ISAAA
International Service for the Acquisition of Agri-biotech Applications

EXECUTIVE SUMMARY

BRIEF 46

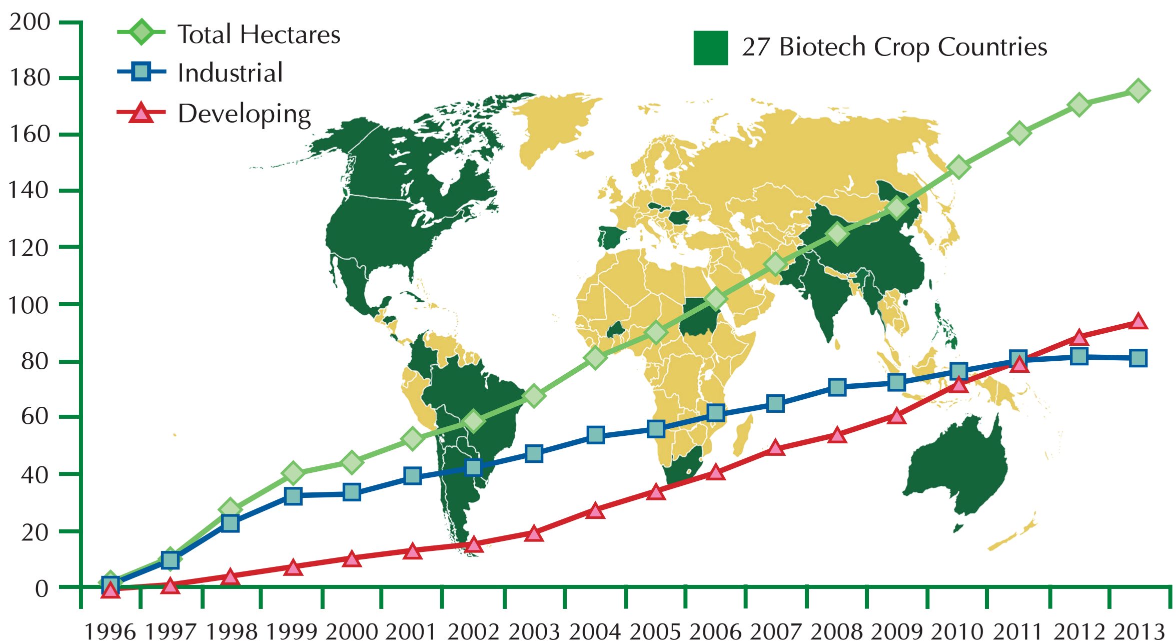
Global Status of Commercialized Biotech/GM Crops: 2013

By

Clive James
Founder and Emeritus Chair of ISAAA

Dedicated to the late Nobel Peace Laureate, Norman Borlaug,
founding patron of ISAAA, on the centenary of his birth, 25 March 2014

GLOBAL AREA OF BIOTECH CROPS
Million Hectares (1996-2013)



A record 18 million farmers, in 27 countries, planted 175.2 million hectares (433 million acres) in 2013, a sustained increase of 3% or 5 million hectares (12 million acres) over 2012.

Source: Clive James, 2013.

No. 46 - 2013

AUTHOR'S NOTE:

Global totals of millions of hectares planted with biotech crops have been rounded off to the nearest million and similarly, subtotals to the nearest 100,000 hectares, using both < and > characters; 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 2013 information for Argentina, Brazil, Australia, South Africa, and Uruguay is hectares usually planted in the last quarter of 2013 and harvested in the first quarter of 2014 with some countries like the Philippines having more than one season per year. Thus, for countries of the Southern hemisphere, such as Brazil, Argentina and South Africa the estimates are projections, and thus are always subject to change due to weather, which may increase or decrease actual planted hectares 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 2013 and more intensively through January and February 2014 is classified as a 2013 crop in this Brief consistent with a policy which uses the first date of planting to determine the crop year. ISAAA is a not-for-profit organization, sponsored by public and private sector organizations. All biotech crops hectare estimates reported in all ISAAA publications are only counted once, irrespective of how many traits are incorporated in the crops. Importantly, all reported biotech crop hectares are for officially approved and planted products, and do not include unofficial plantings of any biotech crops. Details of the references listed in the Executive Summary are found in the full Brief 46.

EXECUTIVE SUMMARY

BRIEF 46

Global Status of Commercialized Biotech/GM Crops: 2013

By

Clive James
Founder and Emeritus Chair of ISAAA

Dedicated to the late Nobel Peace Laureate, Norman Borlaug,
founding patron of ISAAA, on the centenary of his birth, 25 March 2014

ISAAA prepares this Brief and supports its free distribution to developing countries. The objective is to provide information and knowledge to the scientific community and society on biotech/GM crops to facilitate a more informed and transparent discussion regarding their potential role in contributing to global food, feed, fiber and fuel security, and a more sustainable agriculture. The author takes full responsibility for the views expressed in this publication and for any errors of omission or misinterpretation.

Published by: The International Service for the Acquisition of Agri-biotech Applications (ISAAA).

Citation: James, Clive. 2013. Global Status of Commercialized Biotech/GM Crops: 2013. *ISAAA Brief* No. 46. ISAAA: Ithaca, NY.

ISBN: 978-1-892456-55-9

Publication Orders: Please contact the ISAAA *SEAsia*Center to acquire a hard copy of the full version of Brief 46, including the Executive Summary and the Top Ten Facts at http://www.isaaa.org. The publication is available free of charge to eligible nationals of developing countries.

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
105 Leland Lab
Cornell University
Ithaca NY 14853, U.S.A.

ISAAA *Afri*Center
PO Box 70, ILRI Campus
Old Naivasha Road
Uthiru, Nairobi 00605
Kenya

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

Electronically: or email to info@isaaa.org

For Executive Summaries of all *ISAAA Briefs,* please visit http://www.isaaa.org

EXECUTIVE SUMMARY

Global Status of Commercialized Biotech/GM Crops: 2013

Table of Contents

EXECUTIVE SUMMARY

Global Status of Commercialized Biotech/GM Crops: 2013

By

Clive James, Founder and Emeritus Chair of ISAAA

Dedicated to the late Nobel Peace Laureate, Norman Borlaug, founding patron of ISAAA, on the centenary of his birth, 25 March 2014

Biotech Crop hectares continue to grow and exceed 175 million hectares in 2013, with both large and small developing countries, exerting more global leadership

Introduction

This Executive Summary focuses on the highlights of ISAAA Brief 46, details of which are presented and discussed in the full Brief, "Global Status of Commercialized Biotech/GM Crops: 2013".

Biotech crops increase in 2013 in their 18th consecutive year of commercialization.

A record 175.2 million hectares of biotech crops were grown globally in 2013, at an annual growth rate of 3%, up 5 million from 170 million hectares in 2012. This year, 2013, was the 18th year of commercialization, 1996-2013, when growth continued after a remarkable 17 consecutive years of increases; notably 12 of the 17 years were double-digit growth rates.

Biotech crops fastest adopted crop technology

The global hectarage of biotech crops have increased more than 100-fold from 1.7 million hectares in 1996 to over 175 million hectares in 2013 – this makes biotech crops the fastest adopted crop technology in recent history. This adoption rate speaks for itself in terms of its resilience and the benefits it delivers to farmers and consumers.

Millions of risk-averse farmers, both large and small, world-wide, have determined that the returns from planting biotech crops are high, hence repeat planting is virtually 100% which is the acid-test applied by farmers for judging the performance of any technology.

In the 18 year period 1996 to 2013, millions of farmers in ~30 countries worldwide, adopted biotech crops at unprecedented rates. The most compelling and credible testimony to biotech crops is that during the 18 year period 1996 to 2013, millions of farmers in ~30 countries worldwide, elected to make more than 100 million independent decisions to plant and replant an accumulated hectarage of more than 1.6 billion hectares. This is an area equivalent to >150% the size of the total land mass of the US or China which is an enormous area. There is one principal and overwhelming reason that underpins the trust and confidence of risk-averse farmers in biotechnology – biotech crops deliver substantial, and sustainable, socio-economic and environmental benefits. The comprehensive EU 2011 study conducted in Europe, confirmed that biotech crops are safe.

27 countries grow biotech crops in 2013

Of the 27 countries which planted biotech crops in 2013 (Table 1 and Figure 1), 19 were developing and 8 were industrial countries. Each of the top 10 countries, of which 8 were developing grew more than 1 million hectares providing a broad-based worldwide foundation for continued and diversified growth in the future. More than half the world's population, 60% or ~4 billion people, live in the 27 countries planting biotech crops.

Bangladesh approved a biotech crop for planting for the first time, whilst the situation in Egypt put planting on-hold pending review.

Bangladesh approved a biotech crop (Bt eggplant) for planting for the first time in 2013, whilst the situation in Egypt put planting on-hold, pending a Government review. The approval by Bangladesh is important in that it serves as an exemplary model for other small poor countries. Also, very importantly, Bangladesh has broken the impasse experienced in trying to gain approval to commercialize Bt eggplant in both India and the Philippines. It is noteworthy that two other developing countries, Panama and Indonesia, also approved cultivation of biotech crops in 2013 for commercialization in 2014 (these hectarages are not included in the data base for this Brief).

18 million farmers benefit from biotech crops – 90% were small resource-poor farmers.

In 2013, a record 18 million farmers, compared with 17.3 million in 2012, grew biotech crops – remarkably, over 90%, or >16.5 million, were risk-averse small, poor farmers in developing countries. In China, 7.5 million small farmers benefited from biotech cotton and in India there were 7.3 million beneficiary farmers. The latest economic data available for the period 1996 to 2012 indicates that farmers in China gained US$15.3 billion and in India US$14.6 billion. In addition to economic gains, farmers benefited enormously from at least a 50% reduction in the number of insecticide applications, thereby reducing farmer exposure to insecticides, and importantly contributed to a more sustainable environment and better quality of life.

For the second consecutive year developing countries planted more biotech crops than industrial countries in 2013.

Latin American, Asian and African farmers collectively grew 94 million hectares or 54% of the global 175 million biotech hectares (versus 52% in 2012) compared with industrial countries at 81 million hectares or 46% (versus 48% in 2012), thereby almost doubling the hectare gap from 7 to ~14 million hectares between 2012 to 2013, respectively. This trend is expected to continue. This is contrary to the prediction of critics who, prior to the commercialization of the technology in 1996, prematurely

Table 1. Global Area of Biotech Crops in 2013: by Country (Million Hectares)**

Rank	Country	Area (million hectares)	Biotech Crops
1	USA*	70.1	Maize, soybean, cotton, canola, sugar beet, alfalfa, papaya, squash
2	Brazil*	40.3	Soybean, maize, cotton
3	Argentina*	24.4	Soybean, maize, cotton
4	India*	11.0	Cotton
5	Canada*	10.8	Canola, maize, soybean, sugar beet
6	China*	4.2	Cotton, papaya, poplar, tomato, sweet pepper
7	Paraguay*	3.6	Soybean, maize, cotton
8	South Africa*	2.9	Maize, soybean, cotton
9	Pakistan*	2.8	Cotton
10	Uruguay*	1.5	Soybean, maize
11	Bolivia*	1.0	Soybean
12	Philippines*	0.8	Maize
13	Australia*	0.6	Cotton, canola
14	Burkina Faso*	0.5	Cotton
15	Myanmar*	0.3	Cotton
16	Spain*	0.1	Maize
17	Mexico*	0.1	Cotton, soybean
18	Colombia*	0.1	Cotton, maize
19	Sudan*	0.1	Cotton
20	Chile	<0.1	Maize, soybean, canola
21	Honduras	<0.1	Maize
22	Portugal	<0.1	Maize
23	Cuba	<0.1	Maize
24	Czech Republic	<0.1	Maize
25	Costa Rica	<0.1	Cotton, soybean
26	Romania	<0.1	Maize
27	Slovakia	<0.1	Maize
	Total	**175.2**	

* 19 biotech mega-countries growing 50,000 hectares, or more, of biotech crops
** Rounded off to the nearest hundred thousand

Source: Clive James, 2013.

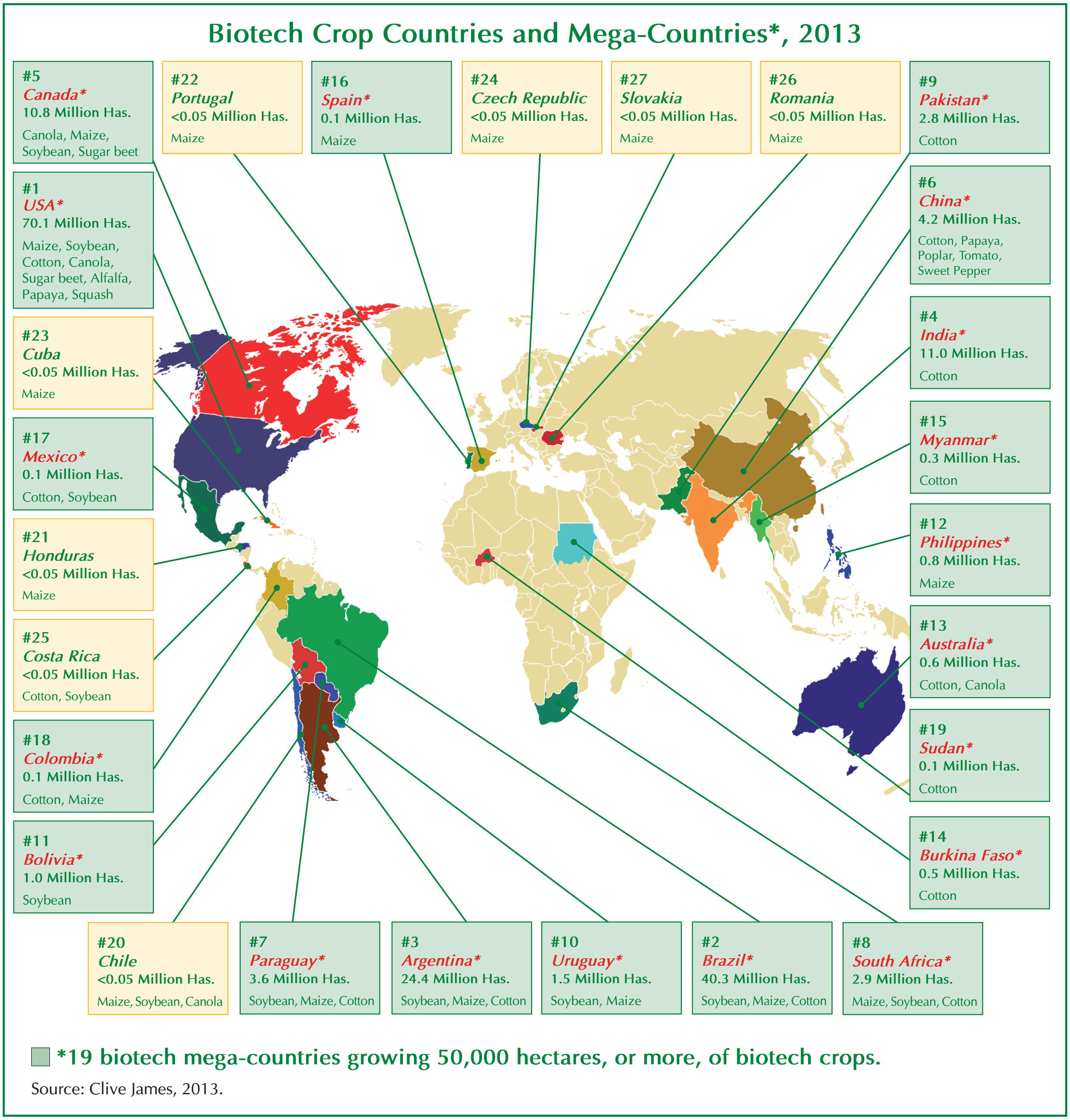


Figure 1. Global Map of Biotech Crop Countries and Mega-Countries in 2013

declared that biotech crops were only for industrial countries and would never be accepted and adopted by developing countries, particularly small poor farmers.

During the period 1996-2012 cumulative economic benefits in industrial countries were at US$59 billion compared to US$57.9 billion generated by developing countries. Moreover in 2012, developing countries had a lower share, 45.9% equivalent to US$8.6 billion of the total US$18.7 billion gain, with industrial countries at US$10.1 billion (Brookes and Barfoot, 2014, Forthcoming).

Stacked traits occupied 27% of the global 175 million hectares.

Stacked traits continued to be an important and growing feature of biotech crops. 13 countries planted biotech crops with two or more traits in 2013, of which 10 were developing countries. About 47 million hectares equivalent to 27% of the 175 million hectares were stacked in 2013, up from 43.7 million hectares or 26% of the 170 million hectares in 2012; this steady and growing trend of more stacked traits is expected to continue.

The 5 lead biotech developing countries on the three continents of the South: Brazil and Argentina in Latin America, India and China in Asia, and South Africa on the continent of Africa, grew 47% of global biotech crops and have ~41% of world population.

The five lead developing countries in biotech crops in the three continents of the South are China and India in Asia, Brazil and Argentina in Latin America, and South Africa on the continent of Africa. They collectively grew 82.7 million hectares (47% of global) and together represent ~41% of the global population of 7 billion, which could reach 10.1 billion by the turn of the century in 2100. Remarkably, population in sub Saharan Africa alone could escalate from ~1 billion today (~15% of global) to a possible high of 3.6 billion (~35% of global) by the end of this century in 2100. Global food security, exacerbated by high and unaffordable food prices, is a formidable challenge to which biotech crops can contribute but are not a panacea.

Brazil, continues to be the engine of biotech crop growth globally.

Brazil ranks second only to the USA in biotech crop hectarage in the world with 40.3 million hectares (up from 36.6 million in 2012) and is emerging as a strong global leader in biotech crops. For the fifth consecutive year, Brazil was the engine of growth globally in 2013, increasing its hectarage of biotech crops more than any other country in the world – a record 3.7 million hectare increase, equivalent to an impressive year-over-year increase of 10%. Brazil grew 23% (up from 21% in 2012) of the global hectarage of 175 million hectares and is consolidating its position by consistently closing the gap with the US. An efficient and science based approval system in Brazil facilitates fast adoption. In 2013, in an important event, Brazil commercially planted its first stacked soybean with insect resistance and herbicide tolerance on 2.2 million hectares. Notably, EMBRAPA, Brazil's agricultural R&D organization, with an annual budget of US$1 billion, has gained approval to commercialize its home-grown biotech virus resistant bean, planned for 2015.

USA maintains leadership role.

The US continued to be the lead producer of biotech crops globally with 70.1 million hectares (40% of global), with an average adoption rate of ~90% across its principal biotech crops. Canada grew 10.8 million hectares of biotech crops in 2013, down from 11.6 million hectares in 2012, as farmers planted ~800,000 hectares less canola and accommodated more wheat in the rotation, which is a sound practice. Biotech canola in Canada still enjoyed a high adoption rate of 96% in 2013. Australia also posted a decrease due to shortage of water, of approximately 100,000 hectares but adoption remained at a high of 99%.

India and China grow more Bt cotton.

India cultivated a record 11.0 million hectares of Bt cotton with an adoption rate of 95%, whilst 7.5 million small resource poor farmers in China grew 4.2 million hectares of Bt cotton with an adoption rate of 90%, cultivating on average, ~0.5 hectare per farm.

Progress in Africa

Africa continued to make progress with Burkina Faso and Sudan increasing their Bt cotton hectarage substantially, and South Africa with its biotech hectarage at marginally less but practically the same level as 2012 (2.85 million hectares rounded off to 2.9). Burkina Faso increased its Bt cotton hectares by over 50% from 313,781 hectares to 474,229. Sudan, in its second year of commercialization tripled its Bt cotton from 20,000 hectares in 2012 to 62,000 in 2013. Encouragingly an additional seven African countries (listed alphabetically they are Cameroon, Egypt, Ghana, Kenya, Malawi, Nigeria and Uganda) have conducted field trials on a broad range (cotton and maize to bananas and cowpeas) of “new” biotech crops, including several orphan crops such as sweet potato. The WEMA project is expected to deliver its first biotech drought tolerant maize in Africa as early as 2017.

Five EU countries planted a record 148,013 hectares of biotech Bt maize, up 15% from 2012. Spain was by far the largest adopter planting 94% of the total Bt maize hectarage in the EU.

Five EU countries, same number as last year, planted a record 148,013 hectares of Bt maize, up 18,942 hectares or 15% from 2012. Spain led the EU with a record 136,962 hectares of Bt maize, up 18%. Portugal was lower by approximately 1,000 hectares due to a seed shortage, and Romania was the same as 2012. The other countries, Czechia and Slovakia, planted lower and small hectarages attributed to onerous and over-demanding EU reporting procedures for farmers.

Biotech crops contribution to Food Security, Sustainability and Climate Change

From 1996 to 2012, biotech crops contributed to Food Security, Sustainability and Climate Change by: increasing crop production valued at US$116.9 billion; providing a better environment, by saving 497 million kg a.i. of pesticides; in 2012 alone reducing CO_2 emissions by 26.7 billion kg, equivalent to taking 11.8 million cars off the road for one year; conserving biodiversity in the period 1996-2012 by saving 123 million hectares of land; and helped alleviate poverty by helping >16.5 million small farmers, and their families totaling >65 million people, who are some of the poorest people in the world. Biotech crops can contribute to a **"sustainable intensification"** strategy favored by many science academies worldwide, which allows productivity/production to be increased only on the current 1.5 billion hectares of global crop land, thereby saving forests and biodiversity. Biotech crops are essential but are not a panacea and adherence to good farming practices, such as rotations and resistance management, are a must for biotech crops as they are for conventional crops.

Contribution of biotech crops to Sustainability

Biotech crops are contributing to sustainability in the following five ways:

- **Contributing to food, feed and fiber security and self sufficiency, including more affordable food, by increasing productivity and economic benefits sustainably at the farmer level**

  Economic gains at the farm level of ~US$116.9 billion were generated globally by biotech crops during the seventeen year period 1996 to 2012, of which 58% were due to reduced production costs (less ploughing, fewer pesticide sprays and less labor) and 42% due to substantial yield gains of 377 million tons. The corresponding figure for 2012 alone was 83% of the total US$18.7 billion gain due to increased yield (equivalent to 47 million tons), and 17% due to lower cost of production (Brookes and Barfoot, 2014, Forthcoming).

- **Conserving biodiversity, biotech crops are a land saving technology**

  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 – a **sustainable intensification** strategy. Approximately 13 million hectares of biodiversity – rich tropical forests, are lost in developing countries annually. If the 377 million tons of additional food, feed and fiber produced by biotech crops during the period 1996 to 2012 had not been produced by biotech crops, an additional 123 million hectares (Brookes and Barfoot, 2014, Forthcoming) of conventional crops would have been required to produce the same tonnage. Some of the additional 123 million hectares would probably have required fragile marginal lands, not suitable for crop production, to be ploughed, and for tropical forest, rich in biodiversity, to be felled to make way for slash and burn agriculture in developing countries, thereby destroying biodiversity.

- **Contributing to the alleviation of poverty and hunger**

  To-date, biotech cotton in developing countries such as China, India, Pakistan, Myanmar, Burkina Faso and South Africa have already made a significant contribution to the income of >16.5 million small resource-poor farmers in 2013. This can be enhanced in the remaining 2 years of the second decade of commercialization, 2014 to 2015 principally with biotech cotton and maize.

- **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 to-date includes: a significant reduction in pesticides; saving on fossil fuels; decreasing CO_2 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 2012 was estimated at 497 million kilograms (kgs) of active ingredient (a.i.), a saving of 8.7% in pesticides, which is equivalent to an 18.5% reduction in the associated environmental impact of pesticide use on these crops, as measured by the Environmental Impact Quotient (EIQ). EIQ is a composite measure based on the various factors contributing to the net environmental impact of an individual active ingredient. The corresponding data for 2012 alone was a reduction of 36 million kgs a.i. (equivalent to a saving of 8% in pesticides) and a reduction of 23.6% in EIQ (Brookes and Barfoot, 2014, 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 30% to over 9 billion by 2050. The first biotech maize hybrids with a degree of drought tolerance were commercialized in 2013 in the USA, and the first tropical biotech drought tolerant maize is expected by ~2017 in sub-Saharan Africa. Drought tolerance is expected to have a major impact on more sustainable cropping systems worldwide, particularly in developing countries, where drought will likely be more prevalent and severe than industrial countries.

- **Helping mitigate climate change and reducing greenhouse gases**

  The important and urgent concerns about the environment have implications for biotech crops, which contribute to a reduction of greenhouse gases and help mitigate climate change in two principal ways. First, permanent savings in carbon dioxide (CO_2) emissions through reduced use of fossil-based fuels, associated with fewer insecticide and herbicide sprays. In 2012, this was an estimated saving of 2.1 billion kg of CO_2, equivalent to reducing the number of cars on the roads by 0.94 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 2012 to 24.61 billion kg of CO_2, or removing 10.9 million cars off the road for one year. Thus in 2012, the combined permanent and additional savings through sequestration was equivalent to a saving of 26.7 billion kg of CO_2 or removing 11.8 million cars from the road (Brookes and Barfoot, 2014, Forthcoming).

  Droughts, floods, and temperature changes are predicted to become more prevalent and more severe as we face the new challenges associated with climate change, 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 crop tools and techniques, including tissue culture, diagnostics, genomics, molecular marker-assisted selection (MAS) zinc fingers, and biotech crops can be used collectively for 'speeding the breeding' and help mitigate the effects of climate change. Biotech crops are already contributing to reducing CO_2 emissions by precluding the need for ploughing a significant portion of cropped land, conserving soil, particularly moisture, and reducing pesticide spraying as well as sequestering CO_2.

In summary, collectively the above five thrusts have already demonstrated the capacity of biotech crops to contribute to sustainability in a significant manner and for mitigating the formidable challenges associated with climate change and global warming, and the potential for the future is enormous. Biotech crops can 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.

Nitrogen Use Efficiency

A chapter in the full Brief provides an initial global overview of nitrogen (N) fertilizer use and efficiency. About 100 million tons of N fertilizer is used on crops at an annual cost of US$50 billion. Up to half of the N applied is not taken up by the crops and causes pollution, particularly in waterways. Conventional and biotech approaches are being explored for increasing N use efficiency. Some indications that in the midterm (5 to 10 years) new technology could save up to half of N currently applied to crops with no yield penalty.

Regulation of biotech crops and labeling

The lack of appropriate, science-based and cost/time-effective regulatory systems continues to be the major constraint to adoption. Responsible, rigorous but not onerous, regulation is needed, particularly for small and poor developing countries, who are "locked out"completely because of the high cost of developing and gaining approval of a biotech crop. It is noteworthy, that on 6 November 2012, in California, USA, voters defeated Proposition 37, the proposed state petition on "Mandatory Labeling of Genetically Engineered Food Initiative" – the final result was No 53.7% and Yes 46.3%. A similar poll in Washington State in November 2013 had a similar outcome except that the result had wider margins in favor of no labelling -- 55% No and 45% Yes.

Status of approved events for biotech crops

As of 30 November 2013, a total of 36 countries (35 + EU-28) have granted regulatory approvals for biotech crops for food and/or feed use and for environmental release or planting since 1994. In these 36 countries, a total of 2,833 regulatory approvals involving 27 GM crops and 336 GM events have been issued by competent authorities, of which 1,321 are for food use (direct use or processing), 918 for feed use (direct use or processing) and 599 for environmental release or planting. Japan has the most number of events approved (198), followed by the U.S.A. (165 not including stacked events), Canada (146), Mexico (131), South Korea (103), Australia (93), New Zealand (83), European Union (71 including approvals that have expired or under renewal process), Philippines (68), Taiwan (65), Colombia (59), China (55) and South Africa (52). Maize has the most number of approved events (130 events in 27 countries), followed by cotton (49 events in 22 countries), potato (31 events in 10 countries), canola (30 events in 12 countries) and soybean (27 events in 26 countries). The event that has received the most number of approvals is the herbicide tolerant soybean event GTS-40-3-2 (51 approvals in 24 countries + EU-28), followed by the insect resistant maize event MON810 (49 approvals in 23 countries + EU-28) and herbicide tolerant maize event NK603 (49 approvals in 22 countries + EU-28), insect resistant maize event Bt11 (45 approvals in 21 countries + EU-28), insect resistant maize event TC1507 (45 approvals in 20 countries + EU-28), herbicide tolerant maize event GA21 (41 approvals in 19 countries + EU-28), herbicide tolerant soybean event A2704-12 (37 approvals in 19 countries + EU-28), insect resistant maize event MON89034 (36 approvals in 19 countries + EU-28), insect resistant cotton event MON531 (36 approvals in 17 countries + EU-28), herbicide tolerant and insect resistant maize event MON88017 (35 approvals in 19 countries + EU-28), and insect resistant cotton event MON1445 (34 approvals in 15 countries + EU-28).

Global value of biotech seed alone was ~US$15.6 billion in 2013

Global value of biotech seed alone was ~US$15.6 billion in 2013. A 2011 study estimated that the cost of discovery, development and authorization of a new biotech crop/trait is ~US$135 million. In 2013, the global market value of biotech crops, estimated by Cropnosis, was US$15.6 billion, (up from US$14.6 billion in 2012); this represents 22% of the US$71.5 billion global crop protection market in 2012, and 35% of the ~US$45 billion commercial seed market. The estimated global farm-gate revenues of the harvested commercial "end product" (the biotech grain and other harvested products) is more than ten times greater than the value of the biotech seed alone.

The Impact of the 2013 World Food Prize's Recognition of Biotechnology's Contribution to Food, Feed and Fiber Security

The World Food Prize (WFP) is the foremost international Foundation that recognizes accomplishments of individuals who have advanced human development by improving the quality, quantity, or availability of food in the world. The 2013 Laureates are three biotechnologists who have independently discovered molecular techniques for genetically engineering improved crops.

As the founder of the World Food Prize and a strong advocate of biotech/GM crops, Norman Borlaug, Nobel Peace Prize Laureate in 1970 had expressed his views to the WFP Foundation that biotechnologists should not be excluded from consideration as World Food Prize Laureates because of the controversy surrounding GM crops. He contended that they should be considered on their own merit and judged by their contribution to global food security and the alleviation of poverty.

Borlaug would have been pleased with the decision to award the 2013 World Food Prize to three internationally recognized biotechnologists, whom he knew personally and respected: Marc Van Montagu, Mary-Dell Chilton and Robert Fraley, who have all made important contributions in their respective areas of crop biotechnology. "The three Laureates have in their own unique ways established the science behind the transfer of genes from other species to the target crops through *Agrobacterium tumefaciens* in the late 1970's. Marc Van Montagu and colleague Jeff Schell were the first to discover, in 1974, that the bacteria carries a Ti-plasmid (plant tumor-inducing plasmid). They did a thorough study on its structure and function which led to the stable transfer of foreign genes into plants. Mary-Dell Chilton and her research team discovered that there is a segment in this plasmid, the Transfer-DNA (T-DNA) that is processed and transferred into the genome of the infected plant cell. Her work provided evidence that plant genomes could be manipulated more precisely than in conventional plant breeding. Robert Fraley and his team's research works were built on the advances made by Van Montagu and Chilton. The team was able to isolate a bacterial marker gene, which was expressed in plant cells. This became the scientific basis of the development of Roundup Ready soybeans."

"The work of the three Laureates became the foundation of plant cell transformation technologies that enabled the development of a host of genetically-enhanced crops with improved yields; resistance to insects and disease; and tolerance against extreme variations in climate. Their combined achievements have contributed significantly to increasing the quantity and availability of food, and can play a critical role as we face the global challenges of the 21st century of producing more food in a sustainable way, while confronting an increasingly volatile climate."

It is noteworthy that the 2013 World Food Prize served as a unique global forum to stimulate and encourage professional debate, and to increase the awareness of both the scientific community and the public about the formidable challenge of food security and the current and future contributions that biotechnology can make to help feed the world of tomorrow with a population of 9 billion in 2050.

The three 2013 Laureates were of the unanimous view **that sharing knowledge and communicating with the Public on biotech crops was the top priority.** ISAAA is of the same view and initiated its extensive global knowledge-sharing activities with the public more than ten years ago in 2000. ISAAA's flagship publication, the Annual Brief on the ***Global Status of Commercialized Biotech/ GM Crops*****, authored for the last 17 years by Dr. Clive James**, is the most quoted publication on biotech crops globally. The major messages from the Brief typically reach up to an unprecedented 3 billion people in ~50 countries and languages. Knowledge-sharing is achieved through multi-media channels, thereby reaching a remarkably large number and broad range of stakeholders from global society at large. Other ISAAA complementary activities organized by the **Global Knowledge Center (KC)** in knowledge-sharing include its active user-friendly website with various educational/learning materials, including, videos, and infographics as well as its weekly newsletter ***Crop Biotech Update*** distributed to subscribers in 140 countries. In addition, ISAAA organizes a continuing series of workshops in developing countries to meet the multiple and changing needs of policy makers, regulators and other stakeholders in crop biotechnology. ISAAA, like the three Laureates, believes that knowledge-sharing is key to increasing biotech crop understanding, acceptance and adoption globally.

The 2013 World Food Prize and the Borlaug dialogue have contributed in a unique and significant way towards an increased measure of consensus by the scientific community and the public about major issues that have been debated for over a decade or more. For example, there has been a marked shift in public sentiment and an increased trust in science-based assessments that confirm that foods from biotech products are safe and that significant productivity and environmental benefits have accrued to both producers and consumers. Similarly, the shift in public support of not denying Golden Rice to millions of malnourished children, who otherwise are condemned to suffer permanent blindness and death, is evident, as Patrick Moore's new and successful moral campaign **"Allow Golden Rice"** in support of Golden Rice has progressed.

Future Prospects

In 2013, as expected, growth continued to plateau for the principal biotech crops in industrial countries and in mature biotech crop markets in developing countries where adoption rates are sustained at an optimal rate of ~90%, leaving little or no room for expansion. Growth in adoption in less mature biotech crop markets in developing countries, such as Burkina Faso (>50% growth in 2013) and Sudan (>300% growth in 2013) was very strong in 2013, and for the fifth consecutive year, Brazil posted an impressive 3.7 million hectare increase, equivalent to a 10% growth between 2012 and 2013.

In the scientific community associated with biotechnology, there is cautious optimism that biotech crops, including both staple and orphan crops, will be increasingly adopted by society, particularly by the developing countries, where the task of feeding its own people is formidable, given that the global population, most of whom will be in the South, will exceed 10 billion by the turn of the century in 2100. **We cannot feed the world of tomorrow with yesterday's technology.**

Whereas rice is the most important food crop in China, maize is the most important feed crop. Over 35 million hectares of maize is grown in China by an estimated 100 million maize-growing households (based on 4 per family ~400 million potential beneficiaries). Phytase maize, which confers increased phosphate uptake in animals is reported to increase the efficiency of meat production – an important new and growing need, as China becomes more prosperous and consumes more meat which requires more expensive imports of maize. China has 500 million pigs (~50% of the global swine herd) and 13 billion chickens, ducks and other poultry which need feed. Given the significant increased demand for maize and rising imports, biotech maize, as a feed crop, may be the first to be commercialized by China and is consistent with the favored chronology of fiber, feed and food. A group of over 60 senior scientists in China recently reiterated the strategic importance of commercializing biotech crops to the country and its commitment to ensure safe testing of the products before deployment. Biotech phytase maize was approved for biosafety in China on 27 November 2009. Other maize producing countries in Asia, including Indonesia and Vietnam, have field tested HT/Bt maize and are likely to commercialize in the near-term, possibly by 2015.

Subject to regulation, another very important product for Asia is Golden Rice which should be ready for release to farmers by 2016 in the Philippines. Bangladesh has also assigned high priority to the product. Golden Rice is being developed to address Vitamin A Deficiency which results in ~2.5 million children a year dying with an additional 500,000 becoming permanently blind. Patrick More has opined that denying Golden Rice to malnourished dying children is ***"a crime against humanity"*** – the moral imperative for Golden Rice is beyond question.

In the Americas the increased adoption of biotech drought tolerant maize and transfer of this technology to selected countries in Africa will be important, as well as the adoption of the virus resistant bean developed by EMBRAPA in Brazil and scheduled for deployment in 2015. The stacked soybean launched in 2013 is expected to reach high adoption rates in Brazil and some neighboring countries in the near-term.

In Africa there are three countries, South Africa, Burkina Faso and Sudan already successfully commercializing biotech crops and the hope is that several of the seven additional countries currently field testing biotech crops will graduate to commercialization. The early predominant products that will likely feature are the well-tested biotech cotton and maize, and subject to regulatory approval, the very important WEMA drought tolerant maize scheduled for 2017. Hopefully, one of several orphan crops such as the insect resistant cowpea will also be made available in the near-term so that farmers can benefit from them as early as possible.

Whereas biotech crops are considered essential as one element (including non-transgenic genome editing tools such as ZFN [Zinc Finger Nucleases] and TALENs [Transcription Activator-Like Effector Nucleases] to increase precision and speed) in a crop improvement program, they are not a panacea. Adherence to good farming practices such as rotations and resistance management are a must for biotech crops as they are for conventional crops. Finally, it is important to note that more modest annual gains, and continued plateauing, are predicted for the next few years. This is due to the already optimal (>90%) adoption rates for the principal biotech crops in both industrial and developing countries, leaving little or no room for expansion. As more countries approve biotech crops, the potential hectares will grow for medium hectarage crops (such as sugarcane – 25 million hectares) and particularly for larger hectarage crops (such as rice – 163 million hectares, and wheat – 217 million hectares). Increased growth in hectares will also be facilitated by a growing portfolio of products from both the public and private sectors and the events will increasingly feature quality traits for improved health and well-being.

The Legacy of Nobel Peace Laureate Norman Borlaug, founding patron of ISAAA

It is fitting to close this chapter on "Future Prospects" of biotech crops with a reminder of the counsel of the late 1970 Nobel Peace Laureate, Norman Borlaug, on biotech/GM crops whose birth centenary will be honored on 25 March 2014. Norman Borlaug, who saved a billion people from hunger, was awarded the Nobel Peace Prize in 1970 for the impact of his semi-dwarf wheat technology on the alleviation of hunger. Borlaug was also the greatest advocate for biotechnology and biotech/GM crops, because he knew their critical and paramount importance in feeding the world of tomorrow. The following is the visionary counsel offered by Norman Borlaug on biotech crops in 2005 – it is as true today as it was in 2005.

"Over the past decade, we have been witnessing the success of plant biotechnology. This technology is helping farmers throughout the world produce higher yield while reducing pesticide use and soil erosion. The benefits and safety of biotechnology has been proven over the past decade in countries with more than half the world's population. What we need is courage by the leaders of those countries where farmers still have no choice but to use older and less effective methods. The Green Revolution and now plant biotechnology are helping meet the demand for food production, while preserving our environment for future generations."

ISAAA
INTERNATIONAL SERVICE
FOR THE ACQUISITION
OF AGRI-BIOTECH
APPLICATIONS

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

Tel.: +63 2 580 5600 ext. 2234/2845 · Telefax: +63 49 5367216
URL: http://www.isaaa.org

For details on obtaining a copy of **ISAAA Brief No. 46 - 2013**, *email* **publications@isaaa.org**