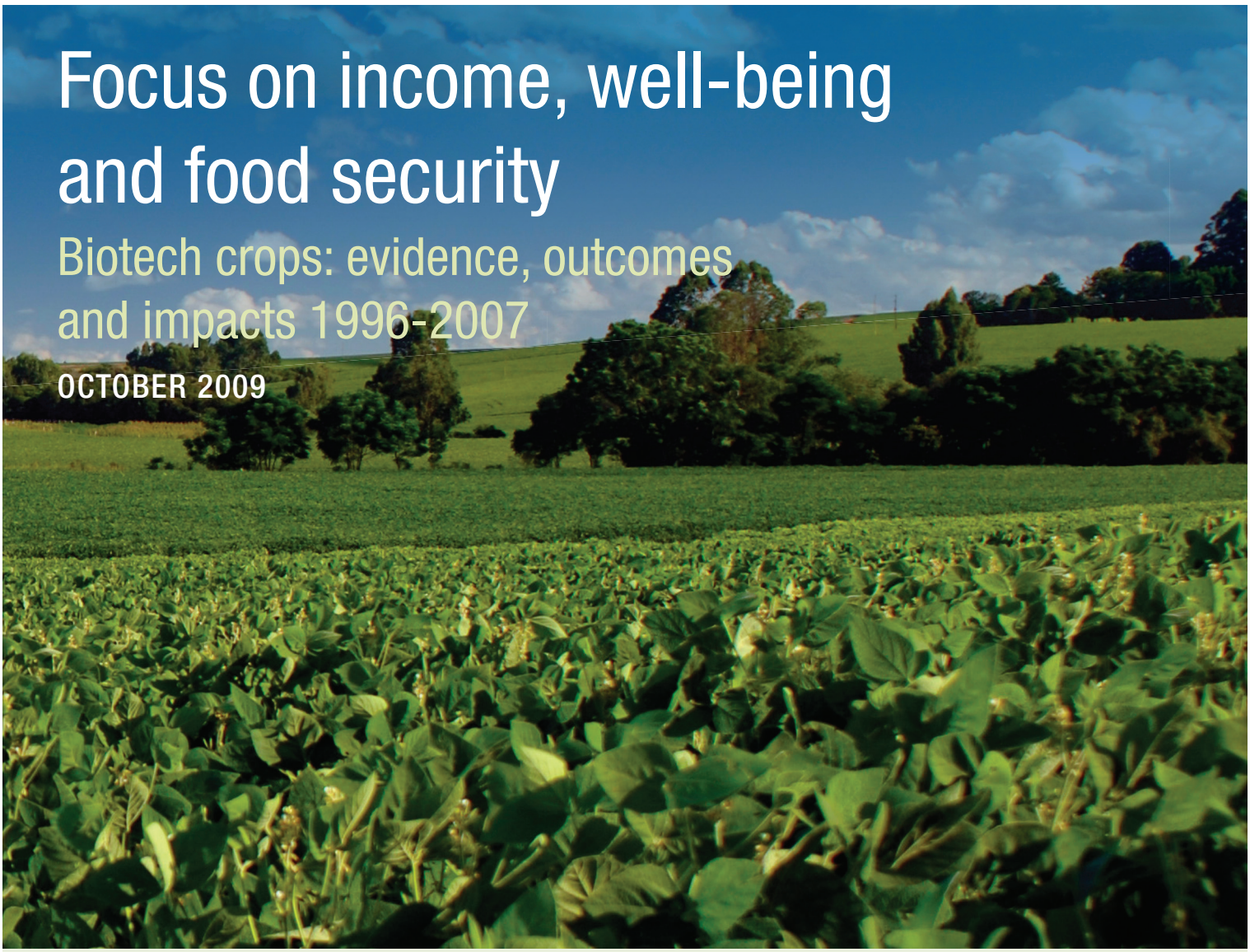
Focus on income, well-being and food security

Biotech crops: evidence, outcomes and impacts 1996-2007

OCTOBER 2009



FOREWORD

This brief is intended for use by a wide range of people with interests in agriculture and the environment. As a summary of the key findings relating to the impact of biotech crops (1996-2007), this brief focuses on farm income, economic well being and food security, as detailed in '*Global impact of biotech crops: socio-economic and environmental effects 1996-2007*'[1], by Graham Brookes & Peter Barfoot[2]

[1] www.pgeconomics.co.uk/pdf/2009globalimpactstudy.pdf. A shorter version of the report can be found in the peer reviewed scientific journal, AgBioForum, Volume 12(2): 184-208 www.agbioforum.org and in the journal, Outlooks on Pest Management, Volume 20(6), Dec. 2009. The food security analysis presented in this document is derived from data contained in the full report.

[2] Of PG Economics Ltd, a UK-based independent consultancy. PG Economics specializes in analyzing the impact of new technology in agriculture. Their research into biotech crops has been widely published in scientific journals including Agbioforum and the International Journal of Biotechnology.

INSIDE THIS BRIEF

Farm income impacts

Biotech crops have had a very positive impact on farm income derived from a combination of enhanced productivity and efficiency gains (Figure 1). Between 1996 and 2007, farm incomes increased by $44.1 billion. In 2007, the direct global farm income benefit was $10.1 billion, equivalent to adding 4.4% to the value of global production of the four main crops of soybeans, corn, cotton and canola.

The largest gains in farm income have arisen in the soybean sector. Of the total income gains from biotech HT soybeans ($21.8 billion 1996-2007), 78% has been due to cost savings and the balance due to yield increases (from improved weed control mainly in Romania and Mexico) and facilitation of 2nd crop soybeans in South America (by shortening the production cycle for soybeans, the technology has enabled many South American farmers to plant a crop of soybeans immediately after a wheat crop 'in the same season'). The average farm income gain over the 1996-2007 period across the total biotech HT soybean area was $42/hectare (ha) and for 2nd crop soybeans the average gain was $167/ha (Figure 2).

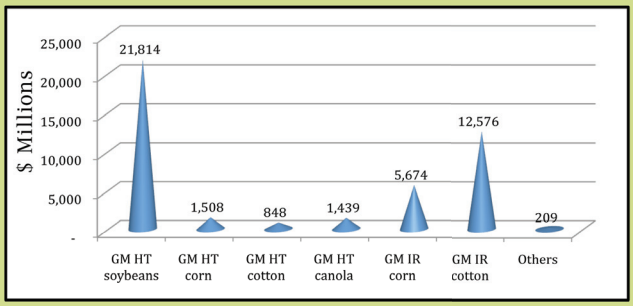
Important farm income gains have also been derived from other biotech HT traits in corn, cotton and canola (Figures 2 & 3) with the respective average gains over the 1996-2007 period being $22/ha, $26/ha and $39/ha for HT corn, HT cotton and HT canola. Almost all of the gains from HT corn and cotton have arisen from cost savings. The income gains from HT canola have come mostly from yield gains (70%) with the balance due to cost savings.

The biotech IR technology has also delivered major farm income gains, mostly from yield gains, although many farmers (especially in the cotton sector) have made important cost savings from reduced insecticide use. Biotech IR cotton has provided the largest gains per hectare (Figure 4), with an average farm income gain across the total biotech IR cotton area, over the 1996-2007 period, of $150/ha. Income gains have been largest in developing countries, notably China and India.

The average farm income gain (1996-2007) from use of IR corn technology (resistant to corn boring pests) has been $39/ha within a range of $13/ha in Uruguay to $158/ha in Spain. In addition to these quantifiable direct impacts on farm income, there have been important indirect benefits that are more difficult to quantify (eg, facilitation of no tillage systems, reduced production risk, convenience, improved crop quality and reduced exposure of farmers and farm workers to pesticides). These less tangible benefits have often been cited by biotech adopting farmers as having been important influences for adoption of the technology. In the US, these benefits have been valued by farmers to be worth the equivalent of an additional £5 billion of farm income (1996-2007).

FIGURE 1:

Global farm income benefits from growing biotech crops 1996-2007 ($ millions)



Note: Others = virus resistant papaya and squash

FIGURE 2:

Average farm income benefits from growing biotech HT soybeans 1996-2007 ($/hectare)

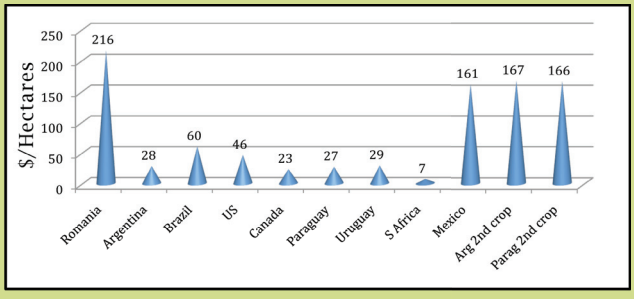


FIGURE 3:

Average farm income benefits from growing other biotech HT crops 1996-2006 ($/hectare)

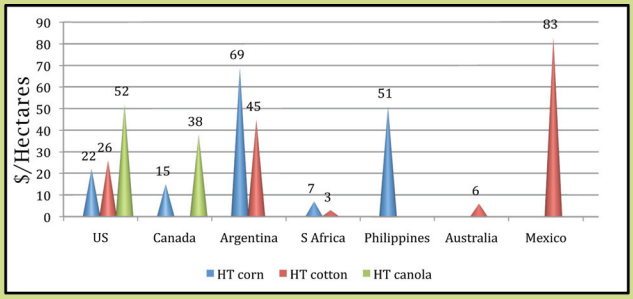


FIGURE 4:

Average farm income benefits from growing other biotech IR cotton 1996-2007 ($/hectare)

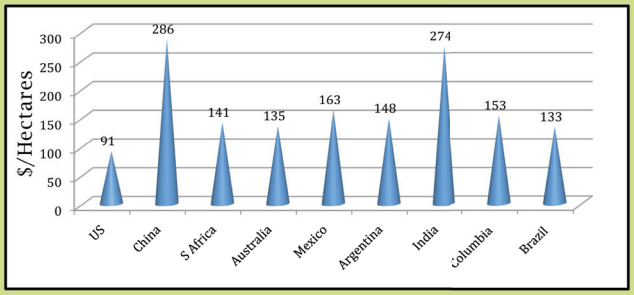
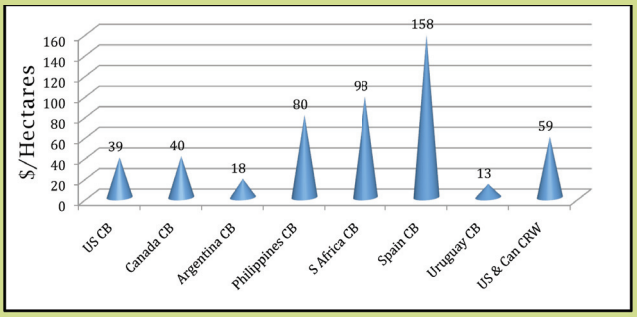


FIGURE 5:

Average farm income benefits from growing other biotech IR corn 1996-2007 ($/hectare)



Improving economic well being and food security

In 2007, 58% of the total farm income gain from using biotech traits went to farmers in developing countries and over the period 1996-2007, 50% of the total gain was obtained by developing country farmers. The majority of the farmers deriving these benefits have been resource-poor farmers in developing countries (90% of the total 12.3 million farmers who grew biotech crops in 2007), notably in China, India, South Africa and the Philippines. Many of these farmers cultivate areas of less than one hectare in size.

These farm income gains have added to farm household incomes which, when spent on goods and services, have had a positive 'knock on' effect on local, regional and national economies. In developing countries, the additional income derived from biotech crops has enabled more farmers to consistently meet their food subsistence needs and to improve the standards of living of their households[3] (for example, household income levels have typically increased by over a third for many farmers using IR cotton in India and for farmers using IR corn in the Philippines.

Biotech crops have also, since 1996, added important volumes to global production of corn, cotton, canola and soybeans (Table 1).

This additional production arising from biotech crops (1996-2007) has also contributed enough energy (in kcal terms) to feed about 402 million people for a year (additional production in 2007 contributed enough energy to feed 88 million, similar to the annual requirement of the population of the Philippines: see appendix for assumptions and calculations). Important contributions to meeting the protein and fat requirements of considerable numbers of people have also arisen (Figure 6).

[3] For example being able to buy more and better quality food, funding improvements to housing, sanitation and access to services and freeing children to be educated instead of having to work to help feed the family

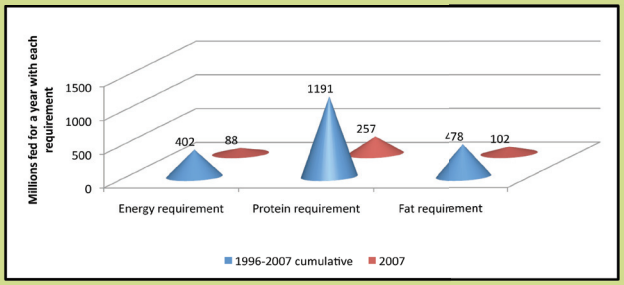
TABLE 1

Additional crop production arising from positive yield/production effects of biotech crops

	1996-2007 additional production (million tonnes)	2007 additional production (million tonnes)	Per cent change in production 2007 on area planted to biotech crops
Soybeans	67.80	14.46	29.8
Corn	62.42	15.08	7.6
Cotton	6.85	2.01	19.8
Canola	4.44	0.54	8.5

FIGURE 6:

Contribution to food security from biotech crop additional production 1996-2007 (millions fed/year)



Environmental benefits

Biotech crop production has also resulted in important environmental benefits. Pesticide use on the four crops in the countries where biotech crops have been planted have fallen by 359 million kg (-8.8%), resulting in a larger, 17.2% reduction in the associated environmental impact[4] (Figure 7).

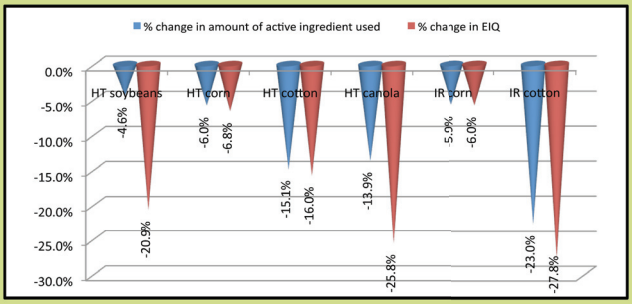
Greenhouse gas emission (GHG) reductions have also been facilitated, equal to 14.2 billion kg of carbon dioxide in 2007, equivalent to removing 6.3 million cars from the roads for a year (equal to 24% of all registered cars in the UK). The GHG emission reductions derive from reduced fuel use (due

to less frequent herbicide and insecticide applications and a reduction in the energy use in soil cultivation). In addition, the facilitation of no and reduced tillage production systems by the biotech HT technology results in less ploughing and increased carbon storage in the soil. This additional carbon storage reduces carbon dioxide emissions to the environment.

[4] As measured by the indicator, the environmental impact quotient (EIQ) – see Brookes & Barfoot (2008) for further details

FIGURE 7:

Change in herbicide and insecticide use from growing GM crops 1996-2006



Appendix

Food security assumptions and calculations

Human food requirements per day (recommended daily allowances)

	MALE	FEMALE	AVERAGE
Energy (kcal)	2,900	2,200	2,550
Proteins (grams)	63	50	56.5
Fat (grams)	100	78	89

Source: FAO

Crop key nutrition composition (per kg of edible material)

	Energy (kcal)	Proteins (grams)	Fat (grams)
Corn	3,650	94	47
Canola oil	8,840	0	1,000
Canola meal	3,540	380	38
Soybean oil	8,840	0	1,000
Soybean meal	3,370	485	10
Cottonseed oil	8,840	0	1,000
Cottonseed meal	3,450	410	21

Source: USDA - Nutritional database for standard reference **www.usda.gov/data/feedgrains**

Main constituents of oilseeds (source: Soya & Oilseed Bluebook)

- Soybeans: 79.2 per cent meal, 17.8 per cent, oil, 3 per cent waste
- Canola: 59 per cent meal, 38 per cent oil, 3 per cent waste
- Cottonseed: 44.9 per cent meal, 16.2 per cent oil, 8.2 per cent lintners, 26.7 per cent hulls, 4.1 percent waste

Assumption on corn utilization – 99 per cent usable

Assumptions for uses of crops

	Food	Feed	Industrial (non-food)
Corn	30%	50%	20%
Soy oil	98%	0%	2%
Soy meal	0%	100%	0%
Canola oil	60%	0%	40%
Canola meal	0%	100%	0%
Cottonseed oil	50%	0%	50%
Cottonseed meal	0%	50%	50%

Source: derived from USDA ERS Feed Grains database **www.ers.usda.gov**

Use of corn and oilseeds in meat production assumptions

The following simplifying assumptions were used:

- As most corn and oilseeds at the global level are used in pig and poultry rations, all usage is assumed to be in these two sectors';
- Corn: 2.6 kg corn produces 1 kg of poultry meat at the consumer level, 6.5 kg of corn produces 1 kg of pig meat at the consumer level (source: USDA ERS – **www.ers.usda/amberwaves/february2008/features/cornprices.htm).** Readers should note these are conservative estimates;
- Feed conversion ratios of 1.8 kg feed produces 1 kg of chicken (live weight) and 3 kg of feed produces 1kg of pig (live weight) – typical feed conversion rates in developed countries for poultry are 1.7/1.75:1 and for pig meat are 2.5/2.8:1, hence the conversion rates used are conservative;
- Conversion of live weight to meat eaten by a consumer – for poultry assumes 50 per cent of live weight converted to meat and for pig meat assumes 35 per cent conversion;
- Corn constitutes 70 per cent of a typical poultry feed ration and 75 per cent of a typical pig ration;
- Meals (from soy, canola and cottonseed) are assumed to supply the main part of the protein requirement in the feed ration with incorporation rates of 25 per cent in poultry feed and 20 per cent in pig feed;
- Based on the above assumptions, it takes 0.93 kg of meal to produce 1 kg of poultry meat (at the consumer level) and 1.73 kg of meal to produce 1kg of pig meat (at the consumer level).