

EXECUTIVE SUMMARY

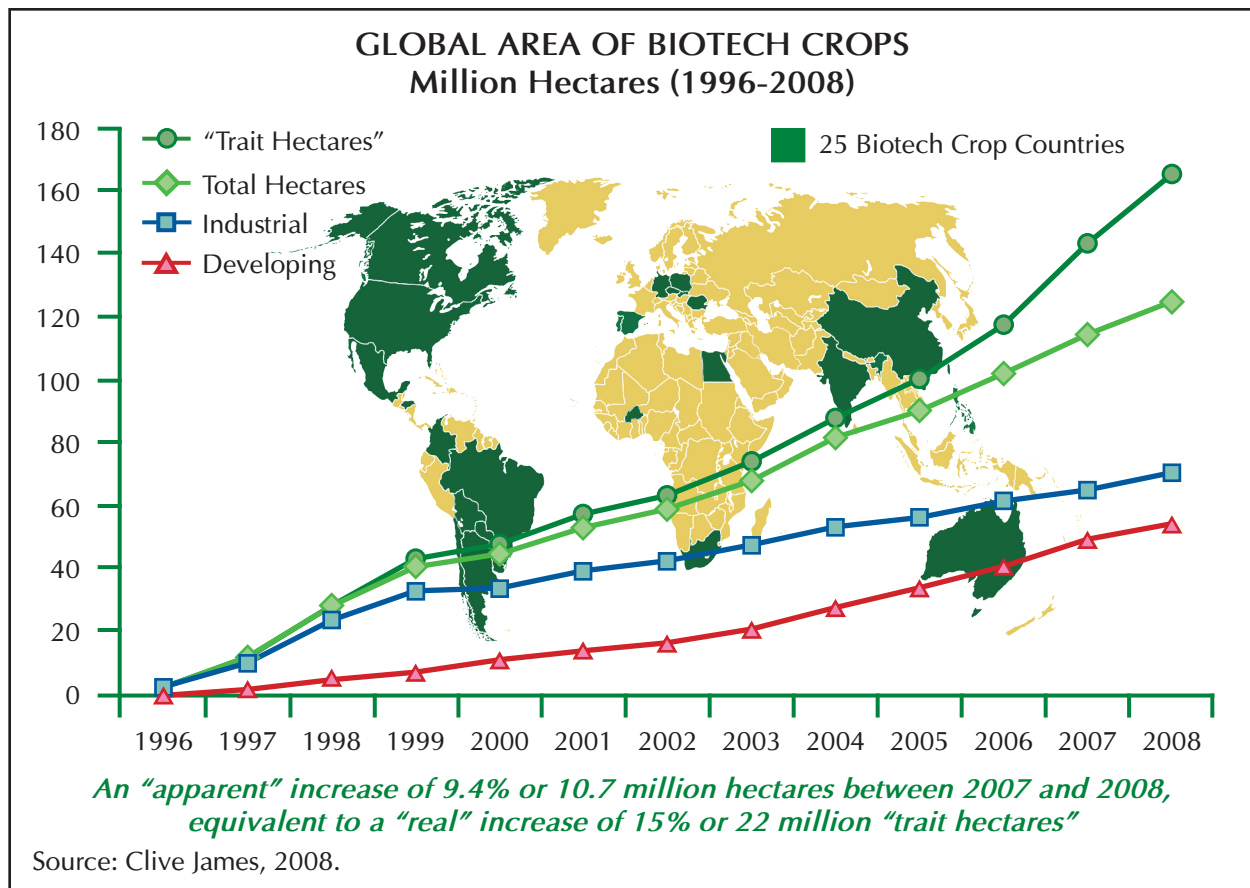
BRIEF 39

Global Status of Commercialized Biotech/GM Crops: 2008

by

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Global Status of Commercialized Biotech/GM Crops: 2008 The First Thirteen Years, 1996 to 2008

Introduction

This Executive Summary focuses on the 2008 biotech crop highlights, which are discussed in more detail in Brief 39. The Brief also includes a fully referenced special feature on the status of drought tolerance in conventional and biotech maize.

As a result of the consistent and substantial economic, environmental and welfare benefits offered by biotech crops, millions of small and resource-poor farmers around the world continued to plant more hectares of biotech crops in 2008, the thirteenth year of commercialization. **Progress was made on several important fronts in 2008 with: significant increases in hectareage of biotech crops; increases in both the number of countries and farmers planting biotech crops globally; substantial progress in Africa, where the challenges are greatest; increased adoption of stacked traits and the introduction of a new biotech crop.** These are very important developments given that biotech crops can contribute to some of the major challenges facing global society, including: **food security, high price of food, sustainability, alleviation of poverty and hunger, and help mitigate some of the challenges associated with climate change.**

Number of countries planting biotech crops soars to 25 – a historical milestone – a new wave of adoption of biotech crops is contributing to a broad-based and continuing hectareage growth of biotech crops globally

It is noteworthy that in 2008, **the number of biotech countries planting biotech crops reached the historical milestone of 25 countries (Table 1 and Figure 1).** The number of countries electing to grow biotech crops has increased steadily from 6 in 1996, the first year of commercialization, to 18 in 2003 and 25 in 2008. A new wave of adoption of biotech crops is fueled by several factors, which are contributing to a broadly based global growth in biotech crops. These factors include: **an increase in the number of biotech countries (3 new biotech countries in 2008); significant progress in Africa, the continent with the greatest challenge with an increase from 1 country in 2007 to 3 countries in 2008 with South Africa being joined by Burkina Faso and Egypt; Bolivia planting biotech soybean for the first time; additional biotech crops being deployed in biotech countries already growing biotech crops (Brazil planting Bt maize, and Australia biotech canola, for the first time); a new biotech crop, biotech sugar beet deployed in the USA and Canada; and significant growth in stacked traits in cotton and maize, increasingly deployed by 10 countries worldwide.** This new wave of adoption is providing a seamless interface with the first wave of adoption resulting in continued and broad-based strong growth in global hectareage of biotech crops. **Notably in 2008, accumulatively the second billionth acre (800 millionth hectare) of a biotech crop was planted – only 3 years after the first one-billionth acre of a biotech crop was planted in 2005. In 2008, developing countries out-numbered industrial countries by 15 to 10,** and this trend is expected to continue in the future with 40 countries, or more, expected to adopt biotech crops by 2015, the final year of the second decade of commercialization. By coincidence, 2015 also happens to be the Millennium Development Goals year, when global society has pledged to cut poverty and hunger in half – a vital humanitarian goal that biotech crops can contribute to, in an appropriate and significant way.

Progress in Africa – two new countries, Burkina Faso and Egypt, plant biotech crops for the first time

Africa is home to over 900 million people representing 14% of the world population and is the only continent in the world where food production per capita is decreasing and where hunger and malnutrition afflicts at least one

Table 1. Global Area of Biotech Crops in 2008: by Country (Million Hectares)

Rank	Country	Area (million hectares)	Biotech Crops
1*	USA*	62.5	Soybean, maize, cotton, canola, squash, papaya, alfalfa, sugarbeet
2*	Argentina*	21.0	Soybean, maize, cotton
3*	Brazil*	15.8	Soybean, maize, cotton
4*	India*	7.6	Cotton
5*	Canada*	7.6	Canola, maize, soybean, sugarbeet
6*	China*	3.8	Cotton, tomato, poplar, petunia, papaya, sweet pepper
7*	Paraguay*	2.7	Soybean
8*	South Africa*	1.8	Maize, soybean, cotton
9*	Uruguay*	0.7	Soybean, maize
10*	Bolivia*	0.6	Soybean
11*	Philippines*	0.4	Maize
12*	Australia*	0.2	Cotton, canola, carnation
13*	Mexico *	0.1	Cotton, soybean
14*	Spain *	0.1	Maize
15	Chile	<0.1	Maize, soybean, canola
16	Colombia	<0.1	Cotton, carnation
17	Honduras	<0.1	Maize
18	Burkina Faso	<0.1	Cotton
19	Czech Republic	<0.1	Maize
20	Romania	<0.1	Maize
21	Portugal	<0.1	Maize
22	Germany	<0.1	Maize
23	Poland	<0.1	Maize
24	Slovakia	<0.1	Maize
25	Egypt	<0.1	Maize

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

Source: Clive James, 2008.

in three Africans. It is noteworthy that two of the three new countries that planted biotech crops for the first time in 2008 were from Africa, the continent with the greatest and most urgent need for crop biotechnology. For the first twelve years of commercialization of biotech crops, 1996 to 2007, South Africa has long been the only country on the African continent to benefit from commercializing biotech crops. Africa is recognized as the continent that represents by far the biggest challenge in terms of adoption and acceptance. Accordingly, the decision in 2008 by Burkina Faso to grow 8,500 hectares of Bt cotton for seed multiplication and initial commercialization and for Egypt to commercialize 700 hectares of Bt maize for the first time was of strategic importance for the African continent. **For the first time, there is a lead country commercializing biotech crops in each of the three principal regions of the continent: South Africa in southern and eastern Africa; Burkina Faso in west Africa; and Egypt in north Africa.** This broad geographical coverage in Africa is of strategic importance in that it allows the three countries to become role models in their respective regions and for **more African farmers to become practitioners of biotech crops and to be able to benefit directly from “learning by doing”, which has proven to be such an important feature in the success of Bt cotton in China and India.** In December

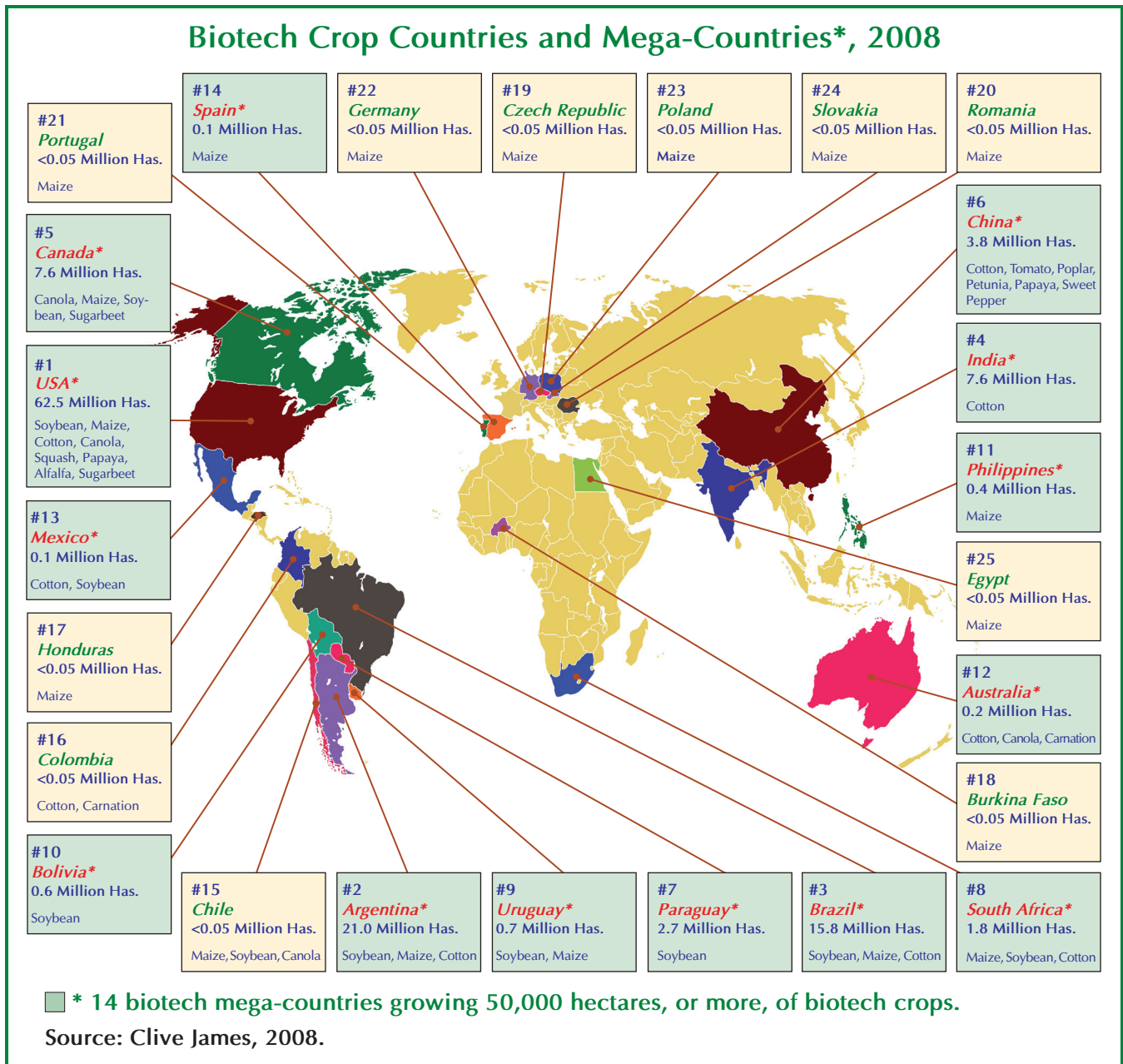


Figure 1. Global Map of Biotech Crop Countries and Mega-Countries in 2008

2008, Kenya, a pivotal biotech crop country in east Africa, enacted a Biosafety Law (pending signature by the President as of end of December 2008), which will facilitate the adoption of biotech crops.

Bolivia becomes the ninth country in Latin America to adopt biotech crops

The third new biotech crop country in 2008 was Bolivia in the Andean region of Latin America. Bolivia is the eighth largest grower of soybean in the world and is no longer disadvantaged compared with its

neighbors, Brazil and Paraguay, which have benefited substantially for many years from herbicide tolerant RR[®] soybean. Bolivia becomes the ninth country in Latin America to benefit from the extensive adoption of biotech crops; the nine Latin American countries, listed in order of hectareage are: Argentina, Brazil, Paraguay, Uruguay, Bolivia, Mexico, Chile, Colombia, and Honduras. Bolivia planted 600,000 hectares of RR[®] soybean in 2008.

Global hectareage of biotech crops continues strong growth in 2008 – reaches 125 million hectares, or more precisely, 166 million “trait hectares”

In 2008, the global hectareage of biotech crops continued to grow strongly reaching 125 million hectares, up from 114.3 million hectares in 2007. This translates to an “apparent growth” of 10.7 million hectares (the sixth largest increase in 13 years) or 9.4% measured in hectares, whereas the “actual growth”, measured more precisely in “trait hectares”, was 22 million hectares or 15% year-on-year growth, approximately double the “apparent growth”. Measuring in “trait hectares” is similar to measuring air travel (where there is more than one passenger per plane) more accurately in “passenger miles” rather than “miles”. Thus in 2008, global growth in “trait hectares” increased from 143.7 million “trait hectares” in 2007 to 166 million “trait hectares”. As expected, more of the growth in the early-adopting countries is now coming 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. For example, in 2008 an impressive 85% of the 35.3 million hectare national maize crop in the USA was biotech and remarkably, 78% of it was hybrids with either double or triple stacked traits – only 22% was occupied by hybrids with a single trait. SmartStax™ biotech maize, with 8 genes for several traits, is expected to be commercialized in the USA in 2010, only two years from now. Similarly, biotech cotton occupies more than 90% of the national area in the USA, Australia and South Africa, with double-stacked traits occupying 75% of all biotech cotton in the USA, 81% in Australia and 83% in South Africa. It is evident that stacked traits have already become a very important feature of biotech crops, and accordingly it is important to measure growth more precisely in “trait hectares” as well as hectares. Notably, the 74-fold hectare increase between 1996 and 2008 makes biotech crops the fastest adopted crop technology in agriculture.

In 2008, accumulated hectareage of biotech crops for the period 1996 to 2008 exceeded 2 billion acres (800 million hectares) for the first time – it took 10 years to reach the first billion acres but only 3 years to reach the second billion acres – of the 25 countries planting biotech crops, 15 were developing and 10 industrial

It took 10 years before the first one billionth acre of biotech crops was planted in 2005 – however it took only three years before the second billionth acre (800 millionth hectare) was planted in 2008. It is projected that 3 billion acres will be exceeded in 2011 with over 4 billion accumulated acres (1.6 billion hectares) by 2015, the Millennium Development Goals year. In 2008, the number of countries planting biotech crops increased to 25, comprising 15 developing countries and 10 industrial countries. The top eight countries each grew more than 1 million hectares; in decreasing order of hectareage they were; **USA (62.5 million hectares), Argentina (21.0), Brazil (15.8), India (7.6), Canada (7.6), China (3.8), Paraguay (2.7), and South Africa (1.8 million hectares)**. Consistent with the trend for developing countries to play an increasingly important role, it is noteworthy that India with a high 23% growth rate between 2007 and 2008 narrowly displaced Canada for the fourth ranking position globally in 2008. **The remaining 17 countries which grew biotech crops in 2008 in decreasing order of hectareage were:** Uruguay, Bolivia, Philippines, Australia, Mexico, Spain, Chile, Colombia, Honduras, Burkina Faso, Czech Republic, Romania, Portugal, Germany, Poland, Slovakia and Egypt. The strong growth in 2008 provides a very broad and stable foundation for future global growth of biotech crops. The growth rate between 1996 and 2008 was an unprecedented 74-fold increase making it the fastest

adopted crop technology in recent history. This very high adoption rate by farmers reflects the fact that biotech crops have consistently performed well and delivered significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. This high adoption rate is a **strong vote of confidence from millions of farmers who have made approximately 70 million individual decisions in 25 countries over a 13-year period to consistently continue to plant higher hectares of biotech crops, year-after-year, after gaining first-hand insight and experience with biotech crops on their own or neighbor's fields.** High re-adoption rates of close to 100% reflect farmer satisfaction with the products that offer substantial benefits ranging from more convenient and flexible crop management, to lower cost of production, higher productivity and/or higher net returns per hectare, health and social benefits, and a cleaner environment through decreased use of conventional pesticides, which collectively contributed to a more sustainable agriculture. The continuing rapid adoption of biotech crops reflects the substantial and consistent benefits for both large and small farmers, consumers and society in both industrial and developing countries.

A new biotech crop, RR[®]sugar beet, was commercialized in two countries, the USA and Canada

In 2008, a new biotech crop, RR[®] herbicide tolerant sugar beet, was introduced for the first time globally in the USA plus a small hectareage in Canada. Notably, of the total US national hectareage of 437,246 hectares of sugar beet, a substantial 59% (the highest ever percent adoption for a launch) or 257,975 hectares were planted with RR[®] biotech sugar beet in 2008, the launch year; the percentage adoption in 2009 is expected to be close to 90%. The success of the RR[®] sugar beet launch has positive implications for sugar cane, (80% of global sugar production is from cane) for which several biotech traits are at an advanced stage of development in several countries.

Five countries Egypt, Burkina Faso, Bolivia, Brazil and Australia introduced, for the first time, biotech crops that have already been commercialized in other countries

Egypt, Burkina Faso, Bolivia, Brazil and Australia introduced for the first time biotech crops that have already been commercialized in other countries: Egypt introduced Bt maize, Burkina Faso Bt cotton, and Bolivia RR[®] soybean. Additional biotech crops were introduced by countries already planting biotech crops with Brazil, planting Bt maize and Australia, planting biotech canola for the first time. In 2008, the breadth and depth of the global deployment of the principal biotech crops was impressive and provides a solid foundation for further growth in the remaining seven years of the second decade of commercialization 2006 to 2015. In 2008, 17, or two-thirds of the 25-biotech countries planted biotech maize (same as 2007), 10 countries planted biotech soybean (up from 9), 10 countries planted biotech cotton (up from 9) and 3 countries planted biotech canola (up from 2 in 2007). In addition, two countries the USA and China grew virus resistant papaya, two countries Australia and Colombia grew biotech carnation, plus a small hectareage of Bt poplar in China, and biotech squash and alfalfa in the USA.

Adoption by crop

Biotech soybean continued to be the principal biotech crop in 2008, occupying 65.8 million hectares or 53% of global biotech area, followed by biotech maize (37.3 million hectares at 30%), biotech cotton (15.5 million hectares at 12%) and biotech canola (5.9 million hectares at 5% of the global biotech crop area).

Adoption by trait

From the genesis of commercialization in 1996 to 2008, herbicide tolerance has consistently been the dominant trait. **In 2008, herbicide tolerance deployed in soybean, maize, canola, cotton and alfalfa occupied 63%**

or 79 million hectares of the global biotech area of 125 million hectares. For the second year running in 2008, the stacked double and triple traits occupied a larger area (26.9 million hectares, or 22% of global biotech crop area) than insect resistant varieties (19.1 million hectares) at 15%. **The stacked trait products were by far the fastest growing trait group between 2007 and 2008 at 23% growth, compared with 9% for herbicide tolerance and -6% for insect resistance.**

Stacked traits – an increasingly important feature of biotech crops – 10 countries planted biotech crops with stacked traits in 2008

Stacked products are a very important feature and future trend, which meets the multiple needs of farmers and consumers and these are now increasingly deployed by ten countries – USA, Canada, Philippines, Australia, Mexico, South Africa, Honduras, Chile, Colombia, and Argentina, (7 of the 10 are developing countries), with more countries expected to adopt stacked traits in the future. A total of 26.9 million hectares of stacked biotech crops were planted in 2008 compared with 21.8 million hectares in 2007. In 2008, the USA led the way with 41% of its total 62.5 million hectares of biotech crops stacked, including 75% of cotton, and 78% of maize; the fastest growing component of stacked maize in the USA was the triple stacks conferring resistance to two insect pests plus herbicide tolerance. Double stacks with pest resistance and herbicide tolerance in maize were also the fastest growing component in 2008 in the Philippines doubling from 25% of biotech maize in 2007 to 57% in 2008. Biotech maize with eight genes, named **Smartstax™**, is expected to be released in the USA in 2010 with eight different genes coding for several pest resistant and herbicide tolerant traits. Future stacked crop products will comprise both 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 1.3 million in 2008, reaching 13.3 million globally in 25 countries – notably 90%, or 12.3 million were small and resource-poor farmers in developing countries

In 2008, the number of farmers benefiting from biotech crops globally in 25 countries reached 13.3 million, an increase of 1.3 million over 2007. Of the global total of 13.3 million beneficiary biotech farmers in 2008, (up from 12 million in 2007), remarkably over 90% or 12.3 million (up from 11 million in 2007) 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 12.3 million small and resource-poor farmers, most were Bt cotton farmers, 7.1 million in China (Bt cotton), 5.0 million in India (Bt cotton), and the balance of 200,000 in the Philippines (biotech maize), South Africa (biotech cotton, maize and soybeans often grown by subsistence women farmers) and the other eight developing countries which grew biotech crops in 2008. **The largest increase in the number of beneficiary farmers in 2008 was in India where an additional 1.2 million more small farmers planted Bt cotton which now occupies 82% of total cotton, up from 66% in 2007. 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.**

Up to 10 million more small and resource-poor farmers may be secondary beneficiaries of Bt cotton in China

A 2008 seminal paper by Wu *et al.* reports that the use of Bt cotton to control cotton bollworm in six northern provinces in China was associated with up to a substantial ten-fold suppression of cotton

bollworm infestations in crops other than cotton, which are also hosts of cotton bollworm; these crops include, maize, soybean, wheat, peanuts, vegetables, and other crops. In contrast to cotton, which occupies 3 million hectares farmed by 5 million farmers in the six provinces, these other crops occupy a much larger area of 22 million hectares and are farmed by 10 million farmers. **The initial findings reported by Wu *et al.*, could be important for two reasons. Firstly, Bt cotton may have a broader and more significant impact than its documented direct impact on the cotton crop. Secondly, the findings may also apply to other countries, such as India, where small and resource-poor farmers practice similar mixed cropping systems and where there is, like China, extensive adoption of Bt cotton to control bollworm.**

Biotech crops have improved the income and quality of life of small resource-poor farmers and their families and contributed to the alleviation of their poverty – case studies are cited from India, China, South Africa, and the Philippines

In India in 2008, 5 million small farmers, (up from 3.8 million farmers in 2007) benefited from planting 7.6 million hectares of Bt cotton, equivalent to a high adoption rate of 82%. Benefits will vary according to varying pest infestation levels in different years and locations. However, on average, conservative estimates for small farmers indicate that yield increased by 31%, insecticide application decreased by 39%, and profitability increased by 88% equivalent to US\$250 per hectare. In addition, in contrast to the families of farmers planting conventional cotton, families of Bt cotton farmers enjoyed emerging welfare benefits including more prenatal care and assistance with at-home births for women, plus a higher school enrollment of their children, a higher percentage of whom were vaccinated.

In China, based on studies conducted by the Center for Chinese Agricultural Policy (CCAP), it was concluded that, on average, small farmers adopting Bt cotton increased yield by 9.6%, reduced insecticide use by 60%, with positive implications for both the environment and the farmers' health, and generated a substantial US\$220/ha increase in income which made a significant contribution to their livelihood as the income of many cotton farmers can be as low as US\$1 per day. In China in 2008, 7.1 million small and resource-poor farmers benefited from Bt cotton.

In South Africa, a study published in 2005 involved 368 small and resource-poor farmers and 33 commercial farmers, the latter divided into irrigated and dry land maize production systems. The data indicated that under irrigated conditions, Bt maize resulted in an 11% higher yield (from 10.9 MT to 12.1 MT/ha), a cost savings in insecticides of US\$18/ha equivalent to a 60% cost reduction, and an increase income of US\$117/hectare. Under rainfed conditions, Bt maize resulted in an 11% higher yield (from 3.1 to 3.4 MT/ha), a cost saving on insecticides of US\$7/ha equivalent to a 60% cost reduction, and an increased income of US\$35/hectare.

In the Philippines at least 200,000 small farmers gained from biotech maize in 2008. A socio-economic impact study reported that for small farmers, **the additional farm income from Bt maize was 7,482 pesos (about US\$135) per hectare during the dry season and 7,080 pesos (about US\$125) per hectare during the wet season of the 2003-2004 crop year.** Using data from the 2004-2005 crop years, it was determined that Bt maize could provide an overall income advantage that ranged from 5 to 14% during the wet season and 20 to 48% during the dry season. Overall, the four studies, which examined net farm income as well as other indicators, confirmed the positive impact of Bt maize on small and resource-poor farmers and maize producers generally in the Philippines.

Five principal developing countries China, India, Argentina, Brazil and South Africa are exerting leadership, and driving global adoption of biotech crops – benefits from biotech crops are spurring strong political will and substantial new investments in biotech crops

The five principal developing countries committed to biotech crops, span all three continents of the South; they are India and China in Asia, Argentina and Brazil in Latin America and South Africa on the African continent – collectively they represent 2.6 billion people or 40% of the global population, with a combined population of 1.3 billion who are completely dependent on agriculture, including millions of small and resource poor farmers and the rural landless, who represent the majority of the poor in the world. The increasing collective impact of the five principal developing countries is an important continuing trend with implications for the future adoption and acceptance of biotech crops worldwide. The five countries are reviewed in detail in Brief 39 including extensive commentaries on the current adoption of specific biotech crops, impact and future prospects. Research and Development investments in crop biotechnology in these countries are substantial, even by multinational company standards. Notably in 2008, China committed an additional US\$3.5 billion over twelve years with Premier Wen Jiabao (Chairman of the State Council/Cabinet of China) expressing China's strong political will for the technology when addressing the Chinese Academy of Sciences in June 2008 said, *"to solve the food problem, we have to rely on big science and technology measures, rely on biotechnology, rely on GM."* Dr. Dafang Huang, former Director of the Biotechnology Research Institute of the Chinese Academy of Agricultural Sciences (CAAS) concluded that *"Using GM rice is the only way to meet the growing food demand"*.

President Luis Inacio Lula da Silva of Brazil has also demonstrated the same strong political will for biotech crops and committed public funds of the same order of magnitude as China with several of its own products being advanced for approval through Brazil's national agricultural research organization, EMBRAPA. Similarly, India is investing approximately US\$300 million additional public funding to support its stable of approximately 15 biotech crops, the first of which, a public sector developed Bt cotton variety, was approved in 2008. Political will and support for biotech crops in India is high as evidenced by the following statement by India's Minister of Finance Dr. P. Chidambaram, who called for an emulation of the remarkable Indian biotech Bt cotton success story in the area of food crops to make the country self sufficient in its food needs. *"It is important to apply biotechnology in agriculture. What has been done with Bt cotton must be done with food grains"* (Chidambaram, 2007). It is notable that the strategically important concept of South-South collaboration is already being realized between China and India with the first Bt cotton developed by China, already being marketed and adopted in India; this is a first indication of a very important new trend that is of great significance.

Due to their potential for producing more affordable food and for mitigating some of the challenges associated with climate change, biotech crops are, also gaining increased political support from global political organizations.

- **G8 members meeting in Hokkaido Japan in July 2008** recognized for the first time the significance of the important role that biotech crops can play in food security. The G8 leaders' statement on biotech crops reads as follows, *"accelerate research and development and increase access to new agricultural technologies to boost agriculture production; we will promote science-based risk analysis, including on the contribution of seed varieties developed through biotechnology."*
- The European Commission stated that *"GM crops can play an important role in mitigating the effects of the food crisis."*
- The World Health Organization (WHO) has emphasized the importance of biotech crops because of their potential to benefit the public health sector by providing more nutritious food, decreasing its allergenic potential and also improving the efficiency of production systems.

All seven EU countries increased their Bt maize hectareage in 2008, resulting in an overall increase of 21% to reach over 100,000 hectares

In 2008, seven of the 27 countries in the European Union officially planted Bt maize on a commercial basis. The total hectareage for the seven countries increased from 88,673 hectares in 2007 to 107,719 hectares in 2008; this is equivalent to a 21% year-on-year increase equivalent to 19,046 hectares. **The seven EU countries listed in order of biotech hectareage of Bt maize were Spain, Czech Republic, Romania, Portugal, Germany, Poland and Slovakia.**

Contribution of biotech crops to Sustainability – the multiple contributions of biotech crops have enormous potential

The World Commission on the Environment and Development defined sustainable development as follows: **“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”**

To-date, biotech crops have contributed to sustainable development in several significant ways, listed and summarized below:

1. Contributing to food security and more affordable food (lower prices)
2. Conserving biodiversity.
3. Contributing to the alleviation of poverty and hunger
4. Reducing agriculture’s environmental footprint
5. Mitigating climate change and reducing greenhouse gases (GHG)
6. Contributing to the cost-effective production of biofuels
7. Contributing to sustainable economic benefits

1. Contributing to food security and more affordable food (lower prices)

Biotech crops can play an important role by contributing to food security and more affordable food through increasing supply (by increasing productivity per hectare) and coincidentally decreasing cost of production (by a reduced need for inputs, less ploughing and fewer pesticide applications) which in turn also requires less fossil fuels for tractors, thus mitigating some of the negative aspects associated with climate change. **Of the economic gains of US\$44 billion during the period 1996 to 2007, 44% were due to substantial yield gains, and 56% due to a reduction in production costs.** In 2007, the total crop production gains globally for the 4 principal biotech crops (soybean, maize, cotton and canola) was 32 million metric tons, which would have required 10 million additional hectares had biotech crops not been deployed. The 32 million metric tons of increased crop production from biotech crops in 2008 comprised 15.1 million tons of maize, 14.5 million tons of soybean, 2.0 million tons of cotton lint and 0.5 million tons of canola. For the period 1996-2007 the production gains were 141 million tons which (at 2007 average yields) would have required 43 million additional hectares had biotech crops not been deployed (Brookes and Barfoot, 2009, forthcoming)¹. Thus, biotechnology has already made a contribution to higher productivity and lower costs of production of current biotech crops, and has enormous potential for the future when the staples of rice and wheat, as well as pro-poor food crops such as cassava will benefit from biotechnology.

Progress with control of abiotic stresses is expected in the near term with drought tolerance becoming available by 2012, or earlier in the USA and in Sub Saharan Africa by 2017 where maize is the staple food.

¹ Brookes, G. and P. Barfoot. 2009. *GM Crops: Global Socio-economic and Environmental Impacts 1996-2007*. P.G. Economics Ltd, Dorchester, UK. forthcoming.

Rice, the most important food crop of the poor in the world, offers a unique opportunity for increasing supply and hence cheaper food (Bt rice) and also for providing more nutritious food (high pro-vitamin A Golden Rice). **Biotech rice, awaiting approval in China has enormous potential to coincidentally contribute to food security, lower food prices and alleviation of poverty.**

2. Conserving biodiversity

Biotech crops are a land-saving technology, capable of higher productivity on the current 1.5 billion hectares of arable land, and thereby can help preclude deforestation and protect biodiversity in forests and in other in-situ biodiversity sanctuaries. **Approximately 13 million hectares of biodiversity-rich forests are lost in developing countries annually.** During the period 1996 to 2007 biotech crops have already precluded the need for an additional area of 43 million hectares of crop land, and the potential for the future is enormous.

3. Contributing to the alleviation of poverty and hunger

Fifty percent of the world's poorest people are small and resource-poor farmers, and another 20% are the rural landless completely dependent on agriculture for their livelihoods. Thus, increasing income of small and resource-poor farmers contributes directly to the poverty alleviation of a large majority (70%) of the world's poorest people. **To-date, biotech cotton in India, China and South Africa and biotech maize in the Philippines and South Africa have already made a significant contribution to the income of over 12 million poor farmers, and this can be enhanced significantly in the remaining 7 years of the second decade of commercialization, 2006 to 2015.** Of special significance is biotech rice which has the potential to benefit 250 million poor rice households in Asia, (up to 1 billion people based on 4 members per household) growing on average only half a hectare of rice with an income as low as US\$1 per day – they are some of the poorest people in the world.

It is evident that much progress has been made in the first thirteen years of commercialization of biotech crops, but progress to-date is just the “tip of the iceberg” compared with potential progress in the second decade of commercialization, 2006-2015. It is a fortunate coincidence that the last year of the second decade of commercialization of biotech crops, 2015 is also the year of the Millennium Development Goals (MDG). **This offers a unique opportunity for the global biotechnology community, from the North and the South, the public and the private sectors, to define in 2009 the contributions that biotech crops can make to the Millennium Development Goals and a more sustainable agriculture in the future** – this gives the global biotech crop community seven years to work towards implementing an action plan for biotech crops that can deliver on the MDG goals of 2015.

4. Reducing agriculture's environmental footprint

Conventional agriculture has impacted significantly on the environment and biotechnology can be used to reduce the environmental footprint of agriculture. **Progress in the first decade includes a significant reduction in pesticides, saving on fossil fuels, and decreasing CO₂ emissions through no/less ploughing, and conserving soil and moisture by optimizing the practice of no till through application of herbicide tolerance.** The accumulative reduction in pesticides for the period 1996 to 2007 was estimated at 359,000 metric tons of active ingredient (a.i.), a saving of 9% in pesticides, which is equivalent to a 17.2% reduction in the associated environmental impact of pesticide use on these crops, as measured by the Environmental Impact Quotient (EIQ) – a composite measure based on the various factors contributing to the net environmental impact of an individual active ingredient. **The corresponding data for 2007 alone was a reduction of 77,000 metric tons a.i.** (equivalent to a saving of 18% in pesticides) and a reduction of 29% in EIQ (Brooks and Barfoot, 2009, forthcoming).

Increasing efficiency of water usage will have a major impact on conservation and availability of water globally. Seventy percent of fresh water is currently used by agriculture globally, and this is obviously not sustainable in the future as the population increases by almost 50% to 9.2 billion by 2050. The first biotech maize hybrids with a degree of drought tolerance are expected to be commercialized by 2012, or earlier in the USA in the more drought-prone states of Nebraska and Kansas where yield increases of 8 to 10% are projected. Notably, the first tropical drought tolerant biotech maize is expected by 2017 for Sub Saharan Africa. The advent of drought tolerance in temperate maize in the industrial countries will be a major milestone and will be of even greater significance in tropical maize in Sub Saharan Africa, Latin America and Asia. Drought tolerance has also been incorporated in several other crops including wheat, which has performed well in initial field trials in Australia, with the best lines yielding 20% more than their conventional counterparts. **Drought tolerance is expected to have a major impact on more sustainable cropping systems worldwide, particularly in developing countries where drought is more prevalent and severe than industrial countries.**

5. Mitigating climate change and reducing greenhouse gases (GHG)

The important and urgent concerns about the environment have implications for biotech crops, which can contribute to a reduction of greenhouse gases and help mitigate climate change in two principal ways. First, permanent savings in carbon dioxide emissions through reduced use of fossil-based fuels, associated with fewer insecticide and herbicide sprays; in 2007, this was an estimated saving of 1.1 billion kg of carbon dioxide (CO₂), equivalent to reducing the number of cars on the roads by 0.5 million. Secondly, additional savings from conservation tillage (need for less or no ploughing facilitated by herbicide tolerant biotech crops) for biotech food, feed and fiber crops, led to an additional soil carbon sequestration equivalent in 2007 to 13.1 billion kg of CO₂, or removing 5.8 million cars off the road. **Thus in 2007, the combined permanent and additional savings through sequestration was equivalent to a saving of 14.2 billion kg of CO₂ or removing 6.3 million cars from the road** (Brookes and Barfoot, 2009, forthcoming).

Droughts, floods, and temperature changes are predicted to become more prevalent and more severe, and hence there will be a **need for faster crop improvement programs to develop varieties and hybrids that are well adapted to more rapid changes in climatic conditions.** Several biotech tools, including tissue culture, diagnostics, genomics, molecular marker-assisted selection (MAS) and genetic engineering of crops can be used collectively for '**speeding the breeding**' and help mitigate the effects of climate change. Biotech crops are already contributing to reducing CO₂ emissions by precluding the need for ploughing a significant portion of cropped land, conserving soil and particularly moisture, reducing pesticide spraying as well as sequestering CO₂.

6. Contributing to the cost-effective production of biofuels

Biotechnology can be used to cost-effectively optimize the productivity of biomass/hectare of first generation food/feed and fiber crops and also second-generation energy crops. This can be achieved by developing crops tolerant to abiotic stresses (drought, salinity, extreme temperatures) and biotic stresses (pests, weeds, diseases), and also to raise the ceiling of potential yield per hectare through modifying plant metabolism. There is also an opportunity to utilize biotechnology to develop more effective enzymes for the downstream processing of biofuels. In the USA, Ceres has just released biotech-based non-transgenic hybrids of switchgrass and sorghum with increased cellulose content for ethanol production and has transgenic varieties under development.

7. Contributing to sustainable economic benefits

The most recent survey of the global impact of biotech crops for the period 1996 to 2007 (Brookes and Barfoot 2009, forthcoming), estimates that **the global net economic benefits to biotech crop farmers**

in 2007 alone was US\$10 billion (US\$6 billion for developing countries and US\$4 billion for industrial countries). The accumulated benefits during the period 1996 to 2007 was US\$44 billion with US\$22 billion each for developing and industrial countries. These estimates include the very important benefits associated with the double cropping of biotech soybean in Argentina.

In summary, collectively the above seven thrusts represent a significant contribution of biotech crops to sustainability and the potential for the future is enormous.

National economic growth – potential contribution of biotech crops in agricultural-based countries and transforming developing countries

The 2008 World Bank Development Report “Agriculture for Development” (World Bank, 2008)² notes that two-thirds of the world’s agricultural added-value is created in developing countries, where agriculture is an important sector. The report classified countries into three categories: **a) Agricultural-based countries** where agriculture on average contributes one-third of GDP, and employs two-thirds of the labor force. **This category has over 400 million poor people, mainly in Sub Saharan Africa and over 80% of the poor are involved in agriculture.** **b) The transforming countries** – this category includes China, India, Indonesia and Romania. **On average, agriculture contributes 7% to GDP but over 80% of the poor are in the rural areas, with most of them involved in agriculture. This category has 2.2 billion rural people.** About 98% of the enormous rural population of South Asia, 96% of East Asia and the Pacific and 92% of the Middle East and North Africa are in transforming countries. **c) Urbanized countries** are the category where agriculture is least important, contributing 5% or less to GDP, and where poverty is mostly urban.

In the absence of agricultural growth, national economic growth is not possible in the agricultural-based countries and plays a critical role in the transforming countries where there is a rural population of 2.2 billion, mainly involved in agriculture and representing over 80% of the poor. The World Bank report concluded that, *“Using agriculture as the basis for economic growth in the agricultural based countries requires a productivity revolution in small holder farming.”* Crops are the principal source of food, feed and fiber globally producing approximately 6.5 billion metric tons annually. The annals of history confirm that technology can make a substantial contribution to crop productivity and production and spur rural economic growth. The best examples are the introduction of the new technology of hybrid maize in the USA in the 1930s, and the green revolution for rice and wheat in the developing countries, particularly Asia, in the 1960s. The semi-dwarf wheat was the new technology that provided the engine of rural and national economic growth during the green revolution of the 1960s, which saved 1 billion people from hunger and for which Norman Borlaug was awarded the Nobel Peace Prize in 1970. Today, at 94 years young Norman Borlaug is again the most credible advocate for the new technology of biotech crops and is an enthusiastic patron of ISAAA.

The biotech Bt rice already developed and field tested in China has the potential to increase net income by approximately US\$100 per hectare for the 110 million poor rice households in China, equivalent to 440 million people, based on an average of 4 per household in the rural areas of China. **In summary, biotech crops have already demonstrated their capacity to increase productivity and income significantly and hence can serve as an engine of rural economic growth that can contribute to the alleviation of poverty for the world’s small and resource-poor farmers during a global financial crisis.**

² World Bank. 2008. *The World Development Report, Agriculture for Development*. World Bank, Washington DC.

In 2008, more than half the world's population lived in the 25 countries, which planted 125 million hectares of biotech crops, equivalent to 8% of the 1.5 billion hectares of all the cropland in the world

More than half (55% or 3.6 billion people) of the global population of 6.6 billion live in the 25 countries where biotech crops were grown in 2008 and generated significant and multiple benefits worth over US\$10 billion globally in 2007. Notably, more than half (52% or 776 million hectares) of the 1.5 billion hectares of cropland in the world is in the 25 countries where approved biotech crops were grown in 2008. **The 125 million hectares of biotech crops in 2008 represent 8% of the 1.5 billion hectares of cropland in the world.**

Need for appropriate cost/time-effective regulatory systems that are responsible, rigorous and yet not onerous, requiring only modest resources that are within the means of most developing countries

The most important constraint to the adoption of biotech crops in most developing countries, that deserves highlighting, is the lack of appropriate cost/time-effective and responsible regulation systems that incorporate all the knowledge and experience of 13 years of regulation. **Current regulatory systems in most developing countries are usually unnecessarily cumbersome and in many cases it is impossible to implement the system to approve products which can cost up to US\$1 million or more to deregulate – this is beyond the means of most developing countries.** The current regulatory systems were designed more than ten years ago to meet the initial needs of industrial countries dealing with a new technology and with access to significant resources for regulation which developing countries simply do not have – **the challenge for developing countries is “how to do a lot with little.”** With the accumulated knowledge of the last thirteen years it is now possible to design appropriate regulatory systems that are responsible, rigorous and yet not onerous, requiring only modest resources that are within the means of most developing countries – this should be assigned top priority.

Today, unnecessary and unjustified stringent standards designed to meet the needs of resource-rich industrial countries are denying the developing countries timely access to products such as Golden Rice, whilst millions die unnecessarily in the interim. **This is a moral dilemma, where the demands of regulatory systems have become “the end and not the means”.** Malawi in Southern Africa is one of many countries that are becoming increasingly aware of the critical need for an appropriate effective regulatory framework and a national biotechnology policy. **President Bingu Wa Mutharika, of Malawi who is also the Minister for Education, Science and Technology** chaired the cabinet meeting in July 2008 that approved the National Biotechnology Policy, which in conjunction with the Biosafety Act of 2002, provides a regulatory framework for effective implementation of biotechnology programs and activities in Malawi. In a foreword to the policy, the President said, *“government recognized the pivotal role biotechnology can play towards economic growth and poverty reduction.”* He said, *“biotechnology will facilitate Malawi’s speedy attainment of capacity to be food secure, create wealth and achieve socio-economic development as stipulated in the Malawi Growth and Development Strategy (MGDS) and Vision 2020.”* The Policy provides an enabling framework to promote and regulate the development, acquisition and deployment of relevant biotechnology products to reposition Malawi from being a predominantly importing and consuming economy to a manufacturing and exporting one. It therefore creates a conducive environment that allows biotechnology business to flourish. With the Biosafety Act already in place the approval of the policy is designed to hasten the country’s plans to advance biotech crops.

Drought tolerance in conventional and biotech maize - an emerging reality

Given the pivotal importance of drought tolerance, ISAAA invited Dr. Greg O. Edmeades, former leader of the maize drought program at CIMMYT, to contribute a timely global overview on the status of drought tolerance

in maize, in both conventional and biotech approaches, in the private and public sector, and to discuss future prospects in the near, mid and long term. The contribution by G. O. Edmeades, **“Drought tolerance in maize: an emerging reality”**, supported by key references, is included in Brief 39 as a special feature to highlight the enormous global importance of the drought tolerance trait, which virtually no crop or farmer in the world can afford to be without; using water at current rates when the world will have to support 9 billion people or more in 2050, is simply not sustainable. **Drought tolerance conferred through biotech crops is viewed as the most important trait that will become available in the second decade of commercialization, 2006 to 2015, and beyond, because it is by far the single most important constraint to increased productivity for crops worldwide. Drought tolerant biotech/transgenic maize, is the most advanced of the drought tolerant crops under development, and is expected to be launched commercially in the USA in 2012, or earlier. Notably, a Private/Public sector partnership hopes to release the first biotech drought tolerant maize by 2017 in Sub Saharan Africa where the need for drought tolerance is greatest.**

Biofuel production in the USA in 2008

In the USA in 2008, biofuel production was mainly ethanol from maize, with some biodiesel from oil crops. It is estimated that production from 29% of the total maize area in the USA in 2008 was used for ethanol, up from 24% in 2007. Accordingly, it is estimated that in 2008, 8.7 million hectares of biotech maize was devoted to ethanol production, up from 7 million hectares in 2007. Corresponding estimates for biodiesel indicate that approximately 3.5 million hectares of biotech soybean (7% of total biotech soybean plantings) was used for biodiesel production in 2008 plus an estimated 5,000 hectares of canola. Estimates for biodiesel production from biotech soybean in Brazil were not available. Thus, in total 12.2 million hectares of biotech crops were used for biofuel production in the USA in 2008.

Number of products approved globally for planting and import – 25 countries have approved planting and another 30 have approved import for a total of 55 countries

While 25 countries planted commercialized biotech crops in 2008, an additional 30 countries, totaling 55, have granted regulatory approvals for biotech crops for import for food and feed use and for release into the environment since 1996. A total of 670 approvals have been granted for 144 events for 24 crops. Thus, biotech crops are accepted for import for food and feed use and for release into the environment in 30 countries, including major food importing countries like Japan, which do not plant biotech crops. Of the 55 countries that have granted approvals for biotech crops, Japan tops the list followed by USA, Canada, Mexico, South Korea, Australia, Philippines, New Zealand, the European Union and China. Maize has the most events approved (44) followed by cotton (23), canola (14), and soybean (8). The event that has received regulatory approval in most countries is the herbicide tolerant soybean event GTS-40-3-2 with 23 approvals (EU=27 counted as 1 approval only), followed by insect resistant maize (MON810) and herbicide tolerant maize (NK603) both with 21 approvals, and insect resistant cotton (MON531/757/1076) with 16 approvals worldwide. An up-to-date listing of all 670 approvals is detailed in Appendix 1 of Brief 39. It is notable that in 2008 both Japan and South Korea imported biotech maize for use as food for the first time. The stimulus for this was the unaffordability of the premium price for conventional maize versus biotech maize. The approvals by Japan and South Korea may be the forerunners of similar decisions by other countries importing biotech maize, including the EU.

The Global Value of the Biotech Crop Market – it was valued at US\$7.5 billion in 2008 with an accumulated value of US\$50 billion for the period 1996 to 2007

In 2008, the global market value of biotech crops, estimated by Croppros, was US\$7.5 billion, (up from US\$6.9 billion in 2007) representing 14% of the US\$52.72 billion global crop protection market in 2008, and 22% of the

approximately US\$34 billion 2008 global commercial seed market. The 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 twelve-year period, since biotech crops were first commercialized in 1996, is estimated at US\$49.8 billion, which when rounded off to US\$50 billion is a historical landmark for the global biotech crop market. The global value of the biotech crop market is projected at approximately US\$8.3 billion for 2009.

Future Prospects

Outlook for the remaining seven years of the second decade of commercialization of biotech crops, 2006 to 2015

The future adoption of biotech crops in developing countries in the period 2009 to 2015 will be dependent mainly on a troika of major issues: first, establishment and effective operation of appropriate, responsible and cost/time-effective regulatory systems; second, strong political will and support for the adoption of biotech crops that can contribute to a more affordable and secure supply of food, feed, and fiber – suffice to note that in 2008 broad and substantial political will was evident for biotech crops, particularly in developing countries; and third, a continuing and expanding supply of appropriate biotech crops that can meet the priority needs of more developing countries in Asia, Latin America and Africa.

The outlook for biotech crops in the remaining 7 years of the second decade of commercialization, 2006 to 2015 looks promising. In 2005, ISAAA projected that the number of biotech crop countries, hectareage and beneficiary farmers would all double by 2015 with the potential for number of farmers ranging from a minimum of 20 million to multiples thereof, depending on when biotech rice is first approved. From 2009 to 2015, 15 or more biotech crop countries are projected to plant biotech crops for the first time, taking the total number of biotech crop countries globally to 40 in 2015, in line with the 2005 ISAAA projection. These new countries may include three to four in Asia; three to four in eastern and southern Africa; three to four in West Africa; and one to two in North Africa and the Middle East. In Latin/Central America and the Caribbean nine countries are already commercializing biotech crops, leaving less room for expansion, however there is a possibility that two or three countries from this region may plant biotech crops for the first time between now and 2015. In eastern Europe, up to six new biotech countries is possible, including Russia, which has a biotech potato at an advanced stage of development, which also has potential in several countries in eastern Europe. Western Europe is more difficult to predict because the biotech crop issues in Europe are not related to science and technology considerations but are of a political nature and influenced by ideological views of activist groups.

The comparative advantage of biotech crops to produce more affordable and better quality food to ensure a safe and secure supply of food globally augurs well for a doubling of hectareage to 200 million hectares of biotech crops by 2015 for two principal reasons.

Firstly, there is considerable potential for increasing the biotech adoption rate of the four current large hectareage biotech crops (maize, soybean, cotton, and canola), which collectively represented 125 million hectares of biotech crops in 2008 out of a total potential hectareage of 315 million hectares; this leaves almost 200 million hectares for potential adoption with biotech crops. Deployment of biotech rice as a crop and drought tolerance as a trait are considered seminal for catalyzing the further adoption of biotech crops globally. In contrast to the first generation biotech crops that realized a significant increase in yield and production by protecting crops from losses caused by pests, weeds, and diseases, the second generation biotech crops will offer farmers additional new incentives for further increasing yield. RR2 soybean, to be launched in 2009, is the first of many such second-generation products. RR2 will further enhance yield by 7 to 11% as a result of genes that code for

increased yield *per se*. Quality traits will also become more prevalent providing a much richer mix of traits for deployment in conjunction with a growing number of input traits.

Secondly, between now and 2015, there will be several new biotech crops that will occupy small, medium and large hectares globally and featuring both agronomic and quality traits as single and stacked trait products. By far, the most important of the new biotech crops that are now ready for adoption is biotech rice: principally the pest/disease resistant biotech rice extensively field tested in China and awaiting approval by the Chinese regulatory authorities; and Golden Rice expected to be available in 2012. Rice is unique even amongst the three major staples (rice, wheat and maize) in that it is the most important food crop in the world and more importantly, it is the most important food crop of the poor in the world. Over 90% of the world's rice is grown and consumed in Asia by some of the poorest people in the world – the 250 million Asian households/families whose resource-poor rice farmers cultivate on average a meager half a hectare of rice. Several other medium hectare crops are expected to be approved before 2015 including: potatoes with pest and/or disease resistance and modified quality for industrial use; sugarcane with quality and agronomic traits; and disease resistant bananas. Some biotech orphan crops are also expected to become available. For example, Bt eggplant may become available as the first biotech food crop in India within the next 12 months and has the potential to benefit up to 1.4 million small and resource-poor farmers. Vegetable crops such as biotech tomato, broccoli, cabbage and okra which require heavy applications of insecticides (which can be reduced substantially by a biotech product) are also under development. Pro-poor biotech crops such as biotech cassava, sweet potato, pulses and groundnut are also candidates. It is noteworthy that several of these products are being developed by public sector national or international institutions in the developing countries. The development of this broad portfolio of new biotech crops augurs well for the continued global growth of biotech crops, which ISAAA projected to reach 200 million hectares by 2015, grown by 20 million farmers, or more.

The second decade of commercialization, 2006-2015, is likely to feature significantly more growth in Asia and Africa compared with the first decade, which was the decade of the Americas, where there will be continued vital growth in stacked traits, particularly in North America, and strong growth in Brazil. Adherence to good farming practices with biotech crops, such as rotations and resistance management, will remain critical, as it has been during the first decade. Continued responsible stewardship must be practiced, particularly by the countries of the South, which will be the major new deployers of biotech crops in the second decade of commercialization of biotech crops, 2006 to 2015. The use of biotechnology to increase efficiency of first generation food/feed crops and second-generation energy crops for biofuels presents both opportunities and challenges. **Whereas biofuel strategies must be developed on a country-by-country basis, food security should always be assigned the first priority and should never be jeopardized by a competing need to use food and feed crops for biofuel.** Injudicious use of the food/feed crops, sugarcane, cassava and maize for biofuels in food insecure developing countries could jeopardize food security goals if the efficiency of these crops cannot be increased through biotechnology and other means, so that food, feed and fuel goals can all be adequately met. The key role of crop biotechnology in the production of biofuels is to cost-effectively optimize the yield of biomass/biofuel per hectare, which in turn will provide more affordable fuel. However, by far the most important potential role of biotech crops will be their contribution to the humanitarian Millennium Development Goals (MDG) of ensuring a secure supply of affordable food and the reduction of poverty and hunger by 50% by 2015.

The 2008 World Bank Development Report emphasized that, *“Agriculture is a vital development tool for achieving the Millennium Development Goals that calls for halving by 2015 the share of people suffering from extreme poverty and hunger”* (World Bank, 2008). The Report notes that three out of every four people in developing countries live in rural areas and most of them depend directly or indirectly on agriculture for their livelihoods. **It recognizes that overcoming abject poverty cannot be achieved in Sub Saharan**

Africa without a revolution in agricultural productivity for the millions of suffering subsistence farmers in Africa, most of them women. However, it also draws attention to the fact that Asia's fast growing economies, where most of the wealth of the developing world is being created, are also home to 600 million rural people (compared with the 800 million total population of Sub Saharan Africa) living in extreme poverty, and that rural poverty in Asia will remain life-threatening for millions of rural poor for decades to come. It is a stark fact of life that poverty today is a rural phenomenon where 70%, of the world's poorest people are small and resource-poor farmers and the rural landless labor that live and toil on the land. The big challenge is to transform this problem of a concentration of poverty in agriculture into an opportunity for alleviating poverty by sharing with resource-poor farmers the knowledge and experience of those from industrial and developing countries which have successfully employed biotech crops to increase crop productivity, and in turn, income. The World Bank Report recognizes that the revolution in biotechnology and information offer unique opportunities to use agriculture to promote development, but cautions that there is a risk that fast-moving crop biotechnology can easily be missed by developing countries if the political will and international assistance support is not forthcoming, particularly for the more controversial application of biotech/GM crops which is the focus of this ISAAA Brief. **It is encouraging to witness the growing "political will" for biotech crops at the G8 international level and at the national level in developing countries. This growing political will and conviction of visionaries and lead farmers for biotech crops is particularly evident in several of the lead developing countries highlighted in this Brief. Failure to provide the necessary political will and support for biotech crops at this time will risk many developing countries missing out on a one-time window of opportunity and as a result become permanently disadvantaged and non-competitive in crop productivity. This has dire implications for the hope of alleviating poverty for up to 1 billion resource-poor farmers and the rural landless whose livelihoods, and indeed survival, is largely dependent on improved yields of crops which are the principal source of food and sustenance for over 5 billion people in the developing world, a significant proportion of whom are extremely poor and desperately hungry – a situation that is morally unacceptable in a just society.**



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