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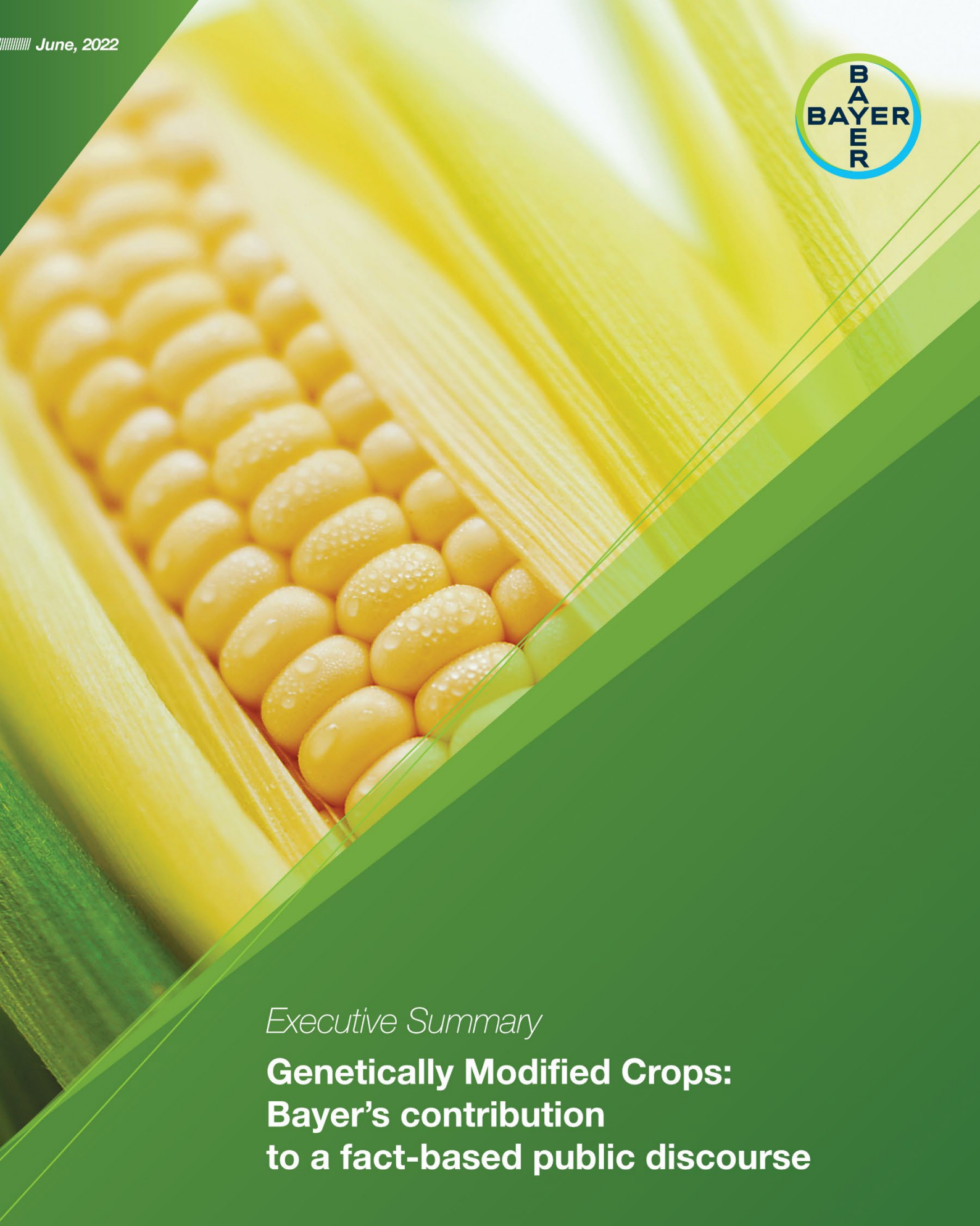

Executive Summary

Genetically Modified Crops: Bayer's contribution to a fact-based public discourse

Science for a ***better life***

1. Executive Summary

Report Goal

When GMOs (genetically modified organisms) in agriculture were launched commercially, there was no blueprint for bringing such a disruptive food technology to market. Based on market realities at the time, Monsanto, which was acquired by Bayer in 2018, focused on marketing GM (genetically modified) crops to farmers and engaging primarily with agriculture organizations and regulatory authorities. Over time, it became clear that this was not sufficient to foster technology acceptance and it would be beneficial to engage in broader discussions about GMOs among various societal stakeholders. The intent of this report is to provide information about the role and benefits of GMOs in sustainable agriculture and the global food system and shed light on our efforts toward minimizing the impact on the environment.

In 2018, the rating agency MSCI ESG Research added a red flag to Bayer over concerns about the compatibility of Bayer's continued production and marketing of GMOs with the environmental principles of the United Nations Global Compact. Bayer has been a member of the UN Global Compact since its founding in 2000. We take this as an opportunity to revise our way of explaining GM crops in our portfolio, while recognizing that GM technology still carries acceptance issues and that disruptive technologies require additional engagement with critical voices.

The Executive Summary and full report will cover:

// What are GMOs?
// GMO's in Today's Food System
// The Controversey Around GMOs: Impact Versus Benefits
// GMO Regulations
// Bayer's Transparency Commitments
// Can GM Crops Make Agriculture More Sustainable?
// Conclusion

What Are GMOs?

For as long as people have been growing crops, they have been crossbreeding them to achieve improvements in taste, appearance, and resistance to plant diseases, among other things. Advances in plant science enable companies like Bayer to develop crops with urgently needed properties more efficiently than traditional breeding could, or to add properties that cannot be achieved through traditional breeding methods.

DEFINITIONS:

GMO (genetically modified organism) / genetic engineering (GE) / genetically modified (GM) / biotech seed or crop – Terms often used synonymously to refer to a process that allows plant breeders to take a desirable trait found in nature and transfer it from a plant or other organism to the plant they want to improve. See detailed definitions in Chapter 1.

GM crops are plants that have been bred using genetic engineering, which involves taking desirable genetic material from one organism found in nature, such as bacterium, and transferring it to a plant scientists want to improve to enable resistance to drought, insects, or tolerance to herbicides. These characteristics are also referred to as "traits."

The process of bringing a GM seed trait or variety from product concept to market launch is rigorous and complex, lasting approximately 16 years and costing $115 million.[i] It involves comprehensive scientific testing and regulatory reviews. Regulatory agencies review and approve individual traits developed through genetic engineering; and certain agencies also review and approve stacked traits when a crop is developed to have several traits (e.g., tolerance to several herbicides). GMOs are imported, grown, and/or field-tested in more than 75 countries and are part of the systemic process of agriculture for farmers today.

GMOs in Today's Food System

Since their introduction in 1994, GM crops have been extensively adopted by farmers around the world, becoming an essential component of the global food system and contributing to food security and the resilience of food supply chains. GM crops are considered the fastest adopted technology in recent times – the GM crop area accounts for 169,2 million hectares world-wide (over 3% growth from 2019 to 2020). In 2020, GM crops represented 51,7% of the overall seed market ($21.205 million of GM seeds versus $19.816[1] million of conventional seeds) and were cultivated – in commercially significant quantities – in 21 countries, with the largest GM planted areas in the US, followed by Brazil and India.[ii]

As of 2019, there were 14 GM crops commercialized, including corn/maize, soybean, cotton, canola/rapeseed, alfalfa, sugarbeets, sugarcane, papaya, safflower, potatoes, eggplant, squash, apples, and pineapple[iii].

Maize (53%), soybean (32%), and cotton (10%) compose a total of 95% of the total GM market, for which the most important GM crop-growing countries are reaching market saturation in GM adoption rates[2] (US: 94,9%; Brazil: 94,9%; India: 99,0%; Argentina: 99,6%; Canada: 87,9%).

In 2020, soybean was the GM crop with the most crop area (73,3 million hectares), followed by maize (62,3 million hectares), cotton (23,8 million hectares), canola (9,6 million hectares), and sugarbeet (0,5 million hectares).

156,6 million of a total of 169,2 million hectares, i.e. 92,5% of all GM crop area is concentrated in 5 countries: US (72,5 million hectares), Brazil (47,7 million hectares), India (13 million hectares), Argentina (11,9 million hectares), and Canada (11,4 million hectares).

Today, Bayer is one of more than 30 GM crop developers, ranging from commercial to government entities. Table 2 in the appendix shows all developers of GM crops.

The Controversy Around GMOs: Impact Versus Benefits

GMOs are one of the most intensely debated topics when it comes to food production. Perspectives range from considering GM crops one of the most significant breakthroughs in modern agriculture to concerns about their impact on the environment and on human and animal safety. Questions have been raised about the negative impact on biodiversity, especially for the use of herbicide-tolerant GM seeds in combination with broad-spectrum herbicides, the contamination of non-GM crop fields caused by gene flow from genetically modified crops, and a decline of local and indigenous crops.

GMOs and Biodiversity

Perhaps the most debated aspect of GMOs has been their impact on the environment, in particular biodiversity. For example, the decline in monarch butterfly populations has been attributed to the use of herbicides on herbicide-tolerant GM crops. Indeed, declines in the monarch population have been documented since the 1990s. Many factors are thought to contribute to the problem: loss of milkweed – a weed that impacts crops and is also the monarch's main source of food, habitat loss in the Mexican forests, climate change, and weather events. Bayer takes action to build and maintain monarch-friendly habitats. We collaborate with conservation groups, academic experts, farmers, and government agencies to study the link between GMOs and the decline in monarch butterfly populations in the United States. Read more about Bayer's efforts in Chapter 2.

Pollinators, such as honeybees, play an important role in food production. They also depend on natural habitats for their nutrition. When more land is dedicated to crop cultivation, biodiversity and natural habitats are negatively impacted.[iv] Therefore, intensive agriculture, which enables the production of more food on the same area, can limit the impact on natural habitats, which are essential for preserving biodiversity. According to ISAAA, due to the planting of GM crops, 231 million hectares of land were saved from cultivation between 1996 and 2018.[v]

[1] Includes soybean, maize, cotton, rapeseed, sugarbeet with GM varieties and vegetables, rice, cereals, and sunflower without GM varieties
[2] Considering adoption rate for maize, soybean, and cotton, which represent over 94% of total GM crops

Critics of GM crops have argued that insect-resistant crops that contain *Bacillus thuringiensis* (Bt) are harmful to bees, but there is no evidence to support this claim. Bayer takes into account pollinator safety when developing all new products. All GM crops are thoroughly tested in the early product development stages to assess their effects on bees. GM crops with insect-resistant traits do not have any biologically relevant effects on honeybees.

Honeybees and other pollinators may be impacted by the overuse of herbicides applied to crops when they reduce the amount of weeds that make up pollinator habitats. To mitigate the potential impact of herbicides applied to GM crops on pollinator food sources, farmers should consult the product labels, which indicate recommended application rates and restrictions on the timing and the number of applications. Insect-protected GM crops reduce the need for insecticides and the potential for beneficial insects to be exposed to insecticides. Spray drift reduction equipment and field buffers are additional measures for ensuring that herbicides and insecticides do not migrate to natural habitats that serve as refuges for biodiversity.

Coexistence of GM and Non-GM Crops

The impact of GM crops on local and indigenous crops has received significant attention. Farmers are accustomed to growing different crops next to each other, and experience shows that various cropping systems (conventional, organic, GM) can coexist successfully. Farmers select the type of cropping system and the types of crops they grow based on market needs and demand. Bayer firmly believes that farmers should be able to choose the cropping system that best helps them meet their needs.

MSCI ESG Research has raised the topic of claims and even litigation involving the cross-pollination of GM and conventional crops. It is important to know that inadvertent cross-pollination is preventable by allowing sufficient distance between fields and timing planting to prevent simultaneous pollination in two adjacent fields. Therefore, these events are extremely rare. Contrary to some claims, there is no evidence to suggest that local or native plants are reduced in the unlikely event of inadvertent cross-pollination between GM and non-GM crops. Moreover, only plants of the same species can cross-pollinate. For example, GM canola would have no impact on an adjacent field of organic corn. This topic is explored in more detail in Chapter 2 of this report. We are not aware of any open litigation claiming cross-pollination or contamination of non-GM crops. An explanation of allegations on coexistence and open litigation is included in Appendix 3 of this report.

Bayer is committed to providing continuous support to farmers by co-designing sustainable farming practices and undertaking stewardship activities and training programs to ensure successful coexistence. In agriculture, coexistence also depends on communication, cooperation, and mutual respect among farmers. Awareness of a neighbor's planting intentions helps farmers decide which Best Management Practices (BMP) to deploy. Our belief in the successful coexistence of various cropping systems is underscored by our recent entry into the organic vegetable seed segment.

Impact on Indigenous Crops

Over the past century, there has been a decline of local seed varieties in the US and Europe. This happened because farmers have opted in favor of seeds with higher yield potential developed professionally by breeding companies.

GMOs and Smallholder Farmers

Patent protection for GM seed has come under scrutiny, especially in instances where smallholder farmers have used GM seed for subsistence needs. As an agriculture company, we are committed to providing smallholder farmers with access to the full spectrum of sustainable agricultural solutions and empowering them to reach their growth potential. Like any publicly traded company that invests heavily in innovation, Bayer values the protection of intellectual property. However, we recognize that smallholder farmers face unique socioeconomic challenges, and therefore we have expressed our commitment in our Intellectual Property Rights, which encompass GM crops. First and foremost, our approach to Intellectual Property Rights is guided by societal benefits. This means that Bayer does not intend to enforce its Intellectual Property Rights against smallholder farmers for private and noncommercial use of farm-saved seed to escape extreme poverty and will work collaboratively to integrate these smallholder farmers into the world of commercial farming to improve their livelihood. It is worth noting that, in 2021, Bayer was ranked 1st in the Access to Seeds Index for Africa [vi] and 3rd for South and South-East Asia [vii] by the World Benchmarking Alliance, an organization that seeks to increase the private sector's impact toward a sustainable future for all and assesses seed companies on their efforts to make quality seeds accessible to smallholder farmers.

GMO Regulations

GMOs are highly regulated. Therefore, GM seeds need a registration or approval before they can be commercialized and be made available to farmers for planting. Today, GM crops are grown in 29 countries.[viii] The established consensus among regulatory agencies globally is that foods and feeds derived from GMOs are as safe and nutritious as those derived by conventional breeding techniques. Nevertheless, some countries, including much of the European Union, do not allow GM crop cultivation. However, most countries, including those in the European Union, approve imports of GM crops such as maize and soybeans to be used primarily as animal feed – and therefore as a basis of protein-based food like meat, milk, and eggs.[ix] The discrepancies in how GM crops are regulated point to the fact that the topic of GMOs is as divisive within regulatory bodies as it is in society, calling for more engagement and information exchanges on the topic. Read more in Chapters 3 through 5.

Bayer's Transparency Commitments

We have come to recognize that there is an information gap about food production and the technologies used to produce food. We understand that consumers deserve to know where their food comes from and how it is grown. As a result, Bayer has expanded its transparency commitments to engage in more conversations about science and food production with internal and external stakeholders. We have formalized our continued dialogue by establishing a transparency-focused platform, which provides interested consumers and the scientific community access to summarized test results and evaluations on the human and environmental safety of active substances used in our crop protection products as well as on the safety of GM crops. We also have provided access to full in-depth study reports evaluated by regulators for the authorization of our products, alongside informational materials to help put regulatory science into context. You can learn more about our transparency platform and commitments in Chapter 5 of this report or by visiting our transparency website.

The introduction of GM crops has offered a valuable lesson on building acceptance for disruptive food technologies, not just for Bayer but for the entire agriculture value chain. The societal debate around GMOs has prompted a reassessment of how we interact with critical perspectives. We've learned that engagement with different groups and intentional listening are critical in identifying gaps in understanding and building consensus based on shared values. Communication needs to happen at all levels, starting with our executive leaders. And input gathering needs to be institutionalized. To achieve our vision for enhanced stakeholder engagement, Bayer has taken the following steps:

// We've established an independent external Sustainability Council that advises the Board of Management and other functions on sustainability initiatives, provides guidance on the contribution that Bayer can make with its research and development, and independently examines the progress made by Bayer in the implementation of its sustainability targets.
// Bayer's Supervisory Board established an ESG Committee, which focuses on corporate social responsibility and the environmental, social, and corporate governance (ESG) elements of the company's business activities.
// At Bayer, sustainability and business strategy are fully integrated. We see sustainability as a growth driver and an essential component of our corporate strategy, our business activities, our corporate values, and the way in which we operate our businesses. Our strategy is aligned to the global Sustainable Development Goals (SDGs) of the United Nations, the attainment of which is targeted for 2030.

In the case of GM crops, we've learned that leading with science and farmer benefits is not enough – we need to describe the benefits of new technologies for all sectors of society rather than our customers alone. GM crops are just one technology in Bayer's portfolio, and we are already applying a new approach to the introduction of other new technologies.

Can GM Crops Make Agriculture More Sustainable?

GM crops deliver a range of benefits to farmers large and small: improved protection from weeds, insects, diseases, and extreme weather, which results in increased yield, reduced pesticide use, and reduced greenhouse gas emissions. According to a recent study, "The adoption of GM insect resistant and herbicide

tolerant technology has reduced pesticide spraying by 775.4 million kg and, as a result, decreased the environmental impact associated with herbicide and insecticide use on these crops (as measured by the indicator, the Environmental Impact Quotient (EIQ)) by 18.5%."[x] Modern agriculture technologies – of which GM crops are an essential component – make it possible to grow food more efficiently, without expanding the surface area of cultivated land to meet growing global demand.

The world's population is expected to grow to around 10 billion people by 2050 – an increase of around two billion people relative to 2020. In addition, both the Food and Agriculture Organization (FAO) of the United Nations and the World Resources Institute (WRI) expect a 50% increase in the demand for food and animal feed by 2050. Intensive agriculture, made possible by advances in breeding technologies, along with fertilization, irrigation and crop protection, is the only time-tested way to grow food without turning more natural habitats into farmland. Over the past 40 years, agricultural yields have grown by 60%, while the amount of agricultural land has increased by only 5%.[xi] While subsistence agriculture and organic farming are viable production options, they cannot scale up to meet existing demand and maintain the resilience of the modern food systems. For example, biotechnology has made it possible to increase global production levels of soybeans by 278 million tons and of maize by 498 million tons since the introduction of the technology in the mid-1990s.[xii]

When objections to modern agriculture technologies are raised, we need to ask ourselves if it is possible to produce enough food to meet the needs of the entire global population with zero impact on the environment. Without using any technology, including GMOs, natural habitats would have to continuously be sacrificed for crop cultivation. Technology makes it possible to limit the amount of agricultural land, but it does have impacts on biodiversity, including pollinators. Trade-offs are inevitable to ensure food systems are resilient and food supplies are ample and affordable. It is important to note that Bayer is committed to conserving and restoring biodiversity within and beyond agricultural fields through our technologies and services and through good stewardship and best management practices. This report describes Bayer's responsible business conduct with regard to GM seed production and our efforts to communicate transparently about GM crops and other technologies.

Bayer, along with many experts, believes that GM crops, as a component of intensive agriculture, contribute to sustainable and resilient food production.

Conclusion

Since their introduction in 1996, GM crops have provided incontestable benefits to farmers, resulting in their broad adoption in the highest ag producing countries. They became systemic to the global food supply, contributing to its efficiency and resiliency. Even countries that don't allow the cultivation of GM crops rely on imports of GM crops to meet their needs for animal feed. Today, Bayer is one of many companies that develop GM crops. Studies have documented the benefits of GMO technology in protecting crops from weeds, pests, and disease, reducing the use of crop protection products and cutting greenhouse gas emissions. While every agricultural technology has some impact on biodiversity, intensive agriculture – including GM crops – makes it possible to grow as much food as needed on existing agricultural land without further expanding into natural habitats. Bayer has learned a lot from the introduction of GM crops, and we have embraced the power of transparency in addressing controversial topics and questions. This report has been developed in the spirit of dialogue and information sharing.

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[i] https://croplife.org/plant-biotechnology/regulatory-2/cost-of-bringing-a-biotech-crop-to-market/
[ii] https://agbioinvestor.com/agbioseed-seed-market-intelligence/
[iii] https://www.isaaa.org/resources/publications/briefs/55/executivesummary/default.asp
[iv] https://ipbes.net/global-assessment
[v] https://www.isaaa.org/resources/publications/briefs/55/executivesummary/default.asp
[vi] https://www.worldbenchmarkingalliance.org/publication/access-to-seeds-index/wca/rankings/
[vii] Ibid.
[viii] https://www.isaaa.org/resources/publications/briefs/55/executivesummary/default.asp
[ix] https://geneticliteracyproject.org/gmo-faq/where-are-gmo-crops-and-animals-approved-and-banned/
[x] https://www.tandfonline.com/doi/full/10.1080/21645698.2020.1773198
[xi] https://acsess.onlinelibrary.wiley.com/doi/epdf/10.2135/cropsci2017.03.0199
[xii] https://www.tandfonline.com/doi/full/10.1080/21645698.2020.1779574