



BIOTECH COUNTRY **FACTS & TRENDS**

Brazil

Brazil is the second largest grower of biotech crops in the world, next to the US, planting 44.2 million hectares of biotech crops in 2015.

In 2015, the total biotech crop hectares in Brazil comprised: 30.3 million hectares biotech soybean, 13.1 million hectares biotech maize, and 0.7 million hectares biotech cotton.

Of the 48.7 million hectares total area planted to soybean, maize, and cotton in Brazil in 2015, 91%, or 44.2 was biotech.

Biotech soybean was planted in 30.3 million hectares, up from 29.1



million hectares in 2013, equivalent to 4.5% growth, and 94.2% adoption rate.

Biotech maize remained the second important crop with a total of 13.1 million hectares for both summer

(4.5 million hectares) and winter (8.6 million hectares), an increase of 5% from 2014, and 84.6% adoption rate.

Biotech cotton was planted in 0.7 million hectares in 2015, an increase of 27% over 2014, and 73.3% adoption rate.

In 2011, Brazil approved a biotech bean that can resist golden bean mosaic virus. Variety registration trials have been completed and it is expected to be commercialized in 2016.

The economic benefit to Brazil from biotech crops for the nine-year period (2003-2014) is US\$13.9 billion and US\$2.5 billion for 2014 alone (Brookes and Barfoot, 2016).

COUNTRY PROFILE

Population: 207.8 million
 GDP: US\$2,253 billion
 GDP per Capita: US\$11,340
 Agriculture as % GDP: 5%
 Agricultural GDP: US\$112.6 billion
 % employed in agriculture: 15.3%
 Arable Land (AL): 72.3 million hectares
 Ratio of AL/Population*: 1.6

Major crops:

- Sugarcane
- Soybean
- Maize
- Cassava
- Oranges

Commercialized Biotech Crops:

- HT & IR/HT Soybean
- HT; IR & IR/HT Cotton
- HT; IR & IR/HT Maize

Total biotech crop area and (%) increase in 2015:
 44.2 Million Hectares (+5%)

Increased farm income, 1997-2014: US\$13.9 billion

*Ratio: % global arable land / % global population

BIOTECH CROP ADOPTION

Biotech soybean occupied 94.2% of the 32.2 million hectares total soybean hectareage in Brazil in 2015. The 30.3 million hectares biotech soybean comprised: 18.5 million hectares herbicide tolerant and 11.9 million hectares stacked IR/HT.

The 13.1 million hectares biotech maize in Brazil in 2015 is comprised of 3.3 million hectares IR, 0.94 million hectares HT, and 8.9 million hectares IR/HT. Biotech maize adoption in summer is 77%, or 4.5 million hectares, and 89% in winter, or 8.6 million hectares.

Of the 0.7 million hectares of biotech cotton planted in Brazil in 2015, 17% is IR, 23% is HT, and 33% is IR/HT, with a total of 73% adoption.

FUTURE PROSPECTS

National and multinational companies and public sector research institutions in Brazil are developing various biotech crops, including sugarcane, potatoes, papaya, rice, and citrus.

The Brazilian Agricultural Research Corporation (EMBRAPA) is developing new GM products, including drought resistant soybean and sugarcane, folate-fortified lettuce, soybean as biofactory of HIV antibody, and a virus-resistant bean expected to be commercially launched in 2016. The herbicide (imidazolinone) tolerant soybean "Cultivance™" is expected to be commercialized in 2016.

Brazil's home-grown virus-resistant bean, approved for planting in 2011, has completed variety registration trials and will be commercialized in 2016. In 2011, the transgenic bean event Embrapa 5.1, with resistance to bean golden mosaic virus was approved for commercial release in Brazil.

FuturaGene Brasil Technology Ltd., developed a fast growing GM eucalyptus with 20% higher productivity (between 30-40% percent) for use in other applications,



including bioenergy. Despite environmentalist opposition and vandalism attacks on their experimental greenhouses in Sao Paulo, this GM Eucalyptus was approved for commercial release by the CTNBio in April 2015, but specific plans for commercialization have not been outlined at this time.

BENEFITS FROM BIOTECH CROPS IN BRAZIL

Agricultural biotechnology was first adopted in Brazil 20 years ago. Céleres® has studied and analyzed the economic benefits resulting from the use of this technology for the last seven years. Based on field studies, it is estimated that since the introduction of agricultural biotechnology in Brazil in the 1996/97 to the 2012/13 crop period, the economic benefits to users of this technology have reached US\$24.8 billion and US\$6.3 billion for 2013 alone.

Another annual global study of benefits from biotech crops covering a different period (2003 to 2014) concluded that Brazil gained US\$13.9 billion in 2003 to 2014, and US\$2.5 billion for 2014 alone (Brookes and Barfoot, 2016).

SOURCES

James, Clive. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, New York.

Food and Agriculture Organization of the United Nations. <http://www.fao.org/countryprofiles/>

The World Bank. <http://www.worldbank.org/>

For more information, contact:

ISAAA SEAsiaCenter
GS Khush Hall, IRRI
Los Baños, Laguna 4031 Philippines
Telefax: +63 49 5367216
Email: knowledge.center@isaaa.org

www.isaaa.org



BIOTECH COUNTRY **FACTS & TRENDS**

Argentina

Argentina maintained its ranking as the third largest producer of biotech crops in the world in 2015, occupying 14% of global biotech crop hectareage.

A total of 24.5 million hectares of biotech crops were planted in Argentina in 2015. Of this, 21.1 million hectares were biotech soybean, 2.9 million hectares were biotech maize, and 0.5 million hectares were biotech cotton.

The 21.1 million hectares of biotech soybean in Argentina in 2015 comprised of 20.4 million hectares HT and 700,000 hectares stacked Bt/HT.



Of the 2.9 million hectares biotech maize in Argentina in 2015, ~69% or 2.0 million hectares were stacked Bt/HT.

A total of 530,000 hectares was planted to biotech cotton in 2015, a 100% adoption. It is composed of 488,000 hectares Bt/HT, and 42,000 hectares HT cotton.

Argentina's benefits from biotech crops from 1996 to 2014 is estimated at US\$19.3 billion, and the benefits for 2014 alone is estimated at US\$1.7 billion.

BIOTECH CROP ADOPTION

In October 6, 2015, Secretary of Agriculture, Livestock and Fisheries Gabriel Delgado approved the conditional marketing in Argentina of drought tolerant soybean (IND-00410-5 event) developed by the Institute of Agricultural Biotechnology of Rosario.

Drought tolerant soybean, which has the potential to increase yields by 14%, was developed by Universidad Nacional del Litoral led by Dr. Rachel Chan who identified and used sunflower gene *hahba-4* which has related natural plant

COUNTRY PROFILE

Population: 43.4 million
 GDP: US\$476 billion
 GDP per Capita: US\$11,570
 Agriculture as % GDP: 9%
 Agricultural GDP: US\$42.84 billion
 % employed in agriculture: 1%
 Arable Land (AL): 38 million hectares
 Ratio of AL/Population*: 4

Major crops:
 • Soybean • Sugarcane • Wheat
 • Maize • Sunflower seed

Commercialized Biotech Crops:
 • HT Soybean • Bt/HT Cotton
 • Bt/HT/Bt-HT Maize

Total biotech crop area and (%) increase in 2015:
 24.5 Million Hectares (+1%)

Increased farm income, 1996-2014: US\$19.3 billion

*Ratio: % global arable land / % global population



response to abiotic stresses such as drought and salinity.

Insect resistant maize was introduced in Argentina in 1998, and herbicide tolerant maize in 2004. Stacked trait (Bt/HT) varieties became available in 2007, and by 2015, 69% of biotech maize hectareage is planted to stacked varieties.

Argentine scientists have developed potato plants resistant to Potato Virus Y (PVY). For six years, researchers tested 2,000 plants from two different lines in the provinces of Córdoba, Mendoza, and Buenos Aires. Results showed that the genetically modified potatoes were not infected, while the infection rate was 60 to 80 percent in non-GM potatoes.

There are 41 biotech crops approved for commercial planting in Argentina from 1996 to 2015: 29 maize events, 8 soybean events, 3 cotton events, and 1 potato event.

In 2015, 3 soybean events and 1 potato event were approved in Argentina. These events are:

- Soybean DAS-44406-6,
- Soybean IND-00410-5,
- Soybean DP-305423-1 x MON-04032-6, and
- Potato TIC-AR233-5

FUTURE PROSPECTS

National and multinational companies and public sector research institutions in Brazil are developing various biotech crops, including sugarcane, potatoes, papaya, rice, and citrus.

Researchers at INTA in collaboration with a team from University of California Davis, are developing drought resistant wheat. The team used a cytokinin synthesis gene under a water stress inducible promoter to confer drought resistance in wheat. Regenerated plants remain green and do not enter into senescence during drought stress.

Also in the pipeline is a glyphosate tolerant sugarcane being developed at the Obispo Colombres Agricultural Station.

BENEFITS FROM BIOTECH CROPS IN ARGENTINA

Recent data on the benefits from biotech crops estimates that Argentina has enhanced farm income from biotech crops by US\$19.3 billion in the first 19 years of commercialization of biotech crops 1996 to 2014, and the benefits for 2014 alone were estimated at ~US\$1.7 billion (Brookes and Barfoot, 2016).

A comprehensive study on the benefits of biotech crops in Argentina for the 15 years of its commercialization (1996-2010) was conducted by Trigo (2011). The study indicated that gross benefit generated by this adoption process for the period 1996-2010 reached US\$72,363 million.

In a study by Massarani et al. (2013) on perception of small farmers in Argentina about genetically modified crops, results showed that local small farmers are satisfied with the new technology, but also have fears concerning the environment and social impacts. Majority of the farmers said that GM plants are more profitable and

require less work. The generally favorable attitude goes hand-in-hand with other concerns, such as human consumption of genetically modified food or the use of GM technology for research purposes in medicine which are acceptable provided control procedures and access to clear information are improved. In addition, participants agreed that they should be heard in the decision-making process for agricultural questions, but also recognized the difficulties in achieving this objective.

SOURCES

- James, Clive. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, New York. Food and Agriculture Organization of the United Nations. <http://www.fao.org/countryprofiles/>
- The World Bank. <http://www.worldbank.org/>

For more information, contact:

ISAAA SEAsiaCenter
 GS Khush Hall, IRRRI
 Los Baños, Laguna 4031 Philippines
 Telefax: +63 49 5367216
 Email: knowledge.center@isaaa.org

www.isaaa.org



BIOTECH COUNTRY FACTS & TRENDS

India

For the first time in history, India became the top cotton producing country in the world in 2015, planting more than China and the USA.

In 2015, India displaced China to become the world's top cotton producing country, planting 11.6 million hectares of Bt cotton. The US Department of Agriculture and the International Cotton Advisory Committee estimate that India produces more cotton than China in 2015 for the first time in history.

A total of 7.7 million farmers in India planted 11.6 million hectares Bt cotton in 2015, which is 95% of the total 12.2 million hectares of cotton in the country.



India produced 6.51 million tonnes of cotton fiber in 2015, compared to 6.48 million tonnes planted by China.

Commercialization of Bt cotton increased 230-fold at 11.6 million hectares in 2015 from only 50,000 hectares in 2002.

India doubled its market share of global cotton production from 12% in 2002 to 27% in 2015, representing a quarter of the total global cotton production.

India was estimated to have enhanced farm income from Bt cotton by US\$18.3 billion in the 13-year period 2002 to 2014, and US\$1.6 billion in 2014 alone.

COUNTRY PROFILE

Population: 1,311 million

GDP: US\$1,859 billion

GDP per Capita: US\$1,500

Agriculture as % GDP: 18%

Agricultural GDP: US\$334.6 billion

% employed in agriculture: 47%

Arable Land (AL): 174 million hectares

Ratio of AL/Population*: 0.6

Major crops:

- Sugarcane
- Rice, paddy
- Wheat
- Vegetables, fresh
- Potato
- Cotton

Commercialized Biotech Crop: Bt Cotton

Total biotech crop area and (%) increase in 2015:

11.6 Million Hectares (0%)

Increased farm income, 2002-2014: US\$18.3 billion

BIOTECH CROP APPROVAL

Bt technology accelerated the adoption of cotton hybrids in India, from 45% in 2002 to 95% in 2015. By 2015, a total of 1,167 Bt cotton hybrids have been released for commercial cultivation across 10 growing states in India, compared to only three hybrids in 2002.

*Ratio: % global arable land / % global population

In 2014-2015, the GEAC resumed regular meetings, and approved the field trials of GM mustard, chickpea, rice, cotton, maize, sugarcane, and Bt brinjal.

FUTURE PROSPECTS

After the moratorium on Bt brinjal was imposed on February 9, 2010, regulatory approval for field trials and commercial cultivation of biotech crops developed by both public and private sector institutions in India became restrained and sluggish.

In mid-2014, the new Government led by Prime Minister Mr. Narendra Modi revisited the functioning of regulatory committees, including the Genetic Engineering Appraisal Committee (GEAC), which resumed meeting regularly and approved the field trials of GM mustard, chickpea, rice, cotton, maize, sugarcane and brinjal in meetings held in August and September 2014 and in February and September 2015.

Three important biotech crops are in the final stages of regulatory review for commercialization in 2015: biotech mustard, stacked trait biotech cotton, and Bt brinjal.

The biosafety dossiers of BGII-RRF® cotton developed by Mahyco and biotech mustard developed by Delhi University have been submitted to GEAC for commercial approval. GEAC has circulated the biosafety dossiers for comments from the experts and is expected to discuss the commercial approval of BGII-RRF® cotton and biotech mustard in the near future. Meanwhile, there has been an indication to revisit the moratorium on Bt brinjal due to increasing farmer demand.

BENEFITS FROM BIOTECH CROPS IN INDIA

A cumulative ~61 million small-holder cotton farmers planted Bt cotton in the 14-year period showing high repeat decision of planting Bt cotton.

Notably, the increase from 50,000 hectares of Bt cotton in 2002 to 11.6 million hectares in 2015, represents an unprecedented 230-fold increase in thirteen years. Estimates by Brookes and Barfoot (2016, Forthcoming) indicate that India enhanced farm income from Bt cotton by US\$18.3 billion in the thirteen-year period 2002 to 2014 and US\$1.6 billion in 2014 alone.

Fourteen peer-reviewed research studies have been conducted over the years, three studies were conducted prior to the commercialization of Bt cotton from 1998 to 2001, whereas eleven studies were carried out to assess ex-ante impact of Bt cotton, which were reported during the post commercialization of Bt cotton from 2002 to 2013. The results of these studies on Bt cotton were consistent with the study undertaken by Gandhi and Namboodiri in 2006 showing yield gains of approximately 31%, a significant 39% reduction in the number of insecticide sprays, leading to an 88% increase in profitability, equivalent to a substantial increase of approximately US\$250 per hectare (Gandhi and Namboodiri, 2006).



SOURCES

- James, Clive. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, New York. Food and Agriculture Organization of the United Nations. <http://www.fao.org/countryprofiles/>
- The World Bank. <http://www.worldbank.org/>

For more information, contact:

ISAAA SEAsiaCenter
GS Khush Hall, IRRRI
Los Baños, Laguna 4031 Philippines
Telefax: +63 49 5367216
Email: knowledge.center@isaaa.org

www.isaaa.org



BIOTECH COUNTRY **FACTS & TRENDS**

China

In 2015, China planted 3.7 million hectares of biotech crops: 3.7 million hectares of biotech cotton, 7,000 hectares of virus resistant papaya, and 543 hectares of Bt poplar.

Bt cotton was planted by an estimated 6.6 million small, resource-poor farmers in China in 2015.

The total biotech cotton plantings in China in 2015 were estimated at ~3.7 million hectares, which is 96% of its 3.8 million hectares total national cotton area.

The adoption rate of Bt cotton in China was estimated at 96% in 2015, compared to 93% in 2014.



Virus-resistant biotech papaya plantings decreased from 8,475 hectares in 2014 to 7,000 hectares in 2015 due to over supply of papaya in 2014, but the adoption rate remained high at ~90%.

Guangdong is the main province for papaya production in China.

Hainan Island planted in 2012, and Guangxi province in 2014.

Bt poplar has been planted in China since 2003. By 2015, 543 hectares of poplar have been planted.

The economic benefit to China from biotech cotton for the period 1997 to 2014 is US\$17.5 billion and US\$1.3 billion for 2014 alone.

COUNTRY PROFILE

Population: 1,376 million

GDP: US\$8,227 billion

GDP per Capita: US\$6,900

Agriculture as % GDP: 10%

Agricultural GDP: US\$822.7 billion

% employed in agriculture: 35%

Arable Land (AL): 114.7 million hectares

Ratio of AL/Population*: 0.4

Major crops:

- Rice, paddy
- Sweet potato
- Vegetables, fresh
- Sugarcane
- Maize
- Cotton

Commercialized Biotech Crops:

- Bt Cotton
- Bt Poplar
- PRSV Papaya

Total biotech crop area and (%) increase in 2015:

3.7 Million Hectares (-5%)

Increased farm income, 1997-2014: US\$17.5 billion

*Ratio: % global arable land / % global population

BIOTECH CROP APPROVAL

China has planted Bt cotton since 1997, as well as small hectares of GM papaya and poplar. Biosafety certificates for Bt rice and phytase maize were issued in 2009, which were renewed in late 2014. In 2015, Bt cotton plantings decreased to 3.7 million hectares, compared to 3.9

million hectares in 2014. However, adoption rates increased to 96% in 2015, compared to 93% in 2014. The decrease in cotton plantings was due to high reserve stocks and global low cotton prices in 2015.

Since 1994, China has approved 60 biotech crop events for food and feed use and cultivation, including Argentine canola (12 events), cotton (10), maize (17), papaya (1), petunia (1), poplar (2), rice (2), soybean (10), sugar beet (1), sweet pepper (1) and tomato (3).

FUTURE PROSPECTS

Origin Biotechnology, a subsidiary of Origin Agritech Ltd., has reached a comprehensive, worldwide agreement with the Institute of Plant Protection, Chinese Academy of Agricultural Sciences (CAAS) for the exclusive rights of the Bt gene developed by CAAS. Origin Biotechnology has the rights to this genetic trait in China, and has been passing this product through the Ministry of Agriculture regulatory trials.

Scientists at Hainan University and Hunan Provincial Academy of



Agricultural Sciences are developing a high yielding salt tolerant rice variety. The initial results showed that the biotech rice could produce 6 tonnes per hectare. The harvest in October 2013 also showed one variety has similar output as those varieties grown in normal farmlands.

China's homegrown biotech maize (Bt or phytase maize) will be commercialized in the next three years, opening up an enormous potential market of 35 million hectares of maize. Biotech crops could help China become less dependent on increasing imports of soybean and maize, over 90% of which are biotech.

BENEFITS FROM BIOTECH CROPS IN CHINA

A study led by KM Wu in 2008 suggested that the potential number of small farmers actually benefiting indirectly from Bt cotton in China might be 10 million more, which was confirmed by a separate study led by WD Hutchinson in 2010. The research estimated that the 10 million beneficiary farmers are those cultivating 22 million hectares of crops other than cotton, which also host cotton bollworm, but where infestations have decreased to up to 10-fold, because of lower infestations in Bt cotton.

The most promising benefit that the farmers derived from Bt cotton adoption is the reduction of pesticide use, which was evident in all of the four provinces. In Hebei, where the adoption rate for Bt cotton is at 100%, the farmers now spray pesticide only 4 times compared to more than 25 times before adopting Bt cotton. Majority of farmers also reported that planting Bt cotton enabled them to use less labor input, but higher yield with good cotton quality. This reduced their farming cost compared to the conventional cotton.

Based on studies conducted by the Center for Chinese Agricultural

Policy (CCAP), it was concluded that at the farm level, Bt cotton increases yield by 10%, reduces insecticide use by 60%, and generates a substantial US\$220 per hectare increase in income which makes a significant contribution to their livelihood as the income of many cotton farmers can be as low as around US\$1 per day (Jikun Huang, 2008, Personal Communication). At the national level, it is estimated that increased income from Bt cotton was approximately US\$1 billion per year in 2011.

SOURCES

James, Clive. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, New York. Food and Agriculture Organization of the United Nations. <http://www.fao.org/countryprofiles/>
The World Bank. <http://www.worldbank.org/>

For more information, contact:

ISAAA SEAsiaCenter
GS Khush Hall, IRRRI
Los Baños, Laguna 4031 Philippines
Telefax: +63 49 5367216
Email: knowledge.center@isaaa.org

www.isaaa.org



BIOTECH COUNTRY **FACTS & TRENDS**

Paraguay

Paraguay, the world's fifth largest exporter of soybean, has successfully grown biotech soybean for 11 years since 2004.

In 2015, Paraguay planted 3.6 million hectares of biotech soybean, maize, and cotton.

Of the 3.6 million hectares of biotech crops planted in Paraguay in 2015, 3.3 million hectares were biotech soybean, 305,000 hectares were biotech maize, and 12,000 hectares were biotech cotton.

Of the total national soybean hectareage of 3.4 million hectares in Paraguay in 2015, 3.3 million hectares were biotech, including up to 98,000 of stacked Bt/HT product.

Economic gains over the period 2004 to 2014 were estimated at US\$1.1 billion and the benefits for 2014 alone at US\$131 million.

BIOTECH CROP APPROVALS AND ADOPTION

In 2015, Paraguay approved 20 biotech events with insect resistance, herbicide tolerance, and stacked traits: soybean (3), maize (14), and cotton (3).

Six biotech maize events were officially approved in 2015. These are: GA21; GA21 x Bt11; Bt11 x GA21 x MIR162; TC1507 x MON810; TC1507 x MON810 x NK603; and MIR162 x GA21.

In 2015, Paraguay planted a total of 305,000 hectares of biotech maize comprised of 53,000 hectares Bt;

8,000 hectares HT, and 244,000 hectares Bt/HT maize.

Intacta, a new stacked HT/IT soybean approved in 2013, was grown on 98,000 hectares in 2015.

SOURCES

James, Clive. 2015. 20th Anniversary (1996 to 2015) of the Global Commercialization of Biotech Crops and Biotech Crop Highlights in 2015. ISAAA Brief No. 51. ISAAA: Ithaca, New York. Food and Agriculture Organization of the United Nations. <http://www.fao.org/countryprofiles/>
The World Bank. <http://www.worldbank.org/>

COUNTRY PROFILE

Population: 6.6 million

GDP: US\$25.5 billion

GDP per Capita: US\$6,040

Agriculture as % GDP: 22%

Agricultural GDP: US\$5.6 billion

% employed in agriculture: 23.5%

Arable Land (AL): 4.4 million hectares

Ratio of AL/Population*: 3.0

*Ratio: % global arable land / % global population

Major crops:

- Cassava
- Soybean
- Sugarcane
- Maize
- Wheat

Commercialized Biotech Crops:

- HT Soybean
- HT Cotton
- Bt/HT Maize

Total biotech crop area and (%) increase in 2015:

3.6 Million Hectares (-8%)

Increased farm income, 2004-2014: US\$1.1 billion

For more information, contact:

ISAAA SEAsiaCenter
GS Khush Hall, IRRI
Los Baños, Laguna 4031 Philippines
Telefax: +63 49 5367216
Email: knowledge.center@isaaa.org

www.isaaa.org