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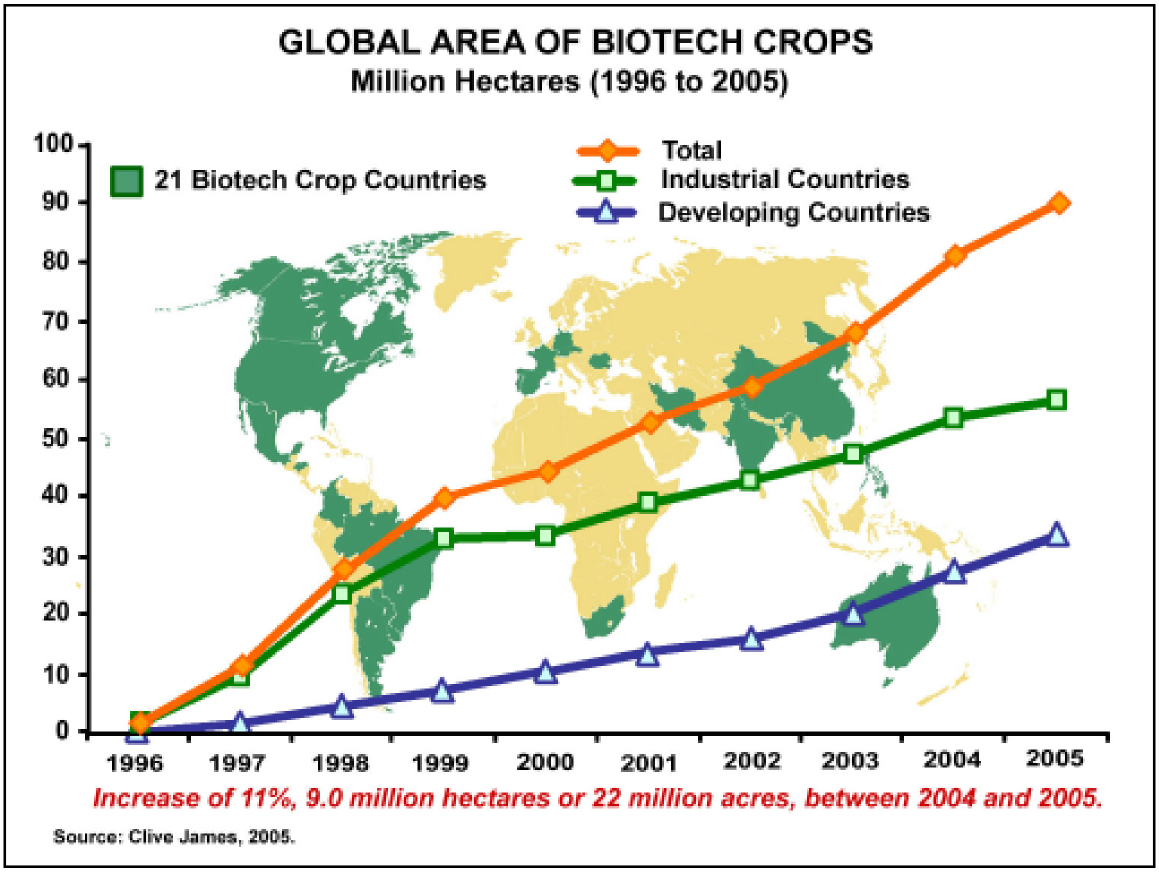
BRIEF 34

Global Status of Commercialized Biotech/GM Crops: 2005

by

Clive James
Chair, ISAAA Board of Directors



No. 34 - 2005

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Global Status of Commercialized Biotech/GM Crops: 2005

- 2005 marks the tenth anniversary of the commercialization of genetically modified (GM) or transgenic crops, now more often called biotech crops, as referred to consistently in this Brief. In 2005, the billionth acre, equivalent to the 400 millionth hectare of a biotech crop, was planted by one of 8.5 million farmers, in one of 21 countries. This unprecedented high adoption rate reflects the trust and confidence of millions of farmers in crop biotechnology. Over the last decade, farmers have consistently increased their plantings of biotech crops by double-digit growth rates every single year since biotech crops were first commercialized in 1996, with the number of biotech countries increasing from 6 to 21 in the same period. Remarkably, the global biotech crop area increased more than fifty-fold in the first decade of commercialization.

- The global area of approved biotech crops in 2005 was 90 million hectares, equivalent to 222 million acres, up from 81 million hectares or 200 million acres in 2004. The increase was 9.0 million hectares or 22 million acres, equivalent to an annual growth rate of 11% in 2005.

- A historic milestone was reached in 2005 when 21 countries grew biotech crops, up significantly from 17 countries in 2004. Notably, of the four new countries that grew biotech crops in 2005, compared with 2004, three were EU countries, Portugal, France, and the Czech Republic whilst the fourth was Iran.

- Portugal and France resumed the planting of Bt maize in 2005 after a gap of 5 and 4 years respectively, whilst the Czech Republic planted Bt maize for the first time in 2005, bringing the total number of EU countries now commercializing modest areas of Bt maize to five, viz: Spain, Germany, Portugal, France and the Czech Republic.

- Bt rice, officially released in Iran in 2004, was grown on approximately four thousand hectares in 2005 by several hundred farmers who initiated commercialization of biotech rice in Iran and produced supplies of seed for full commercialization in 2006. Iran and China are the most advanced countries in the commercialization of biotech rice, which is the most important food crop in the world, grown by 250 million farmers, and the principal food of the world's 1.3 billion poorest people, mostly subsistence farmers. Thus, the commercialization of biotech rice has enormous implications for the alleviation of poverty, hunger, and malnutrition, not only for the rice growing and consuming countries in Asia, but for all biotech crops and their acceptance on a global basis. China has already field tested biotech rice in pre-production trials and is expected to approve biotech rice in the near-term.

- In 2005, the US, followed by Argentina, Brazil, Canada and China continued to be the principal adopters of biotech crops globally, with 49.8 million hectares planted in the US (55% of global biotech area) of which approximately 20% were stacked products containing two or three genes, with the first triple gene product making its debut in maize in the US in 2005. The stacked products, currently deployed in the US, Canada, Australia, Mexico, and South Africa and approved in the Philippines, are an important and growing future trend which is more appropriate to quantify as “trait hectares” rather than hectares of adopted biotech crops. Number of “trait hectares” in US in 2005 was 59.4 million hectares compared with 49.8 million hectares of biotech crops, a 19% variance, and globally 100.1 million “trait hectares” versus 90 million hectares, a 10% variance.

- The largest increase in any country in 2005 was in Brazil, provisionally estimated at 4.4 million hectares (9.4 million hectares in 2005 compared with 5 million in 2004), followed by the US (2.2 million hectares), Argentina (0.9 million hectares) and India (0.8 million hectares). India had by far the largest year-on-year proportional increase, with almost a three-fold increase from 500,000 hectares in 2004 to 1.3 million hectares in 2005.

- Biotech soybean continued to be the principal biotech crop in 2005, occupying 54.4 million hectares (60% of global biotech area), followed by maize (21.2 million hectares at 24%), cotton (9.8 million hectares at 11%) and canola (4.6 million hectares at 5% of global biotech crop area).

- During the first decade, 1996 to 2005, herbicide tolerance has consistently been the dominant trait followed by insect resistance and stacked genes for the two traits. In 2005, herbicide tolerance, deployed in soybean, maize, canola and cotton occupied 71% or 63.7 million hectares of the global biotech 90.0 million hectares, with 16.2 million hectares (18%) planted to Bt crops and 10.1 million hectares (11%) to the stacked genes. The latter was the fastest growing trait group between 2004 and 2005 at 49% growth, compared with 9% for herbicide tolerance and 4% for insect resistance.

- Biotech crops were grown by approximately 8.5 million farmers in 21 countries in 2005, up from 8.25 million farmers in 17 countries in 2004. Notably, 90% of the beneficiary farmers were resource-poor farmers from developing countries, whose increased incomes from biotech crops contributed to the alleviation of their poverty. In 2005, approximately 7.7 million poor subsistence farmers (up from 7.5 million in 2004) benefited from biotech crops – the majority in China with 6.4 million, 1 million in India, thousands in South Africa including mainly women Bt cotton farmers, more than 50,000 in the Philippines, with the balance in the seven developing countries which grew biotech crops in 2005. This initial modest contribution of biotech crops to the Millennium Development Goal of reducing poverty by 50% by 2015 is an important development which has enormous potential in the second decade of commercialization from 2006 to 2015.

- In 2005, the 21 countries growing biotech crops included 11 developing countries and 10 industrial countries; they were, in order of hectarage, USA, Argentina, Brazil, Canada, China, Paraguay, India, South Africa, Uruguay, Australia, Mexico, Romania, the Philippines, Spain, Colombia, Iran, Honduras, Portugal, Germany, France and the Czech Republic.

- During the period 1996 to 2005, the proportion of the global area of biotech crops grown by developing countries has increased every year. More than one-third (38%, up from 34% in 2004) of the global biotech crop area in 2005, equivalent to 33.9 million hectares, was grown in developing countries where growth between 2004 and 2005 was substantially higher (6.3 million hectares or 23% growth) than industrial countries (2.7 million hectares or 5% growth). The increasing collective impact of the five principal developing countries (China, India, Argentina, Brazil and South Africa) representing all three continents of the South, Asia, Latin America, and Africa, is an important continuing trend with implications for the future adoption and acceptance of biotech crops worldwide.

- In the first decade, the accumulated global biotech crop area was 475 million hectares or 1.17 billion acres, equivalent to almost half of the total land area of the USA or China, or 20 times the total land area of the UK. The continuing rapid adoption of biotech crops reflects the substantial and consistent improvements in productivity, the environment, economics, and social benefits realized by both large and small farmers, consumers and society in both industrial and developing countries. The most recent survey[1] of the global impact of biotech crops for the nine-year period 1996 to 2004, estimates that the global net economic benefits to crop biotech farmers in 2004 was $6.5 billion, and $27 billion ($15 billion for developing countries and $12 billion for industrial countries) for the accumulated benefits during the period 1996 to 2004; these estimates include the benefits associated with the double cropping of biotech soybean in Argentina. The accumulative reduction in pesticides for the period 1996 to 2004 was estimated at 172,500 MT of active ingredient, which is equivalent to a 14% reduction in the associated environmental impact of pesticide use on these crops, as measured by the Environmental Impact Quotient (EIQ) – a composite measure based on the various factors contributing to the net environmental impact of an individual active ingredient.

- There is cause for cautious optimism that the stellar growth in biotech crops, witnessed in the first decade of commercialization, 1996 to 2005, will continue and probably be surpassed in the second decade 2006-2015. The number of countries adopting the four current major biotech crops is expected to grow, and their global hectarage and number of farmers planting biotech crops are expected to increase as the first generation of biotech crops is more widely adopted and the second generation of new applications for both input and output traits becomes available.

[1] *GM Crops: The Global Socio-economic and Environmental Impact of the First Nine Years 1996-2004 by Graham Brookes and Peter Barfoot, P.G. Economics. 2005*

Beyond the traditional agricultural products of food, feed and fiber, entirely novel products to agriculture will emerge including the production of pharmaceutical products, oral vaccines, specialty and fine chemicals and the use of renewable crop resources to replace non-renewable, polluting, and increasingly expensive fossil fuels. In the near term, in the established industrial country markets growth in stacked traits, measured as "trait hectares" of biotech crops, will continue to grow with the introduction of new input and output traits stacked to create value and to meet the multiple needs of both consumers and producers who seek more nutritional and healthier food and feed at the most affordable prices. Adherence to good farming practices with biotech crops will remain critical as it has been during the first decade and continued responsible stewardship must be practiced, particularly by the countries of the South, which will be the major deployers of biotech crops in the coming decade.

(1 hectare=2.47 acres)

The Global Value of the Biotech Crop Market

In 2005, the global market value of biotech crops, estimated by Cropnosis, was $5.25 billion representing 15% of the $34.02 billion global crop protection market in 2005 and 18% of the ~$30 billion 2005 global commercial seed market. The $5.25 billion biotech crop market comprised of $2.42 billion for biotech soybean (equivalent to 46% of global biotech crop market), $1.91 billion for biotech maize (36%), $0.72 billion for biotech cotton (14%), and $0.21 billion for biotech canola (4%). The market value of the global biotech crop market is based on the sale price of biotech seed plus any technology fees that apply. The accumulated global value for the ten-year period, since biotech crops were first commercialized in 1996, is estimated at $29.3 billion. The global value of the biotech crop market is projected at over $5.5 billion for 2006.

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Global Status of Commercialized Biotech/GM Crops: 2005

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Introduction

2005 marks the tenth anniversary of the commercialization of genetically modified (GM) or transgenic crops, now more often called **biotech crops** as referred to in this Brief. The experience of the first nine years, 1996 to 2004, during which a cumulative total of 385 million hectares (approximately 950 million acres) of biotech crops were planted globally in 22 countries, has confirmed that the early promise of crop biotechnology has been fulfilled. Biotech crops deliver substantial agronomic, environmental, economic, health and social benefits to farmers and, increasingly, to society at large. The rapid adoption of biotech crops, during the initial nine-year period 1996 to 2004, reflects the substantial multiple benefits realized by both large and small farmers in industrial and developing countries which have grown biotech crops commercially. Between 1996 and 2004, a total of 22 countries, 12 developing and 10 industrial countries, contributed to almost a fifty-fold increase in the global area of biotech crops from 1.7 million hectares in 1996 to 81.0 million hectares in 2004. Adoption rates for biotech crops during the period 1996 to 2004 are unprecedented and, by recent agricultural industry standards, they are the highest adoption rates for improved crops; for example, up to twice as high as the adoption of hybrid maize in its heyday in the mid-west of the USA. High adoption rates reflect farmer satisfaction with the products that offer substantial benefits ranging from more convenient and flexible crop management, lower cost of production, higher productivity and/or net returns per hectare, health and social benefits, and a cleaner environment through decreased use of conventional pesticides, which collectively contribute to a more sustainable agriculture. There is a growing body of consistent and compelling evidence generated by public sector institutions, that clearly demonstrates the improved weed and insect pest control attainable with biotech herbicide tolerant and insect resistant Bt crops, that also benefit from lower input and production costs; biotech crops offer substantial economic advantages to farmers compared with corresponding conventional crops. The severity of weed and insect pests and diseases varies from year-to-year and hence will directly impact pest control costs and the economic advantages of biotech crops in any given time or place.

Despite the continuing debate on biotech crops, particularly in countries of the European Union, millions of large and small farmers in both industrial and developing countries continue to increase their plantings of biotech crops by double-digit adoption growth rates every year since 1996, because of the significant multiple benefits biotech crops offer. This high rate of adoption is a strong vote of confidence in biotech crops, reflecting farmer satisfaction in both industrial and developing countries. About 8.25 million farmers grew biotech crops in 2004 and derived multiple benefits that included significant agronomic, environmental, health, social and economic advantages. ISAAA's 2004 Global Review predicted that the number of farmers planting biotech crops, as well as the global area of biotech crops, would continue to grow in 2005. Global population exceeded 6 billion in 2000 and is expected to reach over 9 billion by 2050, when approximately 90% of the global population will reside in Asia, Africa and Latin America. Today, 852 million people in the developing countries suffer from malnutrition and 1.3 billion are afflicted by poverty. Biotech crops represent promising technologies that can make a vital contribution, but not a total solution, to global food, feed and fiber security and can also make a critically important contribution to the alleviation of poverty, the most formidable challenge facing global society which has made a Millennium Development Goal pledge to decrease poverty, hunger and malnutrition by half by 2015.

The most compelling case for biotechnology, and more specifically biotech crops, is their capability to contribute to:

- **increasing crop productivity**, and thus contributing to global food, feed and fiber security, **with benefits for producers, consumers and society at large**;

- **conserving biodiversity**, as a land-saving technology capable of higher productivity on the current 1.5 billion hectares of arable land, and thereby precluding deforestation and protecting biodiversity in forests and in other in-situ biodiversity sanctuaries;

- **more efficient use of external inputs, thereby contributing to a safer environment and more sustainable agriculture systems;**

- **increasing stability of productivity** and production to lessen suffering during famines due to abiotic and biotic stresses;

- **the improvement of economic, health and social benefits, food, feed, and fiber security and the alleviation of abject poverty, hunger and malnutrition for the rural population dependent on agriculture in developing countries;**

- **the production of renewable resource based bio-fuels which will reduce dependency on fossil fuels, and therefore contribute to a cleaner and safer environment with lower levels of greenhouse gases that will mitigate global warming**;

- **and thus providing significant and important multiple and mutual benefits to producers, consumers and global society.**

The most promising technological option for increasing global food, feed and fiber production is to combine the best of the old and the best of the new by integrating the best of conventional and the best of biotechnology applications. This integrated product must be incorporated as the technology component in a global food, feed and fiber security strategy that must also address other critical issues including population control and improved food, feed and fiber distribution. Adoption of such a holistic strategy will allow society to continue to benefit from the vital contribution that both conventional and modern plant breeding offers the global population.

The author has published global reviews of biotech crops annually since 1996 as ISAAA Briefs. This publication provides the latest information on the global status of commercialized biotech crops. A detailed global data set on the adoption of commercialized biotech crops is presented for the year 2005 and the changes that have occurred between 2004 and 2005 are highlighted. The global adoption trends during the last decade from 1996 to 2005 are also illustrated. Following the approval of the first biotech crops in Europe, after the 1998 moratorium, there is cautious optimism that their acceptance in Europe will parallel their increased global acceptance, initially as approved imported fiber, feed and food products into Europe, and later as cultivated crops following the leadership of Spain which has now grown and benefited from Bt maize for eight years. This Brief documents the global database on the adoption and distribution of biotech crops in 2005.

Note that the words, rapeseed and canola, as well as transgenic, genetically modified crops, GM crops and biotech crops, are used synonymously, reflecting the usage of these words in different regions of the world, with biotech crops being used exclusively in this text because of its growing usage worldwide. Similarly, the words corn, used in North America, and maize, used more commonly elsewhere in the world, are synonymous, with maize being used consistently in this Brief, except for common names like corn rootworm where global usage dictates the use of the word corn. Global figures and hectares planted commercially with biotech crops have been rounded off to the nearest 100,000 hectares and in some cases this leads to insignificant approximations, and there may be minor variances in some figures, totals, and percentage estimates. It is also important to note that countries in the Southern Hemisphere plant their crops in the last quarter of the calendar year. The biotech crop areas reported in this publication are planted, not necessarily harvested, hectarage in the year stated. Thus, for example, the 2005 information for Argentina, Brazil, Australia, South Africa, and Uruguay is hectares usually planted in the last quarter of 2005 and harvested in the first quarter of 2006 with some countries like the Philippines planting more than one season per year.

Over the last ten years, ISAAA has devoted considerable effort to consolidate all the available data on officially approved biotech crop adoption globally. The database draws on a large number of sources of approved biotech crops from both the public and private sectors in many countries throughout the world. Data sources vary by country and include, where available, government statistics, independent surveys, and estimates from commodity groups, seed associations and other groups, plus a range of proprietary databases. Published ISAAA estimates are, wherever possible, based on more than one source of information and thus are usually not attributable to one specific source. Multiple sources of information for the same data point greatly facilitate assessment, verification and validation of a specific estimate. The "proprietary" ISAAA database on biotech crops is unique in that it is global in nature, and provides continuity from the genesis of the commercialization of biotech crops in 1996, to the present. The database has gained acceptance internationally as a benchmark for the global status of biotech crops and is widely cited in the scientific literature and the international press.

Global Area of Biotech Crops in 2005

In 2005, the global area of biotech crops continued to grow for the tenth consecutive year at a sustained double-digit growth rate of 11%. Thus, biotech crops have set a precedent in that they have grown by double-digit rates every single year for the last ten years, since commercialization first began in 1996. The estimated global area of biotech crops for 2005 was 90.0 million hectares, grown by 8.5 million farmers in 21 countries – a significant increase over 2004 when 81.0 million hectares were grown by 8.25 million farmers in 17 countries. The adoption of biotech crops by 21 countries in 2005 is an important historical milestone in the commercialization of biotech crops globally. Four additional countries have been added to the global list of biotech countries in 2005, compared with 2004. Two new countries, the Czech Republic (Czechia) and Iran grew Bt maize and Bt rice respectively, for the first time in 2005, whilst Portugal and France resumed the cultivation of Bt maize which they had cultivated 5 and 4 years ago, respectively. Portugal grew Bt maize in 1999 and France in 1998, 1999 and 2000. These four additional countries are considered significant, given that three of them, Portugal, France and the Czech Republic, are all member states of the European Union whilst Iran is an important country in the Middle East.

To put the 2005 global area of biotech crops into context, 90.0 million hectares of biotech crops is equivalent to almost 10% of the total land area of China (956 million hectares) or the USA (981 million hectares) and almost four times the land area of the United Kingdom (24.4 million hectares). The increase in area between 2004 and 2005 of 11 % is equivalent to 9.0 million hectares or 22 million acres.

During the first decade of commercialization 1996 to 2005, the global area of biotech crops increased more than fifty-fold (53), from 1.7 million hectares in 1996 to 90.0 million hectares in 2005 (Figure 1). This rate of adoption is one of the highest rates of crop technology adoption in agriculture and reflects the growing acceptance of biotech crops by farmers in both industrial and developing countries. In the same period, the number of countries growing biotech crops tripled, increasing from 6 in 1996 to 12 countries in 1999, 17 in 2004 and reaching the historical milestone of 21 countries in 2005, with four countries added to the global list of biotech countries, compared to 2004. Portugal, which grew Bt maize for the first time in 1999 grew approximately 750 hectares of Bt maize in 2005, whilst France, which grew Bt maize in 1998, 1999 and 2000, resumed planting in 2005 with 200 hectares of Bt maize. The Czech Republic cultivated 150 hectares of Bt maize for the first time. In Iran, where Bt rice was officially released in 2004, approximately 4,000 hectares of Bt rice were cultivated in

Table 1. Global Area of Biotech Crops, 1996 to 2005

	Hectares (million)	Acres (million)
1996	1.7	4.3
1997	11.0	27.5
1998	27.8	69.5
1999	39.9	98.6
2000	44.2	109.2
2001	52.6	130.0
2002	58.7	145.0
2003	67.7	167.2
2004	81.0	200.0
2005	**90.0**	**222.0**
TOTAL	474.6	1,173.3

Increase of 11%, 9.0 million hectares or 22 million acres, between 2004 and 2005.
Source: Clive James, 2005.

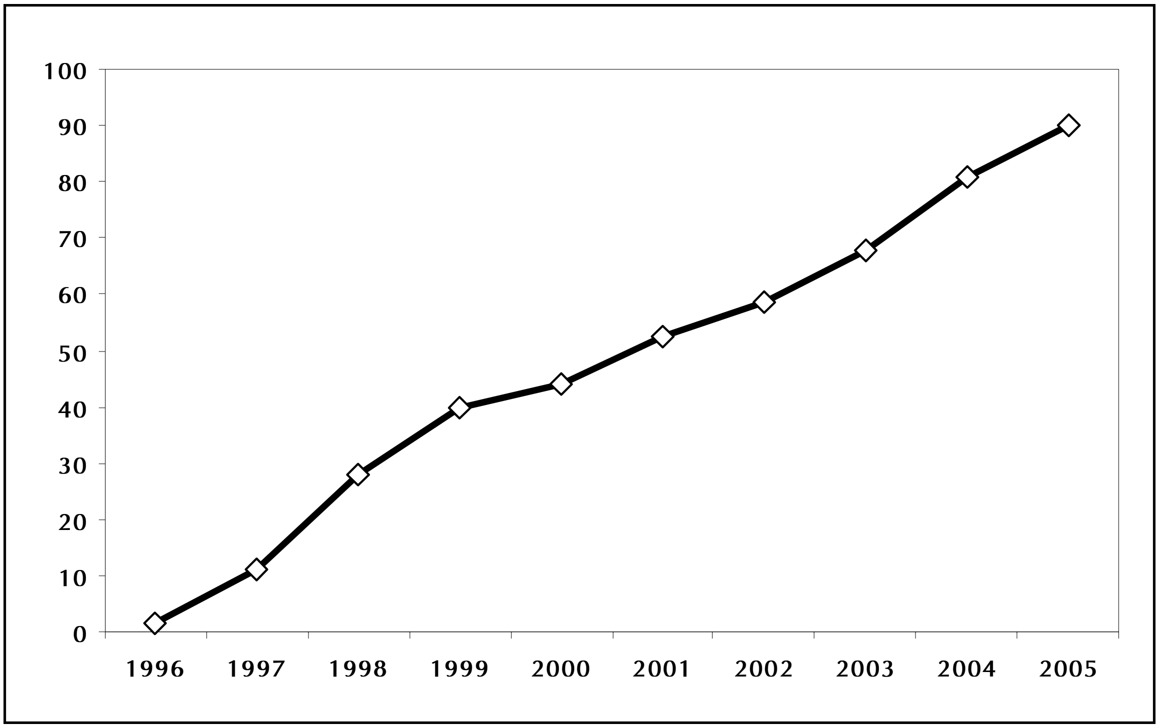
2005 by several hundred farmers in the initial commercialization of biotech rice and to supply seed for full commercialization in 2006. In 2005, Brazil continued to expand significantly its area of herbicide tolerant soybean to a provisional estimate of 9.4 million hectares, up from 5 million hectares in 2004, whilst India reported another substantial increase of between two- and three-fold in its area of Bt cotton.

In summary, during the period 1996 to 2005, an accumulated total of 475 million hectares or 1,173 million acres (over 1 billion acres) has been successfully grown, accumulatively since 1996, as a result of 35 million repeat decisions by farmers to plant biotech crops (Table 1 and Figure 1). Farmers have signaled their strong vote of confidence in crop biotechnology by consistently increasing their plantings of biotech crops by double-digit growth rates every single year since biotech crops were first commercialized in 1996, with the number of biotech countries increasing from 6 to 21 in the same period.

Distribution of Biotech Crops in Industrial and Developing Countries

Figure 2 shows the relative hectarage of biotech crops in industrial and developing countries during the period 1996 to 2005. It clearly illustrates that whereas the substantial but declining share (62%, compared with 66% in 2004) of biotech crops continued to be grown in industrial countries in 2005,

Figure 1. Global Area of Biotech Crops, 1996 to 2005 (Million Hectares)



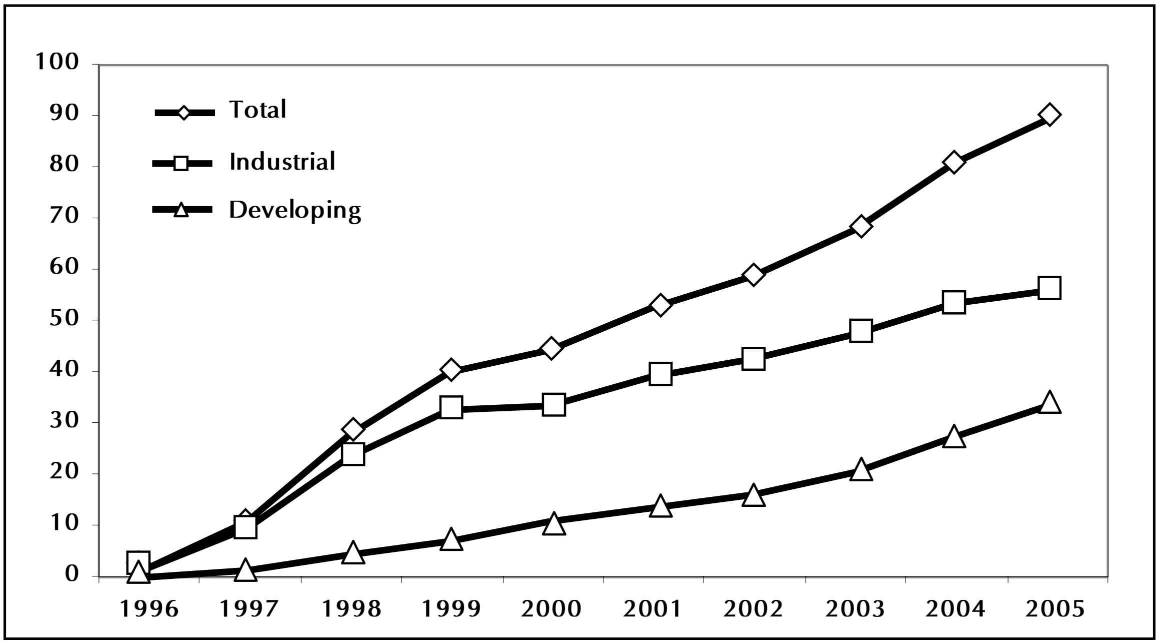
Source: Clive James, 2005

the proportion of biotech crops grown in developing countries has increased consistently every single year from 14% in 1997, to 16% in 1998, to 18% in 1999, 24% in 2000, 26% in 2001, 27% in 2002, 30% in 2003, 34% in 2004 and 38% in 2005. Thus, in 2005, more than one third (38%), of the global biotech crop area of 90.0 million hectares, equivalent to 33.9 million hectares, was grown in 11 developing countries where growth continued to be strong, compared with 10 industrial countries (Table 2). Developing countries that exhibited exceptionally strong growth included India, in Asia and Brazil, in Latin America. It is noteworthy that for the second year in succession, the absolute growth in the biotech crop area between 2004 and 2005 was between 2 and 3 times higher in the developing countries (6.3 million hectares) than in industrial countries (2.7 million hectares). Equally important to note is that the percentage growth was over four times higher (23%) in the developing countries of the South, compared to the industrial countries of the North (5%).

Distribution of Biotech Crops, by Country

The eight principal countries that grew biotech crops on 0.5 million hectares or more, in 2005 listed by hectarage were the USA which grew 49.8 million hectares, (55% of global total), Argentina with 17.1 million hectares (19%), Brazil 9.4 million hectares (10%), Canada 5.8 million hectares (6%),

Figure 2. Global Area of Biotech Crops, 1996 to 2005: Industrial and Developing Countries (Million Hectares)



Source: Clive James, 2005

Table 2. Global Area of Biotech Crops, 2004 and 2005: Industrial and Developing Countries (Million Hectares)

	2004	%	2005	%	+/-	%
Industrial countries	53.4	66	56.1	62	2.7	+5
Developing countries	27.6	34	33.9	38	6.3	+23
TOTAL	**81.0**	**100**	**90.0**	**100**	**9.0**	**+11**

Source: Clive James, 2005.

China 3.3million hectares (4%), Paraguay with 1.8 million hectares (2%), India with 1.3 million hectares (1%) and South Africa with 0.5 million hectares (1%); an additional thirteen countries grew a total of 1 million hectares in 2005 - see Table 3 and Figure 3. It should be noted that of the top eight countries, each growing 0.5 million hectares or more of biotech crops, the majority (6 out of 8) are developing countries, Argentina, Brazil, China, Paraguay, India and South Africa, compared with only two industrial countries, USA and Canada. The number of biotech mega-countries (countries which grow 50,000 hectares, or more, of biotech crops) numbered 14 in 2005, the same as in 2004.

Notably, 10 of the 14 mega-countries are developing countries from Latin America, Asia and Africa. The high proportion of biotech mega-countries in 2005, 14 out of 21 equivalent to two-thirds, reflects the significant broadening, deepening and stabilizing in biotech crop adoption that has occurred within the group of more progressive countries that have adopted more than 50,000 hectares of biotech crops globally on all six continents in the last ten years.

It is noteworthy that, compared with 2004, there were four additional countries, which grew biotech crops in 2005. These were Iran, with approximately 4,000 hectares of Bt rice, the first country to embark on the initial steps of commercialization involving seed multiplication of biotech rice; and three countries, all EU countries, growing Bt maize, Portugal with approximately 750 hectares, France with 200 hectares and Czechia with approximately 150 hectares.

The five countries with the largest increase in absolute area of biotech crops of 0.5 million hectares or more, between 2004 and 2005 were Brazil, with a 4.4 million hectare increase, US 2.2 million hectares, Argentina 0.9 million hectares, India 0.8 million hectares, and Paraguay with an increase of over 500,000 hectares. Modest growth in crop biotech area was reported in Mexico, Romania, Philippines, Colombia and Uruguay. China reported the same level in percentage adoption compared with 2004, but a decrease in actual crop biotech area due to a decrease in total crop plantings, associated with various factors including drought, low and uncertain commodity prices and seed availability.

Based on annual percentage growth in biotech crop area, three countries (notably, all mega-biotech developing countries), India, Brazil and Paraguay had exceptionally high rates of growth of 50% or more, and are worthy of comment. India, for the second consecutive year, had the highest percentage year-on-year growth of all countries in 2005, with an increase of 160% in Bt cotton area over 2004. Brazil increased its 2005 hectarage by 88% due to almost a doubling of RR® soybean from 5 million hectares in 2004 to 9.4 million hectares in 2005. Paraguay, which officially reported RR® soybean for the first time in 2004, when it planted 1.2 million hectares, equivalent to a 60% adoption rate, increased its adoption rate in 2005 by 50% to reach 1.8 million hectares equivalent to 85% of its national soybean hectarage of 2.1 million hectares.

The six principal countries that have gained the most economically from biotech crops, during the period 1996 to 2004 are, in descending order of magnitude, the US ($10.7 billion), Argentina ($10.1 billion), China ($4.2 billion), Brazil ($0.8 billion), Canada ($0.8 billion), India ($0.1 billion) and others ($0.3 billion) for a total of $27 billion ($15 billion for developing countries and $12 billion for industrial countries).*

The 21 countries that grew biotech crops in 2005 are listed in descending order of their biotech crop areas (Table 3). There were 11 developing countries, and 10 industrial countries including Romania

* *GM Crops: The Global Socio-economic and Environmental Impact of the First Nine Years 1996-2004 by Graham Brookes and Peter Barfoot, P.G. Economics. 2005)*

Table 3. Global Area of Biotech Crops in 2004 and 2005: by Country (Million Hectares)

Country	2004	%	2005	%	+/-	%
USA	47.6	59	49.8	55	+2.2	+5
Argentina	16.2	20	17.1	19	+0.9	+6
Brazil	5.0	6	9.4	10	+4.4	+88
Canada	5.4	6	5.8	6	+0.4	+7
China	3.7	5	3.3	4	-0.4	-11
Paraguay	1.2	2	1.8	2	+0.6	+50
India	0.5	1	1.3	1	+0.8	+160
South Africa	0.5	1	0.5	1	- -	- -
Uruguay	0.3	<1	0.3	<1	<0.1	- -
Australia	0.2	<1	0.3	<1	+0.1	- -
Mexico	0.1	<1	0.1	<1	<0.1	- -
Romania	0.1	<1	0.1	<1	<0.1	- -
Philippines	<0.1	<1	0.1	<1	<0.1	- -
Spain	<0.1	<1	0.1	<1	<0.1	- -
Colombia	<0.1	<1	<0.1	<1	<0.1	- -
Iran	- -	- -	<0.1	<1	- -	- -
Honduras	<0.1	<1	<0.1	<1	<0.1	- -
Portugal	- -	- -	<0.1	<1	- -	- -
Germany	<0.1	<1	<0.1	<1	- -	- -
France	- -	- -	<0.1	<1	<0.1	- -
Czech Republic	- -	- -	<0.1	<1	- -	- -
TOTAL	**81.0**	**100**	**90.0**	**100**	**+9.0**	**+11**

Source: Clive James, 2005.

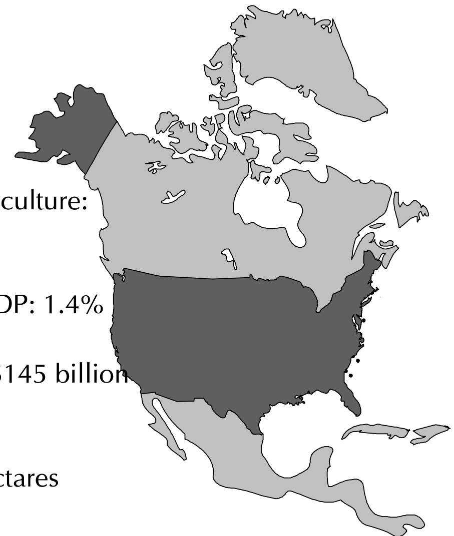
and Czechia from Eastern Europe and Iran from the Middle East. In 2005, biotech crops were grown commercially in all six continents of the world – North America, Latin America, Asia, Oceania, Europe (Eastern and Western), and Africa. The top eight countries, each growing 0.5 million hectares, or more, of biotech crops in 2005, are listed in order of crop biotech hectarage in Table 3 and include the USA, Argentina, Brazil, Canada, China, Paraguay, India and South Africa. These top eight biotech countries accounted for approximately 99% of the global biotech crop hectarage with the balance of 1% growing in the other 13 countries listed in decreasing order of biotech crop hectarage – Uruguay, Australia, Mexico, Romania, Philippines, Spain, Colombia, Iran, Honduras, Portugal, Germany, France and the Czech Republic. The following paragraphs provide a more detailed analysis of the biotech crop situation in selected countries.

USA

The US is one of the six "founder biotech crop countries", having commercialized biotech maize, soybean, cotton and potato in 1996, the first year of global commercialization of biotech crops. In the US in 2005, the total hectarage planted to biotech soybean, maize, cotton, and canola was 49.8 million hectares, up 5% from the 47.6 million hectare planted in 2004. Total plantings of maize in 2005 were 33.0 million hectares, up 1% from 2004 with total plantings of soybean at 29.58 million hectares, down 3% from the record hectarage in 2004, principally due to excessive spring rains in some states. Total plantings of upland cotton at 5.63 million hectares were up 3% on 2004, and canola at 0.44 million hectares was about the same as 2004.

In 2005, the US grew more biotech crops (49.8 million hectares) than any other country in the world, equivalent to 55% of global biotech crop hectarage. Compared to 2004, there was an estimated net gain of 2.2 million hectares for all four biotech crops in the US in 2005 equivalent to a 5% year-over-year growth. The increase is more modest than in the past for two reasons. Firstly, national adoption rates are already high, over 80% for both soybean and cotton and over 50% for both maize and canola. Secondly, the apparent modest growth does not reflect the increased biotech crop hectarage planted with stacked genes, which are masked when biotech crops hectarage is expressed simply as biotech hectares rather than biotech "trait hectares". For example, of the 49.8 million hectares of biotech crops planted in the US in 2005, 9.56 million hectares (equivalent to almost 20%) had two or more stacked genes; it is noteworthy that the US introduced the first triple stacked construct in maize in 2005 on approximately half a million hectares. Thus, the biotech crop "trait hectares" in the US in 2005 was 59.4 million hectares compared with only 49.8 million hectares of biotech crops – almost 20%

<u>**USA**</u>



Population:
288.5 million

% employed in agriculture:
2%

Agriculture as % GDP: 1.4%

Agricultural GDP: $145 billion

Arable Land (AL):
178 million hectares

Ratio of AL/Population*: 2.4

Major crops:
- Maize
- Soybean
- Wheat
- Sugar cane
- Sugar beet

Commercialized Biotech Crops:
- HT/Bt/HT-Bt Maize
- HT Soybean
- Bt/HT/Bt-HT Cotton
- HT Canola
- VR Squash
- VR Papaya

Total area under biotech crops: 49.8 Million Hectares

Increased farm income of $10.7 billion for 1996-2004

*Ratio: % global AL / % global population higher. Similarly, the year-on-year growth in biotech crop hectarage for the US between 2004 and 2005 was 5% whereas it is 10% if expressed as "trait hectares" which was 53.9 million hectarage in 2004 and 59.4 million hectares in 2005. Given that currently the US has proportionally much more stacked traits than any other country, the masking effect leading to apparent lower growth affects the US more than other countries. In fact, Canada, Australia, Mexico and South Africa are the only four other countries that have deployed stacked genes at this time, (the Philippines approved Bt/HT maize in August 2005) albeit at much lower proportions than the US, but this is a trend that will increasingly affect other countries, and the issue needs to be addressed to ensure a transparent and accurate method of expressing adoption. In 2005, globally, the number of "trait hectares" was 100.1 million versus 90 million hectares of adopted biotech crops, a 10% variance.

The biggest increase in US biotech crops was for maize with a gain of more than 10%, compared to 2004 equivalent to approximately 2 million hectares. US biotech canola area increased by about 10% while biotech cotton increased by about 5%. In 2005, the area of biotech soybean plateaued at about 26 million hectares, featuring the highest adoption rate of all US biotech crops at close to 90%, the highest ever. Canola adoption was approximately 10% higher in 2005 at 360,000 hectares compared with 320,000 hectares in 2004. The most recent report from the National Center for Food and Agricultural Policy (NCFAP) estimated that increased farmer income was $2.3 billion for 2004.*

In addition to the four major biotech crops, soybean, maize, cotton and canola, small areas of virus resistant squash and virus resistant papaya were grown in the US. Herbicide tolerant alfalfa and sugar beet were approved in the US in 2005 and are expected to be deployed in the near-term.

The US is estimated to have enhanced farm income from biotech crops by $10.7 billion in the period 1996 to 2004.

Argentina

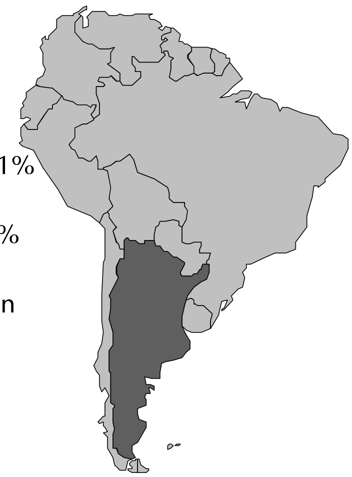
Argentina is also one of the six "founder biotech crop countries", having commercialized RR® soy and Bt cotton in 1996, the first year of global commercialization of biotech crops. Argentina remained the second largest grower of biotech crops (17.1 million hectares) in 2005 comprising 19% of global crop biotech hectarage. In 2005, the year-over-year increase, compared with 2004, was 0.9 million hectares, equivalent to an annual growth rate of 6%. Of the 17.1 million hectares of biotech crops projected for Argentina in 2005/06, 15.4 million hectares are biotech soybean, an increase of 0.9 million hectares in biotech soybean area over 2004. Virtually all (98 to 99%) of the soybean crop in Argentina is herbicide tolerant soybeans. Total plantings of maize in Argentina in 2005 decreased

* *Sankula, S., G. Marmon, and E. Blumenthal. 2005. Biotechnology-Derived Crops Planted in 2004 - Impacts on US Agriculture. Available at http://www.ncfap.org.*

from 2.9 million hectares in 2004 by 0.4 million hectares due to higher production costs compared to other crops, including soybean. The lower hectarage of national maize plantings in 2005 has resulted in a marginally lower hectarage of biotech maize, but the biotech adoption rate was higher in 2005 (65%) than the corresponding rate of 55% in 2004. Argentina continued to grow a modest area of biotech cotton in 2005, approximately 75,000 hectares compared with 25,000 hectares in 2004.

Argentina is estimated to have enhanced farm income from biotech crops by $10.1 billion in the period 1996 to 2004. Biotech crops are also credited with creating 200,000 jobs, which has made a very important contribution to decreasing the high rate of national unemployment.

ARGENTINA



Population: 37.9 million

% employed in agriculture: 1%

Agriculture as % GDP: 10.8%

Agricultural GDP: $11 billion

Arable Land (AL):
33.2 million hectares

Ratio of AL/Population*: 2.0

Major crops:
- Soybean
- Maize
- Sugar cane
- Sunflower seed
- Wheat

Commercialized Biotech Crops:
- HT Soybean
- Bt/HT Maize
- Bt/HT Cotton

Total area under biotech crops: 17.1 Million Hectares

Increased farm income of $10.1 billion for 1996-2004

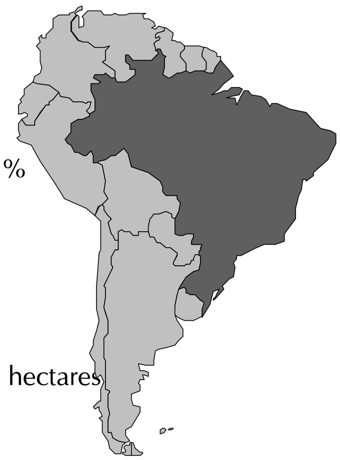
*Ratio: % global AL / % global population

Brazil

In 2005, Brazil replaced Canada as the country with the third largest hectarage of biotech crops in the world, provisionally estimated at 9.4 million hectares. Brazil is the second largest producer of soybeans in the world, after the USA, the third largest producer of maize, the sixth largest producer of cotton and the only major producer of rice outside Asia (3.7 million hectares). Following two Presidential decrees in 2003 and 2004 to approve the planting of farmer-saved biotech soybean seed for the 2003/04 and 2004/05 seasons, the Brazilian Congress passed a Biosafety Bill (Law #11,105) on March 2, 2005 that provides for the first time a legal framework to facilitate the approval and adoption of biotech crops in Brazil. The Bill allows, for the first time, sale of commercial certified RR® soybean seed and also for the first time, the approved use of Bt cotton (event BC 531) in the first registered variety DP9B. However, the latter, will not be planted as officially approved registered seed in 2005, because of unavailability of seed.

The 2004/05 season for soybeans in Brazil was characterized by a severe drought in the southern states where seed is produced and this has led to a limited supply of certified seed of lower than normal quality for the 2005/06 season. Accordingly, for 2005 the Government approved the sale of uncertified seed in the state of Rio Grande do Sul which is expected to sow 90% or more of its soybean hectarage to RR® soybean. The shortage of seed in 2005 has been exacerbated by a lack of credit, uncertainty related to global market prices and royalty payments as well as a seed shortage of varieties adapted to the central and northern states. The latter will become less of a constraint in the future as more adapted varieties are expected to be approved for the central and northern states.

BRAZIL



Population: 174.7 million

% employed in agriculture: 21%

Agriculture as % GDP: 8.7%

Agricultural GDP: $39 billion

Arable Land (AL): 59.6 million hectares

Ratio of AL/Population*: 1.3

Major crops:
- Sugar cane
- Soybean
- Maize
- Cassava
- Oranges

Commercialized Biotech Crops:
- HT Soybean

Total area under biotech crops: 9.4 Million Hectares

Increased farm income of $0.8 billion in 2003/04 and 2004/05

*Ratio: % global AL / % global population

In 2005, some hectarage of RR® soybean is expected to be planted in virtually all of the states in Brazil with the largest plantings expected in the states of Rio Grande do Sul, Parana, Matto Grosso, Goias, and Matto Grosso de Sul. Despite the various constraints related to the supply of soybean seed given farmer options and profitability of alternate crops, total planting of soybean in Brazil in 2005/06 is expected to be approximately 21.6 million hectares, the same as 2004/05. Planting of soybean in Brazil starts in the northern provinces in September and finishes in the southern provinces by mid- to late December. At the time when this Brief went to press in early December 2005, approximately 70% of the soybean crop had been planted in Brazil.

It is provisionally projected that biotech soybean will occupy approximately 9.4 million hectares of the 21.6 million hectare crop in the 2005/06 season, equivalent to approximately 44% of the area planted to soybean in 2005/06 - this is almost double the area of 5 million hectares of RR® soybean planted in Brazil in 2004/05. The constraints that might decrease this projected hectarage include shortage of certified commercial seed, limitation of varieties adapted to areas outside the south, shortage of credit and relatively lower prices. After protracted discussions in early October 2005, an agreement was reached between the national seed organization ABRASEM and Monsanto regarding payment of royalties which were fixed at 0.88 Reias (US$ 0.40) per kilo of seed. In the past, the majority of RR® soy has been grown in the southern state of Rio Grande do Sul and increases are expected to continue in 2005/06. A total of 38 varieties have been approved for use in Brazil. Lack of adapted approved varieties for states outside the south will limit adoption in 2005/06 but approved varieties should start to become available for these areas next season.

The approval in 2005 of one event (BCE 531) in the variety DP9B allows cotton growers in Brazil to legally plant Bt cotton for the first time but official registered seed will not be available in 2005. This variety underwent field-testing in Brazil prior to the events that delayed registration due to legal considerations. Input costs on cotton production in Brazil are very high with insecticides comprising up to 40% of total production costs and involving up to 14 sprays per season. Benefits from Bt cotton are estimated at up to $130 per hectare and accordingly Bt cotton is expected to offer significant benefits to Brazil, particularly for the large cotton growing states of Matto Grosso and Bahia. Brazil is expected to grow approximately 1.1 million hectares of cotton in 2005 making it the sixth largest grower of cotton in the world after India, US, China, Pakistan and Uzbekistan. The adoption of biotech cotton in Brazil is expected to be rapid and reach high adoption rates in the near term as adapted varieties of cotton become available and are approved for registration. Cotton is grown by both large and small farmers, and Bt cotton offers the poor small farmers in Brazil significant socio-economic benefits, similar to those experienced in China and increasingly in India.

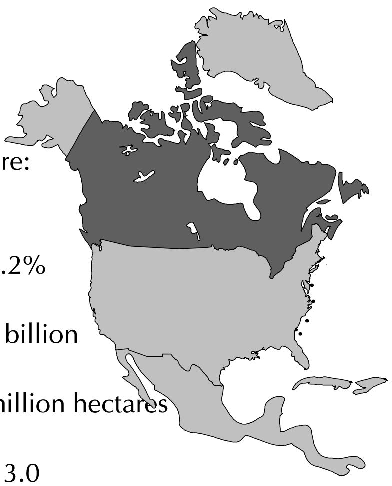
In summary, Brazil is poised to become a world leader in the adoption of biotech crops in the near-term with continued significant growth in RR® soybean hectarage, rapid expansion in Bt cotton supplemented with herbicide tolerance, substantial opportunities on the 13 million hectares of maize and its 3.7 million hectares of rice, as well as the deployment of virus resistant beans and papaya being developed by EMBRAPA.

Brazil is estimated to have enhanced farm income from biotech soybeans by $0.8 billion in 2003/04 and 2004/05.

Canada

Canada is another member of the six "founder biotech crop countries", having commercialized herbicide tolerant canola in 1996, the first year of global commercialization of biotech crops. For the last nine years, Canada has always been the number three country worldwide in terms of biotech crop area; Brazil now occupies that position in 2005. Growth in biotech crop area continued in Canada in 2005 with a net gain of 400,000 hectares equivalent to a 7% year- over-year growth, with a total biotech crop area of 5.8 million hectares for the three biotech crops of canola, maize and soybean. The largest biotech crop, by far, is herbicide tolerant canola, most of which is grown in the west where adoption rates are very high. In 2005, the national adoption rate for biotech canola was 82%, up from 77% in 2004, and equivalent to 4.2 million hectares; this compares with a biotech canola area of 3.9 million hectares in 2004. In Ontario and Quebec, the major provinces for maize

CANADA



Population: 31.3 million

% employed in agriculture: 3%

Agriculture as % GDP: 2.2%

Agricultural GDP: $15.7 billion

Arable Land (AL): 49.9 million hectares

Ratio of AL/Population*: 3.0

Major crops:
- Wheat
- Barley
- Maize
- Rapeseed
- Potato

Commercialized Biotech Crops:
- HT Canola
- HT/Bt/HT-Bt Maize
- HT Soybean

Total area under biotech crops: 5.8 Million Hectares

Increased farm income of $0.8 billion for 1996-2004

*Ratio: % global AL / % global population

and soybean, hectarage of the two biotech crops in 2005 was almost constant at over 700,000 hectares each, with percent adoption of over 60% for both maize and soybean.

Canada is one of only two countries, the other is the USA, which grows maize with stacked genes for herbicide tolerance and Bt for insect resistance. The stacked gene maize hectarage in 2005 was approximately 220,000 hectares compared with six and a half million hectares of stacked maize in the US. The continued growth of biotech crops in Canada in 2005 reflects slightly higher total plantings of canola, 5.4 million hectares compared with 5.2 million hectares in 2004 with consistent adoption rates of over 60% for biotech maize and soybean.

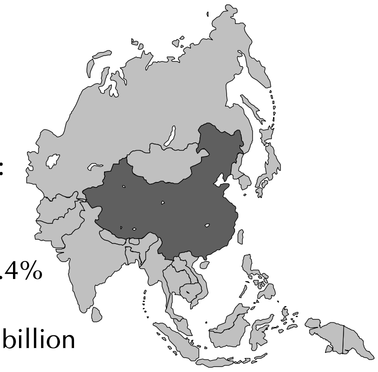
Canada is a major producer of wheat, and biotech varieties have been field-tested but not yet approved and adopted. Several of the current principal wheat varieties have been developed through mutagenesis and the development of biotech wheat varieties resistant to *Fusarium* could be an important future development for Canada. Maize with higher levels of lysine is undergoing field tests whilst herbicide tolerant alfalfa was recently approved for cultivation but will only be launched in 2006.

Canada is estimated to have enhanced farm income from biotech crops by $0.8 billion in the period 1996 to 2004.

China

Like the US, Argentina, and Canada, China is a member of the group of six "founder biotech crop countries", having commercialized Bt cotton in 1996, the first year of global commercialization of biotech crops. The national area planted to cotton in China in 2005 decreased from 5.6 million hectares in 2004 to 5.1 million hectares in 2005. This decrease of 10% in total plantings resulted in a parallel decrease in area of Bt cotton from 3.7 million hectares in 2004 to 3.3 in 2005, with percentage adoption of Bt at 66% the same as in 2004. An estimated 6.4 million small farmers grew Bt cotton in China in 2005, compared with 7 million in 2004 (a 10% decrease over 2004, in line with the 10% decrease in total cotton plantings) and 6 million in 2003.

CHINA



Population: 1.3 billion

% employed in agriculture: 50%

Agriculture as % GDP: 15.4%

Agricultural GDP: $194.9 billion

Arable Land (AL): 143.4 million hectares

Ratio of AL/Population*: 0.46

Major crops:
- Rice, paddy
- Maize
- Sugar cane
- Vegetables fresh
- Sweet potato

Commercialized Biotech Crops:
- Bt Cotton

Total area under biotech crops: 3.3 Million Hectares

Increased farm income of $4.2 billion for 1997-2004

*Ratio: % global AL / % global population

The level of Bt cotton adoption in China may have plateaued at around 66% given that the large cotton areas in the province of Xing Xang are subject to much less pest pressure than eastern provinces such as Hubei where pest pressure is high and where adoption rates are well above the national average. However, the recent report in September 2005 by Guo Sandui of the Chinese Academy of Agriculture Sciences (CAAS) that new Bt cotton hybrids yield up to 25% more than the current Bt cotton varieties could spur a renewed wave of increased adoption that would significantly exceed current adoption rates of around two-thirds of national cotton hectarage. CAAS has already received approval to commercialize one of the new hybrids, Yinmian 2 and it is expected to be planted on about 700 hectares in the Yellow River region in 2006 followed by large scale commercialization in 2007. These new Bt cotton hybrids, like Yinmian 2, could boost farmer income by $1.2 billion per year, making China the second country after India to profit from Bt cotton hybrids which, unlike varieties, offer an incentive for developers of the hybrids which have a built-in value capture system not found in varieties. China, with its track record of having already developed successful Bt cotton that competes with products developed by the private sector, has gained a rich experience in crop biotechnology and this will serve it well in the development of future biotech crops in the near-term.

It is evident that Chinese policymakers view agricultural biotechnology as a strategic element for increasing productivity, improving national food security and ensuring competitiveness in the international market place. There is little doubt that China intends to be one of the world leaders in biotechnology since Chinese policymakers have concluded that there are unacceptable risks of being dependent on imported technologies for food security. China has over a dozen biotech crops being field-tested, including the three major staples - rice, maize, and wheat, as well as cotton, potato, tomato, soybean, cabbage, peanut, melon, papaya, sweet pepper, chili, rapeseed and tobacco.

China is cognizant of the need for biosafety management in order to ensure protection of the environment and consumers, and this is a consideration in the pending approval of Bt rice, which is expected in the near-term. Given the paramount importance of rice as the principal food crop in China, approximately 20% of the government's investment in crop biotechnology has been devoted to rice. This is equivalent to a current annual investment of $24 million at official exchange rates, or $115 million per year at a purchasing power parity rate, which undoubtedly makes China's investment in rice biotechnology, by far, the largest in the world. Three insect resistant hybrid rice varieties, two featuring the Bt gene and the other with the CpTi trypsin gene, entered pre-production field trials in 2001, plus a rice variety carrying the Xa 21 gene that confers resistance to the important bacterial blight disease of rice. Annual and extensive large scale pre-production trials of these new biotech hybrids of rice, starting in 2001, confirmed yield increases of approximately 4 to 8%, plus a saving of 17 kg per hectare in pesticides, with positive health implications, along with a labor saving of 8 days per hectare, resulting in an overall increase in net income per hectare of $80 to $100. It is projected that with full adoption, the new biotech rice hybrids will result in a national benefit to China of $4 billion in 2010; insect borers, which can be controlled by Bt, are prevalent on up to 75% of approximately 30 million hectares of rice in China.

It is estimated that China has enhanced its farm income from biotech cotton by $4.2 billion in the period 1997 to 2004. It is evident that China could enjoy significant and multiple benefits from biotech hybrid rice that has already been extensively tested in environmental and pre-production 2001/03 trials at many locations and has been subjected to regulatory evaluation, including food and biosafety. The approval of biotech rice in China will not only have major implications for China but for the rest of the world, because rice is the major food crop of the world. Iran has already set a precedent in 2005 by growing a modest area of a variety of biotech rice whereas the pending Bt rice from China is a hybrid and not a variety.

With the approval of biotech rice this leaves wheat, as the only one of the three major world staples, - maize, rice and wheat - to be denied the significant advantages offered by biotechnology. The adoption of biotech maize, in Asia will, in due course, greatly facilitate the adoption of biotech wheat, initially with improved resistance to *Fusarium* and thus lower levels of mycotoxin, followed by quality traits and in the longer term, possibly around 2010, improved drought resistance.

The near-term food and feed needs of China, and more broadly Asia, are not limited to rice, but also apply to maize for feed, and also more, and better quality, wheat for food. China's priority-trait needs include disease and insect resistance, herbicide tolerance as well as quality traits. China has its own portfolio of biotech crops with various traits that can be complemented with products developed by the public and private sectors for the global crop biotech market. China can derive significant benefits from biotech cotton and rice projected at $5 billion per year by 2010, and can complement these gains by applying biotechnology to the other staples of maize and wheat, and a dozen other crops. At the opening ceremony of the International High-level Forum on biotechnology held in Beijing in September 2005, the Minster of Science and Technology Xu Guanhhua said that "biotechnology could become the fastest growing industry in China in the next 15 years" and that "biotechnology will be put high on the country's mid- and long- term scientific and technological development strategy." He further predicted that eventually the advancement in R &D will lead to a bioeconomy boom. China currently has 200 government funded biotech labs and 500 companies active in biotechnology.

In summary, there is little doubt that China aims to further enhance its role as a world leader in crop biotechnology, having already approved biotech cotton, pepper and tomato in the 1990s. The substantial economic, environmental and social benefits from Bt cotton have provided China with its first-hand experience of biotech crops. The rich experience with Bt cotton will serve China well in its consideration of biotech rice, which is expected in the near-term following the issuance of biosafety certificates and verification of field safety data, some of which have already been generated thus expediting the final approval for commercialization.

PARAGUAY

Population: 6.3 million

% employed in agriculture: 45%

Agriculture as % GDP: 25.3%

Agricultural GDP: $7.6 billion

Arable Land (AL): 3.02 million hectares

Ratio of AL/Population*: 2.0

Major crops:
- Cassava
- Soybean
- Sugar cane
- Maize
- Wheat

Commercialized Biotech Crops:
- HT Soybean

Total area under biotech crops: 1.8 Million Hectares

Increased farm income of $80 million in 2004

*Ratio: % global AL / % global population

Paraguay

Paraguay is the world's number four exporter of soybeans and grew biotech soybean unofficially for several years until it approved four herbicide tolerant soybean varieties in 2004. In 2005, Paraguay is expected to increase its biotech soybean area by 50% to 1.8 million hectares from 1.2 million hectares in 2004. The percentage adoption also increased significantly from 60% on the 2.1 million hectares in 2004 to 85 % of the national soybean crop of 2.1 million hectares in 2005. Paraguay is one of nine countries that have successfully grown biotech soybeans; the nine countries, listed in order of biotech soybean hectarage are the USA, Argentina, Brazil, Paraguay, Canada, Uruguay, Romania, South Africa and Mexico.

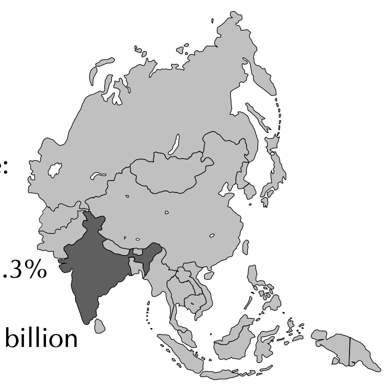
Paraguay grew 440,000 hectares of maize in 2004 and there is probably a potential for utilizing biotech maize for economic, environmental and social benefits because its neighbor Argentina, is already benefiting from Bt and herbicide tolerant maize. Paraguay also grows 320,000 hectares of cotton, which probably could benefit from the biotech traits used in cotton in the neighboring countries of Argentina and Brazil.

Paraguay is estimated to have enhanced farm income from biotech soybean by $80 million in 2004 when it first introduced herbicide tolerant soybean.

India

India which grew approximately 50,000 hectares of officially approved Bt cotton hybrids for the first time in 2002, doubled its Bt cotton area to approximately 100,000 hectares in 2003, and this increased by 400% in 2004 to reach over half a million hectares. In 2005, Bt cotton in India continued to increase reaching 1.3 million hectares, an increase of 160% over 2004 and the highest increase for any biotech crop in any country in 2005. A total of 20 Bt cotton hybrids were approved for planting in 2005 compared with only 4 in 2004. The major states growing Bt cotton in 2005, listed in order of hectarage, are Maharashtra (0.607 million hectares), Andhra Pradesh (0.283 million hectares), Gujarat (0.164 millon hectares), Madhya Pradesh (0.148 million hectares), Northern states (0.064 million hectares), Karnataka

INDIA



Population: 1.04 billion

% employed in agriculture: 67%

Agriculture as % GDP: 23.3%

Agricultural GDP: $118.9 billion

Arable Land (AL): 177.5 million hectares

Ratio of AL/Population*: 0.71

Major crops:
- Sugar cane
- Rice, paddy
- Wheat
- Vegetables, fresh
- Potato

Commercialized Biotech Crops:
- Bt Cotton

Total area under biotech crops: 1.3 Million Hectares

Increased farm income of $124 million for 2002-2004

*Ratio: % global AL / % global population

(0.040 million hectares), and Tamil Nadu (0.029 million hectares) for a national total of 1.3 million hectares. It is estimated that in 2005 approximately 1 million small farmers planted on average between 1.2 and 1.5 hectares of Bt cotton. Thus, the number of farmers growing Bt cotton hybrids in India has increased from 300,000 small farmers in 2004 to 1 million in 2005, close to a three-fold increase. The adoption of approved Bt cotton hybrids in India is expected to continue to increase significantly in 2006, possibly by a factor of two.

The approval and adoption of biotech Bt cotton by the two most populous countries in the world, India (1 billion people) and China (1.3 billion people), can greatly influence the approval, adoption and acceptance of biotech crops in countries throughout the world, particularly in developing countries. It is noteworthy that both countries elected to pursue a similar policy by first exploring the potential benefits of crop biotechnology with a fiber crop, Bt cotton, which has already generated significant and consistent benefits in China, with the same pattern emerging in India, the largest grower of cotton in the world. The most recent national survey of Bt cotton farmers, conducted in 2004 by the Indian Market Research Bureau, reported the following attributes for Bt cotton compared with conventional cotton: a five-fold decrease in insecticides, an average 58% increase in yield and an average 163% increase in profit for Bt cotton farmers. India is estimated to have enhanced farm income from biotech cotton by $124 million between 2002 and 2004.

India is a country with first-hand experience of the life-saving benefits of the Green Revolution in wheat and rice, and the country is now self sufficient in both these staples. However, yields in both wheat and rice are now plateauing and the conventional technology currently used in wheat and rice and other crops will need to be supplemented to feed a growing population that will increase by 50% to 1.5 billion people by 2050. Accordingly, the Government of India, through the Department of Biotechnology (DBT) in the Ministry of Science and Technology, established six centers of plant molecular biology in 1990 and more recently established a new institute, the National Center for Plant Genome Research, to focus on genomics and strengthen plant biotechnology research in the country. The increased public sector investments in crop biotechnology in India are complemented by private sector investments from indigenous Indian seed companies and subsidiaries of multinationals involved in biotech crops. Crop biotech investments, from both the public and private sectors in India, estimated at $25 million per annum in 2001, are focused on the development of biotech food, feed and fiber crops that can contribute to higher and more stable yields and also enhanced nutrition. Given that rice production in India is vital for food security, much emphasis has been assigned to genomics in rice and the development of improved varieties tolerant to the abiotic stresses of salinity and drought, and the biotic stresses associated with pests. Reduction of post-harvest losses, particularly in fruits and vegetables, through delayed ripening genes, is also a major thrust. Reflecting the emphasis on improved crop nutrition, two international collaborative projects involve Golden™ rice, and mustard with enhanced levels of beta-carotene plus an initiative to enhance the nutritional value of potatoes with the *ama1* gene.

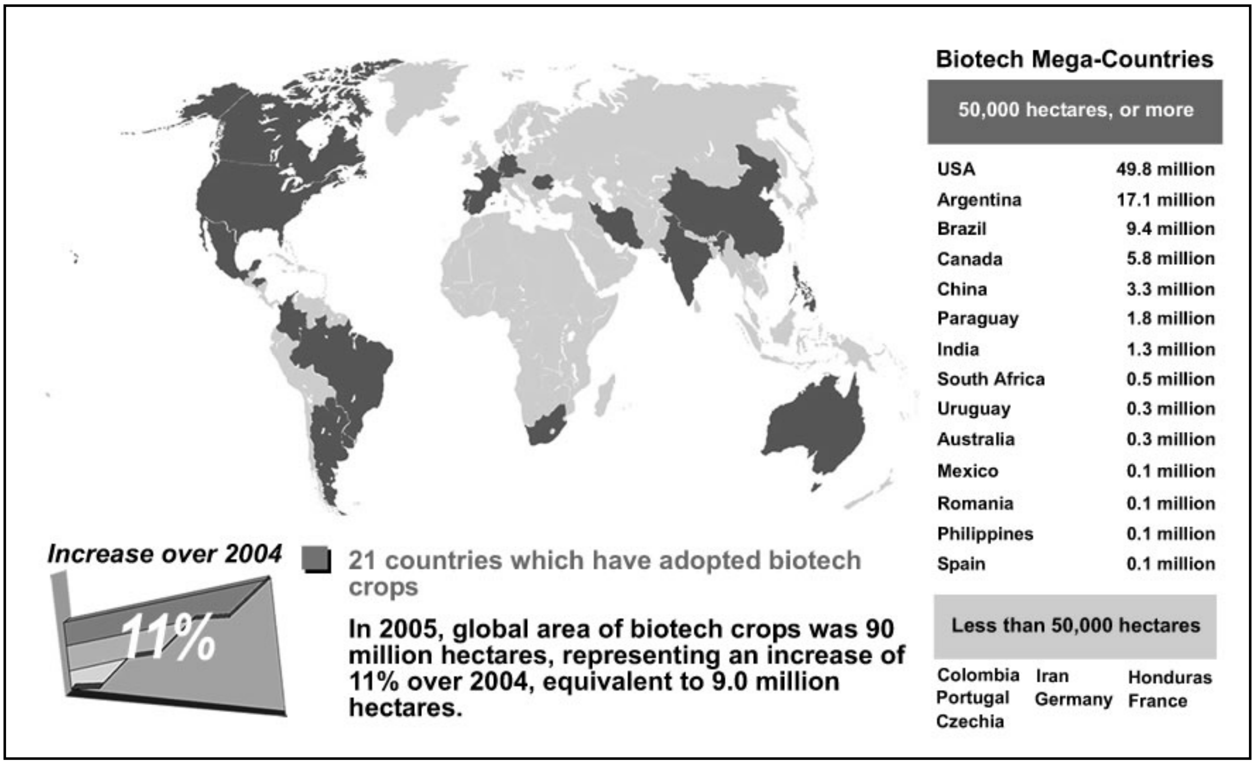
Several public institutions and private companies in India have projects to develop improved varieties of the drought tolerant and important perennial eggplant, known locally as brinjal; it occupies more than 0.5 million hectares, is the main source of cash, and supplies 25% of calories to many resource-poor farmers. The goal of the projects is to improve resistance to shoot and fruit borer which are very important pests that require several insecticide applications costing $40 to $100 per season's worth of insecticides, with environmental and health implications as eggplant is a food crop. These eggplant projects are all geared to deliver biotech products for evaluation and approval by the government in the near-term, representing India's first biotech food product. Bt eggplant will be an important new biotech crop for India and will complement the Bt cotton hybrid that is already approved and other Bt cottons being developed by both the public and private sectors in India. Biotech crops in development by the public sector include the following 16 crops: banana, blackgram, brassica, cabbage, cauliflower, chickpea, coffee, cotton, eggplant, muskmelon, mustard/rapeseed, potato, rice (including basmati), tobacco, tomato, and wheat. In addition, the private sector in India has the following 9 biotech crops under development: brassica, cabbage, cauliflower, cotton, maize, mustard/rapeseed, tomato, pigeonpea, and rice.

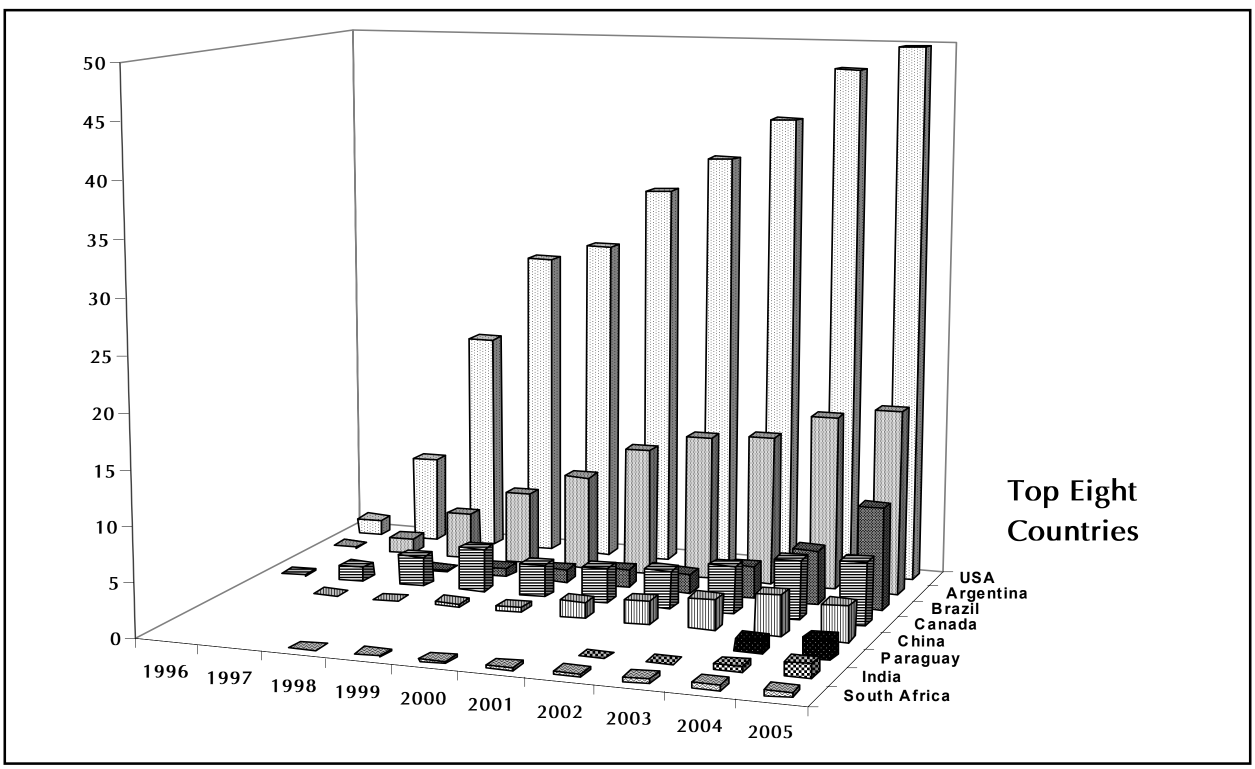
In summary, India's increased public and private sector investments and government support for biotechnology, in conjunction with its intent to explore streamlining regulation with the possible creation of a single window to evaluate and approve products, provides cause for optimism, with the prospects of more approved biotech crops in the near-term. Coincidentally, rapid developments in biotech crops in China, particularly the potential approval of Bt rice in the near-term, and the initial commercialization of Bt rice in Iran in 2005 will provide a stimulus and have a significant impact in India, and indeed in all rice-growing countries throughout Asia, and the world.

South Africa

For many years, South Africa maintained its number seven position in the world ranking but relinquished this position to India in 2004. In 2005, South Africa is ranked eighth with a total biotech crop hectarage of 0.5 million hectares. Total plantings of maize in South Africa in 2005 are expected to decrease by approximately 1.0 million hectares from 2.9 million hectares in 2004 to 1.7 million hectares or less in 2005, a reduction of 42%. This significant decrease is due to a large carry over of maize stocks and higher production costs compared to other crops, including soybean. The lower hectarage of national maize plantings in 2005 is expected to result in parallel lower hectarage of biotech maize. However, the biotech adoption rate is slightly higher in 2005 at 17%. White maize is expected to comprise 60% of the maize area, equivalent to 950,000 hectares of which the biotech percentage will be 9% compared with 8% in 2004. Bt maize will occupy the majority (95%) of the biotech white maize area, with herbicide tolerant maize occupying less than 5%. About 750,000 hectares of yellow maize is expected to be planted in 2005 of which 195,000 hectares equivalent to 26% will be biotech, up from 24% in 2004.

Figure 3. Global Area (Million Hectares) of Biotech Crops, in 2005, by Country and Mega-Country, and for the Top Eight Countries, 1996-2005.



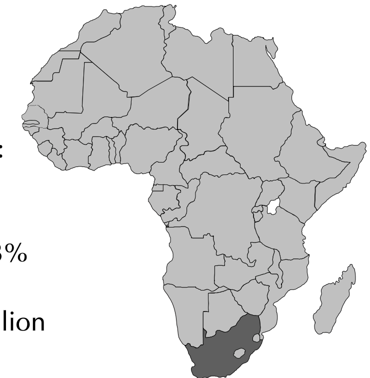


Source: Clive James, 2005

The outlook for soybean is more optimistic with total plantings increasing substantially to approximately 220,000 hectares in 2005. The adoption rate of biotech soybean is expected to remain the same as 2004 at 65% equivalent to a biotech soybean hectarage of about 150,000 hectares in 2005. Total cotton planting is expected to increase by at least 50% with parallel increases in biotech cotton to approximately 30,000 hectares with high adoption rates remaining constant at between 80 and 90%. Currently, South Africa grows both herbicide tolerant and Bt maize as single traits only, and not as stacked products; the approval of the stacked traits is an important policy decision that will allow South Africa to retain its leadership role in biotech crops.

South Africa is estimated to have enhanced farm income from biotech crops by $56 million in the period 1998 to 2004.

SOUTH AFRICA



Population: 44.2 million

% employed in agriculture: 11%

Agriculture as % GDP: 4.3%

Agricultural GDP: $4.5 billion

Arable Land (AL): 14.6 million hectares

Ratio of AL/Population*: 1.4

Major crops:
- Sugar cane
- Maize
- Wheat
- Grapes
- Potato

Commercialized Biotech Crops:
- HT/Bt/HT-Bt Cotton
- HT/Bt Maize
- HT Soybean

Total area under biotech crops: 0.5 Million Hectares

Increased farm income of $56 million for 1998-2004

*Ratio: % global AL / % global population

South Africa can play a pivotal role in sharing its rich experience with other countries in Africa interested in exploring the potential that biotech crops offer. It is encouraging to note that South Africa already participates in technology transfer programs with other African countries and is engaged in training and human development programs with its neighboring sister African countries. Given South Africa's rich experience with biotech crops, it can also play an important role as the key partner country on the continent of Africa that can collaborate and cooperate with its counterparts in Asia, China and India, and Argentina and Brazil in Latin America. South Africa has the necessary resource base and experience in biotech crops, which allows it to exert leadership in international networking with both public and private sector institutions in industrial countries to develop innovative and creative new modes of cooperation and technology transfer that can be shared with other crop biotech aspiring countries in Africa. South Africa plays a critical role as an African and global hub in the sharing of knowledge and experience about biotech crops.

Uruguay

Uruguay, which introduced biotech soybean in 2000, increased its biotech crop area significantly to reach approximately one-third of a million hectares in 2005, with most of the gain coming from a substantial increase in the hectarage of herbicide tolerant soybean that is now 100% of the 300,000 hectares of national soybean hectarage. The adoption of Bt maize, which Uruguay first approved in 2003 continued to grow and occupied approximately one-third of the 90,000 hectares of maize planted in Uruguay in 2005.

Australia

Australia is the fifth member of the six "founder biotech crop countries", having commercialized Bt cotton in 1996, the first year of global commercialization of biotech crops. Australia is expected to plant about 300,000 hectares of biotech cotton in 2005. The overall percentage adoption of biotech cotton in 2005 is expected to be slightly higher, up to 90% compared with 80% in 2004. It is projected that in 2005 about 72%, (up from 40% in 2004) of all cotton in Australia will feature the stacked genes for herbicide tolerance and insect resistance (the dual RR® and Bt gene Bollgard® II); 10% with the dual Bt gene on its own, compared with 25% in 2004; 8% with a single gene for herbicide tolerance, compared with 12% in 2004, and the remaining 10% in conventional cotton, compared with 20% in 2004.

It is noteworthy that Australia achieved the complete substitution of the single Bt gene product (Bollgard® I) with the dual Bt gene varieties (Bollgard® II) in only two years 2002/03, thereby greatly accelerating and enhancing the stability of Bt resistance management, and simultaneously benefiting from better and more reliable protection against the major insect pests. In 2002-2003, there was a limitation in place on the percentage of Bt cotton allowed to be planted in Australia. In 2003-2004, the single Bt gene product was restricted to 15% on any farm in Australia and the combined area of the single and dual gene Bt products was restricted to a maximum of 40%. With the introduction of the dual Bt gene product (Bollgard® II) in Australia, these deployment limitations that applied to the single gene product because of concern related to the deployment of resistance to the single Bt gene, were lifted.

Australia is estimated to have enhanced farm income from biotech cotton by $70 million in the period 1996 to 2004.

To date, Australia, through the Office of the Gene Technology Regulator (OGTR), has approved three crops for commercial planting; cotton, carnations and canola with only one of these crops, biotech cotton, grown widely at this time. Despite a success story with biotech cotton in Australia, there is a vigorous debate over herbicide tolerant canola which was approved by the federal OGTR in 2003 but in the interim has been banned from cultivation by all the major canola growing states in Australia through the implementation of moratoria by state governments. These bans by the states have been instituted because of perceived potential market access restrictions for exports of biotech canola from Australia. However, most farmer groups oppose the ban because they believe it disadvantages them and that Australian canola exports will suffer with long-term negative consequences. The results of a federal study released in September 2005 by the Australian Bureau of Agricultural and Resource Economics (ABARE)* is consistent with the views of some farmers, and estimates that a ban on GM crops in Australia over the next ten years could cost Australian farmers $3 billion. Detection of low levels of biotech canola in conventional crops of canola in September 2005 in Australia has refueled the debate amongst parties. The ban on biotech canola in Australia could have negative implications for Australia in the US-Australian Free Trade Agreement, signed in 2004. This trade agreement opens markets for Australian exports to the US for manufactured products and services of $270 billion, including a modest potential for agricultural products and services.

Mexico

Mexico is the last of the six "founder biotech crop countries" having grown biotech Bt cotton in 1996, the first year of the global commercialization of biotech crops. In 2005, biotech cotton hectarage increased to 120,000 hectares from 65,000 hectares in 2004 –an increase of close to 100%. Biotech cotton in Mexico comprised Bt cotton, herbicide tolerant cotton (HT) and the stacked gene of Bt /HT. Mexico is one of three countries to deploy the Bt /HT stacked cotton, the other countries are the US and Australia. In 2005, the modest area of RR® soy doubled to 25,000 hectares from 12,000 hectares in 2004. Biotech crops that are currently being field-tested and might be adopted in the near-term include RR® Flex cotton, Bollgard® II /RR® Flex cotton and RR® alfalfa.

Mexico is estimated to have enhanced farm income from biotech crops by $41 million in the period 1996 to 2004.

Mexico has no trade constraints related to biotech crops and is a major importer of food, feed and fiber from the US. In 2004, Mexico imported from the US the following: 5.6 million tons of maize, 2.7 million tons of soybeans, 2.8 million tons of wheat and 353,000 tons of cotton. While Mexico has no trade constraints related to biotech crops generally, it is the center of diversity for maize and the conservation of biodiversity in Mexican landraces has fuelled a long standing debate vis-à-vis the potential for gene flow from biotech maize imported from the US. The content and detail of the debate is beyond the scope of this Brief and interested readers are directed to the voluminous literature on this subject, with the latest study contradicting earlier findings, by reporting no trace of Bt genes in Mexican maize.

** Apted, S., McDonald, D., and Rodgers, H. September 2005. Transgenic crops: welfare implications for Australia. ABARE.*

Following years of debate, the Mexican Congress Senate approved a Biosafety law on 15 February 2005 that allows the introduction of biotech crops despite the fear of some regarding gene flow in maize. Under the new law, authorization for the sale, planting and utilization of biotech crops and products is on a case-by-case basis, under the control of CIBIOGEM, an inter-ministerial body. Increasing trade in biotech crops made the new law necessary, and Mexican policy makers believe it is a major step forward in dealing with an issue that required urgent attention.

Romania

Romania is the third largest producer of soybean in Europe after Italy and Serbia Montenegro and ranks equal third with France. As a 2007 accession country to the EU, Romania's positive experience over the last seven years with biotech soybeans could have important policy implications vis-à-vis cultivation of biotech crops in all other EU accession countries. Romania first grew herbicide tolerant soybean in 2001 when it planted 14,250 hectares of RR® soy of its national soybean hectarage of approximately 100,000 hectares - a 15% adoption rate. In 2005, of its national soybean hectarage of 120,000 hectares, approximately 110,000 hectares were planted with RR® soy, (up from 95,000 hectares in 2004), equivalent to over 90% adoption of biotech soybean; this includes commercial seed and farmer-saved seed which is legal in Romania. This very high adoption rate reflects the confidence of farmers in RR® soy, which has delivered unprecedented benefits compared with RR® soy in other countries, particularly in terms of yield gains. A study by PG Economics in 2003 estimated that the average yield gain was plus 31% equivalent to an increase in gross margins ranging from +127% to +185% or an average a gain of $239 per hectare that translates to an annual economic gain at the national level of between $10 and $20 million. Given that RR® soybean technology is usually yield-neutral in other countries such as the US and Argentina which have embraced the technology at high adoption rates, the yield increases in Romania are quite unprecedented. The high yield increases that range from +15% to +50% with an average of +31%, reflect past low usage of herbicides and ineffective weed management, particularly of Johnson grass, which is very difficult to control.

Romania's role model as a successful grower of GM crops in Eastern Europe is clearly important particularly since it is a 2007 accession country to the EU. Furthermore, Romania's success with GM crops need not be limited to RR® soy because it is also by far the largest grower of maize in Europe – 3.1 million hectares in 2004, compared with 1.8 million hectares in France, 1.1 million hectares in both Italy and Hungary and 0.5 million hectares in Germany.

Philippines

The Philippines, which grew Bt maize for the first time in 2003, is projected to increase its total hectarage in the wet and dry seasons in 2005 to approximately 70,000 hectares, up from 50,000 hectares in 2004. The year-on-year increase of 40% was lower than expected because of limited supply of newly approved biotech maize varieties. A total of four events of biotech maize have now been approved for commercial planting in the Philippines viz: MON 810 for insect resistance (2002), NK 603 for herbicide tolerance (2005), Bt 11 for insect resistance (2005) and the stacked gene product of MON810/NK 603 (2005). The future acceptance prospects for biotech crops in the Philippines look very promising with products also being developed by national institutes. These are Golden™ rice, fortified rice resistant to Tungro virus and bacterial blight being developed by the Philippine Rice Research Institute (PHILRICE) and biotech papaya being developed by the Institute of Plant Breeding at the University of the Philippines at Los Banos.

The Philippines passed its first regulation to deal with transgenic crops as early as October 1990, well before its neighboring countries in the region. The Philippines, which grows approximately 2.5 million hectares of maize is the only country in Asia to grow a major biotech feed crop, Bt maize, and moreover has achieved a biotech mega-country status with biotech maize, i.e. 50,000 hectares or more. Asia grows 30% of the global 140 million hectares of maize with China itself growing 25 million hectares, plus significant production in India (7 million hectares), Indonesia (3.3 million hectares), Philippines (2.5 million hectares), Thailand (1.1 million hectares) and Vietnam (1 million hectares).

Spain

Spain is the only country in the European Union to grow a substantial area of a biotech crop. Spain has grown Bt maize for eight years since 1998 when it planted approximately 22,000 hectares out of a national maize area of 500,000 hectares. Since 1998, the area of Bt maize has grown consistently reaching a peak of 58,000 hectares in 2004, qualifying Spain as one of the 14 biotech mega-countries globally growing 50,000 hectares or more of biotech crops. Unfortunately, Spain suffered one of the worst droughts in recent history in 2005. The Spanish Maize Producers Association estimated that although 70,000 to 80,000 hectares of biotech maize were planted, considerable hectarage was lost to severe drought, leaving only 48,000 hectares for harvest. The worst drought occurred in the Ebro valley region that is also the region where the incidence of the European corn borer is most damaging. Thus, in 2005 the Bt maize hectarage of 48,000 is 11% of the total maize area of 438,000, compared with 12% in 2004.

Spain is an important maize growing country in Europe growing 11% of the total area equivalent to half a million hectares. The benefits to Spanish small farmers from Bt maize has been reported by PG Economics and indicates that the average increase in yield was 6%, the net impact on gross margin $112 per hectare. There is potential for increasing Bt maize hectarage in Spain on up to one-third of the total maize area and the national gain is estimated at $13 to 18 million per year. The grain harvested from Bt maize in Spain is sold through the normal channels as animal feed or fed to animals on the farm.

Currently, three events for biotech maize have been approved for planting. Up until 2002, only the variety COMPOA CB was grown with Bt-176 for insect resistance. MON 810, also for insect resistance, was approved in 2003 and now there are 17 varieties registered with MON 810 and four varieties with Bt 176 for a total of 21 European corn borer resistant varieties. In July 2005, NK603, for herbicide tolerance was approved. Biotech maize varieties with NK603 are likely to be deployed in the Ribera del Duero and Andalusia regions of Spain.

Spain is a feed stock deficit country and therefore there is incentive for Spanish farmers to increase productivity and be competitive internationally, by employing innovative and cost effective technologies. The future growth of biotech maize in Spain will be dependent on the continued growth in area of Bt maize, the success of NK603 (some projections are as high as 80% adoption) and particularly a supportive government policy especially in relation to coexistence, where the Government decree of July 2005 calls for a distance of 50 meters to separate conventional and organic crops from biotech crops – the decree is expected to be finalized in the near-term so that it can apply to the planting of biotech maize in Spain in 2006.

Colombia

Colombia introduced Bt cotton in 2002 on approximately 2,000 hectares and in the interim this has increased consistently each year in 2003 and 2004 to reach 28,000 hectares in 2005, equivalent to almost 40 % of the national cotton crop of 72,000 hectares in 2005.Colombia has approximately 630,000 hectares of maize which could be a potential application for biotech maize.

Iran

Iran, with a population of 70 million people, has limited land for crop production in an arid environment and this is exacerbated by limited water supplies, which is particularly important for the rice crop where productivity is constrained by abiotic stresses related to drought and salinity and biotic stresses related to insect pests. Iran grows about 630,000 hectares of rice and, along with Indonesia, Bangladesh and Brazil, is one of four large importers of rice in the world, about 1 million tons per year, or more. The Agricultural Biotechnology Research Institute (ABRI) at Karaj in Iran has developed a Bt rice, which was officially released in Iran in 2004 on 2,000 hectares, to coincide with the International Rice Year with the Prime Minister of Iran inaugurating the first harvest of the biotech rice. The Bt rice was developed in Iran in a breeding program in which rice with Bt incorporated was tested in greenhouse experiments and field trials during the period 1999 to 2004 to meet national regulations for biotech crops. The Bt rice features a synthetic *cry1A(b)* gene in a local high quality aromatic rice variety "Tarom molaii" that confers resistance to stem borers, particularly the striped stem borer which is the most important economic pest on rice in Iran. In 2005, several hundred farmers, (estimated at more than 500 and less than one thousand), grew around 4,000 hectares of Bt rice on their farms in Iran and were involved in the initial stages of commercialization of the Bt rice and to ensure provision of seed supplies for full commercialization in 2006, when it is planned to deploy the Bt rice on 10,000 to 20,000 hectares. The Bt gene has also been backcrossed into higher yielding rice varieties that are well adapted to conditions in Iran, and these should be available in the near-term.

The biotech rice program in Iran is well advanced but is only one of several biotech crop initiatives at 23 institutes in Iran, where 141 researchers are working on several biotech crops. These include Bt cotton, herbicide tolerant canola, and virus resistant sugar beet. The Iranian national biotechnology strategy was presented at the BioAsia 2005 conference in Hyderabad, India in February 2005. Iran and China are the most advanced in the commercialization of biotech rice, which is the most important food crop in the world and thus has enormous implications not only for biotech rice but also for all biotech crops and their acceptance on a global basis.

Honduras

Honduras introduced Bt maize in 2002 with a pre-commercial introductory area of approximately 500 hectares. In the interim, the Bt area has increased modestly, and in 2005 reached 2,000 hectares of the national maize crop of approximately 350,000 hectares. Honduras is the first country in Central America and the Caribbean to grow a biotech crop.

Portugal

Portugal resumed the planting of Bt maize in 2005 after a five year gap having planted an introductory area of approximately 1,000 hectares in 1999 for one year. In 2005 Portugal planted around 750 hectares of the MON 810 biotech maize, resistant to European Corn Borer. As a member country of the EU, Portugal's resumption of the cultivation of Bt maize is an important development even though the national maize area is modest at 135,000 hectares.

The Government of Portugal has recently passed a decree, which requires a minimum distance of 200 meters between biotech and conventional maize and 300 meters between biotech maize and organic maize; buffer zones can substitute for these distances. The decree is also designed to facilitate establishment of biotech crop-free zones. Implementation of coexistence laws will probably result in biotech maize being grown in the central and southern regions of Portugal where the farms are bigger, and where coexistence distances can be accommodated and also where producers are more responsive to the introduction of new and more cost effective technologies. The Ministry of Agriculture has just completed a three-year study on the impact of biotech crops and the findings are favorable. All biotech varieties approved in the EC catalogue can be grown in Portugal.

Germany

Germany has officially grown a small hectarage, from 300 to 500 hectares of Bt maize commercially for the last six years, starting in 2000; Bt176 was used until 2003 when MON810 was introduced. The area of officially approved commercial Bt maize in Germany in 2005 was 345 hectares. Although farmers had registered 1,000 hectares early in the season, various delays eroded the intended area of Bt maize for planting; most of the biotech maize is harvested as silage. The regulation governing the planting of this token area of biotech maize is as follows. Given that Germany does not allow the sale of biotech seeds for unlimited planting, seed companies can apply for special permits annually to supply a limited amount of biotech seed. For maize, the limit is 0.1 percent of any registered variety. To preclude any liability related to the cultivation of this small area of Bt maize in Germany, the milling company Maerka Kraftfutter has voluntarily agreed to purchase, at market prices, all the maize grain from any field within 500 meters of a biotech maize field. In 2004, detailed monitoring of biotech maize fields in Germany confirmed that maize samples taken more than 20 meters from biotech maize had less than the 0.9 percent threshold for biotech content. In early 2005, Germany introduced the first elements of a Genetech law, which covers coexistence and liability; the law has been heavily criticized because it is so restrictive leaving no incentive, but significant disincentive for farmers to adopt Bt maize in Germany.

France

France resumed the planting of Bt maize in 2005 after a four-year gap having planted Bt maize in 1998 (1,500 hectares), 1999 (150 hectares) and 2000 (<100 hectares). In 2005, France planted approximately 500 hectares, of which 200 hectares were for environmental monitoring, 100 hectares for experimental use and 200 hectares for purely commercial purposes. The planting of the commercial Bt maize in 2005 was confirmed by the French Maize Growers Association, which indicated that the grain from the Bt maize harvest will be sold to Spain for animal feed. Most, if not all, of the Bt maize is thought to be MON 810. As one of the lead member states in the EU, and where opposition to biotech crops has been vigorous, the growing of even a token hectarage of Bt maize in France is an important and symbolic development. France is the major maize growing country in the EU with an area of 1.8 million hectares in 2004 and stands to gain more than any other country in the EU from biotech maize. At the Annual meeting of the French Maize Growers Association in September 2005, several hundred maize growers expressed their open support for biotechnology and called on the Minister of Agriculture to expedite the transposition of EU directive 2001/18 into French law. The underlying concern expressed by the maize growers was the fear that France was lagging behind in biotech crops when countries like China and India were embracing the technology to their advantage.

France has a decree in place that prohibits the growing of biotech canola until October 2006. France rigorously implements the EU policy in terms of labeling and traceability. France does not import maize gluten feed for animal feed but does import large quantities of soybean (4.5 million tons of soybean and 470,000 Mt of soybean meal in 2003/04) with Brazil having displaced the US as the major supplier. The government is currently working on a Biotech Law, which should be enacted before the end of 2006 and will include a coexistence policy, as well as evaluation procedures for biotech crop products.

Czech Republic (Czechia)

The Czech Republic, more familiarly known as Czechia, approved the commercial production of a biotech crop for the first time in 2005. Czechia grew 150 hectares of Bt maize in 2005. Czechia grew almost 100,000 hectares of maize in 2005. Provisional coexistence rules apply with 100 meters between Bt maize and conventional maize (or alternatively 50 meters and 6 buffer rows) and 600 meters between Bt maize and organic maize (or alternatively 300 meters and 6 buffer rows); these rules are expected to be revised in the near-term in a new decree. It is noteworthy that Czechia is the fifth EU country to grow biotech crops commercially; the others are, in descending order of biotech hectarage, Spain, Portugal, Germany, and France.

Distribution of Biotech Crops, by Crop

The distribution of the global biotech crop area for the four major crops is illustrated in Figure 4 for the period 1996 to 2005. It clearly shows the continuing dominance of biotech soybean occupying 60% of the global area of global biotech crops in 2005; the entire biotech soybean hectarage is herbicide tolerant RR® soybean. Biotech soybean retained its position in 2005 as the biotech crop occupying the largest area globally occupying 54.4 million hectares in 2005 growing at 12% between 2004 and 2005. Canola grew at 7% between 2004 and 2005, albeit at a much lower hectarage of 4.6 million hectares, compared with the other three biotech crops with most of the growth occurring in Canada. Biotech maize grew at 10% between 2004 and 2005 to reach 21.2 million hectares, and biotech cotton grew 9% to reach 9.8 million hectares in 2005 (Table 4).

Distribution of economic benefits for the four major biotech crops for the period 1996 to 2004 were as follows: Soybean $.17.3 billion, Cotton $ 6.5 billion, Maize $ 2.5 billion, and Canola $ 0.7 billion for a total of $27 billion.

Biotech soybean

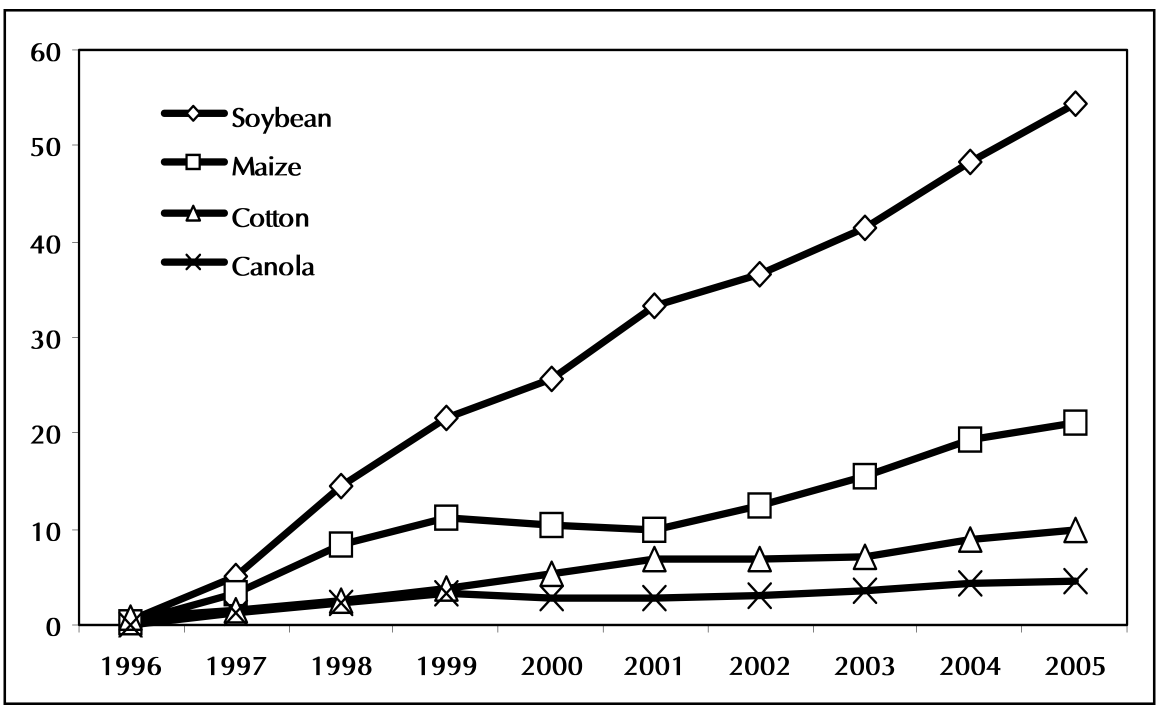
In 2005, the global hectarage of herbicide tolerant soybean is estimated to have increased by 6.0 million hectares, equivalent to a 12% increase. A substantial gain of 4.4 million hectares in biotech soybean is projected for Brazil in 2005 with 44% of the national soybean hectarage of 21.6 million hectares planted to herbicide tolerant soybean. In Argentina, continued growth is projected to result

Table 4. Global Area of Biotech Crops, 2004 and 2005: by Crop (Million Hectares)

Crop	2004	%	2005	%	+/-	%
Soybean	48.4	60	54.4	60	6.0	+12
Maize	19.3	23	21.2	24	1.9	+10
Cotton	9.0	11	9.8	11	0.8	+9
Canola	4.3	6	4.6	5	0.3	+7
TOTAL	**81.0**	**100**	**90.0**	**100**	**+9.0**	**+11**

Source: Clive James, 2005.

Figure 4. Global Area of Biotech Crops, 1996 to 2005: by Crop (Million Hectares)



Source: Clive James, 2005

in 15.4 million hectares in 2005, up from 14.5 million hectares in 2004; virtually all the Argentinean national soybean hectarage is planted with herbicide tolerant soybean. In the US, compared with 2004, herbicide tolerant soybean hectarage in 2005 remained constant at 26.5 million hectares. Paraguay reported 1.2 million hectares of herbicide tolerant soybean in 2004 and this area increased in 2005 to 1.8 million hectares, equivalent to an 85% adoption, up from 60% in 2004 when the national hectarage of soybean was 2 million hectares. Canada continued to plant over 60% of its national soybean hectarage with herbicide tolerant soybean in 2005. Uruguay's herbicide tolerant soybean continued to occupy 100% of the national soybean hectarage of 300,000 hectares in 2005. Romania, which has benefited from yield increases of the order of 30%, as a result of improved weed control, also increased its area of herbicide tolerant soybean by about 10% in 2005 to 110,000 hectares. South Africa increased its soybean hectarage to approximately 220,000 hectares in 2005 and its biotech soybean area doubled to almost 150,000 hectares. Mexico doubled its biotech soybean area in 2005 to about 25,000 hectares.

Biotech maize

In 2005, biotech maize increased by 10%, compared with 12% for soybean, 9% for cotton and 7% for canola. The annual growth rate of 10% for biotech maize in 2005 compares with growth rates over the last three years of 25% in 2004, 25% in 2003, and 27% in 2002. Most of the increase in biotech maize in 2005 occurred in the USA with modest growth in Canada and the Philippines. Marginal decreases were reported in Argentina, South Africa and Spain mainly due to total plantings of maize being lower due to uncertainty regarding weather, trade and prices. Notably, compared with 2004, three new countries grew Bt maize in 2005, Portugal, France and Czechia, all member states of the EU.

Biotech cotton

The area planted to biotech cotton globally in 2005 was up 0.8 million hectares, equivalent to a 9% growth over 2004, with most of the growth coming from India. The total plantings of biotech cotton in the USA in 2005 were slightly higher at approximately 4.6 million hectares, equivalent to over 80% adoption rate with over 70% of the biotech area planted to varieties with the stacked genes of herbicide tolerance and the dual Bt gene, with only 1% deployed with single Bt gene varieties. In China, total cotton plantings were down 10% from 5.6 million hectares to 5.1 million hectares and the decrease in Bt cotton paralleled this decrease from 3.7 million hectares to 3.3 million hectares with the adoption rate remaining approximately the same as 2004 at 66%. It is estimated that in 2005, 6.4 million small resource-poor farmers benefited from Bt cotton in China, farming, on average, approximately one-half of a hectare. Notably, the public sector in China has invested significantly in crop biotechnology and has developed Bt cotton varieties that share the market with varieties developed by the international private sector. The simultaneous marketing of biotech crops from the public and private sectors is unique to China at this time but is expected to also become more prevalent in India as biotech crops are developed by government supported public sector institutions. Compared with approximately 500,000 hectares of approved Bt cotton hybrid grown in India in 2004, the area of approved Bt cotton in 2005 increased more than two- and half- fold, to1.3 million hectares. The advantages of Bt cotton hybrid in India are significant and a substantial increase is projected again for 2006 due to significant gains in production, economic, environmental, health and social benefits. Australian biotech cotton decreased in line with lower plantings. Biotech cotton already occupies between 80% and 90% of the national cotton in Australia and is assigned high priority by cotton farmers because it is delivering important advantages and is a vital element in the implementation of integrated pest management, leading to a significant reduction in insecticides and a more sustainable agriculture.

Biotech canola

The global area of biotech canola in 2005 is estimated to have increased by 0.3 million hectares, from 4.3 million hectares in 2004 to an estimated 4.6 million hectares in 2005 with most of the increase in Canada; the hectarage of herbicide tolerant canola in the USA was approximately 10% higher in 2005. In Canada, of the total national hectarage of canola of 5.4 million hectares in 2005, 4.2 million hectares, equivalent to 82% were biotech herbicide tolerant. The adoption of mutagenic herbicide tolerant canola in Canada decreased from 22% in 2003 to 14% in 2005, leaving only 4% of conventional canola in 2005, compared with 8% in 2004.

Biotech rice

Iran initiated its rice biotech activities in 2005 with several hundred farmers growing 4,000 hectares of Bt rice on their farms and involved in the initial stages of commercialization of the Bt rice and to ensure provision of seed supplies for full commercialization in 2006, when it is planned to deploy the Bt rice on 10,000 to 20,000 hectares.

Other biotech crops

Small areas of biotech virus resistant squash and papaya (Hawaii) continued to be grown in the USA in 2005.

Distribution of Biotech Crops, by Trait

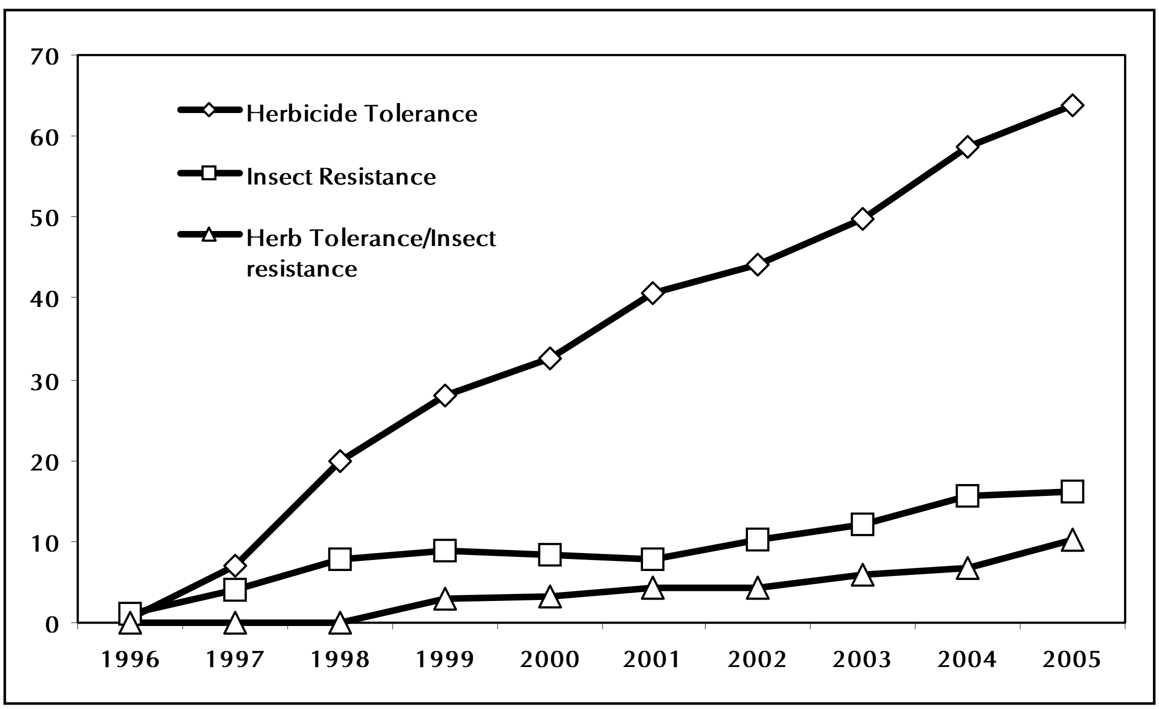
During the ten-year period 1996 to 2005, herbicide tolerance has consistently been the dominant trait with insect resistance being second (Figure 5). In 2005, herbicide tolerance, deployed in soybean,

Table 5. Global Area of Biotech Crops in 2004 and 2005: by Trait (Million Hectares)

Trait	2004	%	2005	%	+/-	%
Herbicide tolerance	58.6	72	63.7	71	5.1	+9
Insect resistance (Bt)	15.6	19	16.2	18	0.6	+4
Bt/Herbicide tolerance	6.8	9	10.1	11	3.3	+49
Virus resistance/Other	<0.1	<1	<0.1	<1	<0.1	<1
Global Totals	**81.0**	**100**	**90.0**	**100**	**+9.0**	**+11**

Source: Clive James, 2005.

Figure 5. Global Area of Biotech Crops, 1996 to 2005: by Trait (Million Hectares)



Source: Clive James, 2005

maize, canola and cotton, occupied 71% of the 90.0 million hectares (Table 5). There were 16.2 million hectares planted to Bt crops in 2005, notably with 4,000 hectares of Bt rice planted in Iran in initial commercialization activities and to produce seed for full commercialization in 2006. It is also noteworthy that two EU countries, Portugal and France resumed planting of Bt maize in 2005 and the Czech Republic grew Bt maize for the first time. Biotech crops with Bt genes occupied 18% of the global biotech area in 2005, with stacked genes for herbicide tolerance and insect resistance deployed in both cotton and maize and occupying 11% of the global biotech area. It is significant that the stacked traits of herbicide tolerance and insect resistance in maize and cotton increased by a substantial 49% in 2005, compared with 17% in 2004. The increase of the stacked traits in maize, a 72% increase from 3.8 million hectares in 2004 to 6.5 million hectares in 2005 was much greater than the corresponding increase in cotton, a 20% increase from 3.0 million hectares in 2004 to 3.6 million hectares in 2005. This significant increase in stacked traits in maize and cotton reflects the needs of farmers who have to simultaneously address the multiple yield constraints associated with various biotic and abiotic stresses - this stacking trend will continue and intensify as more traits become available to farmers and is a very important feature of the technology.

The deployment of stacked genes is becoming increasingly important and is most prevalent in the US, (9.5 million hectares), followed by Canada (0.2 million hectares), Australia (0.2 million hectares), Mexico (< 0.1 million hectares) and South Africa (<0.1 million hectares) for a total of 10.1 million hectares equivalent to approximately 10% of the global biotech crop area. The stacked trait in maize was approved in the Philippines in 2005 for deployment in 2006. Applications for approval of stacked genes are pending for maize in several countries, including Argentina and South Africa. These countries could derive significant benefits from deploying stacked products because productivity constraints at the farmer level are related to multiple biotic stresses, and not a single biotic stress.

In the US in 2005, over a third of the biotech maize hectarage featured a double or triple construct whereas over 70% of biotech cotton in the US featured the stacked genes for insect resistance and herbicide tolerance. In Canada, 28% of the biotech maize hectarage had stacked genes for insect resistance and herbicide tolerance in 2005. Similarly in Australia in 2005, over 70% of the biotech cotton had stacked genes for insect resistance and herbicide tolerance. For the first time a triple gene product in biotech maize was commercialized in the US in 2005. The insect resistance gene, *cry3Bb1,* deployed as event MON 863 in conjunction with a complementary insect resistance gene *cry1Ab* (MON 810), and a third gene for herbicide tolerance, NK603, was deployed as the first triple construct in biotech maize in the US. In its first year of deployment, the triple construct occupied a significant area of almost half a million hectares in the US in 2005. The hectarage of the Bt *cry3Bb1* gene (event MON 863) as a single gene for the control of corn rootworm in the USA expanded to occupy a significant area in 2005, and was also deployed in conjunction with herbicide tolerance as a stacked gene in the USA. The corn rootworm is a major economic pest that costs US farmers about $1 billion dollars per year in losses and insecticide control costs. Event MON 863 has been approved for planting in Canada but was not deployed there in 2005. The Bt gene *cry1Fa2* (event TC 1507), introduced for the first time in 2003 occupied a significant area of approximately two and a quarter million hectares in the USA and a smaller area in Canada in 2005. The *cry1Fa2* gene, as deployed in event TC 1507, provides a broader spectrum of activity that includes excellent protection against first and second generation European corn borer, southwestern corn borer, fall armyworm, black cutworm, western bean cutworm and intermediate suppression of corn earworm. With several approvals of new biotech events in 2005 the country portfolios of deployed biotech crops continued to diversify and expand in area thus creating a broader and more stable base for the new technologies.

In 2005 commercial clearance for planting in 2006 was granted for several products; they include the following, which may not be a comprehensive list of the products approved in 2005. Spain approved herbicide tolerant NK603 maize in July 2005. In the Philippines the stacked events MON810 and NK603 were approved for biotech maize for the next season as well as Bt11. GA21 maize was approved for cultivation in Argentina. Regulatory approvals were granted in the US and Canada for RR® alfalfa and a limited domestic launch is planned for 2006. In the US, Cot102, RR® sugar beet, and RR® Flex cotton were approved with an expected launch for the latter in 2006. The following Herculex® products were approved in 2005: HX1 x RR2 (1507 x NK603), approved for cultivation in Canada (approval was not necessary in the US because it is a breeding stack of two approved events); HXRW (59122), approved for cultivation in the US; HXX (1507 x 59122), approved for cultivation in the US (US approval was necessary for this breeding stack because it contains two Bt events); HXRW x RR2 (59122 x NK603), since it is a breeding stack of approved events no US approval is required; given prior HXX approval in the US no additional approval was required in the US for HXX x RR2 (59122 x 1507 x NK603). Bt Bollgard® cotton was approved in Brazil and is now undergoing seed multiplication and will be commercialized in 2006/07.

Distribution of economic benefits at the farm level by trait, for the period 1996 to 2004 was as follows: herbicide tolerant soybean $.17.3 billion, Bt cotton $ 5.7 billion, insect resistant maize $1.9 billion, herbicide tolerant cotton $750 million, herbicide tolerant canola $713 million, and herbicide tolerant maize $579 million, for a total of $27 billion. In aggregate economic benefits from herbicide tolerance across all four crops was $19.4 billion equivalent to 72% of the total of $27 billion, with the balance of $7.6 billion, equivalent to 28% due to insect resistance in cotton and maize.

Dominant Biotech Crops in 2005

Herbicide tolerant soybean continued to be the dominant biotech crop grown commercially in nine countries in 2005; listed in order of hectarage, the nine countries were the USA, Argentina, Brazil, Paraguay, Canada, Uruguay, Romania, South Africa and Mexico. Globally, herbicide tolerant soybean occupied 54.4 million hectares, representing 60% of the global biotech crop area of 90.0 million hectares for all crops. The second most dominant crop was Bt maize, which occupied 11.3 million hectares, equivalent to 13% of global biotech area and was planted in 12 countries – USA, Argentina,

Table 6. Dominant Biotech Crops, 2005.

Crop	Million Hectares	% Biotech
Herbicide tolerant Soybean	54.4	60
Bt Maize	11.3	13
Bt/ Herbicide tolerant Maize	6.5	7
Bt cotton	4.9	5
Herbicide tolerant Canola	4.6	5
Bt/ Herbicide tolerant Cotton	3.6	4
Herbicide tolerant Maize	3.4	4
Herbicide tolerant Cotton	1.3	2
TOTAL	**90.0**	**100%**

Source: Clive James, 2005.

Canada, South Africa, the Philippines, Spain, Uruguay, Honduras, Portugal, Germany, France, and Czechia. The third most dominant crop was Bt/Herbicide tolerant maize, up from sixth in 2004, which occupied 6.5 million hectares, equivalent to 7% of global biotech area and planted in the US and Canada. It is noteworthy that Bt/Herbicide maize, occupied a total of 6.5 million hectares compared with only 3.8 million hectares in 2004, a year-to-year substantial increase of 71%. The fourth most dominant crop was Bt cotton, about 4.9 million hectares, a 10% growth on 2004, and planted in eight countries, listed in order of hectarage; China, India, Mexico, USA, Argentina, South Africa, Colombia and Australia. The fifth most dominant crop was herbicide tolerant canola occupying 4.6 million hectares, about 10% more area in 2005 than 2004, and planted in Canada and the US. The three other crops listed in Table 6 occupied from 4% to 2% of global biotech crop area and include, in descending order of area: Bt/herbicide tolerant cotton (4%) grown on 3.6 million hectares in the USA, Australia, and Mexico; herbicide tolerant maize, grown in four countries USA, Canada, South Africa and Argentina on 3.4 million hectares (4%); and herbicide tolerant cotton grown in the USA, Argentina Australia, Mexico and South Africa on 1.3 million hectares, equivalent to 2% of the global crop biotech hectarage.

Global Adoption of Biotech Soybean, Maize, Cotton and Canola

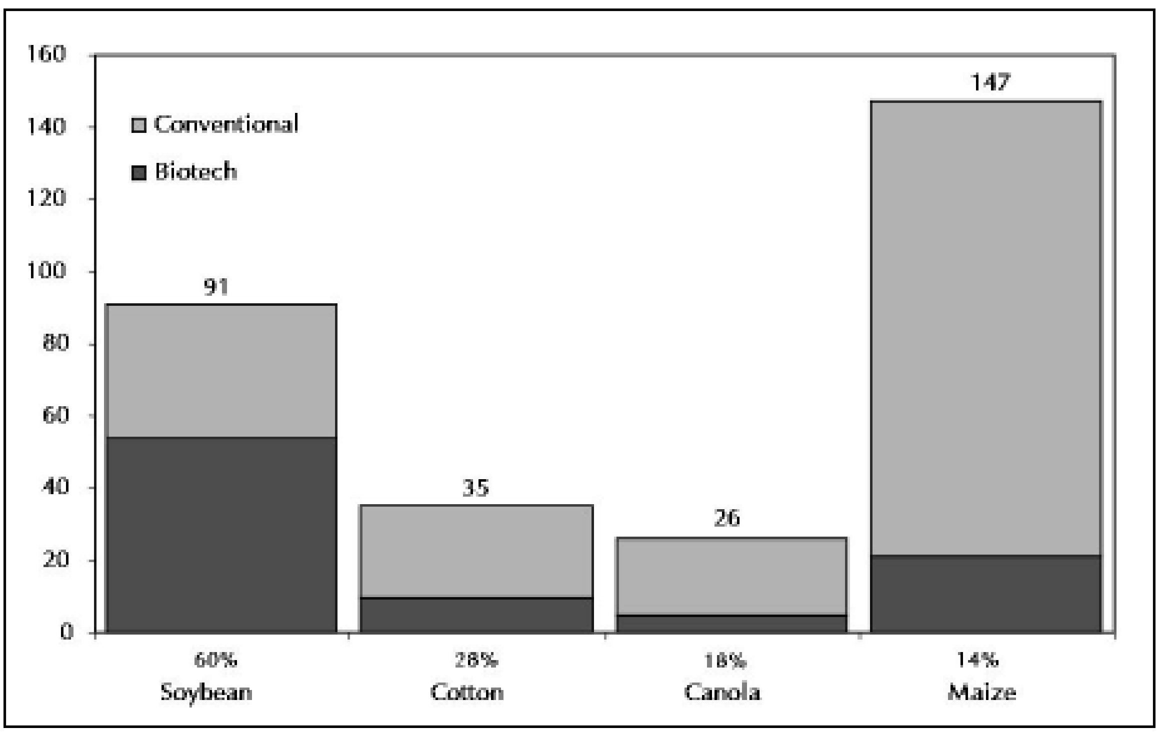
Another way to provide a global perspective of the status of biotech crops is to characterize the global adoption rates as a percentage of the respective global areas of the four principal crops – soybean, cotton, canola and maize – in which biotechnology is utilized (Table 7 and Figure 6). The data indicate that in 2005, 60% of the 91 million hectares of soybean planted globally were biotech - up from 56% in 2004, despite an increase in the global area of soybean from 86 million hectares in

Table 7. Biotech Crop Area as % of Global Area of Principal Crops, 2005 (Million Hectares)

Crop	Global Area*	Biotech Crop Area	Biotech Area as % of Global Area
Soybean	91	54.4	60
Cotton	35	9.8	28
Canola	26	4.6	18
Maize	147	21.2	14
TOTAL	**299**	**90.0**	**30**

Source: Clive James, 2005. *FAO 2004 hectarage

Figure 6. Global Adoption Rates (%) for Principal Biotech crops (Million Hectares), 2005



Source: Clive James, 2005

2004 to 91 million hectares in 2005. Of the 35 million hectares of cotton, 28% or 9.8 million hectares were planted to biotech cotton in 2005, the same percentage adoption as 2004, despite an increase in the global area of cotton from 32 million hectares in 2004 to 35 million hectares in 2005. The area planted to biotech canola, expressed on a percentage basis, was 18%, of the 26 million hectares of canola planted globally in 2005. Similarly, of the 147 million hectares of maize planted in 2005, about 14% was planted to biotech maize, same as 2004, despite an increase in the global area of maize from 143 million hectares in 2004 to 147 million hectares in 2005. If the global areas (conventional plus biotech) of these four crops are aggregated, the total area is 299 million hectares, of which 30%, equivalent to 90.0 million hectares, were biotech - up from 29% in 2004, despite an increase in total global plantings of the four crops from 288 million hectares in 2004 to 299 million hectares in 2005.

Whereas critics of biotech crops often contend that the current focus on biotech soybean, maize, cotton and canola reflects only the needs of large commercial farmers in the richer industrial countries, it is important to note that two-thirds of these 299 million hectares are in the developing countries, farmed mainly by millions of small, resource-poor farmers, where yields are lower, constraints are greater, and where the need for improved production of food, feed, and fiber crops is the greatest.

The Global Value of the Biotech Crop Market

In 2005, the global market value of biotech crops, estimated by Cropnosis, was $5.25 billion representing 15% of the $34.02 billion global crop protection market in 2005 and 18% of the ~$30 billion 2005 global commercial seed market. The $5.25 billion biotech crop market comprised of $2.42 billion for biotech soybean (equivalent to 46% of global biotech crop market), $1.91 billion for biotech maize (36%), $0.72 billion for biotech cotton (14%), and $0.21 billion for biotech canola (4%). The market value of the global biotech crop market is based on the sale price of biotech seed plus any technology fees that apply. The value of the biotech crop market since its commercialization in 1996 is shown in Table 8. The accumulated global value for the ten-year period, since biotech crops were first commercialized in 1996, is estimated at $29.3 billion. The global value of the biotech crop market is projected at over $5.5 billion for 2006.

Concluding Comments

In 2005, an important historic milestone was reached when the one-billionth acre (400 millionth hectare) of biotech crops was planted during the year that marked the tenth anniversary of biotech crops. The positive experience of the first decade of commercialization of biotech crops, 1996 to 2005, was both consistent and compelling and has met the expectations of millions of large and

Table 8. The Global Value of the Biotech Crop Market, 1996 to 2005

Year	Value (Millions of $US)
1996	115
1997	842
1998	1,973
1999	2,703
2000	2,734
2001	3,235
2002	3,656
2003	4,152
2004	4,663
2005	**5,248**
TOTAL	**29,321**

Source: Cropnosis, 2005 (Personal Communication)

small farmers in both industrial and developing countries. A cumulative total of over 475 million hectares (1.17 billion acres,) equivalent to almost half of the total land area of the USA or China, were planted globally in 24 countries. The fifty-fold (53) increase in global commercialized biotech crops in the decade 1996-2005 represents an unprecedented adoption rate of any crop technology in recent times. This very high adoption rate by farmers reflects the fact that biotech crops have consistently delivered significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. Thus, this is a strong vote of confidence resulting from more than 35 million individual decisions by farmers in 24 countries over a ten-year period to plant biotech crops, year after year, after gaining first-hand insight and experience with biotech crops on their own or neighbor's fields. The number of farmers benefiting from biotech crops continued to grow in 2005 to reach 8.5, up from 8.25 million in 2004. Notably, 90% of these 8.5 million farmers (7.7 million) benefiting from biotech crops were resource-poor farmers mostly planting Bt cotton, whose increased incomes have contributed to the alleviation of poverty. The 7.7 million subsistence farmers included: 6.4 million resource-poor farmers in all the cotton growing provinces in China; 1 million, and rapidly growing, small farmers in India; thousands in South Africa, including women cotton farmers in the Makhathini Flats in KwaZulu Natal province; more than 50,000 subsistence farmers cultivating maize in the Philippines; with the balance in the other seven developing countries where biotech crops were planted in 2005.

Ford Runge and Barry Ryan of the University of Minnesota estimated that the global value of total crop production from biotech crops in 2003/04 was $44 billion*, and by extrapolation the value will probably reach $50 billion, or more, in 2005. Biotech crops are also delivering benefits to consumers and society at large, through more affordable food, feed and fiber that require less pesticides and hence a more sustainable agriculture. In developing countries, biotech crops have also delivered invaluable humanitarian social benefits to poor subsistence farmers and the rural landless dependent on agriculture for their livelihood, in terms of a contribution to the alleviation of poverty, hunger and malnutrition.

The most recent survey** of the global impact of biotech crops for the nine year period 1996 to 2004, by Graham Brookes and Peter Barfoot, PG Economics, estimates that the global net economic benefits to crop biotech farmers in 2004 was $6.5 billion, and $27 billion for the accumulated benefits during the period 1996 to 2004; these estimates include the benefits associated with the double cropping of biotech soybean in Argentina. The accumulative reduction in pesticides for the period 1996 to 2004 was estimated by Brookes & Barfoot at 172,500 MT of active ingredient, which is equivalent to a 14% reduction in the associated environmental impact of pesticide use on these crops, as measured by the Environmental Impact Quotient (EIQ) – a composite measure based on the various factors contributing to the net environmental impact of an individual active ingredient. In addition to the direct savings from insect resistant and herbicide tolerant traits associated with yield improvements, reduced pesticides, fuel and labor, there were also indirect benefits associated with herbicide tolerance related to an increased usage of no/low till systems and lower fuel consumption. These benefits (direct and indirect) have contributed to a permanent reduction in carbon dioxide emissions and resulted in higher carbon sequestration in soil, estimated to have produced carbon dioxide savings of 1 billion kg in 2004 alone.

The six principal countries that have gained the most economically from biotech crops, during the period 1996 to 2004 are, in descending order of magnitude, the US ($10.7 billion), Argentina ($10.1), China ($4.2 billion), Brazil ($0.8 billion), Canada ($0.8 billion), India ($0.1 billion) and others ($0.3 billion) for a total of $27 billion. Distribution of economic benefits amongst the four major biotech crops for the period 1996 to 2004 was as follows: soybean $17.3 billion, cotton $6.5 billion, maize $2.5 billion, and canola $0.7 billion for a total of $27 billion. Distribution of economic benefits at the farm level by trait, for the period 1996 to 2004 was as follows: herbicide tolerant soybean $17.3 billion, Bt cotton $5.7 billion, insect resistant maize $1.9 billion, herbicide tolerant cotton $750 million, herbicide tolerant canola $713 million, and herbicide tolerant maize $579 million, for a

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* *Runge and Ryan. 2004. The Global Diffusion of Plant Biotechnology: International Adoption and Research in 2004. University of Minnesota. Available at http://www.apec.umn.edu/faculty/frunge/globalbiotech04.pdf*

** *GM Crops: The Global Socio-economic and Environmental Impact of the First Nine Years 1996-2004 by Graham Brookes and Peter Barfoot, P.G. Economics. 2005* total of $27 billion. The aggregate economic benefits from herbicide tolerance across all four crops was $19.4 billion equivalent to 72% of the total of $27 billion, with the balance of $7.6 billion, equivalent to 28% due to insect resistance in cotton and maize.

The most recent report from the National Center for Food and Agricultural Policy (NCFAP) in the US estimated that the net economic benefits to producers from biotech crops in the USA in 2004 was $2.3 billion*, up from $1.9 billion in 2003. Jikun Huang, from the Chinese Academy of Sciences, has projected potential gains for China of $5 billion in 2010, $1 billion from Bt cotton and $4 billion from Bt rice, expected to be approved in the near-term. A global study by the Australian Bureau of Agricultural and Resource Economics (ABARE)** on biotech grains, oil seeds, fruit and vegetables, has projected a global potential gain of $210 billion by 2015; the projection is based on full adoption with 10% productivity gains in high and middle income countries, and 20% in low income countries.

There is cause for cautious optimism that the stellar growth in biotech crops, witnessed in the first decade of commercialization, 1996 to 2005, will continue and probably be surpassed in the second decade 2006-2015. The number of countries adopting the four current major biotech crops is expected to grow; for example, Pakistan is expected to approve Bt cotton cultivation in 2006. The global hectarage and number of farmers planting biotech crops are expected to increase as the first generation of biotech crops is more widely adopted and the second generation of new applications for both input and output traits becomes available. Beyond the traditional agricultural products of food, feed and fiber, entirely novel products to agriculture will emerge including the production of pharmaceutical products, oral vaccines, specialty and fine chemicals and the use of renewable crop resources to replace non-renewable, polluting, and increasingly expensive fossil fuels. In the near-term, in the established industrial country markets growth in "trait hectares" of biotech crops will continue to grow with the introduction of new input and output traits, stacked to create value and to meet the multiple needs of both consumers and producers who seek more nutritional and healthier food and feed at the most affordable prices.

The global number and proportion of small farmers from developing countries growing biotech crops are expected to increase dramatically early in the next decade (2006-2015) as staple crops of biotech rice and maize are adopted by hundreds of millions of small farmers in Asia to meet their food/feed crop requirements and meat demands of their burgeoning and more affluent populations - there are more than a hundred million rice farmers in China alone and a similar number in India. A similar trend will apply to the less affluent and more agriculturally based countries of Eastern Europe such as

* *Sankula, S., G. Marmon, and E. Blumenthal. 2005. Biotechnology-Derived Crops Planted in 2004 - Impacts on US Agriculture. Available at http://www.ncfap.org.*

** *Abdalla, A., Berry, P., Connell, P., Tran, Q.T. and Buetre, B. 2003, Agricultural Biotechnology: Potential for Use in Developing Countries, ABARE eReport 03.17, Canberra.*

Czechia which has recently joined the EU, and those expected to join in 2007 and beyond, such as Romania, which already knows from first-hand experience the value of biotech crops. In 2005, there were signs of progress in the European Union as five countries, Spain, Portugal Germany, France and the Czech Republic commercialized Bt maize, albeit on modest hectarages, but of significant strategic importance. The Commission has approved 17 maize varieties, with insect resistance conferred by MON 810, making it the first biotech crop to be approved for planting in all 25 EU countries. The use of MON 810 maize, in conjunction with practical and equitable coexistence policies, opens up new opportunities for other EU member countries to benefit from the commercialization of biotech maize, which Spain has successfully deployed since 1998, and now four more countries, including France, are initiating commercialization with French maize producers demanding access to a technology that will make them competitive. Notably, in Iran, the initial activities of commercialization involved several hundred farmers growing Bt rice on their farms in 2005 and to ensure sufficient seed supply to implement full commercialization on 10,000 to 20,000 hectares in 2006. The substantial 2.6-fold increase in hectarage of approved Bt cotton in India and the significant 1.8-fold increase of RR® soybean in Brazil plus the registration of the first Bt cotton variety, signals that Brazil is embarking on a growth curve that will involve six principal biotech crops including soybean, cotton, maize, rice, beans and papaya. New laws and regulatory mechanisms that facilitate timely approval and adoption were promulgated in both Brazil and Mexico in 2005. These will allow these two key Latin American economies to significantly benefit from biotech crops and to compete with Argentina, the third largest economy on the continent. Argentina has already enhanced its net farm income by $10.1 billion in the period 1996 to 2004 when the country went through an economic crisis mitigated to some extent by the contribution of biotech crops to the economy and to unemployment through the creation of 200,000 jobs. Taking all these global developments in both industrial and developing countries into account, the outlook for the period 2006 to 2010 points to continued growth in the global hectarage of biotech crops, up to 150 million hectares, with at least 15 million farmers growing biotech crops in up to 30 countries, or more.

The best guide to the future is the history of the past, and the sharing of the growing body of knowledge and experience that has been accumulated in the first decade of commercialization (1996-2005) provides the best guidance for setting a prudent course for the next decade (2006-2015). The collective and varied experience of the 21 countries (11 developing and 10 industrial) that grew biotech crops in 2005 is an important experience to capture and use to guide effective and responsible future deployment of biotech crops on a significant proportion of the world's 1.5 billion hectares of arable land. Prudent management and vigilance of the technology will continue to be paramount, and become even more important as Iran and China embark on the introduction of biotech rice that will occupy large hectarages and concentrated in the rice growing and consuming countries of Asia. Adherence to good farming practices with biotech crops is critical, including the prudent rotation of crops and the deployment and effective management of diverse genes that confer resistance to pests, pathogens and herbicides. Responsible stewardship allowed the first decade of biotech crops to be ushered in without any of the dire outcomes predicted by the opponents of the technology. Their use has already contributed to the alleviation of poverty for over 7 million subsistence farmers; these represent some of the poorest people in the world's 1.3 billion poor people who are destined to continue to suffer unless global society make good on its promise to reduce poverty by 50% by 2015. Deploying biotech crops is one of many thrusts in a global strategy that must include improved food distribution and access to water, that should not be denied to poor subsistence farmers. Continued responsible stewardship in the coming decade must be practiced by the countries of the South, which will be the major deployers of biotech crops. There is little doubt, based on the evidence and experience of the first decade of commercialization that biotech crops do have the potential to contribute to the alleviation of poverty for hundreds of millions of subsistence farmers and the rural landless in the next decade, 2006 to 2015. Coincidentally, biotech crops can contribute significantly to national food security and produce more affordable and nutritious food for the urban poor in the mega-cities of the developing countries of the world as urbanization and its associated squalor grows and poses new challenges in alleviating poverty, hunger and malnutrition in the coming decades.

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