

Al-Farabi Kazakh National University (KazNU)

Faculty of Biology and Biotechnology



DISCIPLINE: «Modern Problems of Plant Genetics»

Lecture 8

Risks of modern biotechnologies and legal aspects of their implementation in agriculture.

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Aim of the lesson: familiarization with the risks of modern biotechnologies and legal aspects of their implementation in agriculture.

Main questions:

1. Development of modern biotechnologies and risks of implementing in agriculture.
2. Biotech Crops in Industrial and Developing Countries.
3. Future prospects
4. Main problems of food safety.
5. International policies and standard systems for food safety.



*** Development of modern biotechnologies and risks of implementing in agriculture.**

One of the important tasks of genetic engineering in agriculture is to obtain plants resistant to viruses, since currently there are no other ways to combat viral infections of crops.

Introduction in plant cells of genes of virus's shell protein makes plants resistant to this virus.

Currently, scientists have obtained transgenic plants capable of resisting the effects of more than a dozen different viral infections.

Another important task of genetic engineering is related to the protection of plants from insect pests.

Application of genetic engineering in agriculture has reduced the use of insecticides by 40-60%.

*** Development of modern biotechnologies and risks of implementing in agriculture.**

As a result, production of genetically modified organisms (GMOs) can increase crop yields and intensify the productivity of farm animals.

All of this increases opportunity to solve the world's food problem and becomes a way to reduce food prices.

However, the use of GMOs, despite wide and rapid spread, is a natural concern. While some experts do not deny the enormous potential of agricultural biotechnology in the production of foods, they warn that benefits of biotechnology should not be overestimated and that its potential negative effects should not be overlooked in determining its role in global agricultural production.

- **Biotech Crop Highlights in 2019**

- In 2019, the 24th year of commercialization of biotech crops, 190.4 million hectares of biotech crops were planted by up to 17 million farmers in 29 countries.
- From the initial planting of 1.7 million hectares in 1996 when the first biotech crop was commercialized, the 2019 planting indicates ~112-fold increase (Figure 1).
- Thus, biotech crops are considered as the fastest adopted crop technology in the history of modern agriculture.

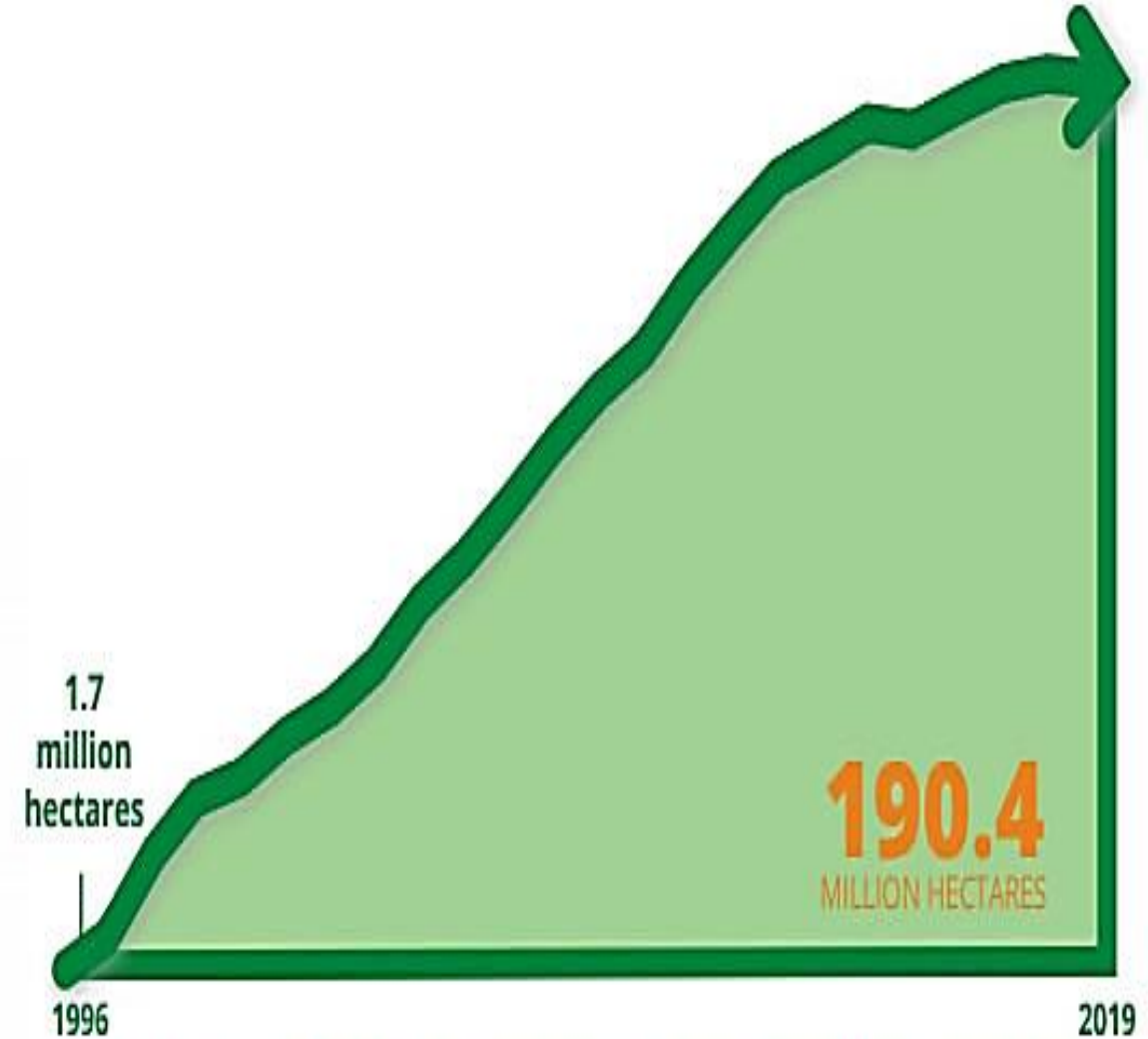


FIGURE 1. GLOBAL AREA OF BIOTECH CROPS, 1996 TO 2019 (MILLION HECTARES).

Source: ISAAA, 2019

- **Biotech Crops in Industrial and Developing Countries**
- For the past eight years, developing countries have planted more biotech crops than industrial countries (Figure 2).
- In 2019, 24 developing countries planted 56% of the global biotech hectares, while 5 industrial countries took the 44% share.
- This trend is expected to continue in the upcoming years due to the increasing number of countries in the southern hemisphere adopting biotech crops and the commercialization of new biotech crops such as rice, which is mostly grown in developing countries.



FIGURE 2.
DISTRIBUTION OF BIOTECH CROPS IN DEVELOPING
AND INDUSTRIAL COUNTRIES IN 2019

Source: ISAAA, 2019

- **Distribution of Biotech Crops, by Country**

- **Of the 29 countries that planted biotech crops in 2019, 19 countries were considered as biotech mega-countries, which grew at least 50,000 hectares (Table 1).**
- **The USA remained as the top producer of biotech crops globally, which planted 71.5 million hectares in 2019.**
- **Brazil landed on the second spot, with 52.8 million hectares.**

Table 1. Global Area of Biotech Crops in 2018 and 2019: by Country (million hectares)

Rank	Country	2018	2019
1	USA*	75	71.5
2	Brazil*	51.3	52.8
3	Argentina*	23.9	24
4	Canada*	12.7	12.5
5	India*	11.6	11.9
6	Paraguay*	3.8	4.1
7	China*	2.9	3.2
8	South Africa*	2.7	2.7
9	Pakistan*	2.8	2.5
10	Bolivia*	1.2	1.1

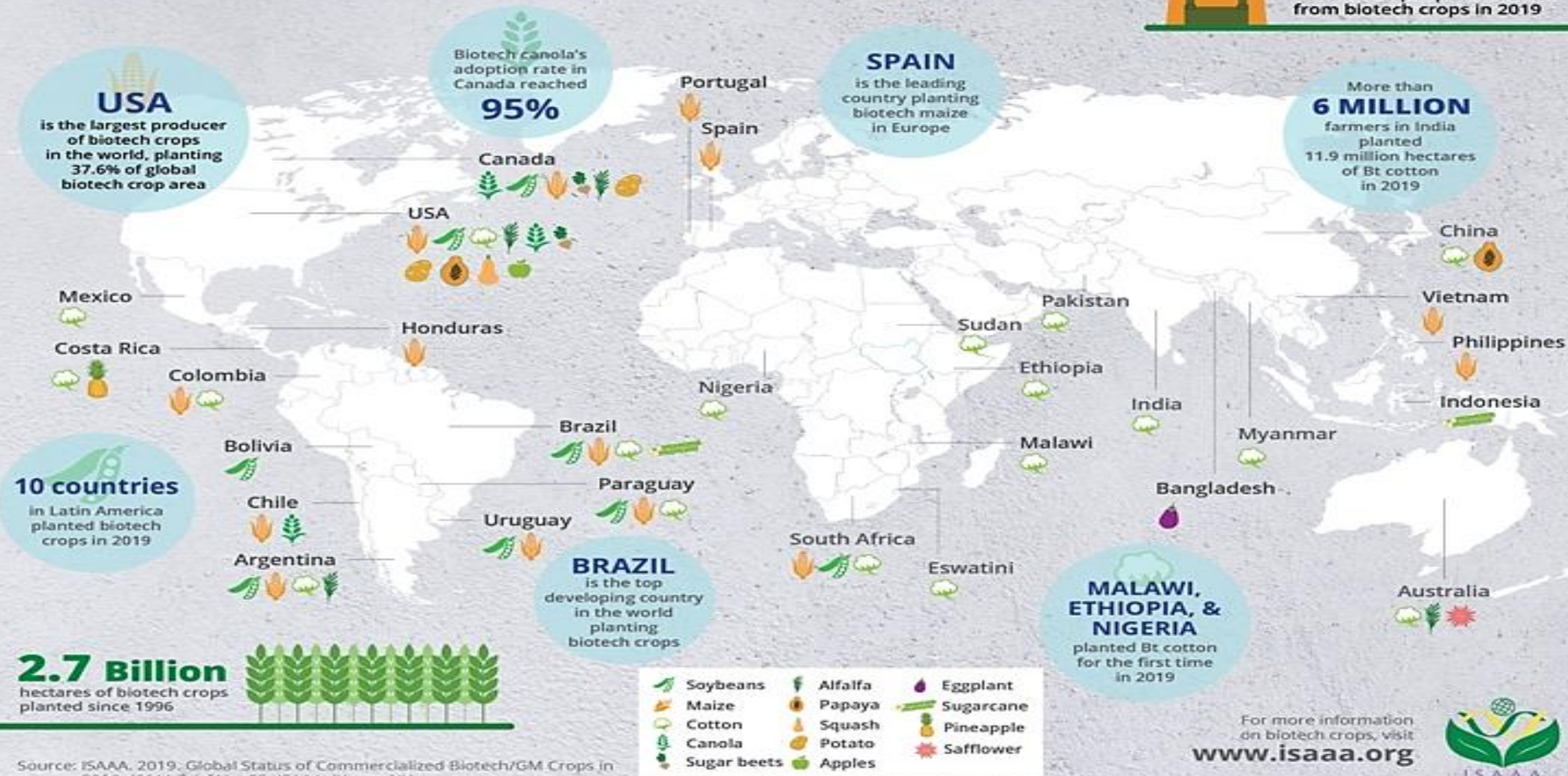
Do you know where biotech crops are grown?

More than 30 countries have planted biotech crops since 1996. See where they were grown in 2019.



17 MILLION

small, resource-poor farmers and their families totaling >65 million people benefited from biotech crops in 2019

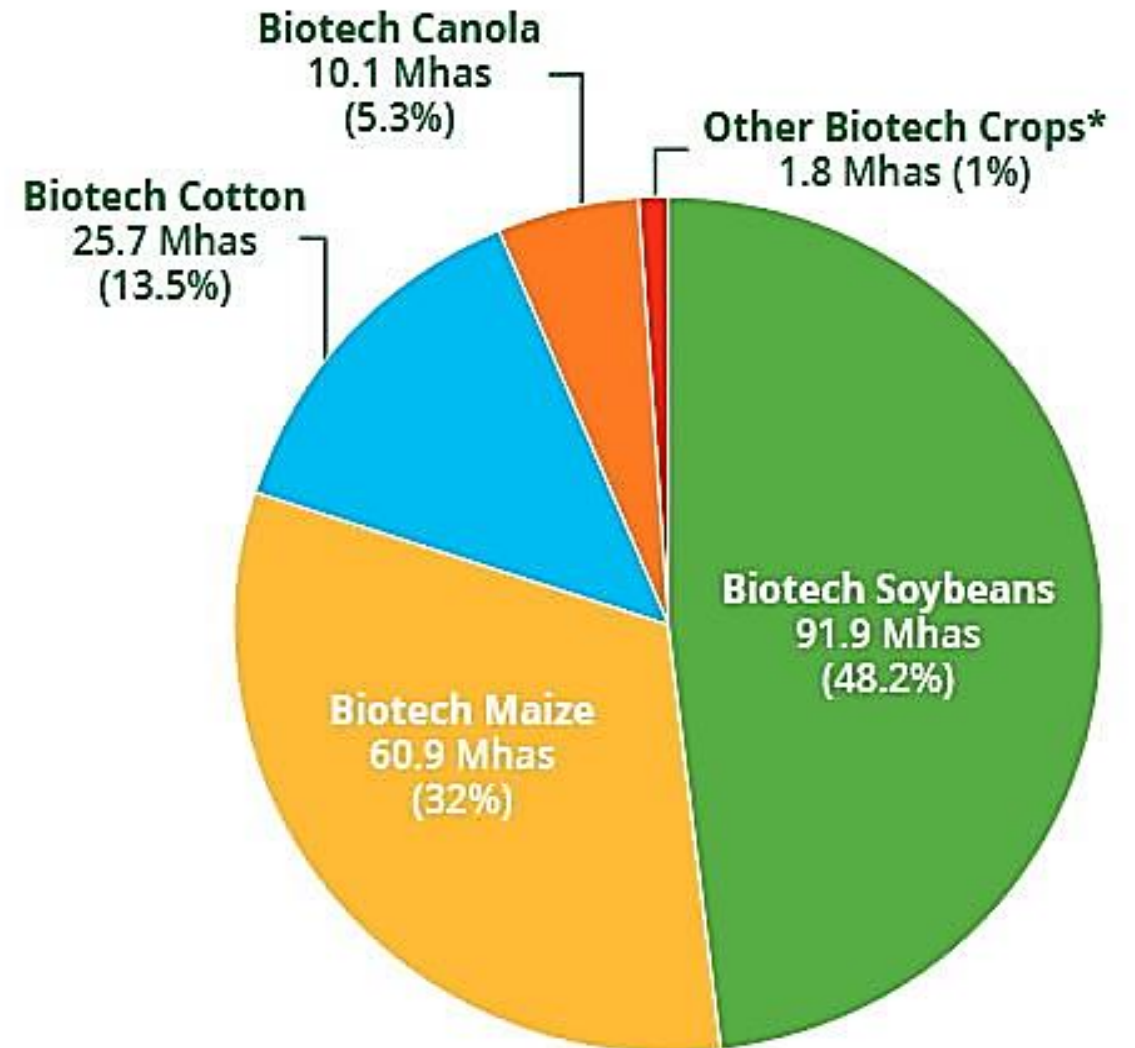


Source: ISAAA. 2019. Global Status of Commercialized Biotech/GM Crops in 2019. ISAAA Brief No. 55. ISAAA: Ithaca, NY.

For more information on biotech crops, visit www.isaaa.org



- **Global Adoption of Biotech Soybean, Maize, Cotton, and Canola**
- The most planted biotech crops in 2019 were soybean, maize, cotton, and canola.
- Although there was a 4% reduction in the planting of biotech soybean, it maintained its high adoption rate of 48% of the global biotech crops or 91.9 million hectares.
- This area was 74% of the total soybean production worldwide in 2019 (Figure 3).



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

FIGURE 3. BIOTECH CROPS IN 2019 (AREA AND ADOPTION RATE)

Source: ISAAA, 2019

- About 17 million farmers, mostly from developing countries, adopted biotech crops because of the improvement in their socio-economic conditions.
- For the last 23 years (1996-2018), global economic gains from biotech crops reached US\$ 224.9 billion.



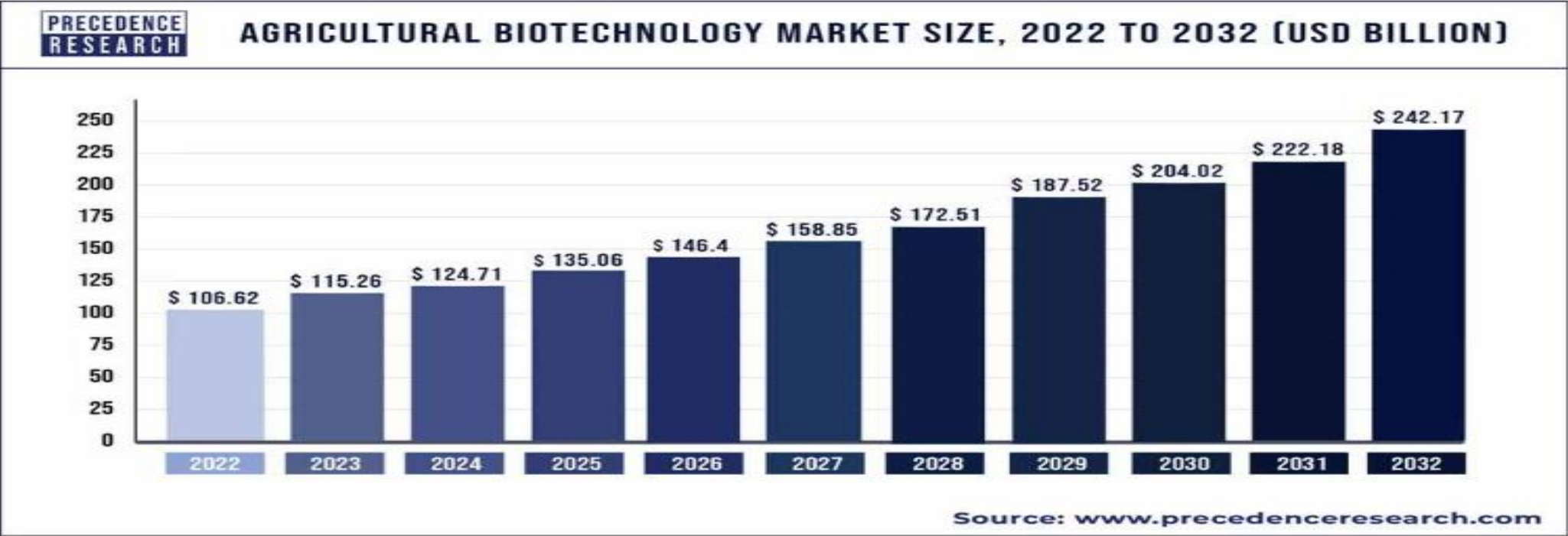
TOP 5 BIOTECH CROPS

Soybeans, Maize, Cotton, Canola, and Alfalfa

Aside from the economic benefits, biotech crops also contributed significantly to food security, sustainable development, and climate change mitigation from 1996 to 2018 through the following:

- **increasing crop productivity by 822 million tons;**
- **conserving biodiversity by saving 231 million hectares of land;**
- **providing a safer environment by saving 776 million kg of pesticides from being released into the environment;**
- **reducing CO2 emissions by 23 billion kg, equivalent to taking 15.3 million cars off the road for one year (2018); and**
- **helping alleviate poverty through uplifting the economic situation of 16-17 million small farmers, and their families totaling >65 million people (2018).**

The global agricultural biotechnology market size was exhibited at USD 106.62 billion in 2022 and is projected to hit around USD 242.17 billion by 2032, poised to grow at a CAGR of 8.6% during the forecast period from 2023 to 2032.



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<https://www.precedenceresearch.com/agricultural-biotechnology-market>

Agricultural biotechnology, also called 'Agritech', is a domain of agricultural science that involves the usage of scientific techniques and tools, including molecular markers, genetic engineering, vaccines, molecular diagnostics, and tissue culture.

Agricultural biotechnology is adopted for modifying living organisms: animals, plants, and microorganisms.

The adoption of agricultural biotechnology is mainly for increasing the productivity of agricultural crops. The use of agricultural biotechnology for altering the genomics sequence of respective crops is common. Various latest agricultural techniques help in improving the resistance of plants to numerous diseases and viruses. With enhanced crop output and exceptional food quality, agricultural biotechnology is benefiting farmers, producers, and consumers.

<https://www.precedenceresearch.com/agricultural-biotechnology-market>

- **Future prospects**

- **The continuous adoption of biotech crops for 24 years has contributed to alleviation of global problems of poverty, malnutrition, food insecurity, crop diseases, and climate change. In 2019, the accumulated biotech crop area has reached 2.7 billion hectares (6.7 million acres) since 1996.**
- **Scientists all over the world are also combining their efforts to develop new biotech crops and traits that will be beneficial to farmers and consumers.**

- **Future prospects**

- **With public engagement initiatives to ensure public acceptance and facilitate enabling policies, the numerous benefits of biotechnology will continue to provide solutions and opportunities to resource-poor farmers and their families, as well as the growing global population in need of sustainable resources for survival.**

- <https://www.isaaa.org/resources/publications/pocketk/16/>

*** Main problems of food safety.**

- **Global challenges, strategic socio-economic priorities of the future of Russia and its regions determined acceleration of the study, forecasting and development of tools that should contribute to sustainable development of rural areas, ensure safety and quality of life, protect the environment and improve environmental management.**
- **The Rome Declaration of World Food Security Summit between 13 – 17 November 1997 defined food security as:
“ensuring that all people have access at all times to the food they need for a healthy and active life.”**

*** Main problems of food safety.**

- **In the 21st century agriculture faces many challenges:**
 - **it must produce more food, fodder and dietary fiber for a growing population with fewer rural workers,**
 - **more raw materials for a potentially larger bioenergy market,**
 - **contribute to overall development in agriculture-dependent developing countries,**
 - **adopt more efficient and sustainable production methods as well as adapt to climate change.**

*** Main problems of food safety.**

- **Food security from the viewpoint of any state is the ability of the state regardless of external and internal threats to meet the needs of the population in food in volumes, quality and assortment that correspond to accepted standards and safety regulations.**
- **Key issues:**
 - *“Is our food safe in terms of application of new biotechnologies?”*
 - *“What measures should be taken in terms of convergence of global food market to standardize approaches, regulation and to provide consumer safety”?*

*** International policies and standard systems for food safety.**

- In 2005, within the international program for future development of the Organization for Economic Cooperation and Development, a project was launched: “Prospects for Development of Bioeconomy by 2030”.
- **Main preconditions for bioeconomy development on a global scale are:**
 - population growth, its income per capita and educational level, primarily in developing countries, where, according to forecasts in 2030, 97% of 8.3 billion inhabitants of the planet will live;
 - increased energy demand coupled with the need for measures to reduce greenhouse effect;
 - ageing of the population in the EU, BRIC countries, as well as growing need for food, thus, to produce it transgenic plants and animals will be used.

*** International policies and standard systems for food safety.**

- At the international level, the World Trade Organization (WTO) is responsible for developing regulations on food hygiene and safety.**
- The agreement on sanitation and phytosanitary (SPE-agreement), concluded by WTO members, includes a wide range of activities related to the protection of people and animals from diseases associated with use of food products.**
- EU legislation reflects its obligations to the World Trade Organization (WTO) and complies with requirements of the Codex Alimentarius Commission where appropriate.**

- * **International policies and standard systems for food safety.**
- **European legislation on food products can be divided into following three main components.**
- **The first**, food products safety legislation that covers such areas as hygiene of food products, food additives, materials in contact with food products, new types of food products, as well as control systems.
- **The second** family of laws relates to information for consumers, which is mainly presented on labels.
- **The third** family of laws establishing quality requirements is aimed at protecting quality and includes “vertical” directives, i.e. directives for dairy products, dietary products and specific products produced in certain regions.

- **Questions for monitoring the material being studied:**

- 1. Development of modern biotechnologies and risks of implementing in agriculture.**
- 2. Biotech Crops in Industrial and Developing Countries.**
- 3. Future prospects**
- 4. Main problems of food safety.**
- 5. International policies and standard systems for food safety.**

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GOOD LUCK!