ISAAA
International Service for the Acquisition of Agri-biotech Applications

EXECUTIVE SUMMARY

BRIEF 41

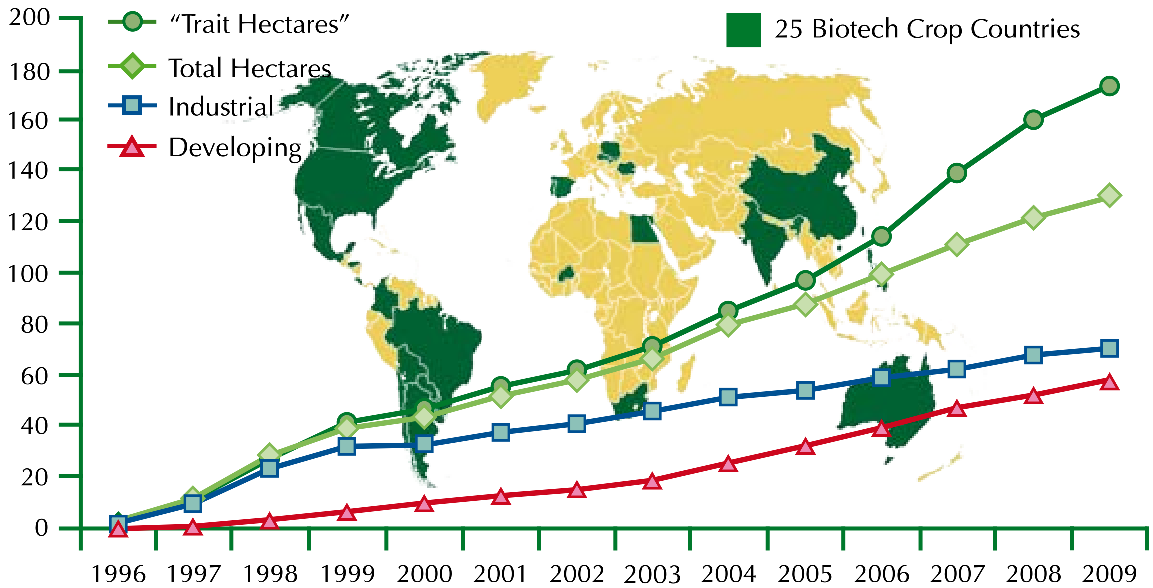
Global Status of Commercialized Biotech/GM Crops: 2009

by

Clive James
Founder and Chair, ISAAA Board of Directors

Dedicated by the author to the late Nobel Peace Laureate Norman Borlaug,
First Founding Patron of ISAAA

GLOBAL AREA OF BIOTECH CROPS
Million Hectares (1996-2009)



A record 14 million farmers, in 25 countries, planted 134 million hectares (330 million acres) in 2009, a significant increase of 7% or 9 million hectares (22 million acres) over 2008.

Source: Clive James, 2009.

No. 41 - 2009

AUTHOR'S NOTE:

Global figures and hectares planted commercially with biotech crops have been rounded off to the nearest 100,000 hectares, using both < and > characters, and hence in some cases this leads to insignificant approximations, and there may be minor variances in some figures, totals, and percentage estimates that do not always add up exactly to 100% because of 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 2009 information for Argentina, Brazil, Australia, South Africa, and Uruguay is hectares usually planted in the last quarter of 2009 and harvested in the first quarter of 2010 with some countries like the Philippines having more than one season per year. Thus, for countries of the Southern hemisphere, such as Brazil and Argentina the estimates are projections, and thus are always subject to change due to weather, which may increase or decrease actual planted before the end of the planting season when this Brief has to go to press. For Brazil the winter maize crop (safrinha) planted in the last week of December 2009 and more intensively through January and February 2010 is classified as a 2009 crop in this Brief consistent with a policy which uses the first date of planting to determine the crop year. Details of the references listed in the Executive Summary are found in Full Brief 41.

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ISAAA *SEAsia*Center
c/o IRRI
DAPO Box 7777
Metro Manila, Philippines

Info on ISAAA: For information about ISAAA, please contact the Center nearest you:

ISAAA *Ameri*Center
417 Bradfield Hall
Cornell University
Ithaca NY 14853, U.S.A.

ISAAA *Afri*Center
PO Box 70, ILRI Campus
Old Naivasha Road
Uthiru, Nairobi 90665
Kenya

ISAAA *SEAsia*Center
c/o IRRI
DAPO Box 7777
Metro Manila
Philippines

Electronically: or email to info@isaaa.org

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Global Status of Commercialized Biotech/GM Crops: 2009
The First Fourteen Years, 1996 to 2009

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Global Status of Commercialized Biotech/GM Crops: 2009
The First Fourteen Years, 1996 to 2009

Introduction

This Executive Summary focuses on the 2009 global biotech crop highlights, which are comprehensively discussed in the full version of Brief 41, dedicated to the late Nobel Peace Laureate, Norman Borlaug. An ISAAA tribute to Norm, the First Founding Patron of ISAAA who passed away on 12 September 2009, is also included as a commemorative brochure in Brief 41. Having been awarded the Nobel Peace Prize in 1970 for successfully implementing the green revolution, which saved up to 1 billion people from hunger in the 1960s, Norman Borlaug was the world's most ardent and credible advocate of biotech crops and their vital contribution to the alleviation of poverty, hunger and malnutrition.

This Brief also includes a fully referenced special feature on "Biotech Rice – Present Status and Future Prospects" by Dr. John Bennett, Honorary Professor, School of Biological Sciences, University of Sydney, Australia and former senior molecular biologist of the Plant Molecular Biology Laboratory at the International Rice Research Institute in the Philippines, which hosts the ISAAA South East Asia Center.

China approves Bt rice and phytase maize in a landmark decision.

Shortly before this Brief went to press, biotech Bt rice and biotech phytase maize were approved by China on 27 November 2009. These approvals are momentous and have enormous implications for biotech crop adoption not only for China and Asia, but for the whole world. There are several aspects that make them unique:

- Both nationally-developed proprietary products were produced in China entirely with public sector resources from the Government;

- Rice is the most important food crop in the world. Bt rice can deliver estimated benefits of US$4 billion per year to up to 110 million rice households in China alone (440 million beneficiaries, assuming 4 per family) who grow 30 million hectares of rice – on average they farm one-third of a hectare of rice. Increased yield and farmer income from Bt rice can contribute to a better quality of life and a safer and more sustainable environment due to less dependency on insecticides. Nationally, it can be a very significant and critical contribution to China's goal of food and feed "self-sufficiency" (optimizing the nations' home-grown food and feed crops) and "food security" (enough food and feed for all) – the distinction is important and the two goals are not mutually exclusive.

- Maize is the major animal feed crop in the world. In China, maize occupies 30 million hectares and farmed by 100 million maize households (400 million beneficiaries) with an average maize holding per farm of one third of one hectare. Potential benefits of phytase maize include more efficient pork production (China has the largest swine herd in the world, 500 million equivalent to 50% of global). Pork production with phytase maize will be more efficient because pigs can more easily digest phosphorus, thereby coincidentally enhancing growth and reducing pollution from lower phosphate animal waste. Farmers will no longer be required to purchase and mix phosphate supplement resulting in savings in supplements, equipment and labor. Nationally, increased efficiency of meat production is critical at a time when prosperity is driving increased meat consumption in China which has to import maize for feed. Maize is also used to feed China's 13 billion chickens, ducks and poultry.

- China's approval of biotech rice and maize will probably facilitate and expedite the decision making process regarding acceptance and approval of biotech rice, maize and other biotech crops in developing countries. This will be particularly so in Asia, which is facing the same challenges as China in relation to food self-sufficiency and the 2015 MDG goals to alleviate poverty, hunger and malnutrition and increase small farmer prosperity.

- The approvals of vital nationally-developed Chinese biotech rice and maize staples could also shift the dynamics of global food, feed and fiber trade, the role of developing countries in food security, and could stimulate other countries to emulate China and/or engage in technology transfer/sharing programs with China.

The Chinese Government's assignment of high priority to crop biotechnology, championed by Premier Wen Jiabao, is paying off handsome returns to China, both in terms of Bt cotton and strategically important new crops like biotech rice and maize and also reflects growing academic excellence of China in biotech crop development. Agricultural science is China's fastest-growing research field with China's share of global publications in agricultural science growing from 1.5% in 1999 to 5% in 2008. In 1999, China spent only 0.23% of its agricultural GDP on agricultural R & D but this increased to 0.8% in 2008 and is now close to the 1% recommended by the World Bank for developing countries. The new target for the Chinese Government is to increase total grain production to 540 million tons by 2020 and to double Chinese farmers' 2008 income by 2020 and biotech crops can make a significant contribution to this goal (Xinhua, 2009a).

Unfortunately, time constraints associated with the printing and publication of this Brief allowed only an initial cursory discussion of the enormous global significance and implications of the approval of biotech rice and maize in China, both of which will have to satisfy and complete 2 to 3 years of the standard field registration trials prior to full scale commercialization in farmers field. The approvals are also discussed later in this Brief.

The challenge of feeding the world in 2050

It is useful to put global food production into context, by tracing the major developments over the last two centuries. Starting at the beginning of the 19th century, when global population was less than 1 billion in 1800, it was relatively easy to increase food production over the next 100 years to feed another 0.6 billion, by simply **increasing the area of land under the plough.** An abundance of new productive land was available and brought into production in the prairies of North America, the pampas of South America, the steppes of Eastern Europe and Russia, and the outback of Australia. In the 20th century (when world population was still only 1.6 billion in 1900), an increase in global food production over the next 100 years was achieved mainly **by increasing crop productivity (yield per hectare)** dramatically, through the green revolution and other agronomic improvements. Fossil fuel was a prerequisite for large-scale mechanization, with tractors replacing horses, and equally important, an increased usage of fossil fuel-based ammonium fertilizers.

At the beginning of the 21st century, with a population of 6.1 billion in 2000 and headed for 9.2 billion by 2050, the challenge of yet again doubling food production in only 50 years has become a daunting task in itself. The situation is further exacerbated because now, we must also **double food production sustainably by 2050** on approximately the same area of arable land (a notable exception is Brazil) **using less resources, particularly, fossil fuel, water and nitrogen**, at a time when we must also mitigate some of the **enormous challenges associated with climate change**. Furthermore, there is the **critical and urgent humanitarian need to alleviate poverty, hunger and malnutrition which is afflicting more than 1 billion people for the first time** in the history of the world. The most promising technological strategy at this time for increasing global food, feed and fiber productivity (kg per hectare) is to combine the best of the old and the best of the new, by **integrating the best of conventional crop technology (adapted germplasm) and the best of crop biotechnology applications including novel traits.** The improved integrated crop products, resulting from this synergy must be incorporated as the **innovative technology component** in a global food, feed and fiber security strategy that must also address other critical issues, including population growth and improved food, feed and fiber distribution systems. Adoption of such a holistic strategy will allow global society to continue to benefit from the vital contribution that both conventional and modern innovative plant breeding offers mankind, at this critical juncture in the history of a world that is desperately struggling with food security as a potential threat to a more peaceful and secure world. **It is striking that Borlaug's acceptance speech for his Nobel Peace Prize, delivered forty years ago, entitled The Green Revolution, Peace and Humanity, focused on basically the same issues.**

More support to Agriculture for "a substantial and sustainable intensification of crop productivity", using both conventional and crop biotechnology applications

ISAAA Brief 41, 2009 is published at a critical juncture when several prestigious international bodies, including the G8, the 2009 FAO Food Summit, the Bill and Melinda Gates Foundation and the Royal Society of London, have all advocated an urgent need for assigning top priority to agriculture, food self-sufficiency and security and the alleviation of hunger, malnutrition and poverty. More specifically, given the pivotal role of crops in food, feed and fiber production, there has been a universal clarion call to utilize both conventional and biotech crop applications to achieve "**a substantial and sustainable intensification of crop productivity" on the 1.5 billion hectares of crop land in use today.** This urgent action has been called for, to avert possible imminent life-threatening consequences for 1.02 billion people, the highest number to ever suffer from the debilitating and destructive effects of poverty, hunger and malnutrition, which is unacceptable in a just society. The situation is exacerbated with **global grain reserves down to a perilous 75 days supply**, compared with a recommended minimum of 100 days, the need to mitigate the multiple challenges associated with climate change, particularly drought that is already in evidence globally, and last, but not least, to protect, at all costs, the natural resource base for future generations in a reasonable state.

Global hectarage planted to biotech crops continued to climb in 2009 – record hectarages for all four major biotech crops – progress on other fronts.

Following the consistent and substantial, economic, environmental and welfare benefits generated from biotech crops over the last fourteen years, millions of large, small and resource-poor farmers in both industrial and developing countries continued to plant more hectares of biotech crops in 2009 than ever before; this testimony to biotech crops from millions of practitioner farmers around the world is the simplest but probably the single most compelling, pragmatic and common-sense measure of the superior performance of biotech crops globally. Despite the severe effects of the 2009 economic recession, record hectarages of all biotech crops were reported in 2009 with the following new highs for the four principal biotech crops. For the first time, more than three-quarters (77%) of the 90 million hectares of soybean grown globally were biotech; for cotton, almost half (49%) of the 33 million hectares were biotech; for maize, over a quarter (26%) of the 158 million hectares grown globally were biotech; and finally for canola, 21% of the 31 million hectares were biotech. In addition to increases in hectares, progress was also made with the number of farmers electing to plant biotech crops globally. Continued substantial progress was achieved in all three biotech crop countries in Africa, where the challenges are greatest. As predicted in previous ISAAA Briefs, developing countries continued to command an increasing share of global plantings, with Brazil clearly exhibiting its potential for becoming the future engine of growth in Latin America. These are very important developments given that biotech crops have already made a modest contribution; more importantly, they have substantial potential to continue to contribute to some of the major challenges facing global society in the future, including: food self-sufficiency and security, more affordable food, sustainability, alleviation of poverty and hunger, and help mitigate some of the challenges associated with climate change and global warming.

134 million hectares of biotech crops in 2009 – fastest adopted crop technology, 80-fold increase from 1996 to 2009, year-to-year growth of 9 million hectares or 7%

Global hectarage of biotech crops continued to grow in 2009 and reached 134 million hectares, (Table 1 and Figure 1) or 180 million "trait or virtual hectares". This translates to an "apparent growth" of 9 million hectares or 7% measured in hectares, whereas the "actual growth", measured in "trait or virtual hectares", was 14 million hectares or 8% year-on-year growth. Measuring in "trait or virtual hectares" is similar to measuring air travel (where there is more than one passenger per plane) more accurately in "passenger miles" rather than "miles". Global growth

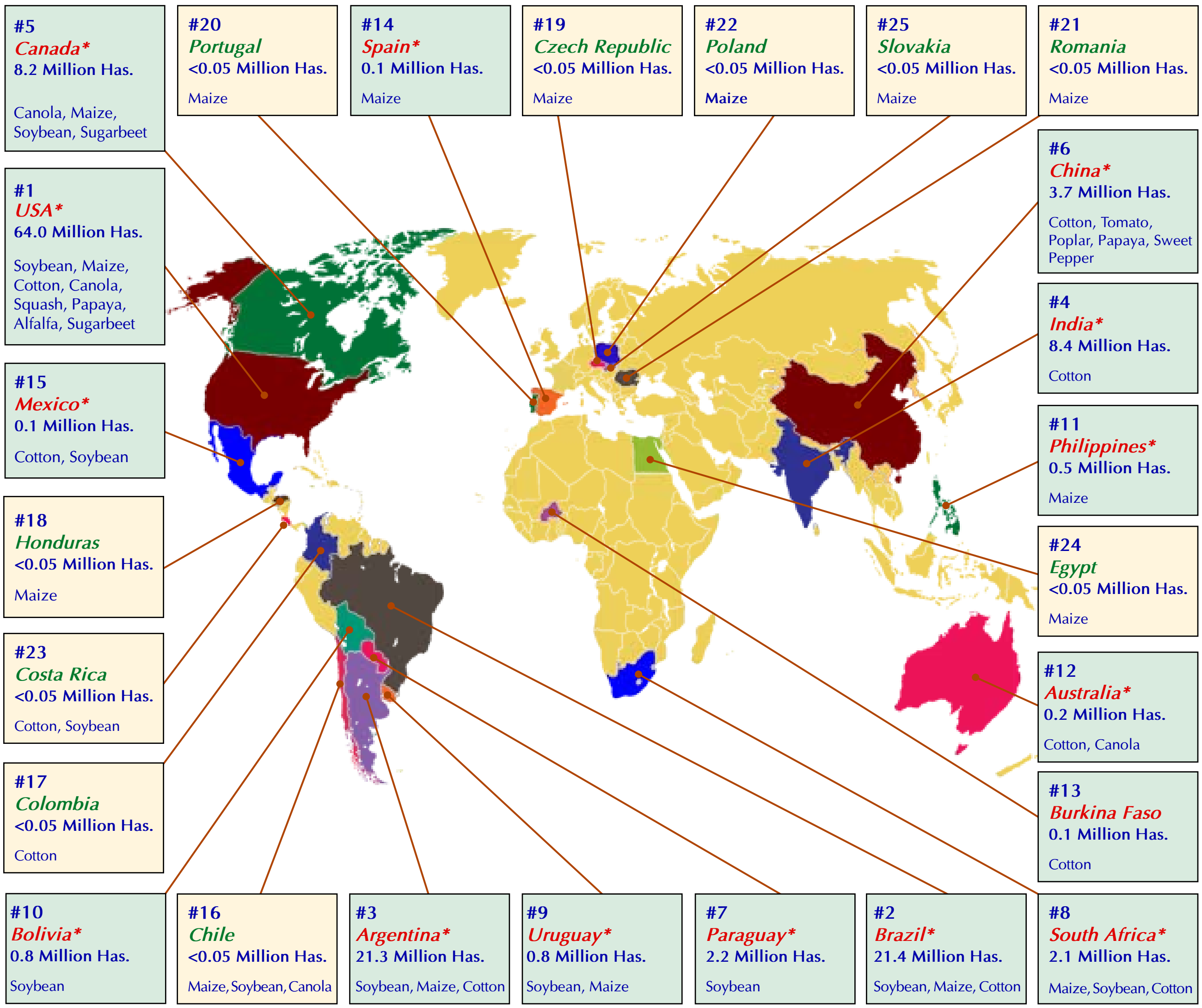
Table 1. Global Area of Biotech Crops in 2009: by Country (Million Hectares)

Rank	Country	Area (million hectares)	Biotech Crops
1*	USA*	64.0	Soybean, maize, cotton, canola, squash, papaya, alfalfa, sugarbeet
2*	Brazil*	21.4	Soybean, maize, cotton
3*	Argentina*	21.3	Soybean, maize, cotton
4*	India*	8.4	Cotton
5*	Canada*	8.2	Canola, maize, soybean, sugarbeet
6*	China*	3.7	Cotton, tomato, poplar, papaya, sweet pepper
7*	Paraguay*	2.2	Soybean
8*	South Africa*	2.1	Maize, soybean, cotton
9*	Uruguay*	0.8	Soybean, maize
10*	Bolivia*	0.8	Soybean
11*	Philippines*	0.5	Maize
12*	Australia*	0.2	Cotton, canola
13*	Burkina Faso*	0.1	Cotton
14*	Spain*	0.1	Maize
15*	Mexico*	0.1	Cotton, soybean
16	Chile	<0.1	Maize, soybean, canola
17	Colombia	<0.1	Cotton
18	Honduras	<0.1	Maize
19	Czech Republic	<0.1	Maize
20	Portugal	<0.1	Maize
21	Romania	<0.1	Maize
22	Poland	<0.1	Maize
23	Costa Rica	<0.1	Cotton, soybean
24	Egypt	<0.1	Maize
25	Slovakia	<0.1	Maize

* 15 biotech mega-countries growing 50,000 hectares, or more, of biotech crops

Source: Clive James, 2009.

Biotech Crop Countries and Mega-Countries*, 2009



* 15 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.

Source: Clive James, 2009.

Figure 1. Global Map of Biotech Crop Countries and Mega-Countries in 2009

in "trait or virtual hectares" increased from 166 million "trait or virtual hectares" in 2008 to approximately 180 million "trait or virtual hectares" in 2009. Recent growth over the last few years in the early-adopting countries has come largely from the deployment of "stacked traits" (as opposed to single traits in one variety or hybrid), as adoption rates measured in hectares reach optimal levels in the principal biotech crops of maize and cotton of the major biotech crop countries. For example in 2009, an impressive 85% of the 35.2 million hectare national maize crop in the USA was biotech, and remarkably, 75% of it was hybrids with either double or triple stacked traits – only 25% was occupied by hybrids with a single trait. Similarly, biotech cotton occupies up to approximately

90%, or more of the national area of cotton in the USA, Australia and South Africa, with double-stacked traits occupying 75% of all biotech cotton in the USA, 88% in Australia and 75% in South Africa. It is evident that stacked traits have already become a very important feature of biotech crops, and accordingly it is prudent to also measure growth in "trait or virtual hectares" as well as hectares. This unprecedented high growth rate starting from 1.7 million hectares in 1996 to 134 million hectares in 2009 makes biotech crops the fastest adopted crop technology, increasing approximately 80-fold (79) between 1996 and 2009.

Stacked traits planted by 11 countries – 8 of the 11 were developing countries

Stacked products are an important feature of biotech crops and future trend, which meets the multiple needs of farmers and consumers, and these are now increasingly deployed by 11 countries. In descending order of hectarage they were – USA, Argentina, Canada, Philippines, South Africa, Australia, Mexico, Chile, Colombia, Honduras and Cost Rica, (note that 8 of the 11 were developing countries**)**, with more countries expected to adopt stacked traits in the future. A total of 28.7 million hectares of stacked biotech crops were planted in 2009 compared with 26.9 million hectares in 2008. In 2009, the USA led the way with 41% of its total 64.0 million hectares of biotech crops stacked. In the Philippines, double stacks with pest resistance and herbicide tolerance in maize were the fastest growing component increasing from 57% of biotech maize in 2008 to 69% in 2009. The new biotech maize, **SmartStax™, will be released in the USA in 2010 with eight different genes coding for a total of three traits, two for pest resistance, (one for above ground pests and the other for underground pests) and herbicide tolerance.** Future stacked crop products are expected to comprise multiple agronomic input traits for pest resistance, tolerance to herbicides and drought, plus output traits such as high omega-3 oil in soybean or enhanced pro-Vitamin A in Golden Rice.

Number of biotech crop farmers increased by 0.7 million to 14.0 million, 90%, or 13.0 million were small and resource-poor farmers in developing countries.

In 2009, the number of farmers benefiting from biotech crops globally in 25 countries reached 14.0 million, an increase of 0.7 million over 2008. Of the global total of 14.0 million beneficiary biotech farmers in 2009, (up from 13.3 million in 2008), over 90% or 13.0 million (up from 12.3 million in 2008) were small and resource-poor farmers from developing countries; the balance of 1 million were large farmers from both industrial countries such as the USA and Canada, and developing countries such as Argentina and Brazil. Of the 13.0 million small and resource-poor farmers, most were Bt cotton farmers, 7.0 million in China (Bt cotton), 5.6 million in India (Bt cotton), and the balance made up of 250,000 in the Philippines (biotech maize), South Africa (biotech cotton, maize and soybeans often grown by subsistence women farmers) and the other twelve developing countries which grew biotech crops in 2009. **The largest increase in the number of beneficiary farmers in 2009 was in India where, an additional 0.6 million more small farmers planted Bt cotton which now occupies 87% of total cotton, up from 80% in 2008. The increased income from biotech crops for small and resource-poor farmers represents an initial modest contribution towards the alleviation of their poverty. During the second decade of commercialization, 2006 to 2015, biotech crops have an enormous potential for contributing to the Millennium Development Goals (MDG) of reducing poverty by 50% by 2015. Initial research in China indicates that up to 10 million more small and resource-poor farmers may be secondary beneficiaries of Bt cotton in China.**

Twenty-five countries planted biotech crops in 2009 – 10 in Central and South America.

In 2009, the number of biotech countries planting biotech crops remained the same as 2008, at 25, with Costa Rica listed for the first time and Germany discontinuing planting of Bt maize at the end of the 2008 season. Costa Rica, like Chile, grows biotech crops exclusively for the seed export market. With the addition of Costa Rica, this brings the total number of countries growing biotech crops in Latin America to an historical figure of 10. The number of countries growing biotech crops has increased steadily from 6 in 1996, the first year of commercialization, to 18 in 2003 and 25 in 2009. Japan initiated commercialization of a biotech blue rose in 2009 – the roses are partially grown in greenhouses, and like biotech carnations in Colombia and Australia are not included in the ISAAA global hectarage of food, feed and fiber biotech crops as defined in the FAO listing of crops.

Biotech crop hectares grew in 2009 even when 2008 percent adoption rates were high.

Global biotech hectares grew in 2009 by a robust 7% or 9 million hectares even though there was limited room for hectare growth in biotech crops in 2009 because:

- adoption rates were already 80% or more in the principal biotech crops in most of the major biotech countries;
- there was uncertainty due to extensive droughts and unfavorable climatic conditions;
- an economic crisis, which was the worst since the depression, led to more static or declining total crop plantings; and
- plummeting commodity prices compared with the highs of mid 2008 provided less incentive for farmers to increase total plantings significantly as in previous years.

The percent adoption of biotech crops continued to grow in 2009, even when the 2008 adoptions rates were very high, for example, from 80% to 87% for Bt cotton in India, from 80% to 85% for biotech maize in the USA, and from 86% to 93% for biotech canola in Canada (Figures 2 and 3). For countries, such as China where, consistent with international trends, total crop plantings of cotton declined, the percent adoption remained the same at 68%, but in the case of the USA even when total plantings of cotton were down 4%, percent adoption increased from 86% in 2008 to 88% in 2009. It is notable, that the global area of biotech crops has grown every single year since its first commercialization in 1996, at double digit growth rates consistently for the first twelve years, at 9.4% in 2008, and 7% in 2009 during the economic recession.

Brazil displaced Argentina to become the second largest grower of biotech crops in the world.

For 2009, biotech crops in Brazil were estimated to occupy 21.4 million hectares, an increase of 5.6 million hectares, the largest increase in any country in the world and equivalent to a 35% increase over 2008. Brazil now plants 16% of all the biotech crops in the world. Of the 21.4 million hectares of biotech crops grown in Brazil in 2009, 16.2 million hectares were planted to RR®soybean for the seventh consecutive year, up from 14.2 million hectares in 2008. The adoption rate was a record 71% versus 65% in 2008 with an estimated 150,000 farmers benefiting from RR®soybeans. In addition in 2009, Brazil planted 5 million hectares of Bt maize for the second time in both the summer and winter (safrinha) seasons. The hectarage of Bt maize increased by 3.7 million hectares, or almost a 400% increase over 2008, and was by far the largest absolute increase for any biotech crop in any country in the world in 2009. The adoption rates were 30% for the summer maize and 53% for the winter maize. Finally, 145,000 hectares of Bt cotton were grown officially for the fourth time in 2009, of which 116,000 hectares were Bt cotton and for the first time 29,000 hectares were HT cotton. Thus in 2009, the collective hectarage of biotech