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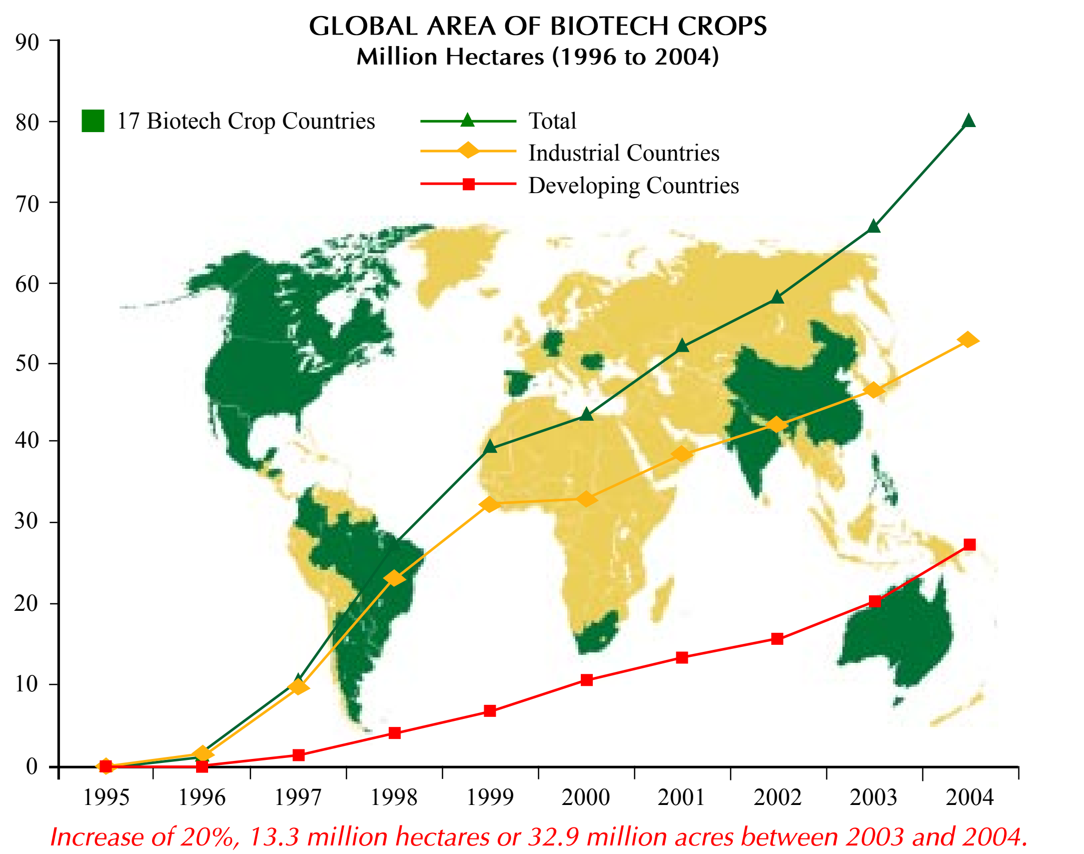
# PREVIEW

## Global Status of Commercialized Biotech/GM Crops: 2004

by

**Clive James**
Chair, ISAAA Board of Directors




Source: Clive James, 2004

No. 32 - 2004

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## Global Status of Commercialized Biotech/GM Crops: 2004

### Global Status of Biotech Crops in 2004

- **2004 is the penultimate year of the first decade of the commercialization of genetically modified (GM) or transgenic crops, now often called biotech crops, as referred to consistently in this Brief. In 2004, the global area of biotech crops continued to grow for the ninth consecutive year at a sustained double-digit growth rate of 20%, compared with 15% in 2003. The estimated global area of approved biotech crops for 2004 was 81.0 million hectares, equivalent to 200 million acres, up from 67.7 million hectares or 167 million acres in 2003. Biotech crops were grown by approximately 8.25 million farmers in 17 countries in 2004, up from 7 million farmers in 18 countries in 2003. Notably, 90% of the beneficiary farmers were resource-poor farmers from developing countries, whose increased incomes from biotech crops contributed to the alleviation of poverty. The increase in biotech crop area between 2003 and 2004, of 13.3 million hectares or 32.9 million acres, is the second highest on record. In 2004, there were fourteen biotech mega-countries (compared with ten in 2003), growing 50,000 hectares or more, 9 developing countries and 5 industrial countries; they were, in order of hectarage, USA, Argentina, Canada, Brazil, China, Paraguay, India, South Africa, Uruguay, Australia, Romania, Mexico, Spain and the Philippines. During the period 1996-2004, the accumulated global biotech crop area was 385 million hectares or 951 million acres, equivalent to 40% of the total land area of the USA or China, or 15 times the total land area of the UK. The continuing rapid adoption of biotech crops reflects the substantial improvements in productivity, the environment, economics, health and social benefits realized by both large and small farmers, consumers and society in both industrial and developing countries**.

- During the nine-year period 1996 to 2004, global area of biotech crops increased more than 47 fold, from 1.7 million hectares in 1996 to 81.0 million hectares in 2004, with an increasing proportion grown by developing countries. More than one-third (34%) of the global biotech crop area of 81 million hectares in 2004, equivalent to 27.6 million hectares, was grown in developing countries where growth continued to be strong. It is noteworthy that the absolute growth in biotech crop area between 2003 and 2004 was, for the first time, higher for developing countries (7.2 million hectares) than for industrial countries (6.1 million hectares), with the percentage growth almost three times as high (35%) in the developing countries of the South, compared with the industrial countries of the North (13%). The increased hectarage and impact of the five principal developing countries (China, India, Argentina, Brazil and South Africa) growing biotech crops is an important trend with implications for the future adoption and acceptance of biotech crops worldwide; see full Brief for biotech crop overviews for each of the five countries. In 2004, the number of developing countries growing biotech crops (11) was almost double the number of industrial countries (6) adopting biotech crops.

## Biotech Crop Area by Country, Crop and Trait

- Countries that grow 50,000 hectares, or more, of biotech crops are classified as biotech mega-countries. In 2004, there were 14 mega-countries, compared with 10 in 2003, with Paraguay, Spain, Mexico and the Philippines joining the mega-country group for the first time in 2004. This 40% increase in the number of mega-countries reflects a more balanced and stabilized participation of a broader group of countries adopting biotech crops. The 14 mega-countries, in descending order of hectarage of biotech crops, were: USA with 47.6 million hectares (59% of global total), followed by Argentina with 16.2 million hectares (20%), Canada 5.4 million hectares (6%), Brazil 5.0 million hectares (6%), China 3.7 million hectares (5%), Paraguay with 1.2 million hectares (2%) reporting biotech crops for the first time in 2004, India 0.5 million hectares ((1%), South Africa 0.5 million hectares (1%), Uruguay 0.3 million hectares (<1%), Australia 0.2 million hectares (<1%), Romania 0.1 million hectares (<1%), Mexico 0.1 million hectares (<1%), Spain 0.1 million hectares (<1%), and the Philippines 0.1 million hectares (<1%).

- Based on annual percentage growth in area, of the eight leading biotech crop countries, India had the highest percentage year-on-year growth in 2004 with an increase of 400% in Bt cotton area over 2003, followed by Uruguay (200%), Australia (100%), Brazil (66%), China (32%), South Africa (25%), Canada (23%) Argentina (17%) and the USA at 11%. In 2004, India increased its area of approved Bt cotton, introduced only two years ago, from approximately 100,000 hectares in 2003 to 500,000 hectares in 2004 when approximately 300,000 small farmers benefited from Bt cotton. Whereas growth in Uruguay in 2004 was accentuated by a conservative 2003 adoption rate, biotech soybean now occupies >99 % of the total soybean area in Uruguay, plus a significant increase in biotech maize taking the total biotech crop area above 300,000 hectares**.** After suffering severe drought for the last two years, Australia increased its total cotton plantings to about 310,000 hectares of which 80%, equivalent to 250,000 hectares, were planted with biotech cotton in 2004. Brazil increased its biotech soybean area by two-thirds from 3 million hectares in 2003 to a projected conservative 5 million hectares in 2004, with another significant increase likely in 2005. China increased its Bt cotton area for the seventh consecutive year; an increase of one-third from 2.8 million hectares in 2003 to 3.7 million hectares in 2004, equivalent to 66% of the total cotton area of 5.6 million hectares in 2004, the largest national cotton hectarage planted in China since the introduction of Bt cotton in 1997. South Africa reported a 25% increase in its combined area of biotech maize, soybean and cotton to 0.5 million hectares in 2004; growth continued in both white maize used for food, and yellow maize used for feed, as well as strong growth in biotech soybean, up from 35% adoption in 2003 to 50% in 2004, whilst Bt cotton has stabilized at about 85% adoption. Canada increased its combined area of biotech canola, maize and soybean by 23% with a total of 5.4 million hectares with 77% of its canola hectarage planted to biotech varieties. The adoption of herbicide tolerant soybeans in Argentina, which was close to 100% in 2003, continued to climb in 2004 as total plantings of soybean increased, which along with biotech maize and cotton reached an all time high of 16.2 million hectares of biotech crops. In the USA, there was an estimated net gain of 11% of biotech crops in 2004, as a result of significant increases in the area of biotech maize, followed by biotech soybean, with modest growth in biotech cotton which started to peak in the USA in 2004 as adoption approached 80%. In 2004, for the first time, Paraguay reported 1.2 million hectares of biotech soybean, equivalent to 60% of its national soybean hectarage of 2 million hectares. Spain, the only EU country to grow a significant hectarage of a commercial biotech crop, increased its Bt maize area by over 80% from 32,000 hectares in 2003 to 58,000 hectares in 2004, equivalent to

12% of the national maize crop. In Eastern Europe, Romania, which is a biotech mega-country, growing more than 50,000 hectares of biotech soybean, also reported significant growth. Bulgaria and Indonesia did not report biotech maize and cotton, respectively in 2004 due to expiry of permits. Two countries, Mexico and the Philippines which attained the status of biotech mega-countries for the first time in 2004 reported 75,000 hectares and 52,000 hectares of biotech crops, respectively for 2004. Other countries that have only recently introduced biotech crops, such as Colombia and Honduras reported modest growth, whilst Germany planted a token hectarage of Bt maize.

- Globally, in 2004, growth continued in all four commercialized biotech crops. Biotech soybean occupied 48.4 million hectares (60% of global biotech area), up from 41.4 million hectares in 2003. Biotech maize was planted on 19.3 million hectares (23% of global biotech crop area), up substantially from 15.5 million hectares in 2003, co-sharing the highest growth rate with cotton at 25% - this follows a 25% growth rate in biotech maize in 2003 and 27% in 2002. Biotech maize is projected to have the highest percentage growth rate for the near term as maize demand increases and as more beneficial traits become available and approved. Biotech cotton was grown on 9.0 million hectares (11% of global biotech area) compared with 7.2 million hectares in 2003. Bt cotton is expected to continue to grow in 2005 and beyond, as India and China continue to increase their hectarage and new countries introduce the crop for the first time. Biotech canola occupied 4.3 million hectares (6% of global biotech area), up from 3.6 million hectares in 2003. In 2004, 5% of the 1.5 billion hectares of all global cultivable crop land was occupied by biotech crops.

- During the nine-year period 1996 to 2004, herbicide tolerance has consistently been the dominant trait followed by insect resistance. In 2004, herbicide tolerance, deployed in soybean, maize, canola and cotton occupied 72% or 58.6 million hectares of the global biotech 81.0 million hectares, with 15.6 million hectares (19%) planted to Bt crops. Stacked genes for herbicide tolerance and insect resistance, deployed in both cotton and maize continued to grow, occupying 9% or 6.8 million hectares, up from 5.8 million hectares in 2004. The two dominant biotech crop/trait combinations in 2004 were: herbicide tolerant soybean occupying

48.4 million hectares or 60% of the global biotech area and grown in nine countries; and Bt maize, occupying 11.2 million hectares, equivalent to 14% of global biotech area and also grown in nine countries. Whereas the largest increase in Bt maize was in the USA, growth was witnessed in all other eight countries growing Bt maize. Notably, South Africa grew 155,000 hectares of Bt white maize for food in 2004, a substantial 25 fold increase from when it was first introduced in 2001. Bt/ herbicide tolerant maize and cotton both increased substantially, reflecting a continuing trend for stacked genes to occupy an increasing area planted to biotech crops on a global basis.

- Another way to provide a global perspective of the adoption of biotech crops is to express the global adoption rates for the four principal biotech crops as a percentage of their respective global areas. In 2004, 56% of the 86 million hectares of soybean planted globally were biotech - up from 55% in 2003. Twenty-eight percent of the 32 million hectares of cotton were biotech crops, up from 21% last year. The area planted to biotech canola in 2004 was 19% of 23 million hectares, up from 16% in 2003. Finally, of the 140 million hectares of maize grown globally, 14% was biotech in 2004 equivalent to 19.3 million hectares, up from 11% or 15.5 million hectares in 2003. If the global areas (conventional and biotech) of these four principal biotech crops are aggregated, the total area is 284 million hectares of which 29% was biotech in 2004, up from 25% in 2003. Thus, close to 30% of the aggregate area of the four crops, totaling over one quarter billion hectares is now biotech. The biggest increase in 2004 was a 7.0 million hectares increase in biotech soybean equivalent to a 17% year-on-year growth, followed by a 3.8 million hectare increase in biotech maize equivalent to a substantial 25% year-on-year growth, which follows a 25% year-on-year growth in 2003.

## The Global Value of the Biotech Crop Market

- In 2004, the global market value of biotech crops, forecasted by Cropnosis, was \$4.70 billion representing 15% of the \$32.5 billion global crop protection market in 2003 and 16% of the \$30 billion global commercial seed market. 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 nine year period 1996 to 2004, since biotech crops were first commercialized in 1996, is $24 billion. The global value of the biotech crop market is projected at more than $5 billion for 2005.

**Benefits from Biotech Crops**

- The experience of the first nine years, 1996 to 2004, during which a cumulative total of over 385 million hectares (951 million acres, equivalent to 40% of the total land area of the USA or China) of biotech crops were planted globally in 22 countries, has met the expectations of millions of large and small farmers in both industrial and developing countries. 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 environment. The global value of total crop production from biotech crops in 2003 was estimated at $44 billion. Net economic benefits to producers from biotech crops in the USA in 2003 were estimated at $1.9 billion whilst gains in Argentina for the 2001/02 season were $1.7 billion. China has projected potential gains 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 Australian economists, on biotech grains, oil seeds, fruit and vegetables, projects 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. The 2004 data are consistent with previous experience confirming that commercialized biotech crops continue to deliver significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. The number of farmers benefiting from biotech crops continued to grow to reach 8.25 million in 2004, up from 7 million in 2003. Notably, 90% of these 8.25 million farmers benefiting from biotech crops in 2004, were resource-poor farmers planting Bt cotton, whose increased incomes have contributed to the alleviation of poverty. These included 7 million resource-poor farmers in all the cotton growing provinces of China, an estimated 300,000 small farmers in India, and subsistence farmers in the Makhathini Flats in KwaZulu Natal province in South Africa, and in the other eight developing countries where biotech crops were planted in 2004.

## Future Prospects

- 2004 is the penultimate year of the first decade of the commercialization of biotech crops during which double-digit growth in global hectarage of biotech crops has been achieved every single year; this is an unwavering and resolute vote of confidence in the technology from the 25 million farmers, who are masters in risk aversion, and have consistently chosen to plant an increasing hectarage of biotech crops year, after year, after year. The 10$^{th}$ anniversary in 2005, will be a just cause for celebration worldwide by farmers, the international scientific and development community, global society, and the peoples in developing and industrial countries on all six continents that have benefited significantly from the technology, particularly the humanitarian contribution to the alleviation of poverty, malnutrition and hunger in the countries of Asia, Africa and Latin America. On a global basis, there is cause for cautious optimism with the global area and the number of farmers planting biotech crops expected to continue to grow in 2005 and beyond. In the established industrial country markets of the USA and Canada, growth will continue with the introduction of new traits; for example, the significant biotech hectarage planted in 2004 in North America to MON 863 for corn rootworm control (approximately 700,000 hectares of the single/stacked product) and TC 1507 for broader lepidopteran control (approximately 1.2 million hectares). The global number and proportion of small farmers from developing countries growing biotech crops is expected to increase significantly to meet their food/feed crop requirements and meat demands of their burgeoning and more affluent populations. A similar trend may also apply to the poorer and more agriculturally based countries of Eastern Europe which have recently joined the EU, and those expected to join in 2007 and beyond. Finally, there were signs of progress in the European Union in 2004 with the EU Commission approving, for import, two events in biotech maize (Bt 11 and NK603) for food and feed use, thus signaling the end of the 1998 moratorium. The Commission also 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 co-existence policies, opens up new opportunities for EU member countries to benefit from the commercialization of biotech maize, which Spain has successfully deployed since 1998. Taking all factors into account, the outlook for 2010 points to continued growth in the global hectarage of biotech crops, up to 150 million hectares, with up to 15 million farmers growing crops in up to 30 countries.

**The Potential Impact of the Lead Developing Countries on Global Acceptance of Biotech Crops**

- Of the 11 developing countries that have already approved and adopted biotech crops to meet their own food, feed and fiber needs and/or to optimize exports, there are five lead countries that will exert leadership and have a significant impact on future adoption and acceptance of biotech crops globally, because of their significant role in biotech crops and generally in world affairs. These five countries are China and India in Asia, Brazil and Argentina in Latin America, and South Africa on the continent of Africa. Collectively, they planted approximately 26 million hectares of biotech crops in 2004, (equivalent to approximately one-third of global biotech hectarage) to meet the needs of their combined populations of 2.6 billion (approximately 40% of global population) which generated an aggregated agricultural GDP of almost $370 billion and provided a livelihood for 1.3 billion of their people. Of the five principal biotech developing countries, China is likely to be the most influential, and what China is to Asia, Brazil is to Latin America, and South Africa is to the continent of Africa. 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, feed and fiber security.

- The sharing of the significant body of knowledge and experience that has been accumulated on biotech crops in developing countries, since their commercialization in 1996, is an essential ingredient for a transparent, and knowledge-based discussion by an informed global society about the potential humanitarian and material benefits that biotech crops offer developing countries. The five lead biotech crop countries from the South, China, India, Argentina, Brazil and South Africa, offer a unique experience from developing countries in all three continents of the South – Asia, Latin America and Africa. The collective experience and voice of these five key countries represent a coalition of influential opinion from the South re biotech crops that will also influence acceptance of biotech crops globally. In the near term, the one single event that is likely to have the greatest impact is the approval and adoption of Bt rice in China, which is considered to be likely in the near term, probably in 2005. The adoption of biotech rice by China, not only involves the most important food crop in the world but the culture of Asia. It will provide the stimulus that will have a major impact on the acceptance of biotech rice in Asia and, more generally, on the acceptance of biotech food, feed and fiber crops worldwide. Adoption of biotech rice will contribute to a global momentum that will herald a new chapter in the debate on the acceptance of biotech crops which will be increasingly influenced by countries in the South, where the new technology can contribute the biggest benefits and where the humanitarian needs are greatest – a contribution to the alleviation of malnutrition, hunger and poverty. Global society has pledged to reduce poverty by half by 2015, and if it is to maintain credibility, it must practice what it preaches and deliver what it promises. Reducing poverty by half by 2015 is an imperative moral obligation and is one of the most formidable challenges facing the world today, to which biotech crops can make a vital contribution. It is appropriate that it is the countries of the South, led by China, India, Argentina, Brazil and South Africa, which are exerting increasing leadership in the adoption of biotech crops and have the courage to address issues that will determine their own survival and destiny, at a time when some segments of global society are still engaged in an ongoing debate on biotech crops that has resulted in paralysis through over-analysis.

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**PREVIEW**
**Global Status of Commercialized Biotech/GM Crops: 2004**

by

**Clive James**
Chair, ISAAA Board of Directors

## Introduction

2004 is the penultimate year of the first decade of the commercialization of genetically modified (GM) or transgenic crops, now often called biotech crops as referred to in this Brief. The experience of the first eight years, 1996 to 2003, during which a cumulative total of 300 million hectares (approximately 750 million acres) of biotech crops were planted globally in 21 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 eight year period 1996 to 2003, reflects the substantial multiple benefits realized by both large and small farmers in industrial and developing countries that have grown biotech crops commercially. Between 1996 and 2003, a total of twenty-one countries, 11 developing and 10 industrial countries, contributed to a forty-fold increase in the global area of biotech crops from 1.7 million hectares in 1996 to 67.7 million hectares in 2003. Adoption rates for biotech crops during the period 1996 to 2003 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 corn in the USA mid-west. High adoption rates reflect farmer satisfaction with the products that offer substantial benefits ranging from more convenient and flexible crop management, 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 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 7 million farmers grew biotech crops in 2003 and derived multiple benefits that included significant agronomic, environmental, health, social and economic advantages. ISAAA's 2003 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 2004. 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, 840 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 pledge to decrease poverty by half by 2015.

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

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

- **conserving biodiversity**, as a land-saving technology capable of higher productivity, 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 for the rural population dependent on agriculture in developing countries**.

- **and thus providing significant and important multiple benefits to farmers, consumers and global society**

The most promising approach 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 is 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, a Preview of the 2004 Annual Review to be published later, 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 2004 and the changes that have occurred between 2003 and 2004 are highlighted. The global adoption trends during the last nine years from 1996 to 2004 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 several years. This Preview documents the global database on the adoption and distribution of biotech crops in 2004.

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, due to rounding off. 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 2004 information for Argentina, Brazil, Australia, South Africa, and Uruguay is hectares usually planted in the last quarter of 2004 and harvested in the first quarter of 2005 with some countries like the Philippines planting in more than one season per year.

Over the last nine 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 sector in many countries throughout the world. Data sources vary by country and include, where available, government statistics, independent surveys, 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 2004

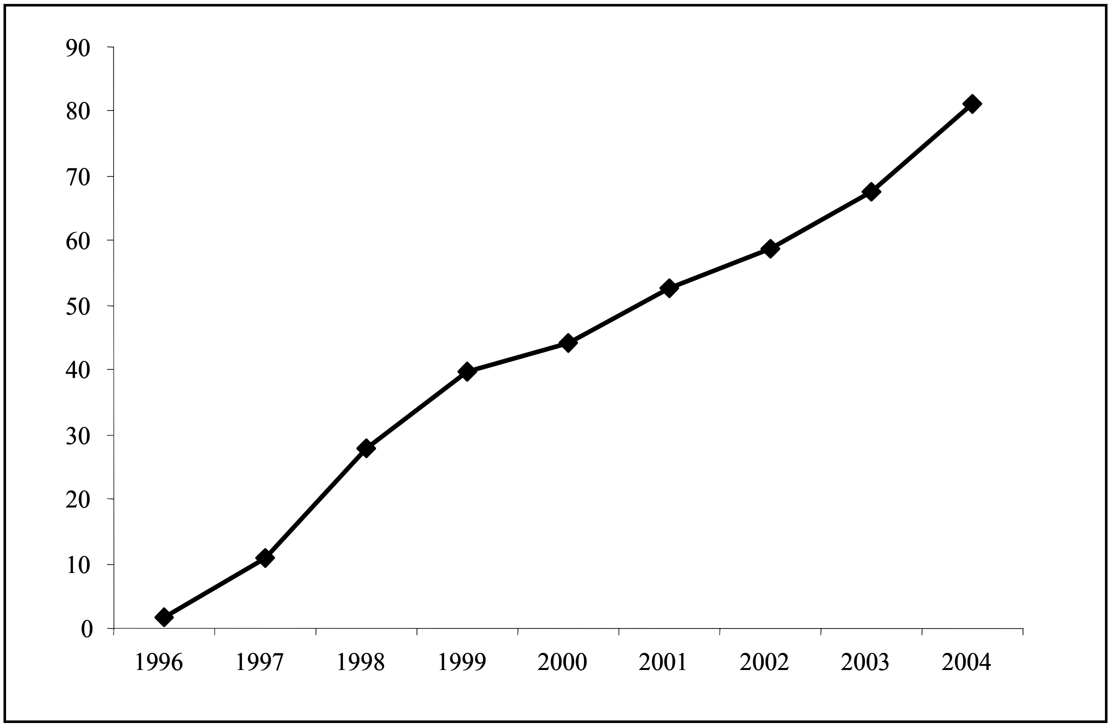
In 2004, the global area of biotech crops continued to grow for the ninth consecutive year at a sustained double-digit growth rate of 20%, compared with 15% in 2003. The estimated global area of biotech crops for 2004 was 81.0 million hectares, grown by 8.25 million framers in 17 countries – a significant increase over 2003 when 67.7 million hectares was grown by 7.0 million farmers in 18 countries. Paraguay reported approved biotech soybean for the first time in 2004/05 whilst Bulgaria and Indonesia did not report biotech crops because permits had expired. To put the 2004 global area of biotech crops into context, 81.0 million hectares is equivalent to over 8% of the total land area of China (956 million hectares) or the USA (981 million hectares) and more than three times the land area of the United Kingdom (24.4 million hectares). The increase in area between 2003 and 2004 of 20 % is equivalent to 13.3 million hectares or 32.9 million acres. The 2004 increase of 13.3 million hectares is the second highest annual increase of biotech crops on record.

**Table 1. Global Area of Biotech Crops, 1996 to 2004**

| | **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** |
| **TOTAL** | **384.6** | **951.3** |

**Increase of 20%, 13.3 million hectares or 32.9 million acres between 2003 and 2004.**
**Source: Clive James, 2004**.

**Figure 1. Global Area of Biotech Crops, 1996 to 2004 (Million Hectares)**




Source: Clive James, 2004.

During the nine-year period 1996 to 2004, the global area of biotech crops increased more than 47 fold, from 1.7 million hectares in 1996 to 81.0 million hectares in 2004 (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. During the nine-year period 1996 to 2004, the number of countries growing biotech crops tripled, increasing from 6 in 1996 to 9 in 1998, to 12 countries in 1999, to 17 in 2004. Paraguay, which has unofficially grown biotech soybeans for several years, approved four biotech varieties for the first time in 2004 and is projected to grow an estimated 1.2 million hectares in 2004/05. Following the expiry of Government permits in 2003, Bulgaria and Indonesia did not report biotech crops in 2004.

In summary, during the period 1996 to 2004, an accumulated total of 385 million hectares or 951 million acres (almost 1 billion acres) has been successfully grown, accumulatively, by about 25 million farmers since 1996. 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 year since biotech crops were first commercialized in 1996.

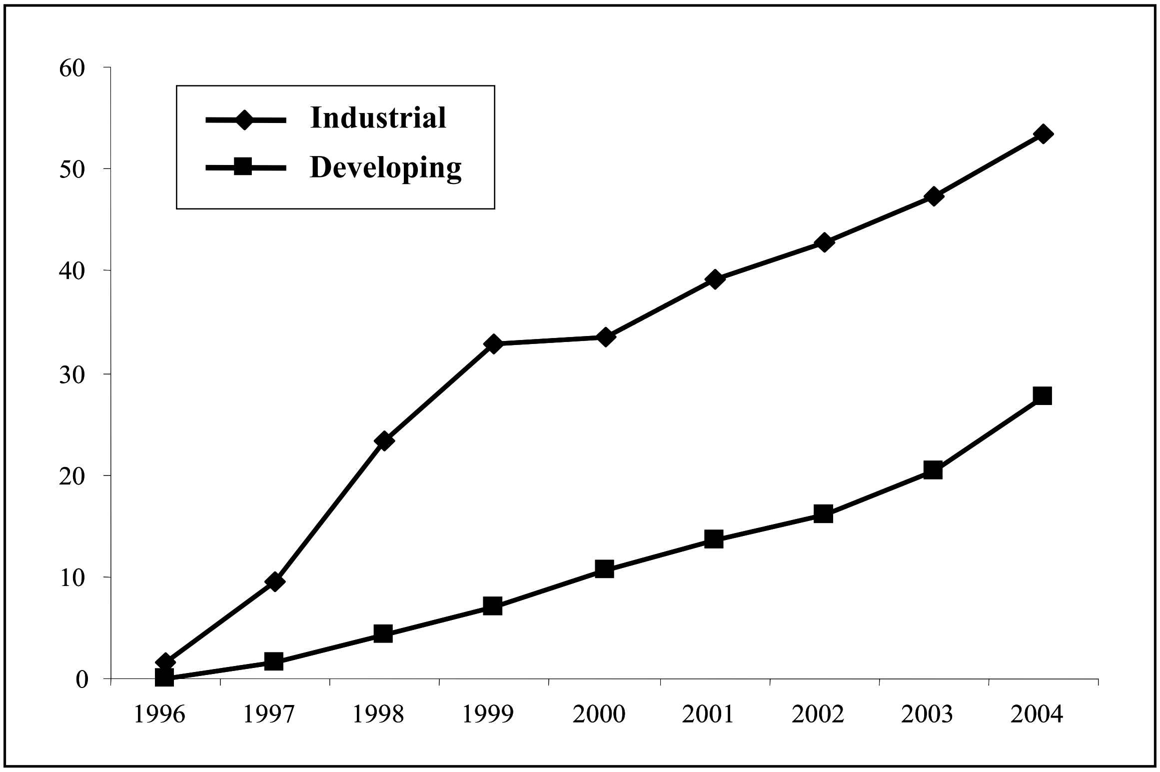
## Distribution of Biotech Crops in Industrial and Developing Countries

Figure 2 shows the relative hectarage of biotech crops in industrial and developing countries during the period 1996 to 2004. It clearly illustrates that whereas the substantial share (66%) of biotech crops was grown in industrial countries, the proportion of biotech crops grown in developing countries has increased consistently every 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 and 34% in 2004. Thus, in 2004, more than one third, of the global biotech crop area of 81.0 million hectares, equivalent to 27.6 million hectares, was grown in developing countries where growth continued to be very strong between 2003 and 2004 (Table 2). Continued strong growth was reported by China, India, and the Philippines in Asia as well as by the three large economies of Latin America, Argentina, Brazil and Mexico plus Uruguay and Paraguay and South Africa on the African continent. It is noteworthy that for the first time the absolute growth in the biotech crop area between 2003 and 2004 was higher in the developing countries (7.2 million hectares) than in industrial countries (6.1 million hectares). Equally important to note that the percentage growth was almost three times as high (35%) in the developing countries of the South, compared to the industrial countries of the North (13%).

## Distribution of Biotech Crops, by Country

It is particularly noteworthy that the number of mega-countries, (countries which grow 50,000 hectares, or more, of biotech crops) increased from 10 in 2003 to 14 in 2004 with Paraguay Spain, Mexico and the Philippines joining the mega-country group in 2004; This is a very important development which reflects a broadening, deepening and stabilizing of the group of more progressive countries adopting biotech crops. The principal countries that grew biotech crops in 2004 included the USA

**Figure 2. Global Area of Biotech Crops, 1996 to 2003: Industrial and Developing Countries (Million Hectares)**




Source: Clive James, 2004.

**Table 2. Global Area of Biotech Crops in 2003 and 2004: Industrial and Developing Countries (Million Hectares)**

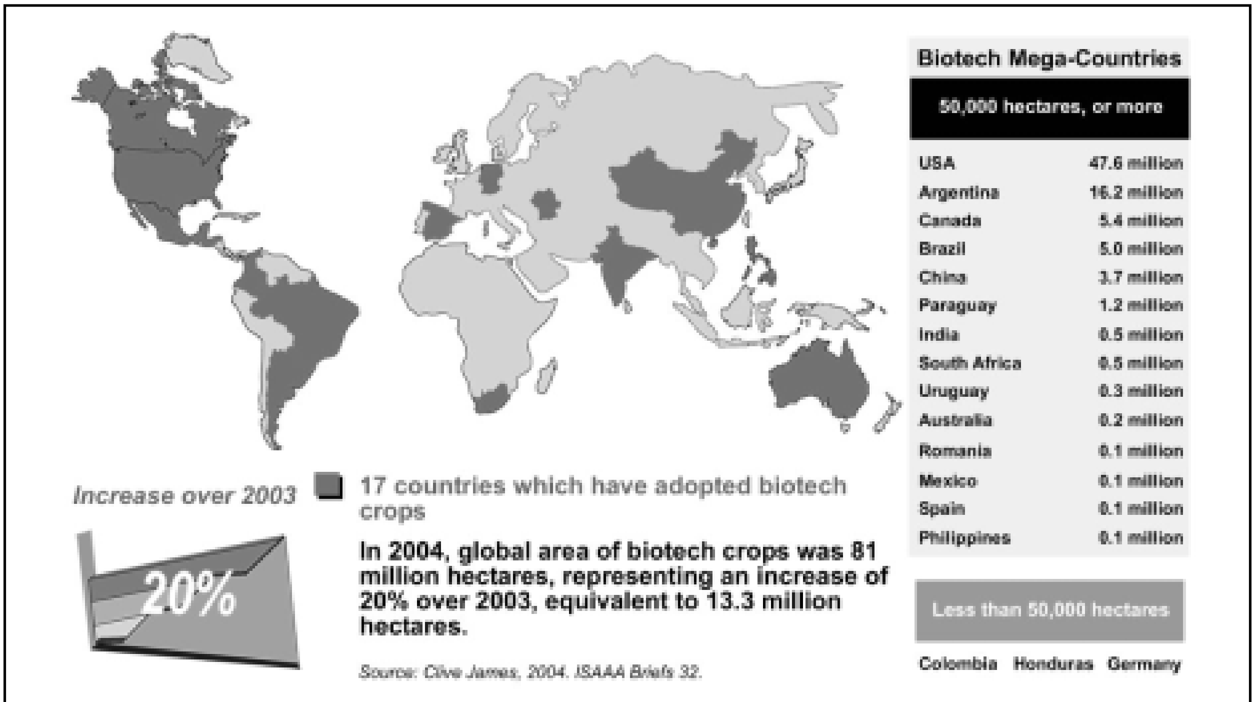
| | 2003 | % | 2004 | % | +/- | % |
|---|---|---|---|---|---|---|
| **Industrial Countries** | 47.3 | 70 | 53.4 | 66 | 6.1 | + 13 |
| **Developing Countries** | 20.4 | 30 | 27.6 | 34 | 7.2 | + 35 |
| **Total** | **67.7** | **100** | **81.0** | **100** | **13.3** | **+ 20** |

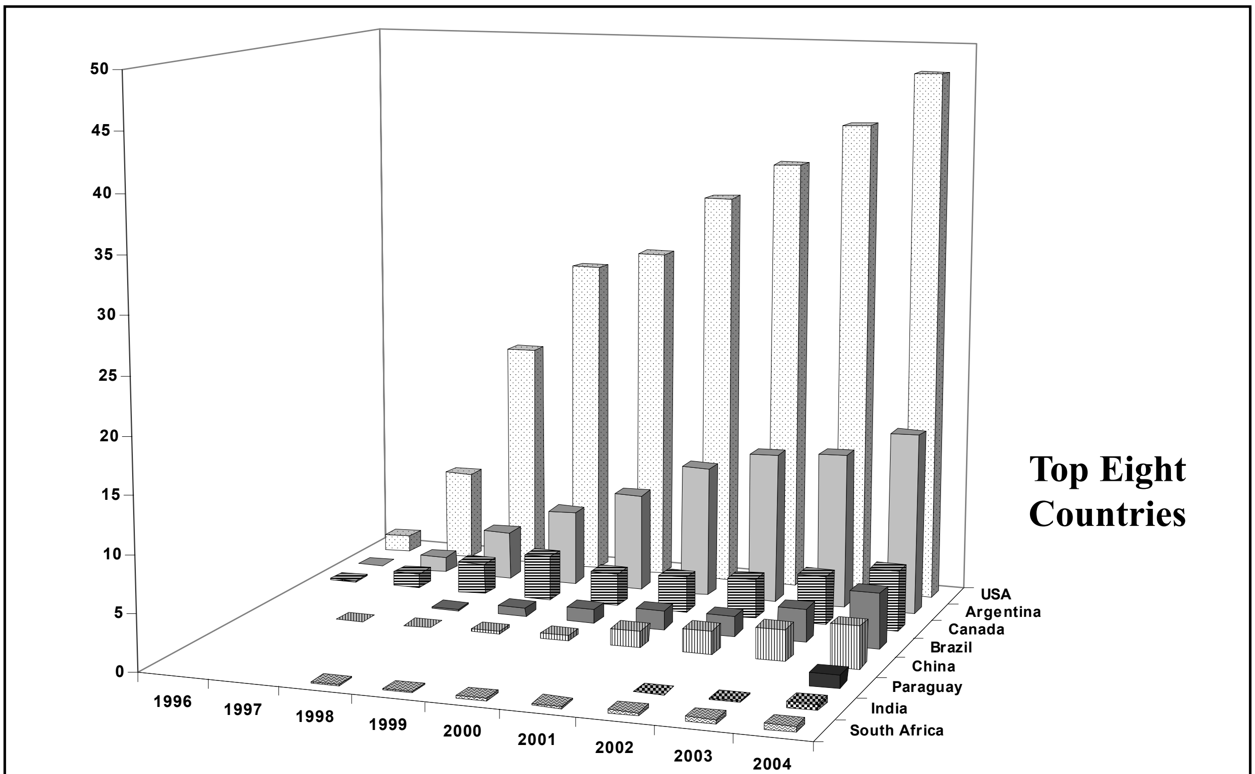
Source: Clive James, 2004.

which grew 47.6 million hectares of biotech crops, (59% of global total), followed by Argentina with 16.2 million hectares (20%), Canada 5.4 million hectares (6%), Brazil 5 million hectares (6%), China 3.7 million hectares (5%) Paraguay with1.2 million hectares (2%) and with India and South Africa at 0.5 million hectares each (1%) (Table 3 and Figure 3). It should be noted that of these top eight countries, growing half a million hectares or more of biotech crops, the majority (six) are developing countries, Argentina, Brazil, China, Paraguay, India and South Africa, compared with a minority of two industrial countries, USA and Canada. Of the top six biotech developing countries, Brazil promulgated a Presidential decree in October 2004 to sanction the continued growing of biotech crops officially for the second year, whilst the other five countries all reported continued significant growth of biotech crops between 2003 and 2004. The projected 5 million hectares of herbicide tolerant soybean in Brazil represents a conservative 22% of the projected plantings of around 23 million hectares of the national soybean hectarage in 2004/05. Notably, Paraguay registered four varieties of herbicide tolerant soybean for the first time in 2004 with an estimated hectarage of biotech soybean of 1.2 million hectares; this represents approximately 60% of the national hectarage of 2 million hectares of soybean in Paraguay in 2004.

Based on annual percentage growth in area, of the eight leading biotech crop countries, India had the highest percentage year-on-year growth in 2004 with an increase of 400% in Bt cotton area over 2003, followed by Uruguay (200%), Australia (100%), Brazil (66%), China (32%), South Africa (25%), Canada (23%), Argentina (17%) and the USA at 11%. In 2004, India increased its area of approved Bt cotton, introduced only two years ago, from approximately 100,000 hectares in 2003 to 500,000 hectares in 2004. Whereas growth in Uruguay in 2004 was accentuated by a conservative 2003 adoption rate, biotech soybean now occupies >99% of the total soybean area. There was also a significant increase in biotech maize in Uruguay in 2004, taking the total biotech area above 300,000 hectares. After suffering severe drought for the last two years, Australia increased its total cotton plantings to about 310,000 hectares of which 80%, equivalent to 250,000 hectares were planted with biotech cotton in 2004. Brazil increased its biotech soybean area by two-thirds from 3 million hectares in 2003 to a projected 5 million hectares in 2004, and another significant increase is likely in 2005. China increased its Bt cotton area for the seventh consecutive year; an increase of one-third from 2.8 million hectares in 2003 to 3.7 million hectares in 2004, equivalent to 66% of the total cotton area of 5.6 million hectares in 2004, the

**Figure 3. Global Area (Million Hectares) of Biotech Crops, 1996 to 2004, by Country and for the Top Eight Countries**




Source: Clive James, 2004.

**Table 3. Global Area of Biotech Crops in 2003 and 2004: by Country (Million Hectares)**

| | 2003 | % | 2004 | % | +/- | % |
|---|---|---|---|---|---|---|
| USA* | 42.8 | 63 | 47.6 | 59 | +4.8 | +11 |
| Argentina* | 13.9 | 21 | 16.2 | 20 | +2.3 | +17 |
| Canada* | 4.4 | 6 | 5.4 | 6 | +1.0 | +23 |
| Brazil* | 3.0 | 4 | 5.0 | 6 | +2.0 | +66 |
| China* | 2.8 | 4 | 3.7 | 5 | +0.9 | +32 |
| Paraguay* | – – | – – | 1.2 | 2 | +1.2 | – – |
| India * | 0.1 | <1 | 0.5 | 1 | +0.4 | +400 |
| South Africa* | 0.4 | 1 | 0.5 | 1 | +0.1 | +25 |
| Uruguay* | 0.1 | <1 | 0.3 | <1 | +0.2 | +200 |
| Australia* | 0.1 | <1 | 0.2 | <1 | +0.1 | +100 |
| Romania* | <0.1 | <1 | 0.1 | <1 | <0.1 | – – |
| Mexico* | <0.1 | <1 | 0.1 | <1 | <0.1 | – – |
| Spain * | <0.1 | <1 | 0.1 | <1 | <0.1 | – – |
| Philippines* | <0.1 | <1 | 0.1 | <1 | <0.1 | – – |
| Colombia | <0.1 | <1 | <0.1 | <1 | <0.1 | – – |
| Honduras | <0.1 | <1 | <0.1 | <1 | <0.1 | – – |
| Germany | <0.1 | <1 | <0.1 | <1 | <0.1 | – – |
| **Total** | **67.7** | **100** | **81.0** | **100** | **+13.3** | **+ 20** |

Source: Clive James, 2004. *Biotech mega-countries which grew more than 50,000 hectares, or more, of biotech crops in 2004.

largest national cotton hectarage planted in China since the introduction of Bt cotton in 1997. South Africa reported a 25% increase in its combined area of biotech maize, soybean and cotton to 0.5 million hectares in 2004, with continued growth in both white maize used for food, and yellow maize used for feed, as well as strong growth in biotech soybean, up from 35% adoption in 2003 to 50% in 2004, whilst Bt cotton has stabilized at about 85% adoption. Canada increased its combined area of biotech canola, maize and soybean by 23% with a total of 5.4 million hectares with 77% of its canola hectarage planted to biotech varieties. The adoption of herbicide tolerant soybeans in Argentina, which was close to 100% in 2003, continued to climb in 2004 as total plantings of soybean increased, which along with biotech maize and cotton reached an all time high of 16.2 million hectares of biotech crops. In the USA, there was an estimated net gain of 11% of biotech crops in 2004, as a result of significant increases in the area of biotech maize, followed by biotech soybean, with modest growth in biotech cotton which started to peak in the USA in 2004 as adoption approached 80%.

In 2004, for the first time Paraguay reported that 1.2 million hectares of biotech soybean were planted, equivalent to 60% of its total national hectarage of 2 million hectares of soybean. Spain, the only EU country to grow a significant hectarage of a commercial biotech crop, increased its Bt maize area by over 80% from 32,000 hectares in 2003 to 58,000 hectares in 2004, equivalent to 12% of the national maize crop. In Eastern Europe, Romania, which is a biotech mega-country, growing more than 50,000 hectares of biotech soybean, also reported significant growth. Two countries, Mexico and the Philippines, which attained the status of biotech mega-countries for the first time in 2004, reported 75,000 hectares and 52,000 hectares of biotech crops, respectively for 2004. Other countries that have only recently introduced biotech crops for the first time, such as Colombia and Honduras reported modest growth, whilst Germany planted a token hectarage of Bt maize.

The 17 countries that grew biotech crops in 2004 are listed in descending order of their biotech crop areas (Table 3). There were 11 developing countries, and 6 industrial countries including Romania from Eastern Europe. In 2004, 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 half a million hectares, or more, of biotech crops in 2004, are listed in order of crop biotech hectarage in Table 3, they were the USA, Argentina, Canada, Brazil, 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 9 countries. In 2004, the number of biotech mega-countries, growing 50,000 hectares or more of biotech crops increased by 40% from 10 in 2003 to 14 in 2004. The additional four countries that qualified as biotech mega- countries in 2004 listed in order of biotech crop hectarage were Paraguay, Mexico, Spain and the Philippines. - see Table 3 for the complete list of the 14 biotech crop mega countries (identified by an *) that grew 50,000 or more hectares of biotech crops in 2004. The following paragraphs provide a more detailed analysis of the biotech crop situation in selected countries.

In the USA, there was an estimated net gain of 11% in biotech crops in 2004, as a result of significant increases in the area of biotech maize, followed by biotech soybean. There was modest growth in biotech cotton which started to peak in the USA in 2004 as adoption approached 80% of the total area planted to upland cotton crop of approximately 5.5 million hectares. In contrast, there was growth in the national hectarage of maize and soybean, which were more profitable than biotech cotton or canola, and this stimulated an increase in biotech maize and soybean. A small decrease of the hectarage of biotech canola was reported as farmers substituted canola for the more profitable crops, soybean and maize.

In Argentina in 2004 the year-over-year increase, compared with 2003, was 2.3 million hectares. Of the 16.2 million hectares of biotech crops projected for Argentina in 2004/05, 14.5 million hectares are biotech soybean, an increase of 1.7 million hectares in soybean area over 2003, all of which is biotech soybeans. There was continued growth in Argentina of Bt maize, which now represents 55 % of the national maize hectarage, and is expected to reach almost 3 million hectares in 2004, with continued growth in area in 2005 and beyond, as domestic and export demand grows for both processing and feed maize.

For Canada, a net gain of 1.0 million hectares was reported, equivalent to a total of 5.4 million hectares in 2004; this compares with an increase of 0.9 million hectares in 2003, from 3.5 million hectares in 2002, to 4.4 million hectares in 2003. The continued high growth rate in Canada reflects higher total plantings of canola in 2004 and consistent increased adoption rates in all three biotech crops, canola, soybean and maize.

Brazil, the second largest producer of soybeans in the world after the USA, passed a second Presidential decree in mid October 2004 to approve the planting of biotech soybean farmer-saved seed for the 2004/05 season. At the time when this Brief went to press in early December 2004, more than 50% of the soybean crop had been planted in Brazil; it is projected that biotech soybean will occupy approximately 22% of the 23 million hectare crop in the 2004/05 season.

The area planted to Bt cotton in China increased by a significant 0.9 million hectares, equivalent to over 32% growth, increasing from 2.8 million hectares in 2003 to 3.7 million hectares in 2004. An estimated 7 million small farmers grew Bt cotton in China in 2004, up from 6 million in 2003. This brings the total number of biotech crop farmers globally in 2004 to approximately 8.25 million, 90% of whom are resource-poor farmers from developing countries, particularly in China, India and South Africa and the other 8 developing countries in Asia, Africa and Latin America benefiting from biotech crops in 2004.

Paraguay is the world's number four exporter of soybeans and has grown biotech soybean unofficially for several years. It approved four herbicide tolerant soybean varieties on 20 October 2004, thus becoming the ninth country in the world to officially approve and adopt herbicide tolerant biotech soybean. The four varieties of soybean, tolerant to the herbicide Roundup® were approved and placed on the approved registered seed list, thus allowing farmers to plant these biotech seeds officially in the 2004/05 season. The four registered varieties were AW 7110, AW5581, M-Soy 7878, and M-Soy 8080. Thus, in 2004, Paraguay officially grew biotech soybean for the first time, and joins the following eight countries which have successfully grown biotech soybeans for several years; the eight countries, listed in order of biotech soybean hectarage are the USA, Argentina, Brazil, Canada, Uruguay, Romania, South Africa and Mexico. In 2004, Paraguay is expected to plant approximately 60% of its total hectarage of 2 million hectares of soybean to biotech varieties, equivalent to 1.2 million hectares of biotech soybean in 2004.

India which grew approximately 50,000 hectares of officially approved hybrid Bt cotton 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. It is estimated that approximately 300,000 small farmers, growing an average of less than 2 hectares of Bt cotton, benefited from growing approved hybrid Bt cotton in India in 2004. The adoption of the approved Bt cotton hybrids is expected to continue to increase significantly in 2005.

A significant increase in biotech crop area was also reported for South Africa, where the combined area of biotech maize, cotton and soybean is expected to be almost half a million hectares in 2004/05. Australia, recovering from one of the worst droughts in its history in 2002 and 2003, is expected to plant slightly over 300,000 hectares of cotton (approximately 90% irrigated) in 2004/2005, with 80% of the national cotton hectarage planted to biotech varieties. It is projected that about 40% of the biotech cotton varieties in Australia will feature the stacked genes for herbicide tolerance and insect resistance (the dual Bt gene Bollgard II); 25% with the dual Bt gene on its own; 15% with a single gene for herbicide tolerance, and the remaining 20% in conventional cotton. It is noteworthy that Australia will have achieved the complete substitution of the single Bt gene product (Bollgard I) with the dual Bt gene varieties (Bollgard II) in only two years, 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) to 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, have been lifted. Following the current rapid adoption of the dual Bt gene on its own and as a stacked product (65%), the dual Bt gene product is expected to reach high adoption rates in Australia in the near term.

Spain increased its area of Bt maize by 80% in 2004 to 58,000 hectares from 32,000 hectares in 2003. Thus, in 2004 Spain became the first EU country to achieve the status of a biotech mega-country (a country growing 50,000 hectares, or more) for the first time. Elsewhere in Europe, Romania continued to increase its area of biotech soybean and Germany continued to grow a token area of Bt maize. In 2004, Bulgaria did not report the cultivation of herbicide tolerant maize, which it has done successfully for several years because Government issued special permits expired and the new biotech bill intended to evaluate and approve all biotech crops is not yet in place. Mexico doubled its biotech area of cotton and soybean to over 75,000 hectares and became a biotech mega-country for the first time with most of the increase in Bt cotton as well as the stacked product for insect resistance and herbicide tolerance. Uruguay, which introduced biotech soybean in 2000, increased its biotech crop area significantly to reach approximately 325,000 hectares in 2004, with most of the gain coming from a substantial increase in the hectarage of herbicide tolerant soybean that is now virtually 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 30% of the 90,000 hectares of maize planted in Uruguay in 2004.

The Philippines which grew Bt maize for the first time in 2003 is projected to increase its total hectarage in the wet and dry season (now being planted) in 2004 to just over 50,000 hectares; this will make the Philippines the first biotech country in Asia to achieve the mega-country status with a major feed/food crop, Bt maize, in Asia, which grows 30% of the global 140 million maize hectares with China itself growing 25 million hectares, plus significant production in India, Indonesia, Thailand and Vietnam.

Colombia, in Latin America, doubled its area of Bt cotton to approximately 10,000 hectares in 2004. Honduras continued to plant modest small Bt maize plantings, after becoming the first country in Central America to grow a biotech crop in 2002 when it grew a pre-commercial introductory area of approximately 500 hectares of Bt maize.

The country portfolios of deployed biotech crops continued to diversify and expand in area in 2004 providing a broader and more stable base to the new technologies. The hectarage of the Bt *cry3Bb1* gene (event MON 863) for the control of corn rootworm in the USA expanded to occupy a significant area in 2004 as a single gene, and also in conjunction with herbicide tolerance as a stacked gene in the USA. The corn rootworm is a major economic pest that costs USA farmers about $1 billion dollar per year in losses and insecticide control costs. The *cry3Bb1* gene, deployed as event MON 863 is also expected to be introduced in the near term in conjunction with *cry1Ab* (MON 810), and as the first triple construct in biotech maize, incorporating herbicide tolerance (NK603). Event MON 863 has been approved for planting in Canada but was not deployed there in 2004. The Bt gene *cry1Fa2* (event TC 1507), introduced for the first time in 2003 also occupied a significant area in the USA and a smaller area in Canada in 2004. The *cry1Fa2* gene, as deployed in event TC 1507, provides a broader spectrum of activity that includes excellent protection against 1st and 2nd generation European corn borer, southwestern corn borer, fall armyworm, black cutworm, western bean cutworm and intermediate suppression of corn earworm.

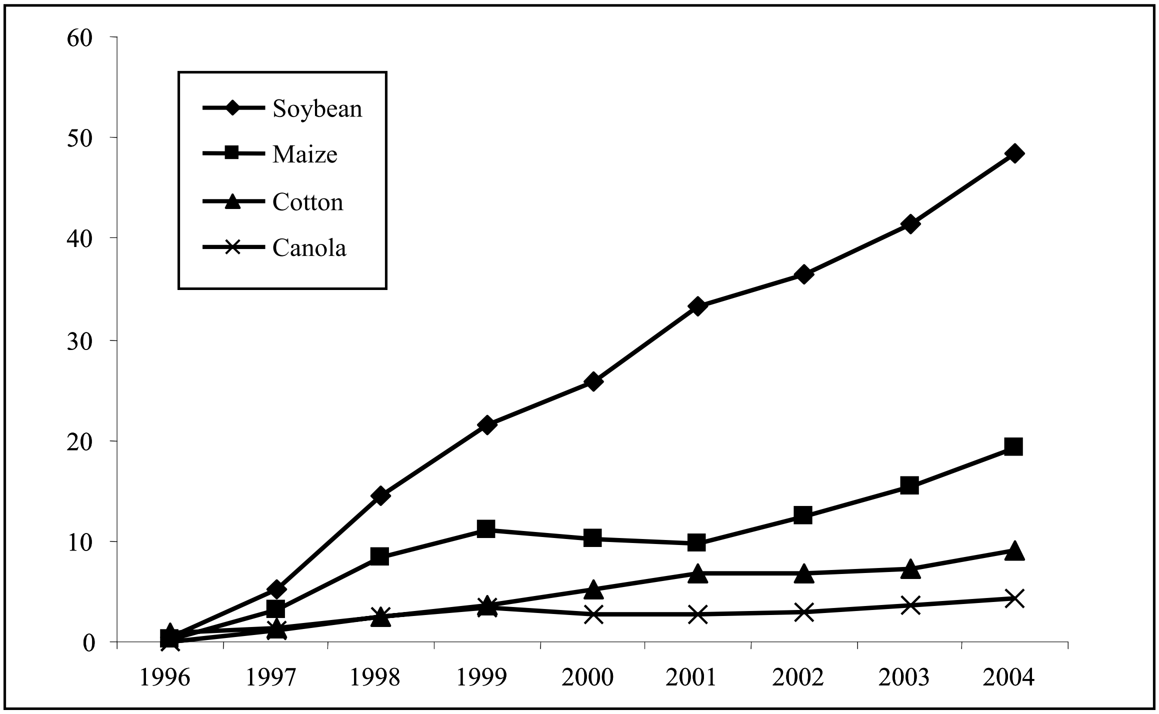
## Distribution of Biotech Crops, by Crop

The distribution of the global biotech crop area for the four major crops is illustrated in Figure 4 for the period 1996 to 2004. It clearly shows the continuing dominance of biotech soybean occupying 60% of the global area of biotech crops in 2004; the entire biotech soybean hectarage is herbicide tolerant. Biotech soybean retained its position in 2004 as the biotech crop occupying the largest area. Globally, biotech soybean occupied 48.4 million hectares in 2004, with biotech maize growing fast in second place at 19.3 million hectares, biotech cotton in third place at 9.0 million hectares, and finally canola at 4.3 million hectares (Table 4).

In 2004, the global hectarage of herbicide tolerant soybean is estimated to have increased by 7.0 million hectares, equivalent to a 17% increase. Significant gains of biotech soybean were reported for the USA in 2004 with over 80% of the national soybean area of 32.8 million hectares planted to herbicide tolerant soybean. Brazil planted an estimated 5.0 million hectares with herbicide tolerant soybean for the second year and Argentina reported that virtually all of its 14.5 to 15.0 million hectares of national soybean hectarage was planted with herbicide tolerant soybean. In 2004, for the first time, Paraguay reported that 1.2 million hectares of herbicide tolerant soybean were planted, equivalent to 60% of its total national hectarage of 2 million hectares of soybean. Canada planted more than half its national soybean hectarage with herbicide tolerant soybean for the first time. Uruguay increased its biotech soybean hectarage to 300,000 hectares in 2004. Romania, which has benefited from yield increases of the order of 30%, as a result of improved weed control, particularly control of Johnson grass, also increased its area of herbicide tolerant soybean in 2004. South Africa exceeded 50,000 hectares of biotech soybean for the first time in 2004 and Mexico planted more than 10,000 hectares of biotech soybean for the first time.

As in 2002 and 2003, biotech maize benefited from the highest year-to-year percentage increase in adoption rates. In 2004, biotech maize increased by 25%, with cotton achieving the same gain of 25%, compared with 19% for canola, and 17% for soybean. The high annual growth rate of 25% for biotech maize in 2004, is consistent with growth over the last two years of 27% growth in 2002 and a 25% in 2003 Much of the increase in biotech maize occurred in the USA, but there was also strong growth

**Figure 4. Global Area of Biotech Crops, 1996 to 2004: by Crop (Million Hectares)**




Source: Clive James, 2004.

**Table 4. Global Area of Biotech Crops in 2003 and 2004: by Crop (Million Hectares)**

| Crop | 2003 | % | 2004 | % | +/- | % |
|---|---|---|---|---|---|---|
| **Soybean** | 41.4 | 61 | 48.4 | 60 | + 7.0 | + 17 |
| **Maize** | 15.5 | 23 | 19.3 | 23 | + 3.8 | + 25 |
| **Cotton** | 7.2 | 11 | 9.0 | 11 | + 1.8 | + 25 |
| **Canola** | 3.6 | 5 | 4.3 | 6 | + 0.7 | + 19 |
| **Squash** | <0.1 | <1 | <0.1 | <1 | - - | - - |
| **Papaya** | <0.1 | <1 | <0.1 | <1 | - - | - - |
| **Total** | **67.7** | **100** | **81.0** | **100** | **+ 13.3** | **+ 20** |

Source: Clive James, 2004.

in the well established biotech crop markets of Canada, Argentina, South Africa and Spain. Countries which have more recently adopted biotech maize, including the Philippines also recorded significant increases. In South Africa, Bt yellow maize used for feed increased from 200,000 hectares of the crop in 2003 to 240,000 hectares in 2004, equivalent to approximately 24% of the yellow maize crop of 1 million hectares. Bt white maize, used for food, first introduced in South Africa in 2001 on 6,000 hectares, equivalent to 0.3 % of the total white maize area, increased almost twenty-five fold to 155,000 hectares in 2004; this is equivalent to 10 % of the 2004 white maize crop of 1.6 million hectares. The year-to-year increase in biotech maize in South Africa between 2003 and 2004 would have been much higher if it had not been for a shortage of seed.

The area planted to biotech cotton globally in 2004 was up 1.8 million hectares, equivalent to a 25% growth over 2003, with most of the growth coming from the three countries of China, India and Australia. The total plantings of biotech cotton in the USA in 2004 was slightly higher at approximately 4.3 million hectares, equivalent to about an 80% adoption rate with approximately two-thirds of the biotech area planted to varieties with the stacked genes of herbicide tolerance and the dual Bt gene, with less than 2% deployed with single Bt gene varieties. In contrast, the plateauing of biotech cotton hectarage in the USA was offset by a significant increase of about one-third in China, equivalent to 0.9 million hectares, increasing from 2.8 million hectares in 2003 to 3.7 million hectares in 2004 equivalent to 66% of the national hectarage of 5.6 million hectares in 2004. This will be the seventh consecutive year for biotech cotton increases to be reported by China where biotech cotton continues to deliver significant production, economic, environmental, health and social benefits. As a result Bt cotton is now grown in all ten, or more, cotton growing provinces including Xingjiang Province in the west where the insect pests pressure is low compared with the Yellow and Yangtze river valleys, where pest pressure is the highest in provinces such as Shandong, Henan and Hebei. It is estimated that in 2004, 7 million small resource-poor farmers benefited from Bt cotton in China, farming, on average, approximately one-half of one hectare. Notably, the public sector in China has invested significantly in crop biotechnology and has developed Bt cotton varieties which share the market with varieties developed by the international private sector. The simultaneous marketing of biotech crops from the public and private sector 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 the 100,000 hectares of approved hybrid Bt cotton grown in India in 2003, the area of approved Bt cotton in 2004 increased five fold, exceeding half a million hectares. The advantages of hybrid Bt cotton in India are similar to those experienced by China in terms of production, economic, environmental, health and social benefits. Australian biotech cotton was up significantly from about 100,000 to 250,000 hectares and already occupies about 80% of the national cotton. Biotech cotton is assigned high priority by cotton farmers in Australia where it is delivering important advantages as a vital element in the implementation of integrated pest management, leading to a significant reduction in insecticides and a more sustainable agriculture.

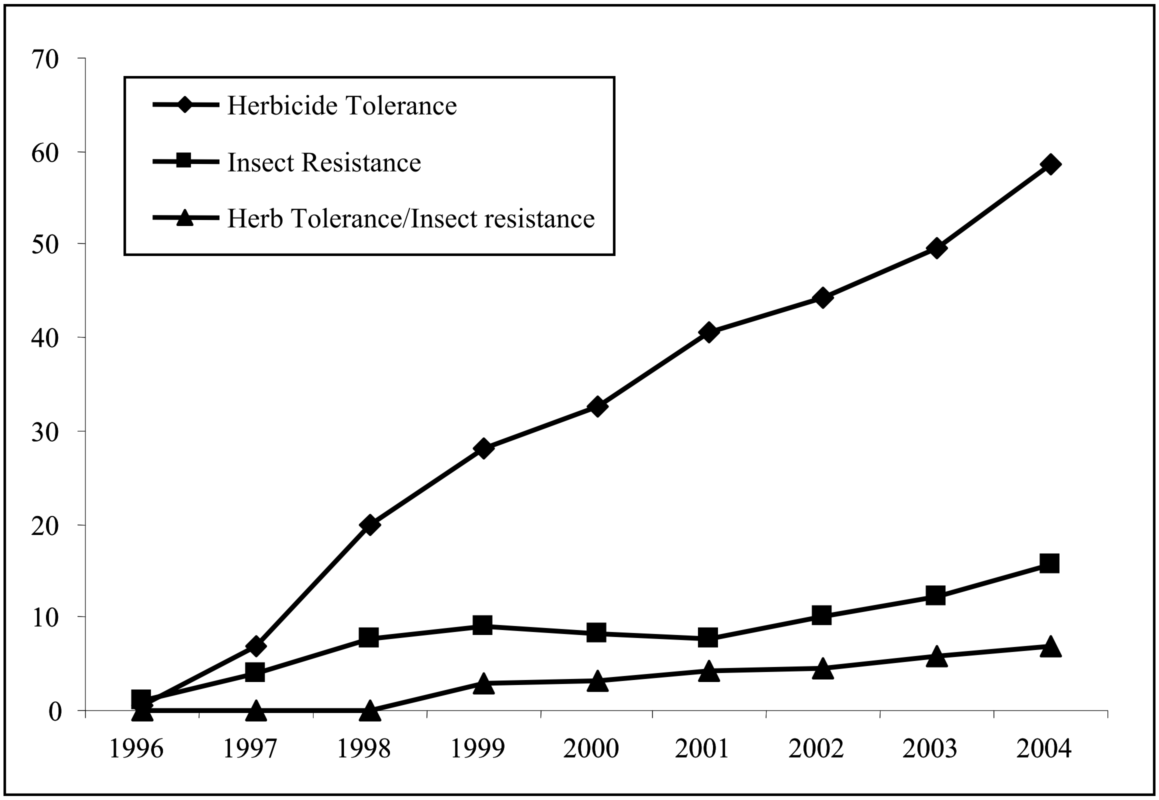
The global area of biotech canola in 2004 is estimated to have increased by 0.7 million hectares, from 3.6 million hectares in 2003 to an estimated 4.3 million hectares in 2004 with all the increase in Canada. The hectarage of herbicide tolerant canola in the USA was slightly lower due to substitution by more profitable biotech soybean. In Canada, of the total national hectarage of canola of 5.2 million hectares in 2004, 3.9 million hectares, equivalent to 77% were biotech herbicide tolerant. The adoption of mutagenic herbicide tolerant canola in Canada decreased from 22% in 2003 to 15% in 2004, leaving only 8 % of conventional canola in 2004, compared with 10% in 2003.

Small hectarages of biotech squash and papaya continued to be grown in the USA in 2004.

## Distribution of Biotech Crops, by Trait

During the nine-year period 1996 to 2004, herbicide tolerance has consistently been the dominant trait with insect resistance being second (Figure 5). In 2004, herbicide tolerance, deployed in soybean, maize canola and cotton, occupied 72% of the 81.0 million hectares (Table 5). There were 15.6 million hectares planted to Bt crops, equivalent to 19%, with stacked genes for herbicide tolerance and insect resistance deployed in both cotton and maize occupying 9% of the global biotech area in 2004. It is noteworthy that whereas the area of herbicide tolerant crops increased by a

**Figure 5. Global Area of Biotech Crops, 1996 to 2004: by Trait (Million Hectares)**




Source: Clive James, 2004.

**Table 5. Global Area of Biotech Crops in 2003 and 2004: by Trait (Million Hectares)**

| Trait | 2003 | % | 2004 | % | +/- | % |
|---|---|---|---|---|---|---|
| **Herbicide tolerance** | 49.7 | 73 | 58.6 | 72 | + 8.9 | + 18 |
| **Insect resistance (Bt)** | 12.2 | 18 | 15.6 | 19 | + 3.4 | + 28 |
| **Bt/Herbicide tolerance** | 5.8 | 9 | 6.8 | 9 | 1.0 | + 17 |
| **Virus resistance/Other** | <0.1 | <1 | <0.1 | <1 | < 0.1 | - - |
| **Global Totals** | **67.7** | **100** | **81.0** | **100** | **+ 13.3** | **+ 20** |

Source: Clive James, 2004.

significant 18% (8.9 million hectares) Bt crops increased at a higher level of 28% (3.4 million hectares) between 2003 and 2004. This increase in Bt crops reflects the significant increase in Bt maize in 2004 (2.0 million hectares) and the increase of Bt cotton (1.4 million hectares) in China, India and Australia. Whereas most of the growth in Bt maize occurred in the USA, significant increases in Bt maize hectarage also occurred in Argentina, Canada, South Africa, Spain, and the Philippines. The stacked traits of herbicide tolerance and insect resistance in both maize and cotton increased by 17% in 2004, reflecting the needs of farmers who have to simultaneously address the multiple yield constraints associated with various biotic stresses - this trend will continue and intensify as more traits become available to farmers and is an important feature of the technology.

## Dominant Biotech Crops in 2004

Herbicide tolerant soybean continued to be the dominant biotech crop grown commercially in nine countries in 2004; listed in order of hectarage, the countries were the USA, Argentina, Brazil, Paraguay, Canada, Uruguay, Romania, South Africa and Mexico. Globally, herbicide tolerant soybean occupied 48.4 million hectares, representing 60% of the global biotech crop area of 81.0 million hectares for all crops. The second most dominant crop was Bt maize, which occupied 11.2 million hectares, equivalent to 14% of global biotech area and, like herbicide tolerant soybean, was planted in nine countries – USA, Argentina, Canada, South Africa, Spain, the Philippines, Uruguay, Honduras and Germany. It is noteworthy that Bt maize, deployed as a single Bt gene and in the stacked product Bt/HT, occupied a total of 15.0 million hectares compared with 12.3 million hectares in 2003, a year-to-year increase of 22%. The third most dominant crop was Bt cotton, up from sixth in 2003, which occupied 4.5 million hectares, equivalent to 6% of global biotech area and planted in eight countries, listed in order of hectarage; China, India, Australia, USA, Mexico, Argentina, South Africa, and Colombia. Five other crops listed in Table 6 occupied from 5% to 2% of global biotech crop area and include, in descending order of area: herbicide tolerant maize, grown in four countries USA, Canada, South Africa and Argentina on 4.3 million hectares (5%); herbicide tolerant canola grown in two countries, Canada and the USA, also on 4.3 million hectares (5%); Bt/herbicide tolerant maize on 3.8 million hectares in the USA and Canada occupying 4% of the global crop biotech

**Table 6. Dominant Biotech Crops, 2004**

| Crop | Million Hectares | % Biotech |
|---|---|---|
| **Herbicide tolerant Soybean** | 48.4 | 60% |
| **Bt Maize** | 11.2 | 14% |
| **Bt Cotton** | 4.5 | 6% |
| **Herbicide tolerant Maize** | 4.3 | 5% |
| **Herbicide tolerant Canola** | 4.3 | 5% |
| **Bt/Herbicide tolerant Maize** | 3.8 | 4% |
| **Bt/Herbicide tolerant Cotton** | 3.0 | 4% |
| **Herbicide tolerant Cotton** | 1.5 | 2% |
| **Total** | **81.0** | **100%** |

Source: Clive James, 2004.

area; Bt/herbicide tolerant cotton (4%) grown on 3 million hectares in the USA, Australia, and Mexico; and herbicide tolerant cotton grown in the USA, Australia and South Africa on 1.5 million hectares, equivalent to 2% of the global crop biotech hectarage.

## Global Adoption of Biotech Soybean, Maize, Cotton and Canola

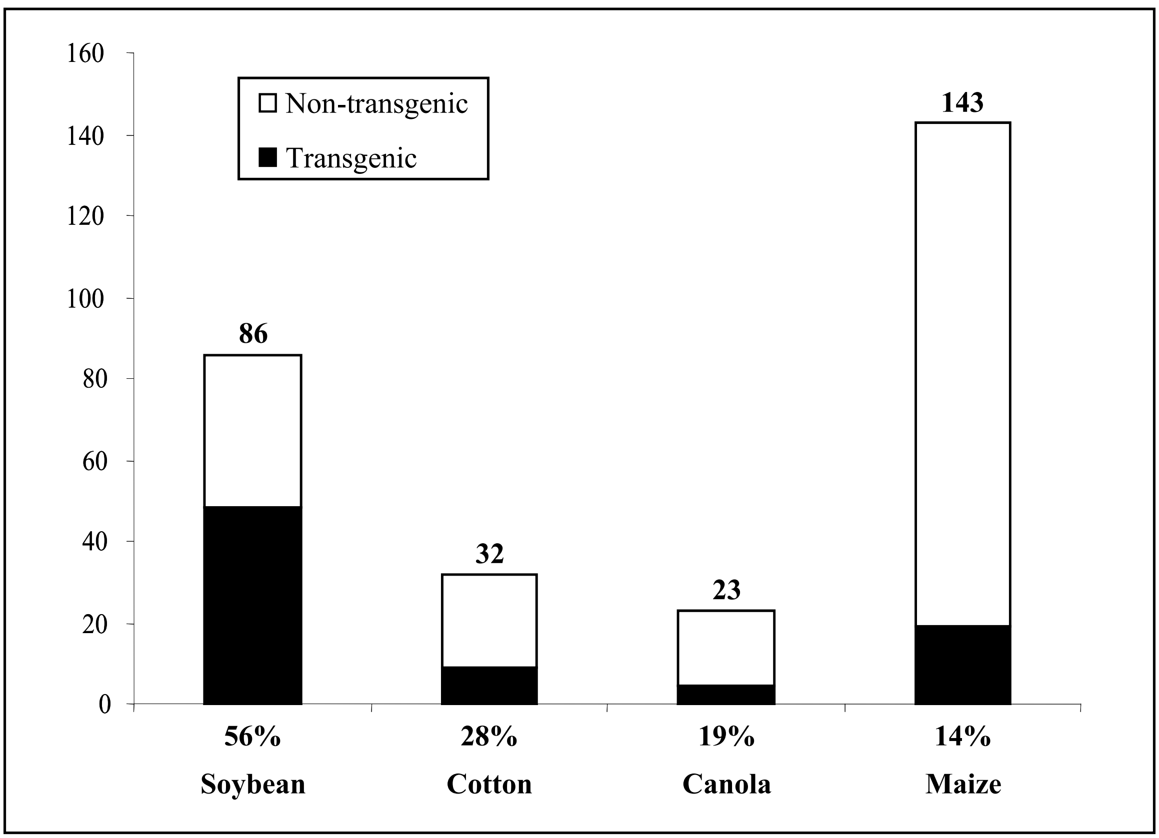
Another way to provide a global perspective of the status of biotech crops is to characterize the global adoption rates as a percentage of the respective global areas of the four principal crops – soybean, cotton, canola and maize – in which biotech technology is utilized (Table 7 and Figure 6). The data indicate that in 2004, 56% of the 86 million hectares of soybean planted globally were biotech - up from 55 % in 2003, despite an increase in the global area of soybean from 76 million hectares in 2003 to 86 million hectares in 2004. Of the 32 million hectares of cotton, 28% or 9.0 million hectares were planted to biotech cotton in 2004. The area planted to biotech canola, expressed on a percentage basis, increased from 16% in 2003 to 19% or 4.3 million hectares of the 23 million hectares of canola planted globally in 2004. Similarly,

**Table 7. Biotech Crop Area as % of Global Area of Principal Crops, 2004 (Million Hectares)**

| Crop | Global Area | Biotech Crop Area | Biotech Area as % of Global Area |
|---|---|---|---|
| **Soybean** | 86 | 48.4 | 56% |
| **Cotton** | 32 | 9.0 | 28% |
| **Canola** | 23 | 4.3 | 19% |
| **Maize** | 143 | 19.3 | 14% |
| **Total** | **284** | **81.0** | **29%** |

Source: Clive James, 2004.

**Figure 6. Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares), 2004**




Source: Clive James, 2004.

of the 143 million hectares of maize planted in 2004, 14% was planted to biotech maize, up significantly from 11% in 2003. Thus, the global adoption rates for all four biotech crops, soybeans, maize, cotton and canola all increased significantly between 2003 and 2004. If the global areas (conventional and biotech) of these four crops are aggregated, the total area is 284 million hectares, of which 29%, were biotech - up significantly from 25% in 2003. 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 noteworthy that two-thirds of these 284 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 2004, the global market value of biotech crops, forecasted by Cropnosis, was $4.70 billion representing 15% of the $32.5 billion global crop protection market in 2003 and 16% of the $30 billion global commercial seed market. The market value of the global biotech crop market is based on the sale price of biotech seed plus any technology fees that apply. Cropnosis recently completed a revision of the value of the biotech crop market since its commercialization in 1996 and the revised values are shown in Table 8. The accumulated global value for the nine year period in 1996 to 2004, since biotech crops were first commercialized in 1996, is $24 billion. The global value of the biotech crop market is projected at more than $5 billion for 2005.

## Benefits from Biotech Crops

The experience of the first nine years, 1996 to 2004, during which a cumulative total of over 385 million hectares (951 million acres, equivalent to 40% of the total land area of the USA or China) of biotech crops were planted globally in 22 countries, has met the expectations of millions of large and small farmers in both industrial and developing countries. Biotech crops are also delivering benefits to consumers and society at large, through more affordable food, feed and fiber that require less pesticides

**Table 8. The Global Value of the Biotech Crop Market, 1996 to 2004**

| | **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 |
| **TOTAL** | **24,073** |

Source: Cropnosis 2004 (Personal Communication) *Forecast

and hence a more sustainable environment. The global value of total crop production from biotech crops in 2003 was estimated at $44 billion. Net economic benefits to producers from biotech crops in the USA in 2003 were estimated at $1.9 billion, whilst gains in Argentina for the 2001/02 season were $1.7 billion. China has projected potential gains 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 Australian economists, on biotech grains, oil seeds, fruit and vegetables, projects 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. The 2004 data are consistent with previous experience confirming that commercialized biotech crops continue to deliver significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. The number of farmers benefiting from biotech crops continued to grow to reach 8.25

million in 2004, up from 7 million in 2003. Notably, 90% of these 8.25 million farmers benefiting from biotech crops in 2004, were resource-poor farmers planting Bt cotton, whose increased incomes have contributed to the alleviation of poverty. These included 7 million resource-poor farmers in all the cotton growing provinces of China, an estimated 300,000 small farmers in India, and subsistence farmers in the Makhathini Flats in KwaZulu Natal province in South Africa, and in the other nine developing countries where biotech crops were planted in 2004.

## Future Prospects

On a global basis, there is cause for cautious optimism with the global area and the number of farmers planting biotech crops expected to continue to grow in 2005 and beyond. In the established industrial country markets of the USA and Canada, growth will continue with the introduction of new traits; for example, the significant biotech hectarage planted in 2004 in North America to MON 863 for corn rootworm control (approximately 700,000 hectares of the single/stacked product) and TC 1507 for broader lepidopteran control (approximately 1.2 million hectares). The global number and proportion of small farmers from developing countries growing biotech crops is expected to increase significantly to meet their food/feed crop requirements and meat demands of their burgeoning and more affluent populations. A similar trend may also apply to the poorer and more agriculturally based countries of Eastern Europe which have recently joined the EU, and those expected to join in 2007 and beyond. Finally, there were signs of progress in the European Union in 2004 with the EU Commission approving, for import, two events in biotech maize (Bt 11 and NK603) for food and feed use, thus signaling the end of the 1998 moratorium. The Commission also 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 co-existence policies, opens up new opportunities for EU member countries to benefit from the commercialization of biotech maize, which Spain has successfully deployed since 1998. Taking all factors into account, the outlook for 2010 points to continued growth in the global hectarage of biotech crops, up to 150 million hectares, with up to 15 million farmers growing biotech crops in up to 30 countries.

## Concluding Remarks

2004 is the penultimate year of the first decade of the commercialization of biotech crops, during which double-digit growth in global hectarage of biotech crops has been achieved every single year; this is an unwavering and resolute vote of confidence in the technology from the 25 million farmers, who are masters in risk aversion, and have consistently chosen to plant an increasing hectarage of biotech crops year, after year, after year. The $10^{th}$ anniversary in 2005, will be a just cause for celebration worldwide by farmers, the international scientific and development community, global society, and the peoples in developing and industrial countries on all six continents that have benefited significantly from the technology, particularly the humanitarian contribution to the alleviation of poverty, malnutrition and hunger in the countries of Asia, Africa and Latin America. The experience of the first nine years, 1996 to 2004, during which a cumulative total of over 385 million hectares of biotech crops or 951 million acres, (equivalent to 40% of the total land area of the USA or China), were planted globally in 22 countries, has met the expectations of millions of large and small farmers in both industrial and developing countries. In 2004, commercialized biotech crops continued to deliver consistent and significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. The global area of biotech crops in 2004 continued to grow at an annual sustained double-digit growth rate of 20% reaching 81 million hectares, an increase of 13.3 million hectares over the 67.7 million hectares planted in 2003; this is the second largest increase on record, since the beginning of commercialization in 1996. The number of farmers that benefited from biotech crops also continued to grow and reached 8.25 million in 2004, up from 7 million in 2003. Notably, 90% of these farmers benefiting from biotech crops in 2004, were resource-poor farmers in developing countries planting Bt cotton, mainly in China, 300,000 small farmers in India, several thousand in the KwaZulu Natal province in South Africa and in the other 8 developing countries that adopted and benefited from biotech crops in 2004. The marked and consistent trend for increased adoption of biotech crops by developing countries is an important feature with many implications and is discussed in more detail in the following paragraphs.

## The status and potential influence of the five principal developing countries

Of the 11 developing countries that have already approved and adopted biotech crops to meet their own food, feed and fiber needs and/or to optimize exports, there are probably five lead countries that will exert leadership and have a significant influence on future adoption and acceptance of biotech crops globally, because of their significant biotech crop plantings and role in world affairs. These five countries are China and India in Asia, Brazil and Argentina in Latin America and South Africa on the continent of Africa. Collectively, they planted approximately 26 million hectares of biotech crops in 2004, (equivalent to approximately one-third of global biotech hectarage) to meet the needs of their combined populations of 2.6 billion (approximately 40% of global population) which generated an aggregated agricultural GDP of almost $370 billion and which provided a livelihood for 1.3 billion of their people.

### *China*

Of the five principal biotech developing countries, China is likely to be the most influential, and what China is to Asia, Brazil is to Latin America and South Africa is to the continent of Africa. China, which has to feed 20% of the world's population on 6% of the world's arable land, has a formidable challenge to feed its people, particularly as wealth is created and the demand for a richer diet with more meat increases, which translates to more maize for feed. It is projected that China's demand for maize will increase by 80% between 1997 and 2020, and the same is true to a lesser extent for the tiger economies of South East Asia, however the influence of China will be dominant because of its large population and increasingly high profile and important role in all aspects of world affairs. With a relatively stable population of 1.3 billion, and a land area of 956 million hectares of which 15% is arable, 15% of China's GDP of $1.3 trillion is generated by agriculture, but which provides employment to 50% of its population.

It is important to note that China was one of the pioneers in crop biotechnology and, unlike the industrial countries with private sector investments, China's biotech investments are entirely derived from the public sector. China, with its track record of having already developed a successful Bt cotton that competes with products developed by the private sector, has a rich experience in crop biotechnology and this will serve it well in the development of future biotech crops in the near term. Recent publications by Dr Jikun Huang of the Chinese Academy of Sciences, and colleagues, clearly reaffirm 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 not wavered in its commitment to crop biotechnology since its first investments in the mid 1980s and it 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. Chinese observers note that "the growth of government investment in agricultural biotechnology research has been remarkable". The research agenda on biotech crops has been formulated to meet the multiple needs of national food/feed security, small resource-poor farmers requiring abiotic and biotic stress resistant crops grown on marginal land as well as farmers in high potential areas. China is cognizant of the need to better integrate its myriad of biotechnology activities and to progress biosafety management in order to ensure protection of the environment and consumers, within the context of a more sustainable agriculture. Dr Jikun Huang and colleagues conclude that based on strong demand from both producers (higher productivity and profit) and consumers (more affordable prices), and the past success and increasing investments in agricultural biotechnology, "products from China's plant biotechnology are likely to become widespread in China in the near future."

At the beginning of this decade, China was investing just over \$100 million per year in crop biotechnology; this investment has benefited from quantum annual increases, with an intent to reach \$500 million in 2005, making China the second largest global investor in crop biotechnology after the USA, where most of the investment is by the private sector. The most recent survey, conducted in 2004, reports government spending in China  on agricultural biotechnology at \$200 million annually, equivalent to \$1 billion per year in terms of purchasing power parity. China has two thousand professionals dedicated to crop biotechnology and the Chinese scientific community is recommending even more resources for crop biotechnology which they consider to be a strategic investment area. In 2004, China significantly increased its area of Bt cotton for the seventh consecutive year since its introduction in 1997. Bt cotton occupied

3.7 million hectares in China in 2004, equivalent to 66% of its national cotton hectarage of 5.6 million; this compares with 2.8 million hectares, equivalent to 58% of a total of 4.8 million hectares in 2003. In 2004, 7 million small resource-poor cotton farmers, compared with 6 million in 2003, derived significant productivity, economic, environmental, health and social benefits, including a substantial contribution to the alleviation of poverty, as a result of higher incomes from Bt cotton. It is noteworthy that both the national area of cotton and Bt cotton area have grown significantly since the introduction of Bt cotton in 1997. Benefits have flowed to producers, the textile industry and consumers, (because of more affordable cotton products), with national benefits to China from Bt cotton alone projected at $1 billion per year for 2010.

Given the paramount importance of rice as the principal food crop in China, approximately 20% of the government's investments 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 preproduction 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 ha, 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, that can be controlled by Bt, are prevalent on up to 75% of approximately 30 million hectares of rice in China.

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. Thus, it is likely that biotech rice will be approved in China in the near term, probably in 2005. 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 and biotech rice will be the first major food crop to be approved, adopted and commercialized globally. The only precedent, at a more modest scale, is white maize used for food in South Africa, approved, adopted and well accepted in 2001 and now occupying 155,000 hectares. China's decision to approve biotech rice will, firstly, have immediate implications for China itself, secondly for the legion of rice growing countries in Asia which grow and consume approximately 90% of world rice production – approval of biotech rice by China would greatly influence and accelerate the adoption of biotech rice by other developing countries in Asia. Thirdly, given China's increasing role and influence in all aspects of world affairs, including agricultural trade, and particularly its involvement and adoption of biotech food and fiber crops, the approval of biotech rice will facilitate and accelerate the general acceptance of biotech food, feed and fiber crops globally, in both the industrial and developing countries. With the approval of biotech rice in China, this would leave 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 sector 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 complement these gains by applying biotechnology to the other staples maize and wheat, and a dozen other crops. It is noteworthy that China and India alone each have approximately 75 million hectares of the three major staples, making a combined hectarage of 150 million hectares of staples, equivalent to 10% of the total cultivable land in the world. Thus, the approval and adoption of biotech crops by the two most populous countries in the world can greatly influence the approval, adoption and acceptance of biotech crops countries throughout the world. 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. With the consistent success of Bt cotton over the last eight years, China is now exerting leadership again by executing due diligence before approving biotech rice, which in turn will facilitate approval and adoption by India, and other rice growing developing countries in Asia. It is entirely appropriate that the approval and adoption of the first biotech rice, which represents both the principal food and culture of Asia, be achieved through the exertion of leadership and confidence in the new science of biotechnology by an Asian sovereign state.

### *India*

India, with a current population of 1 billion people is the second most populous country in the world after China. It is destined to become the most populous country in the world in 2050 with 1.5 billion people. India, like China, has also identified crop biotechnology as a strategic science investment that can coincidentally contribute to food, feed and fiber security and to a more sustainable agriculture. With a fast growing population (1.5 % per annum ) and a land area of 329 million hectares, of which 54% is arable, 23% of India's GDP of $510 billion is generated by agriculture, which provides employment to 67% of its population.

India first adopted the officially approved Bt cotton hybrids in 2002 and due to their success, by 2004 approximately 300,000 farmers planted over half a million hectares with a quantum five fold increase in Bt cotton area between 2003 and 2004. India is the largest cotton growing country in the world with 9 million hectares, of which almost half, 4 million hectares, is hybrid cotton. The adoption rate for hybrid Bt cotton is already 11% of the hybrid cotton area in India and the adoption rate is expected to follow a similar pattern to China, which now has two thirds of its cotton area planted to Bt cotton varieties. India, like China, is deriving significant and multiple benefits from Bt cotton in terms of productivity, environmental, health and social benefits that contribute to the alleviation of poverty through increased incomes for resource-poor cotton farmers in India. In 2003, benefits per hectare in India from Bt cotton included a 60% savings in insecticides equivalent to $65, plus an average 29% yield increase for an overall increase in net income of $150 per hectare. In India, approximately 75,000 farmers benefited from growing 100,000 hectares of the approved Bt hybrid cotton in 2003, produced 76,000 more bales of cotton, used 305,000 liters less insecticide, and received a premium of 8% for the cleaner higher quality Bt cotton. In addition, significant environmental, health and social benefits accrued to the small resource-poor farmers that have adopted Bt cotton in India and future hectarage is expected to grow significantly in 2005 and beyond.

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 sector 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. 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 because eggplant is a food crop. These eggplant projects are geared to deliver biotech products for evaluation and approval by 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 hybrid Bt cotton that is already approved and other Bt cottons being developed by both the public and private sector in India. Biotech crops in development by the public sector include the following sixteen 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 nine 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, will have a significant impact in India, and indeed in all rice-growing countries throughout Asia, and the world.

The positive experience with Bt cotton in China, and more recently in India, where it has already delivered significant and multiple advantages in terms of production, economics, environment, health and social benefits, and its contribution to the alleviation of poverty through increased incomes to subsistence farmers, provide both countries with the important first-hand experience and knowledge of biotech crops - "doing is knowing". The first-hand experience with a fiber crop, Bt cotton, provides both China and India with the confidence and experience to approve their first biotech food crops – rice in China and eggplant in India. These two products will serve as evident and transparent demonstrations to Governments, consumers and producers alike, of the direct and enormous benefits that biotech crops can contribute to food, feed and fiber security and a more sustainable agriculture – benefits projected by China valued at $4 billion per year for Bt rice alone. Leadership by the two most populous countries in the world, China and India, in managing superior food and fiber biotech crops will generate a unique knowledge base and a precedent that could provide the stimulus and the momentum that would provide other developing countries in Asia, and ultimately Latin America and Africa, with the incentive and confidence to accelerate national initiatives that would safely expedite the evaluation of biotech crops that have significant potential to benefit their peoples.

***Argentina***

With a land area of 276 million hectares, of which 12% is arable, 11% of Argentina's GDP of $102 billion is generated by agriculture, which generates almost one-third of total exports($25.7 billion), valued at $8.1 billion per year. Of the countries of Latin America, Argentina is the global pioneer in biotech crops, having adopted the first biotech crops in 1996, the first year of commercialization of biotech crops globally – the same year as the USA. Argentina has consistently been the number two country in the world, after the USA, in terms of biotech crop hectarage, which is projected at 16.2 million hectares for 2004; this is equivalent to 20%, or one-fifth, of the total global biotech crop hectarage of 81 million hectares. Argentina deploys biotech soybean, maize and cotton with approximately 90% of the national biotech crop area devoted to herbicide tolerant soybean.

Independent rigorous studies and surveys have been published by Dr. Eduardo Trigo, and others, who have chronicled the significant and consistent benefits that Argentina has derived from biotech crops in terms of improved productivity, economic gains, safer environment, all of which have contributed to a more sustainable agriculture and increased soybean exports. In 2001/02, biotech crops were estimated to enhance crop value for producers in Argentina by the order of $1.7 billion, plus an additional significant contribution to the environment and sustainability. Biotech soybean, in conjunction with low or no-till agriculture and herbicide tolerant soybean, has contributed to sustainability in two important ways. Firstly, in conjunction with low or no-till practices, biotech soybean has made a vital contribution to the control of soil erosion which used to be the most serious and important agronomic constraint in Argentina, and more generally in the southern cone countries of Latin America. Secondly, a contribution to the conservation of moisture, (lack of water is by far the most important constraint to production globally) associated with no or low-till agriculture, which is greatly facilitated by the adoption of herbicide tolerant soybean. The introduction of biotech soybean in conjunction with no/low till has resulted in significant time savings for farmers who in turn have increased the area planted with soybeans, which otherwise would not have been possible.

Biotech soybeans are already adopted on virtually the entire national hectarage of soybean in Argentina, with an increasing hectarage devoted to biotech maize. Of the 3 million hectares of maize grown in Argentina in 2004, 55% was planted to Bt maize, plus about 10,000 hectares of herbicide tolerant maize. Argentina also grows about 25,000 hectares of Bt cotton, equivalent to about 20 to 25% of national hectarage. The challenge for Argentina is to maintain its early advantage and global lead position in biotech crops. This can best be achieved through a national initiative to ensure that the technology is well managed, in all aspects, including adherence to intellectual property rights through appropriate payment for the technologies, which in turn will ensure timely access to new traits that will become available. Appropriate regulation to facilitate and expedite the approval of stacked products in a timely manner is also important because failure to do so will erode Argentina's comparative advantage in biotech crops, that to-date has served it extremely well. Indeed, during the recent financial crisis in Argentina, biotech crops generated a vital contribution to the national economy by generating income streams in agriculture and crop exports that were not being realized in other sectors. Argentina is blessed with rich agricultural resources, and some surplus cultivable land, that can contribute significantly to its future economic growth. It is one of few developing countries with significant capability to contribute to increased grain exports in the future. Increased global demands for grains in the next fifty years provide Argentina with a unique opportunity which will not be realized unless it is competitive in grain production in the international market place. A national strategy that will ensure timely access and adoption of new and superior biotech crops, that will continue to confer a competitive advantage to Argentina, will be a prerequisite to maintaining Argentina's leadership role in biotech crops in Latin America and globally.

***Brazil***

In considering the potential impact of biotech crops in the countries of the South, and the global influence of key developing countries in the future, what China is to Asia, Brazil is to Latin America. Brazil is the most populous (population of 175 million) and largest country (land area of 851 million hectares, of which 7% is arable), and has the largest economy (GDP of $452 billion) in Latin America. Of a population of 175 million, 21% are employed in agriculture which contributes 9% to GDP with agricultural exports, led by soybean, representing 10% ($6 billion) of total exports of $60 billion per year. The public and private sector crop biotechnology investments in Brazil, including significant investments in genomics, were estimated at $15 million per year in 2001. Brazilian universities, foundations and EMBRAPA (the national agricultural research system) have significant investments in biotechnology and there are two EMBRAPA public-good products that are well advanced. They are a virus resistant papaya and bean, both of which can deliver significant economic and social benefits to resource-poor farmers in Brazil, and thus meet an important priority goal of the Brazilian Government.  Brazil has enormous potential for biotech crops, and could have significant influential global impact on acceptance of biotech crops globally, including Europe, which is a major importer of Brazilian soybeans – the other large and growing Brazilian export market for soybean is China. Brazil is the number two producer of soybeans in the world, after the USA, with the intent of becoming the lead world producer of soybean in the future.

After growing biotech soybean unofficially for several years, Brazil officially approved biotech soybeans in 2003 and 2004 by two successive Presidential decrees that provides temporary approval pending the passage of a biotech bill that will provide a permanent framework for evaluating and approving biotech crops in Brazil. The new broad ranging biotech bill, which includes medical applications, is expected to become law in 2005. The new law, will for the first time, provide a legal and regulated system that should greatly facilitate the evaluation and approval of biotech crops other than soybean, including biotech maize and cotton, (already commercialized in nine other countries) papaya and beans (being developed as a public good product by EMBRAPA in Brazil) and rice, a relatively important crop in Brazil, which has by far the largest rice area (3 million hectares) in Latin America.

In 2004, of the projected 23 million hectares of soybean in Brazil 22% or 5 million hectares are likely to be planted with biotech soybean – up from 3 million hectares in 2003. The long term potential for biotech soybean in Brazil is up to 30 million hectares, or more, as the hectarage sown to soybean increases to meet global demand, particularly China. It is notable that Brazil has more new land that can be brought into agricultural production than any other country in the world - up to 100 million hectares, or more, with an ample water supply which is the major global constraint to increased crop production. Brazil, after the USA and China, also has the third largest hectarage of maize in the world, with significant potential for both biotech insect resistant and herbicide tolerant varieties. Unlike soybean, which are generally produced on larger farms, the 12 million hectares of maize in Brazil is farmed mainly by small farmers to whom the social benefits of increased income would be very important and consistent with the present Government's top priority for alleviating poverty. Brazil also has the sixth largest area of cotton in the world and is the highest user of cotton insecticides in Latin America. Adoption of insect resistant biotech cotton could result in significant advantages, including less exposure to insecticides and higher net incomes, to both the small and large farmers that grow cotton in Brazil. Using only current proven biotech crops of soybean, maize, and cotton, already successfully commercialized by other countries, the collective crop value for these three crops in Brazil could probably be increased by up to $1 billion per year, with significant added environmental, health and social benefits, that are particularly important for small resource poor farmers who could enhance their income and have less exposure to pesticides.

Thus, there is enormous potential for Brazil to employ a portfolio of biotech crops for creating economic growth at the national, and producer level and providing consumers and importers of their soybeans with products that have been produced in more sustainable agricultural systems less dependent on pesticides with positive health, environmental and economic implications for all stakeholders. Given its high and rising political profile, its role model in Latin America, and increasing influence in world affairs, the policies Brazil choose to pursue with biotech crops will undoubtedly have high impact in the MERCOSUR trading region in Latin America and also globally, including China and Europe, to whom it is a major supplier of soybeans and likely to become the leading producer in the world.

***South Africa***

With a land area of 112 million hectares, of which 12% is arable, and a population of 44 million, 4 % of South Africa's GDP of $104 billion, (the largest on the African continent), is generated by agriculture which provides a livelihood for 11% of its population. South Africa enjoys the status of being the only country on the continent of Africa to officially approve, adopt and benefit from biotech crops. South Africa established a Government committee, SAGENE to draft biosafety guidelines as early as 1978 and field-tested its first biotech crop, Bt cotton, in 1990 which was first commercialized in 1997. Bt cotton was followed by Bt maize (MON 810) commercialized in 1998, herbicide tolerant cotton and soybeans in 2000, the dual Bt gene in cotton (Bollgard II) in 2002, and another insect resistant maize (Bt11) in 2003. Thus, South Africa has commercialized a broader range of biotech crops, that include fiber, feed and food crops compared with the lead countries of Asia, China and India, which are currently commercializing one product, Bt cotton, with other products likely to follow in the near term.

A draft National Biotechnology Strategy was completed in 2001 with three centers of excellence funded at $64 million over three years. These centers provide a framework for a national PlantBio network, with facilities worth $4 million at the University of Pretoria that acts as a hub for crop biotechnology, including an informatics and a gene technology center. The most advanced public sector product is a Bt potato, resistant to tuber moth which is currently being field tested. Other potential new biotech crops from both private and public sectors that are in advanced field tests are, stacked Bt/herbicide tolerant cotton and maize, sugarcane with modified carbohydrate, and virus resistant potatoes undergoing tests in greenhouses. The outlook for biotech crops in South Africa is encouraging with Bt cotton having already achieved 85% adoption with well-documented significant economic, environmental, health and social benefits for small resource-poor framers in the Makhatini Flats region of KwaZulu Natal. The stacked Bt/herbicide tolerant cotton is currently under advanced field testing. South African maize production comprises 60% white maize for food and 40% yellow for animal feed and processing. Despite shortage of biotech maize seed, which has constrained adoption rates, 240,000 hectares of yellow maize (24% of total) and 155,000 hectares (10% adoption) of white maize are estimated for 2004/05 with continued strong growth projected for the future. It is notable that Bt white maize has been rapidly accepted as a food crop, increasing from 6,000 hectares in 2001 to 155,000 hectares in 2004. The stacked Bt/herbicide tolerant maize is currently under advanced field testing and expeditious approval of this product is important so that South Africa maintains its lead role in biotech crops. Biotech soybeans were introduced in 2001, with the adoption rate moving rapidly from 5% in 2001 to an estimated 50% in 2004, with continued strong growth in 2005 and beyond.

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 and 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.

## Global Sharing of Knowledge and Experience on Crop Biotechnology

The sharing of the significant body of knowledge and experience that has been accumulated on biotech crops in developing countries, since their commercialization in 1996, is an essential ingredient for a transparent, and knowledge-based discussion by an informed global society about the potential humanitarian and material benefits that biotech crops offer developing countries. The five lead biotech crop countries from the South, China, India, Argentina, Brazil and South Africa, grew approximately one-third of global biotech crops in 2004 and offer a unique experience from developing countries in all three continents of the South –Asia, Latin America and Africa. The collective experience and voice of these five key countries represent a coalition of influential opinion from the South re biotech crops that will also influence acceptance of biotech crops globally. In the near term, the one single event that is likely to have the greatest impact is the approval and adoption of Bt rice in China, which is considered to be likely in the near term, probably in 2005. The adoption of biotech rice by China, not only involves the most important food crop in the world but the culture of Asia. It will provide the stimulus that will have a major impact on the acceptance of biotech rice in Asia and, more generally, on the acceptance of biotech food, feed and fiber crops worldwide. Adoption of biotech rice will contribute to a global momentum that will herald a new chapter in the debate on the acceptance of biotech crops which will be increasingly influenced by countries in the South, where the new technology can contribute the biggest benefits and where the humanitarian needs are greatest – a contribution to the alleviation of malnutrition, hunger and poverty. Global society has pledged to reduce poverty by half by 2015, and if it is to maintain credibility, it must practice what it preaches and deliver what it promises. Reducing poverty by half by 2015 is an imperative moral obligation and is one of the most formidable challenges facing the world today, to which biotech crops can make a vital contribution. It is appropriate that it is the countries of the South, led by China, India, Argentina, Brazil and South Africa, which are exerting increasing leadership in the adoption of biotech crops and have the courage to address issues that will determine their own survival and destiny, at a time when some segments of global society are still engaged in an ongoing debate on biotech crops that has resulted in paralysis through over-analysis.

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