Focus on Yields

Biotech crops: evidence, outcomes and impacts 1996-2007

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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 yield effects, 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.

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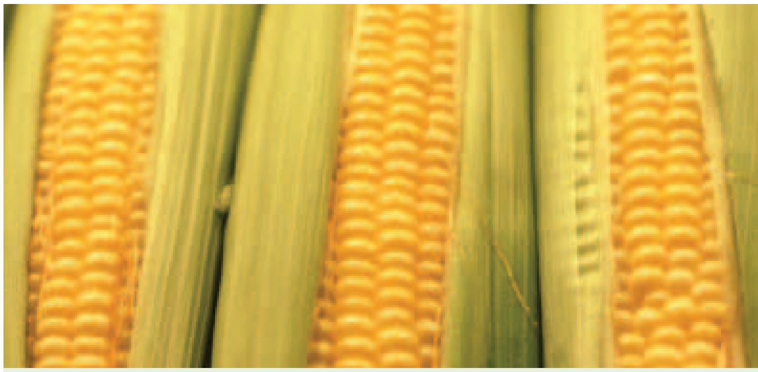


Positive yield and production impacts

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

Production of the four crops, on the 111 million hectares planted to biotech crops in 2007, were significantly higher than levels would have otherwise been if GM technology had not been used by farmers (Table 1). Incremental yields ranged from eight percent for canola to 30 percent for soybeans.

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

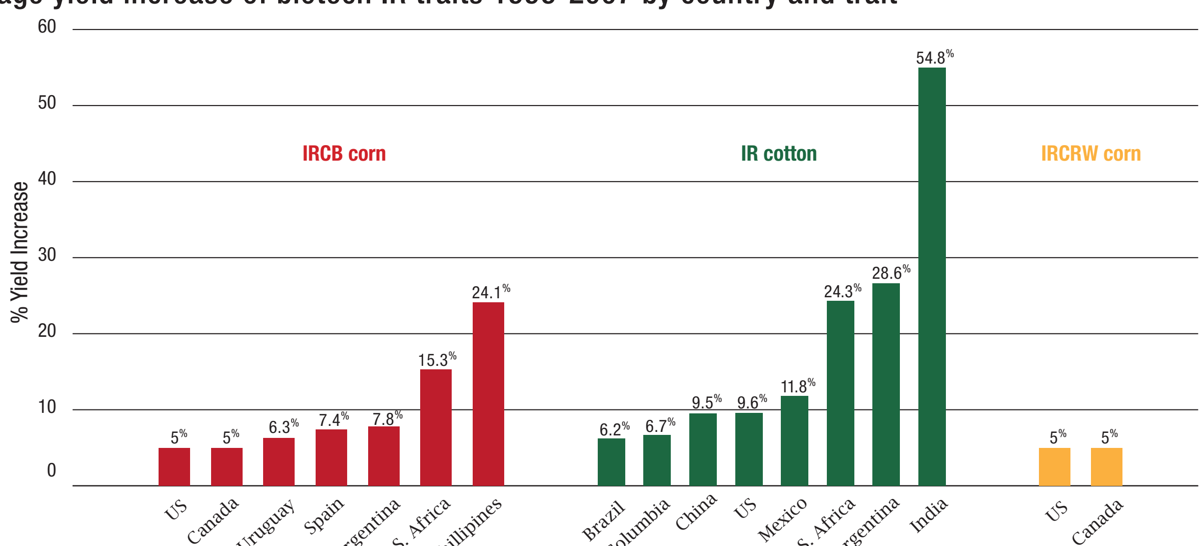
The biotech insect resistant (IR) traits have targeted major pests of corn and cotton crops. These pests, persistent in many parts of the world, significantly reduce yield and crop quality, unless crop protection practices are employed. The biotech IR traits have delivered positive yield impacts in all user countries (except Australia) when compared to average yields derived from crops using conventional technology (such as application of insecticides and seed treatments). Since 1996, the average yield impact across the total area planted to these traits over the 12 year period has been +6.1 percent for corn traits and +13.4 percent for cotton traits (Figure 1).

Although the primary impact of biotech herbicide tolerant (HT) technology has been to provide more cost effective (less expensive) and easier weed control versus improving yields from better weed control (relative to weed control obtained from conventional technology), improved weed control has, nevertheless occurred - delivering higher yields. Specifically, HT soybeans in Romania improved the average yield by over 30 per cent and biotech HT corn in Argentina and the Philippines delivered yield improvements of +9 per cent and +15 per cent respectively.

Biotech HT soybeans have also facilitated the adoption of no tillage production systems, shortening the production cycle. This advantage enables many farmers in South America to plant a crop of soybeans immediately after a wheat crop in the same growing season. This second crop, additional to traditional soybean production, has added 67.5 million tonnes to soybean production in Argentina and Paraguay between 1996 and 2007.

FIGURE 1:

Average yield increase of biotech IR traits 1996-2007 by country and trait



Notes: IRCB = resistant to corn boring pests, IRCRW = resistant to corn rootworm

Improving economic well being and food security

Biotech traits have increased farmer incomes by a total of $44.1 billion (1996-2007). Half of this extra income has been earned by farmers in developing countries.

This incremental farm income, when spent on goods and services, has had a positive multiplying 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. In India and the Philippines, where farmers use biotech IR cotton and corn respectively, their household incomes have typically increased by over a third and often by even higher amounts.

The 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 2).

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 (Figure 3).

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 derived 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.

FIGURE 2:

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

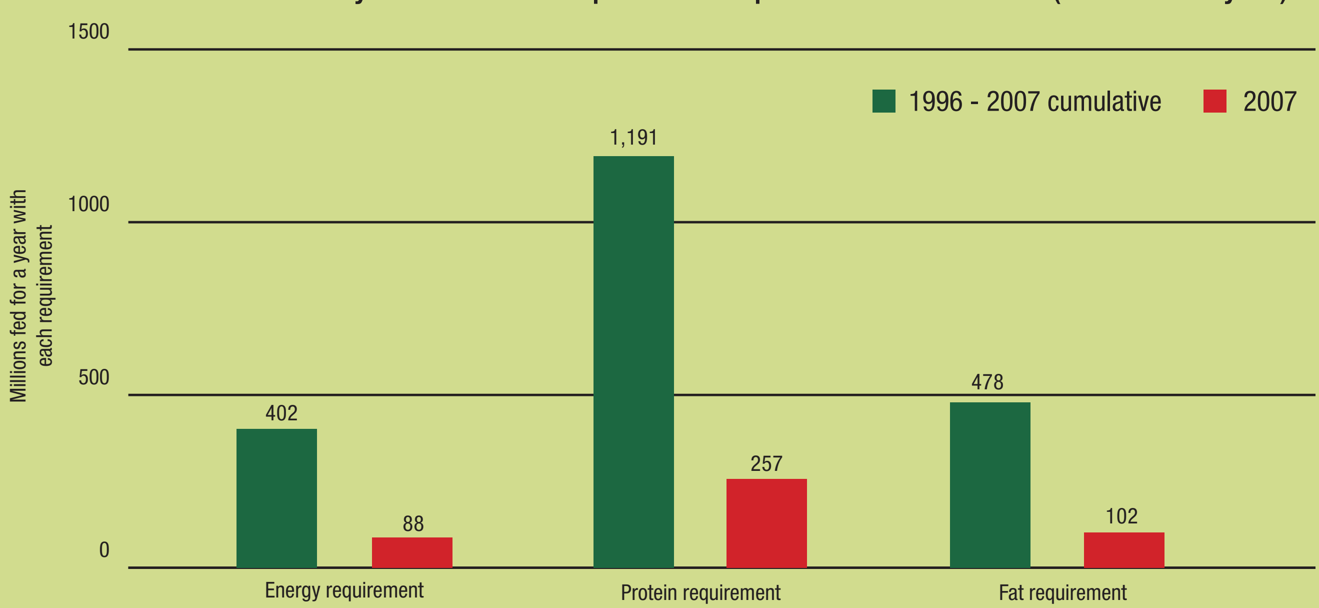
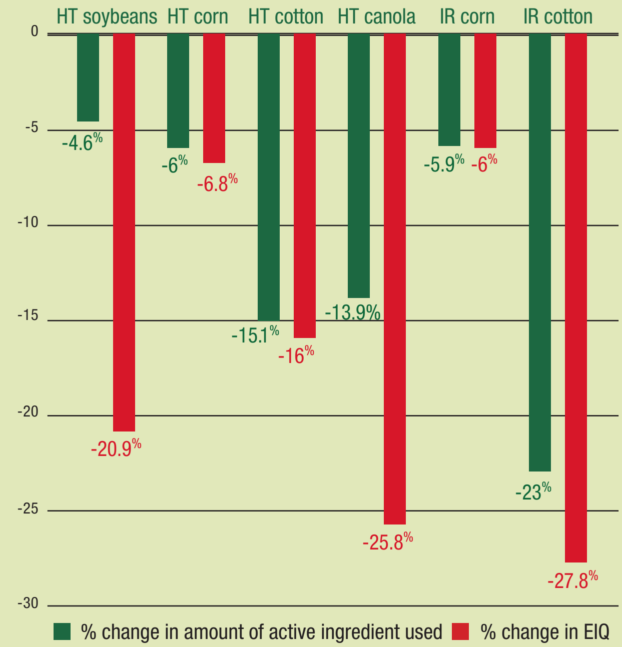


FIGURE 3:

Change in herbicide and insecticide use from growing GM crops 1996-2007



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**

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% of live weight converted to meat and for pig meat assumes 35% conversion;
- Corn constitutes 70% of a typical poultry feed ration and 75% 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% in poultry feed and 20% 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).