ISAAA
International Service for the Acquisition of Agri-biotech Applications

ISAAA Briefs

BRIEF 54

EXECUTIVE SUMMARY

GLOBAL STATUS OF COMMERCIALIZED BIOTECH/GM CROPS IN 2018:

Biotech Crops Continue to Help Meet the Challenges of Increased Population and Climate Change

In 2018, 191.7 million hectares of biotech crops were grown in 26 countries by up to 17 million farmers.

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No. 54 – 2018

ISAAA prepares this Brief 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. ISAAA takes full responsibility for the views expressed in this publication and for any errors of omission or misinterpretation.

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INTRODUCTION

Biotechnology can be used to develop stress-tolerant and more nutritious crop varieties to protect natural resources and human health. Each biotech crop is evaluated on a case-by-case basis, while approved commercial products in the market have been subjected to rigorous scientific scrutiny. Biotech crops should be considered as a tool for improving crop yields, has unblemished record of food safety, and obtain larger income for food-insecure farmers. These economic benefits, health improvement, and social gains obtained through biotech crop adoption should be made known to the global community so that farmers and consumers can make informed choices on what crops to grow and consume, respectively; to the policy makers and regulators to craft enabling biosafety guidelines for commercialization and adoption of biotech crops; and to the science communicators and the media to facilitate dissemination of the benefits and potentials of the technology.

The International Service for the Acquisition of Agri-biotech Applications strongly supports the above and the scientific truths underpinning them with the publication of Global Status of Commercialized Biotech/GM Crops: 2018 (Brief 54). This publication documents the latest information on the subject, the global database on the adoption and distribution of biotech crops since the first year of commercialization in 1996, country situations and future prospects of the technology in the world. Termed as ISAAA Briefs, the annual reports from 1997 to 2015 were authored by Dr. Clive James, and the 1996 report was co-authored with Dr. Anatole Krattiger.

ISAAA dedicates this Brief to Dr. Clive James, Founder and Emeritus Chair of ISAAA, who has painstakingly authored the 20 Annual Reports making it the most credible source of information on biotech crops in the last two decades. We also dedicate this Brief to the late Dr. Randy A. Hautea, former ISAAA Global Coordinator and *SEAsia*Center Director for more than two decades. They have been great advocates of biotechnology and biotech products and believe that ISAAA can make a difference in enhancing the knowledge and capacities of the global community in order to benefit from the technology, especially the poor and marginalized people of the world.

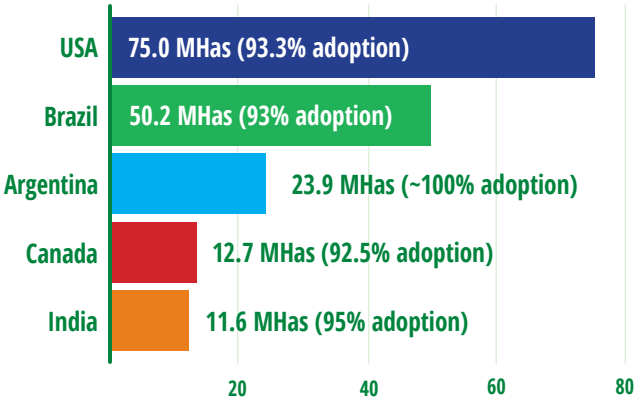
HIGHLIGHTS OF THE 2018 ADOPTION OF BIOTECH CROPS

- **High adoption of biotech crops continued in 2018 with 191.7 million hectares worldwide.**

On the 23rd year of commercialization of biotech/GM crops in 2018, 26 countries grew 191.7 million hectares of biotech crops – an increase of 1.9 million hectares (4.7 million acres) or 1% from 189.8 million hectares in 2017. Except for the 2015 adoption, this is the 22nd series of increases every single year; and notably 12 of the 18 years with double-digit growth rates.

- **The adoption rates of the top five biotech crop-growing countries reached close to saturation.**

The average biotech crop adoption rate in the top five biotech crop-growing countries increased in 2018 to reach close to saturation, with USA at 93.3% (average for soybeans, maize, and canola adoption), Brazil (93%), Argentina (~100%), Canada (92.5%), and India (95%). Expansion of biotech crop areas in these countries would be through immediate approval and commercialization of new biotech crops and traits to target problems related to climate change and the emergence of new pests and diseases.



TOP 5 COUNTRIES THAT PLANTED BIOTECH CROPS IN 2018 (AREA AND ADOPTION RATE)

Source: ISAAA, 2018

- **Biotech crops increased ~113-fold from 1996 with accumulated biotech area at 2.5 billion hectares; thus, biotechnology is the fastest adopted crop technology in the world.**

Global area of biotech crops has increased ~113-fold from 1.7 million hectares in 1996 to 191.7 million hectares in 2018 – this makes biotech crops the fastest adopted crop technology in recent times. An accumulated 2.5 billion hectares or 6.3 billion acres were achieved in 23 years (1996-2018) of biotech crop commercialization.

- **A total of 70 countries adopted biotech crops – 26 countries planted and 44 additional countries imported.**

The 191.7 million hectares of biotech crops were grown by 26 countries – 21 developing and 5 industrial countries. Developing countries grew 54% of the global biotech crop area compared to 46% for industrial countries. An additional 44 countries (18 plus 26 EU countries) imported biotech crops for food, feed, and processing. Thus, a total of 70 countries in total have adopted biotech crops.

- **Biotech crops provided more diverse offerings to consumers in 2018.**

Biotech crops have expanded beyond the big four (maize, soybeans, cotton, and canola) to give more choices for many of the world's consumers and food producers. These biotech crops include alfalfa, sugar beets, papaya, squash, eggplant, potatoes, and apples, all of which are already in the market. Two generations of Innate® potatoes with non-bruising, non-browning, reduced acrylamide, and late blight resistant traits as well as non-browning Arctic® apples were already planted in the USA. Brazil planted the first insect resistant (IR) sugarcane; Indonesia, the first drought tolerant sugarcane; and Australia planted the first high oleic acid safflower for R&D and seed propagation. Various trait combinations were also approved including high oleic acid canola,

isoxaflutole herbicide tolerant (HT) cotton, stacked herbicide tolerant and high oleic acid soybean, HT and salt tolerant soybean, IR sugarcane, and biotech maize with various IR/HT combinations in stack. Additionally, biotech crop research conducted by public sector institutions include rice, banana, potatoes, wheat, chickpea, pigeon pea, and mustard with various economically-important and nutritional quality traits beneficial to food producers and consumers in developing countries.

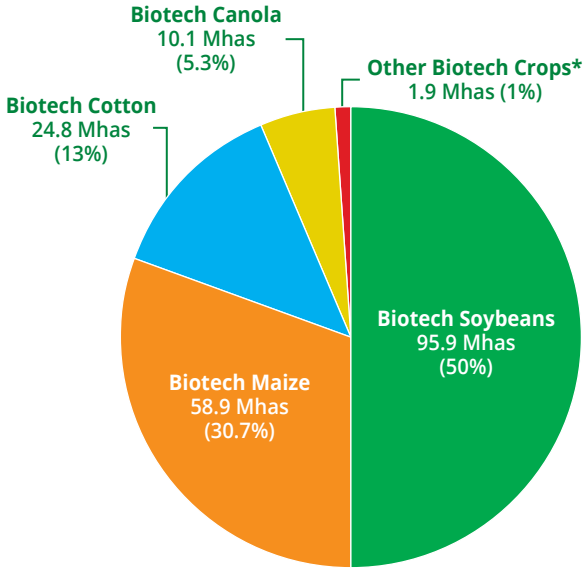
- **Biotech soybeans covered 50% of global biotech crop area.**

The four major biotech crops -- soybeans, maize, cotton, and canola -- in decreasing area, were the most adopted biotech crops by 26 countries. Soybeans lead at 95.9 million hectares at 50% of the global biotech crop adoption, a 2% increase from 2017. This is followed by maize (58.9 million hectares), cotton (24.9 million hectares), and canola (10.1 million hectares). Based on the 2017 FAO global crop area for individual crops, 78% of soybeans, 76% of cotton, 30% of maize, and 29% of canola were biotech crops in 2018.

- **The area planted to biotech crops with stacked traits increased by 4% and occupied 42% of the global biotech crop area.**

Stacked traits with insect resistance and herbicide tolerance increased by 4% and covered 42% of the global area, a testimony to farmers' adherence to smart agriculture with no till and reduced insecticide use. Herbicide tolerance in soybeans, canola, maize, alfalfa, and cotton has consistently been the dominant trait, which in 2018 covered 46% of the global area – a decrease of 1% compared to 2017.

- **The top five countries (USA, Brazil, Argentina, Canada, and India) planted 91% of the global biotech crop area of 191.7 million hectares.**



** Biotech sugar beets, potatoes, apples, squash, papaya, and brinjal/ eggplant.*

BIOTECH CROPS IN 2018 (AREA AND ADOPTION RATE)

Source: ISAAA, 2018

The USA led the biotech crop planting in 2018 at 75 million hectares, followed by Brazil (51.3 million hectares), Argentina (23.9 million hectare), Canada (12.7 million hectares), and India (11.6 million hectares) (Table 1) for a total of 174.5 million hectares, representing 91% of the global area. Thus, biotechnology benefitted more than 1.95 billion people in the five countries or 26% of the current world population of 7.7 billion.

The US reached an average 93% adoption rate for plantings of biotech soybeans, maize, and cotton

In 2018, the biotech area planted in the USA was 75 million hectares, covering 39% of the global biotech area, with an average adoption rate of 93%. The biotech crops planted were soybeans (34.08 million hectares), maize (33.17 million hectares), cotton (5.06 million hectares), canola (900,000 hectares), sugar beets (491,000 hectares), alfalfa (1.26 million hectares), and some 1,000 hectares of papaya, squash, potatoes, and apples. Weather patterns in the beginning of spring 2018 characterized by cold April to warm May,

Table 1. Global Area of Biotech Crops in 2018: by Country (Million Hectares)**

Rank	Country	Area (Million Hectares)	Biotech Crops
1	USA*	75.0	Maize, soybeans, cotton, canola, sugar beets, alfalfa, papaya, squash, potatoes, apples
2	Brazil*	51.3	Soybeans, maize, cotton, sugarcane
3	Argentina*	23.9	Soybeans, maize, cotton
4	Canada*	12.7	Canola, maize, soybeans, sugar beets, alfalfa, potatoes
5	India*	11.6	Cotton
6	Paraguay*	3.8	Soybeans, maize, cotton
7	China*	2.9	Cotton, papaya
8	Pakistan*	2.8	Cotton
9	South Africa*	2.7	Maize, soybeans, cotton
10	Uruguay*	1.3	Soybeans, maize
11	Bolivia*	1.3	Soybeans
12	Australia*	0.8	Cotton, canola
13	Philippines*	0.6	Maize
14	Myanmar*	0.3	Cotton
15	Sudan*	0.2	Cotton
16	Mexico*	0.2	Cotton
17	Spain*	0.1	Maize
18	Colombia*	0.1	Cotton, maize
19	Vietnam	<0.1	Maize
20	Honduras	<0.1	Maize
21	Chile	<0.1	Maize, soybeans, canola
22	Portugal	<0.1	Maize
23	Bangladesh	<0.1	Brinjal/Eggplant
24	Costa Rica	<0.1	Cotton, soybeans
25	Indonesia	<0.1	Sugarcane
26	eSwatini	<0.1	Cotton
	Total	**191.7**	

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

Source: ISAAA, 2018

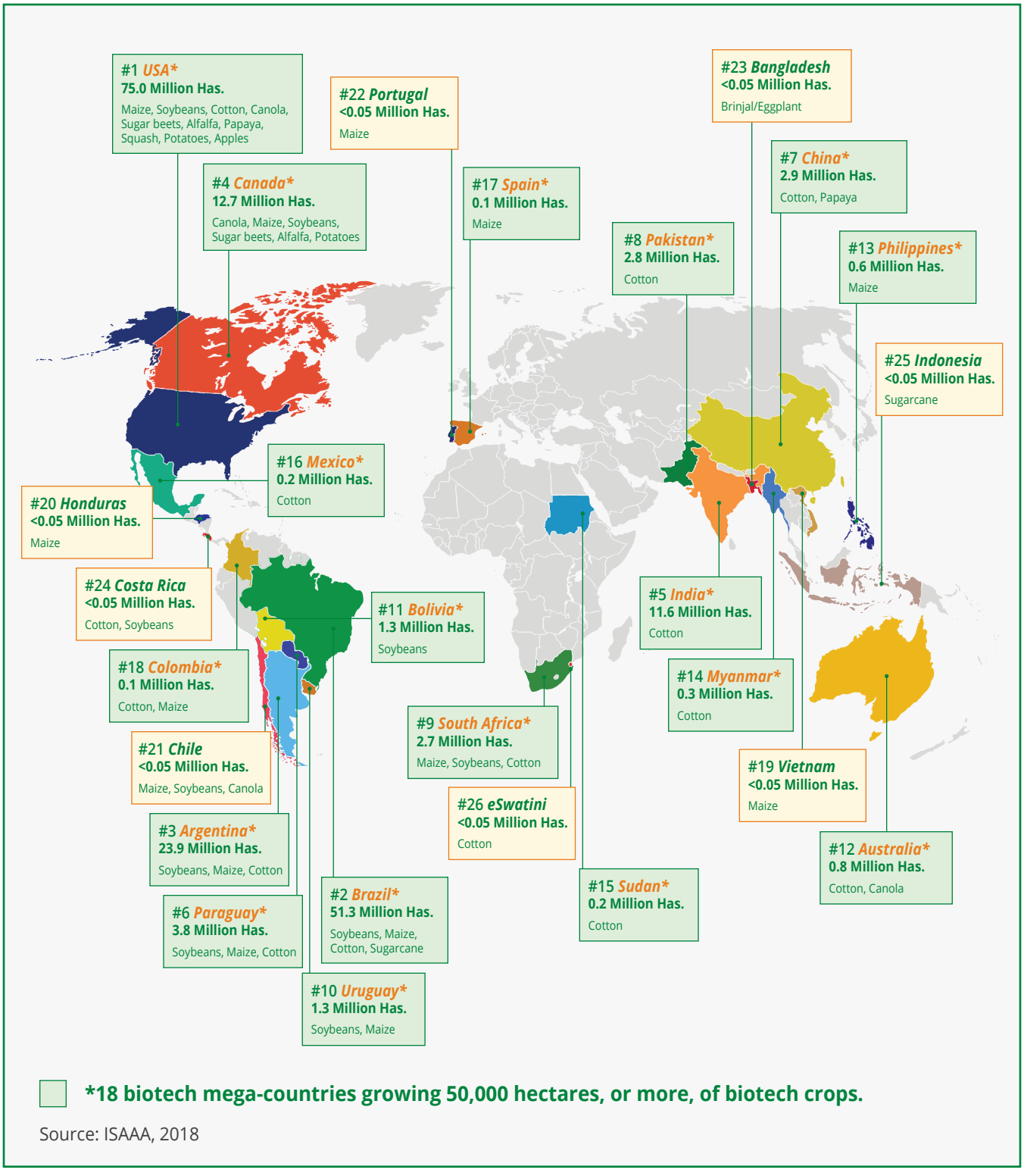


Figure 1. Global Map of Biotech Crop Countries and Mega-Countries in 2018

In 2018, biotech soybeans were grown in the USA, Brazil, Argentina, Paraguay, Canada, Bolivia, Uruguay, Chile, South Africa, and Costa Rica.

oversupply of water in some parts in California, and some drought in the southwestern and south central USA contributed to reduced yield. Strong support by the US government on biotechnology calls for streamlining of regulations that have blocked cutting edge technology, setting free the farmers to innovate, thrive, and grow. The average biotech adoption rate of 93.3% from the three major crops: maize, soybeans, and cotton may mean minimal increases expected in the coming years. Thus, expansion in biotech crop area will rely on other biotech crops: canola, alfalfa, sugar beets, potatoes, and apples. The US leads the bandwagon in the discovery, development, and commercialization of biotech crops. The US government's strong support to biotechnology and the commitment of the U.S. Food and drug Administration (US FDA) to modernize the coordinated framework to regulate biotech products reflect the country's leadership in acceptance and recognition of the scientific basis of the technology. Expeditious approval of new products of agri-biotechnology benefits not only the USA, but also the global community. In 2018, new food/feed and processing approvals include the Chinese insect resistant rice and IRRI's Golden Rice. New generation of HT cotton, high oleic acid canola, and low gossypol cotton were approved for environmental release.

Brazil expanded biotech crop area to reach 51.3 million hectares

Brazil planted the second largest area of biotech crops globally in 2018 at 51.3 million hectares compared to 50.2 million hectares in 2017, a 2% increase (1 million hectares), and represents 27% of the global biotech area of 191.7 million hectares. The biotech crops planted in the country include soybeans at 34.86 million hectares, maize (summer and winter) at 15.38 million hectares, cotton at 1.0 million hectares, and 400 hectares sugarcane, which was planted for the first time in Brazil. The total planted area of these three crops in Brazil was 54.88 million hectares, a 1% increase from 53.39 million hectares in 2017. The 51.3 million hectares biotech crop area is a 93% adoption rate, a 1% reduction from 2017. The area grown to biotech soybeans and cotton increased significantly in 2018 compared to 2017 due to profitability, higher prices, high market demand both domestically and internationally, and available seed technologies. China was the main export market for soybeans and cotton. In 2018, 80% of Brazil soybean exports were sent to China, estimated to have hit a record of 83 million tonnes total. The availability of subsidized credit for farmers and foreign investments from large agricultural companies has supported the widespread adoption of biotech crops in the foreseeable future. Moreover, the Brazilian court has issued a ruling that lifts the ban on glyphosate in the country. The decision ensures growers' continued access to glyphosate-based herbicides. A 20-year study of biotech crop cultivation in Brazil indicated an immense reduction in the application of pesticides per hectare and fewer losses caused by pests. Consequently, the productivity and yield of biotech crops have been, on average, higher than conventional crops.

Argentina reached close to 100% adoption rate of biotech crops

Argentina ranked third in the top 10 countries that planted biotech crops in 2018, with a total of 23.9 million hectares, 12% of the global total of 191.7 million hectares and close to 100% adoption rate. The biotech crop area was comprised of 18 million hectares soybeans, 5.5 million hectares maize, and 370,000 hectares cotton. The 23.9 million hectares is an increase of 309,540 hectares or 1.3% from 23.6 million hectares planted in 2017. Severe drought during the peak summer months reduced the area planted to biotech soybeans and resulted to importation of US soybeans to Argentina for the first time in decades. Soybean stacked trait Intacta™ introduced to farmers in 2015 was launched on 70,000 hectares, increased by 40.2% from 2017 (3.08 million hectares) – an indication of farmers adopting a technology that reduces costs and increases profits. The total maize area in 2018 increased by 5.6% from 5.4 million hectares in 2017 to 5.7 million hectares, and total cotton area in Argentina increased by 60% from 250,000 hectares in 2017 to 400,000 in 2018. After the previous years' low approval, the Argentinian government through the Argentine National Advisory Committee on Agricultural Biotechnology (CONABIA) approved eight biotech crop applications in 2018: seven full approvals comprised of four maize IR/HT stacked events, two HT soybeans, and alfalfa event, plus one soybean event for food, feed, and processing only.

Canada reached 92.5% adoption rate

Canada planted a total of 12.75 million hectares of six biotech crops in 2018, a ~3% decrease from 13.11 million hectares in 2017. This was 7% of the global biotech crop area and was comprised of 2.4 million hectares soybeans, 1.6 million hectares maize, 8.7 million hectares canola, 15,000 hectares sugar beets, 4,000 hectares alfalfa, and 65 hectares potatoes. The slight decrease in biotech area was due to reduction in planted areas of soybeans, maize, and canola. Other biotech crops, including alfalfa, sugar beets, and potatoes, planted in smaller area, increased slightly in 2018.

In 2018, biotech sugar beets were planted in the USA and Canada.

However, the average adoption rate of 92.5% was an increase of 2% from 2017. Several approvals were given by the government of Canada. Three varieties of biotech apples (Arctic® Golden Delicious, Arctic® Granny Smith, and Arctic® Fuji) were approved for commercial planting purposes, livestock feed, and food use. Biotech Golden Rice with provitamin A Event GR2E received approval from Health Canada. This decision coincides with the approval from Food Standards Australia New Zealand (FSANZ) in 2018. Health Canada also approved the insect resistant sugarcane and decided that the sugar produced was as safe as the produce from conventional sugarcane. Also in 2018, 7 tonnes of biotech salmon fillet were sold by US-based AquaBounty Technologies in Canada.

India: IR (Bt) cotton adoption increased to 95%

In 2017-18, the adoption of officially approved IR cotton represents 95% of 12.24 million hectares of cotton planted in India. Due to the successful control of the spread of unapproved IR(Bt)/HT cotton, India achieved higher planting of officially approved IR cotton to 11.6 million hectares in 2018-19, an increase of 200,000 hectares over

2017-18 and planted by over 6 million farmers. Adoption rate went down to 93% in 2017 after an all-time high of 96% in 2016 when unapproved IR/HT cotton estimated at 3.5 million packets were planted over approximately 760,000 hectares. Thus, attaining 95% adoption rate again and 6% biotech crop area indicate the restoration of farmers' confidence on the Bt cotton technology and a sign of demand for the approval of next generation biotech cotton technology including stacked IR/HT cotton. The nationwide management of pink bollworm campaign, which was implemented in cotton growing States, focused on dryland farmers in Maharashtra in 2018. The campaign included farmers educational programs, workshops, and awareness and training programs involving key stakeholders. This contributed to increasing farmer awareness resulting in significant control of pink bollworm in the 2018 Kharif season. However, reports from different maize growing States of India indicated the devastating infestation of fall armyworm on maize, causing heavy damages in both Kharif and Rabi seasons. Activities to raise awareness on the control of fall armyworm is in full swing which could push IR maize planting in India.

In 2018, biotech cotton was grown in India, USA, Pakistan, China, Brazil, Australia, Myanmar, Argentina, Mexico, South Africa, Paraguay, Colombia, Sudan, Costa Rica, and eSwatini.

- **Ten countries in Latin America grew 81.93 million hectares of biotech crops**

Ten countries in Latin America planted biotech crops in 2018 including Brazil (51.3 million hectares), Argentina (23.9 million hectares), Paraguay (3.8 million hectares), Uruguay (1.3 million hectares), Bolivia (1.3 million hectares), Mexico (218,000 hectares), Colombia (88,000 hectares), Honduras (35,500 hectares), Chile (10,454 hectares), and Costa Rica (139 hectares) for a total of 81.93 million hectares, an increase of 2.4% from 79.4 million hectares in 2017. Latin America covered 42.7% of the global biotech area of 191.7 million hectares in 2018. Increases in absolute number of hectares and percent area were recorded in several countries, led by Brazil at 1.1 million hectares (2%), Paraguay (800,000 hectares, 27%), Argentina (300,000 hectares, 1%), Uruguay (200,000 hectares, 18%), Mexico (100,000 hectares, 100%), and a small increase of 4,000 hectares (10%) in Honduras. The increase in biotech crop area in most of the Latin American countries compensated for the losses from the extensive drought in 2017. In addition, profitability, elevated prices, high market demand in local and international market, and available seed technologies for soybeans and cotton; available subsidized credit for farmers and foreign investments from the industry; favorable weather and improved agronomic practices with efficient fertilizer applications encouraged farmers in Brazil, Argentina, Paraguay, Uruguay, and Honduras to plant biotech crops. In Mexico, the 100% increase in cotton area was due to farmers' return to maize planting after a year of crop rotation as well as the favorable climate for planting and price of cotton.

The prospect for future expansion of biotech area in Latin America looks positive as more technologies come with different crops and traits. In Brazil, IR sugarcane has been planted in 400 hectares for the first time. In Argentina, the government approved the HT and low lignin alfalfa for commercialization (the third approval in the world after the USA and Canada), and approved

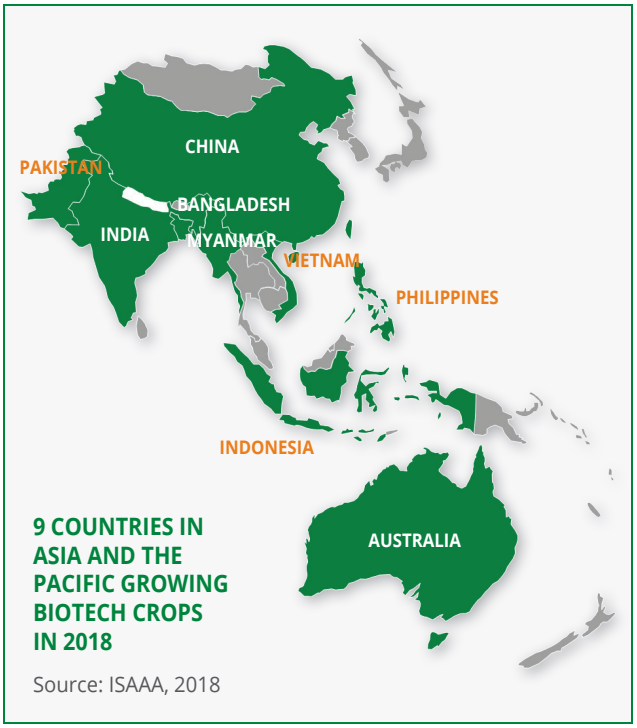
the field trials of drought tolerant wheat and soybeans, new generation HT soybeans, and non-browning apples. The other Latin American countries may follow Brazil and Argentina as they enhance their capacity and increase awareness on biotechnology.

- **Nine countries in Asia and the Pacific grew 19.13 million hectares of biotech crops**

Biotech countries in the Asia and Pacific region were led by India with the largest area of biotech crops at 11.6 million hectares cotton, followed by China (2.9 million hectares cotton and papaya), Pakistan (2.8 million hectares cotton), Australia (793,000 hectares cotton and canola), Philippines (630,000 hectares maize), Myanmar (310,000 hectares cotton), Vietnam (49,000 hectares maize), Bangladesh (2,975 hectares eggplant), and a returning biotech crop country, Indonesia (1,342.59 hectares drought tolerant sugarcane). This region planted 19.13 million hectares (the same as 2017) of biotech crops, 10% of the global biotech crop area of 191.7 million hectares.

Increases in biotech area were obtained in India (200,000 hectares, at 2%), China (100,000 hectares, 4%), Vietnam (4,000 hectares, 9%), and Bangladesh (575 hectares, 24%). The favorable global cotton price has positively impacted biotech cotton adoption in India and China, while public acceptance of clean and hazard free production of biotech eggplant motivated more farmers in Bangladesh. In Vietnam, the low price of imported maize and overall production trend of switching from maize to other higher value crops has minimally increased biotech maize area.

However, this area expansion of biotech crops was made almost even by the decrease in biotech crop areas in Pakistan (decrease of 200,000, at -7%), Australia (decrease of 100,000 hectares, -11%), Philippines (decrease of 12,000 hectares, -2%), and Myanmar (decrease of 10,000 hectares, -3%).



Indonesia, a returning biotech country has planted a new biotech drought tolerant sugarcane that can yield 20-30% higher than the parental varieties during drought conditions. The planting of the biotech drought tolerant sugarcane was developed to close the gap between domestic supply and demand for sugar as Indonesia is the world's largest importer of sugar. The drought tolerant trait would allow farmers to plant even at periods with low rainfall which seems to become worse and frequent due to climate change.

There are a number of new biotech crops and traits in the pipeline for commercial release including the staple crops Golden Rice, late blight resistant potato, various biotech traits for wheat, and IR (Bt) eggplant; biotech soybeans and maize for livestock and poultry feed; and varieties of cotton which contain stacked IR/HT traits.

One of the most important problems in Asia and the Pacific was the delay in approving new biotech crops and traits in China, Vietnam, and the Philippines. Regulatory guidelines in these

countries have been in place and used to regulate biotech products efficiently for more than a decade, but the changing political climate and the loud voice of critics have become a strong barrier for trade and commercialization of biotech crops.

- **The Kingdom of eSwatini (formerly Swaziland) was the latest and third African country to plant biotech cotton**

The African continent remains the region with the biggest potential to reap the benefits associated with modern agricultural biotechnology. In 2018, the continent recorded impressive growth with South Africa planting 2.7 million hectares of biotech crops sustaining its ranking among the top 10 biotech crop countries in the last two decades. Moreover, Nigeria became the first country in the world to approve biotech cowpea, thus, adding a new biotech crop to the global biotech basket. The kingdom of eSwatini (formerly Swaziland) started commercial planting of IR (Bt) cotton on an initial launch of 250 hectares, making it the third African country to plant biotech crops. This brought the number of African countries currently growing biotech crops to 3 again – South Africa (2.7 million hectares), Sudan (with 243,000 hectares IR cotton), and eSwatini for a total of 3.14 million hectares. Two more countries – Ethiopia and Nigeria gave environmental release approvals: Ethiopia for Bt cotton, while Nigeria approved cotton and cowpea. Earlier, Kenya and Malawi also granted environmental release approvals and are working towards commercialization of biotech cotton in the short-term.

- **Two countries in the European Union continued to plant biotech maize at 121,000 hectares**

Two countries in the European Union (EU), Spain and Portugal, have consistently planted biotech IR maize event MON810, the only biotech event approved in the EU. The total biotech crop area planted was 120,990 hectares, a slight decrease of 8% from 2017 area of 131,535 hectares. Spain

In 2018, biotech maize was grown in the USA, Brazil, Argentina, Canada, South Africa, Philippines, Paraguay, Uruguay, Spain, Colombia, Vietnam, Honduras, Chile, and Portugal.

planted 115,246 hectares, 95% of the total 131,535 biotech maize hectares, while Portugal planted 5,733 hectares. The acceptance of biotech crops in the EU is still far from improving. Spain and Portugal planted biotech maize because of the expected infestation brought by the European corn borer. There was less motivation to plant biotech maize in the EU since the market calls for non-biotech raw materials. Imports of feedstocks from Argentina, Brazil, and the US were mostly biotech. There were up to 30 million metric tons soybean products, 10 to 15 million metric tons of maize, and 2.5 to 4.5 million metric tons canola that have been exported to the EU. This situation is expected to continue as there was no change in the EU regulation, there was no approval for cultivation in sight, and movement against biotech crops was still strong. In the beginning of 2018, six biotech crops were authorized for entry into the EU for food and feed uses including four soybean events, one canola, and one renewal for maize. Before the end of the year, two new varieties of maize and renewal of three existing authorizations for maize and sugar beets were approved for food and feed uses.

STATUS OF APPROVED EVENTS FOR BIOTECH CROPS USED IN FOOD, FEED, PROCESSING, AND CULTIVATION

A total of 70 countries (42 + EU 28, counted as one) have issued regulatory approvals to genetically modified or biotech crops for consumption either as human food, animal feed, as well as for commercial cultivation. Since 1992, there have been 4,349 approvals granted by regulatory authorities of these 70 countries. These were granted to 387 biotech events from 27 biotech crops, excluding carnation, rose, and petunia.

Of these approvals, 2,063 were food, either for direct use or for processing, 1,461 were feed use, for direct use or processing, while 825 were for environmental release or cultivation. United States had the most number of GM events approved, followed by Mexico, Japan, Canada, South Korea, Taiwan, Australia, New Zealand, Philippines, EU, Colombia, and Brazil. Maize still had the most number of approved events (137 in 35 countries), followed by cotton (63 events in 27 countries), potatoes (49 events in 13 countries), soybeans (38 events in 31 countries), and canola (37 events in 15 countries).

The HT maize event NK603 (61 approvals in 28 countries + EU 28) still had the most number of approvals. It was followed by HT soybeans GTS 40-3-2 (57 approvals in 28 countries + EU 28), IR maize MON810 (55 approvals in 26 countries + EU 28), HT/IR maize Bt11 (54 approvals in 25 countries + EU 28), HT/IR maize TC1507 (53 approvals in 25 countries + EU 28), IR maize MON89034 (51 approvals in 24 countries + EU 28), HT maize GA21 (50 approvals in 23 countries + EU 28), HT soybeans MON89788 (45 approvals in 25 countries + EU 28), HT soybeans A2704-12 (45 approvals in 24 countries + EU 28), HT/IR maize MON88017 (45 approvals in 23 countries + EU-28), IR cotton MON531 (44 approvals in 20 countries + EU 28), IR maize MIR162 (43 approvals in 23 countries + EU 28), and HT maize T25 (43 approvals in 20 countries + EU 28).

Table 2. Top Ten Countries which Granted Food, Feed and Cultivation/Environment Approvals*

Rank	Country	Number of Approvals			
		Food	Feed	Cultiva-tion	Total
1	USA**	190	180	174	544
2	Japan*	185	177	130***	492
3	Canada	147	138	144	429
4	South Korea	156	148	0	304
5	Brazil	89	89	85	263
6	Mexico	188	29	15	232
7	Argentina	76	68	74	218
8	Philippines	103	102	13	218
9	European Union	99	100	3	202
10	Australia	118	19	39	176
11	Others	712	411	148	1,271
	Total	**2,063**	**1,461**	**825**	**4,349**

*For Japan, data is collected from Japan Biosafety Clearing House (JBCH, English and Japanese) as well as the website of the Ministry of Health, Labor and Welfare (MHLW). However, intermediate events derived from an approved pyramided event recorded in JBCH are not included in our database if they do not appear in MHLW. Also, expired approvals are included in our database from 1992 while JBCH's records starts in 2004.
**USA only approves individual events.
***While cultivation approvals are granted in Japan, there are no current GM planting done.

Source: ISAAA, 2018

CONTRIBUTION OF BIOTECH CROPS TO FOOD SECURITY, SUSTAINABILITY, AND CLIMATE CHANGE MITIGATION

Biotech crops are being adopted globally because of the enormous benefits to the environment, health of humans and animals, and contributions to the improvement of socio economic conditions of farmers and the general public. Global economic gains contributed by biotech crops in the last 21 years (1996-2016)

have amounted to US$186.1 billion economic benefits to more than 16 to 17 million farmers, 95% of whom come from developing countries.

Biotech crops contributed to food security, sustainability and climate change solutions by:

- **increasing crop productivity** by by 657.6 million tons valued at US$186.1 billion in 1996-2016; and 82.2 million tons valued at US$18.2 billion in 2016 alone;
- **conserving biodiversity** in 1996 to 2016 by saving 183 million hectares of land, and 22.5 million hectares of land in 2016 alone; **providing a better environment**
  - by saving on 671 million kg. a.i. of pesticides in 1996-2016, and by 48.5 million kg in 2016 alone from being released into the environment;
  - by saving on pesticide use by 8.2% in 1996-2016, and by 8.1% in 2016 alone;
  - by reducing EIQ (Environmental Impact Quotient) by 18.4% in 1996-2016, and by 18.3% in 2016 alone
- **reducing CO2 emissions** in 2016 by 27.1 billion kg, equivalent to taking 16.7 million cars off the road for one year; and
- **helping alleviate poverty through uplifting the economic situation of** 16-17 million small farmers, and their families totaling >65 million people, who are some of the poorest people in the world (Brookes and Barfoot, 2018).

Thus, biotech crops can contribute to a "sustainable intensification" strategy favored by many science academies worldwide, which allows productivity and production to be increased on the current 1.5 billion hectares only 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.

ECONOMIC GAINS FROM BIOTECH CROPS REACHED US$186.1 BILLION FROM 1996 TO 2016

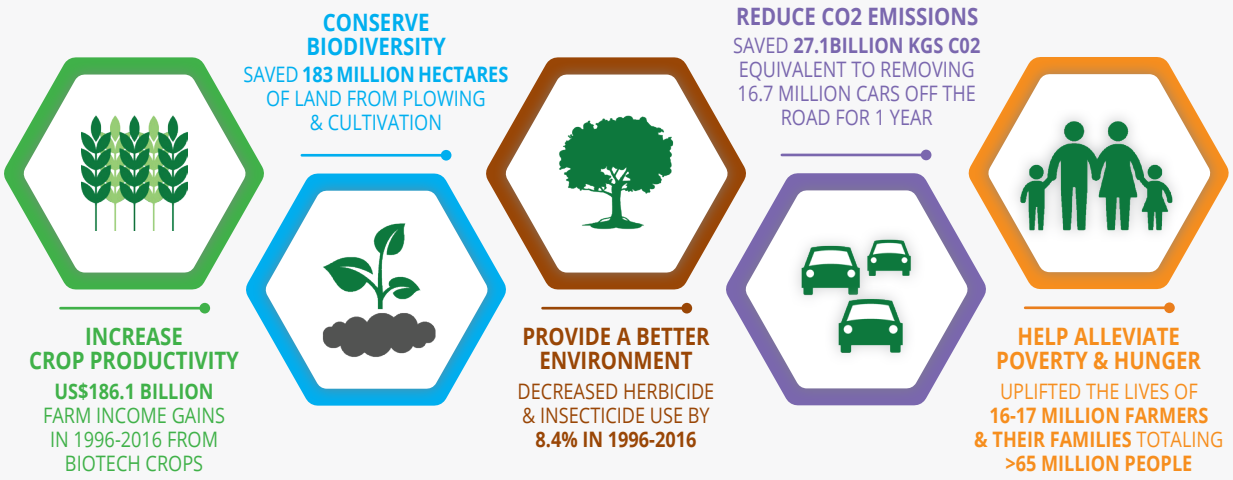
A total of US$186.1 billion economic benefits were gained by countries planting biotech crops from 1996 to 2016. The highest gain was obtained by the USA (US$ 80.3 billion), Argentina (US$23.7 billion), India (US$21.1 billion), Brazil (US$19.8 billion), China (US$19.6 billion), Canada (US$8 billion), and others (US$13.6 billion). For 2016 alone, six countries gained the most economically from biotech crops in 2016, they were the USA (US$7.3 billion), Brazil (US$3.8 billion), India (US$1.5 billion), Argentina (US$2.1 billion), China (US$1 billion), Canada (US$ 0.7 billion), and others (US1.8 billion) for a total of US$18.2 billion. For 2017, the US$18.2 billion economic benefits comprised of US$10 billion for developing countries and US$8.2 for industrial countries.

In 2017, the global market value of biotech crops, estimated by Cropnosis was US$17.2 billion, representing 23.9% of the US$70.9 billion global crop protection market in 2016, and 30% of the US$56.02 billion global commercial seed market (Cropnosis, personal communication, 2018). Two industry sources projected an increase of 8.3% to 10.5% in the global value of biotech seed market by the end of 2022 and 2025, respectively. These are enormous benefits that can be obtained in the seed market if biotech crops are continuously planted globally.

CONCLUSION

The Global Report on Food Crises 2017 revealed that the UN Millennium Development Goals (UN-MDG) that ended in 2015 were not achieved, and that around 108 million people in 48 food crisis-affected countries are still at risk or in severe acute food insecurity since 2016 (FAO, July 23, 2017). Moreover, the United Nations (UN) report State of Food Security and Nutrition in

CONTRIBUTION OF BIOTECH CROPS TO FOOD SECURITY, SUSTAINABILITY, AND CLIMATE CHANGE MITIGATION



Source: Brookes and Barfoot, 2018

the World in 2018 indicated that for three years in a row (since 2016), there was a continuous increase of hunger worldwide, with current levels equivalent to the records a decade ago. The report also emphasized that there was a slow progress in addressing the multiple forms of malnutrition which includes child stunting and adult obesity, making the health of hundreds of millions of people at risk. These findings translate into a clear warning that more efforts must be done rapidly to achieve the Sustainable Development Goal of Zero Hunger by 2030.

Once again, in its 23rd year of commercialization, the increase in global biotech crop adoption (cultivation and import for food, feed, and processing) manifest satisfaction of more than 17 million farmers, 95% of whom are small farmers, and consumer acceptance due to the agricultural, socio-economic, and environmental benefits as well as food safety and nutritional improvement brought by biotech crops. The contribution of this continuing increase in biotech crop adoption could help in alleviating the problems of hunger and malnutrition globally. Ensuring that these benefits will continue now and in the future depends on the diligence and forward-looking regulatory steps based on science, critically looking at the benefits instead of risks, agricultural productivity with a sense of environmental conservation and sustainability, and most importantly taking into consideration the millions of hungry and impoverished populace in need of resources.

EXECUTIVE SUMMARY

ISAAA Brief 54

Global Status of Commercialized Biotech/GM Crops in 2018: Biotech Crops Continue to Help Meet the Challeges of Increased Population and Climate Change

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