

Vol. 5, No. 1 June 2026

DOUBLE HELIX

DECODING BIOTECH STRAND BY STRAND

SENIOR HS

Breaking the Cycle: Can Biotech Seeds Save Our Farming Future?

Next Generation of Biotech Crops: Bioengineered Plants for a Healthier Planet

Exploring Microalgae as Bioremediation Agents

Recent Biotech/GM Crop Approvals Around the World

EDITORIAL TEAM

Janine Cyren Escasura • Jeanette Capistrano
Kaymart Gimutao • Dr. Pierangeli G. Vital
Shiela Chavez

Writers

Clement Dionglay
Design and Layout

Eric John F. Azucena
Masthead Design

Dr. Rhodora Romero-Aldemita
Panfilo G. De Guzman • Kristine Grace N. Tome
Editors/Advisers

The *Double Helix* is a magazine supplement for senior high school students taking the academic strand. This magazine is published by ISAAA Inc. and available for free download in the ISAAA Inc. website at www.isaaa.org. Send all inquiries to double.helix@isaaa.org.

Welcome!

Dear Teachers, Students, and Readers,

Welcome to the sixth issue of the *Double Helix*, the only magazine on agricultural biotechnology for senior high school students in the Philippines!

Biotech crops—including engineered trees and houseplants—are becoming vital tools for environmental conservation and climate resilience. Genetically enhanced trees are being developed to grow faster and capture significantly more atmospheric carbon, boosting global reforestation efforts. Indoors, bioengineered houseplants act as continuous, living air purifiers, efficiently scrubbing volatile organic compounds (VOCs) and pollutants from the air. These innovations strengthen ecosystems, mitigate greenhouse gases, and help both natural and urban environments adapt to a changing climate.

This issue of the *Double Helix* presents biotech products developed for the environment, and how biotech crops help in mitigating the effects of climate change.

If there are topics that you want to be covered in the *Double Helix*, send us a message at double.helix@isaaa.org. Please share the *Double Helix* with your family and friends!

— *Double Helix* Editorial Team

NEWS BRIEFS

GE POPLAR TREES HELP FIGHT CLIMATE CHANGE

Researchers in California, USA developed genetically engineered poplar trees to improve carbon capture and storage. Photosynthesis in the genetically engineered (GE) trees was enhanced by photorespiration bypass pathway that allowed more energy to go into tree growth and increases both biomass accumulation and carbon assimilation. The findings indicated that the GE trees have reduced the expression of genes responsible for the transport of toxic byproducts of photorespiration out of the chloroplast. The GE trees also have increased height, stem volume growth, and biomass accumulation.



ENABLING PLANTS TO COMBAT CLIMATE CHANGE BY STORING MORE CARBON DIOXIDE

Scientists from the University of Würzburg, Germany, and partners are exploring the capability of modified plants to store more carbon dioxide to possibly slow down climate change. The researchers conducted a study on plants with modified metabolism, which can absorb residual carbon dioxide more efficiently. They combined two strategies to modulate the metabolism of the plant cell and found that the combination can enable the plants to absorb five times more carbon dioxide than in the normal state.

HIGH-YIELD RICE EMITS UP TO 70% LESS METHANE

Scientists found that the roots of SUSIBA2, a low-methane-emitting genetically modified rice, produced significantly less fumarate. They also noted a correlation between the amount of fumarate secreted and the abundance of methane-releasing archaea or “methanogens” in the surrounding soil. Further study showed that SUSIBA2 plants also release significantly more ethanol. Adding ethanol to the soil surrounding rice plants reduced methane emissions. When the research team grew these low fumarate and high ethanol (LFHE) rice varieties at various field sites throughout China, the LFHE rice produced 70 percent less methane compared with the elite variety from which it was bred. The LFHE crops also have high yields at 8.96 tons/hectare on average, compared to the 2024 global average of 4.71 tons/hectare.



MIT SCIENTISTS SEEK TO DEVELOP SELF-FERTILIZING CROPS, COMBAT CLIMATE CHANGE

Researchers from various fields of expertise at the Massachusetts Institute of Technology (MIT) are working together to reduce agriculture-driven emissions, combat climate change, and produce healthier crops. “Our team’s research seeks to address two connected challenges: first, the need to reduce the greenhouse gas emissions produced by agricultural fertilizer; second, the fact that the yields of many current agricultural crops will decrease, due to the effects of climate change on plant metabolism,”



said Christopher Voigt, project lead and professor in MIT’s Department of Biological Engineering.

EXPERTS FROM UC SAN DIEGO PUSH GENETICALLY ENHANCED CROPS FOR CO2 REMOVAL

Researchers at the University of California, San Diego (UC San Diego) said that genetically enhanced crops with larger root systems can help remove carbon dioxide from the atmosphere. Their study showed that carbon-enhanced crops could sequester up to 1.2 gigatons of carbon dioxide annually within 13 years of initial adoption. This is about seven times more than what current global offset programs deliver today. The researchers emphasize that this approach should complement broader climate efforts to decarbonize the economy.



BREAKING THE CYCLE: Can Biotech Seeds Save Our Farming Future?

By Jeanette Capistrano

Agriculture is locked in a complex struggle with the environment. While it is essential for human survival, traditional farming methods are becoming increasingly challenging to sustain as the Earth continues to warm. In the Philippines, a region frequently hit by extreme weather conditions, understanding how biotechnology serves as an environmental intervention is crucial for food security.

Climate Change as an Environmental Impact Amplifier

Recent global research indicates that climate change acts as a “second amplifier” of agriculture’s environmental footprint. Currently, the agricultural sector is accountable for nearly a quarter of global greenhouse gas emissions. As the climate shifts, it creates a dangerous cycle where rising temperatures and unpredictable rainfall reduce productivity. This often leads to an increased reliance on intensive farming practices to compensate for losses.

This amplification manifests through rising pest infestation, soil erosion, and reduced efficacy of agrochemicals. When these substances leach into the ecosystems, they cause nutrient pollution and a significant loss of biodiversity. Without a technological shift, this response could make it impossible to reach the Paris

Agreement goal of limiting global warming to 1.5 degrees or 2 degrees Celsius.¹

Reduction Through Genetic Modification

Genetically modified (GM) crops provide a beneficial pathway to reduce this environmental pressure. By altering the plant’s genetic makeup to withstand specific stressors, biotechnology enables farmers to produce more while using fewer resources. This “land-saving” approach has already prevented the conversion of 183 million hectares for agricultural use, effectively preventing further deforestation.

The environmental benefits of GM crops are measurable in terms of carbon reduction and reduced chemical use. Because herbicide tolerant crops allow “no-tillage” farming, where weed management happens without physical plowing, carbon remains stored in the soil. This practice alone has reduced carbon dioxide (CO₂) emissions by 39 billion kilograms, equivalent to removing nearly 26 million cars from the road for a year.² Furthermore, the adoption of insect-resistant traits saved 748.6 million kilograms of active pesticide ingredients between 1996 and 2020, leading to a 17.3% decrease in the overall environmental impact associated with pesticide use.³

The Halo Effect and the Future of Sustainability

The use of GM crops extends beyond individual fields through what is known as the “halo effect.” When a biotech trait, such as virus resistance, is used widely, it lowers the overall pathogen load in a region. This indirectly protects neighboring conventional crops and preserves biodiversity by reducing the need for area-wide chemical treatments.⁴

While biotechnology is a powerful tool, its success depends on integration with other sustainable practices like precision farming and integrated soil management. As we face more unpredictable global conditions, these scientific interventions offer a way to stabilize the environment while ensuring the world stays fed.



References

- 1 Climate change worsens agriculture’s environmental impacts <https://bit.ly/49zXikN>
- 2 Genetically Modified (GM) Crop Use 1996–2020: Impacts on Carbon Emission <https://bit.ly/4fRc9Vp>
- 3 Genetically Modified (GM) Crop Use 1996–2020: Environmental Impacts Associated with Pesticide Use Change <https://bit.ly/4uKJ5Ur>
- 4 GM crops’ impact creates a halo effect <https://bit.ly/43L9wx7>

Next Generation of Biotech Crops: Bioengineered Plants for A Healthier Planet

By Kaymart Gimutao

Look around, and you will see plants almost everywhere: on windowsills, lining city streets, and across rice fields. They keep us alive by making oxygen, growing our food, and soaking up carbon dioxide, a major driver of climate change. For years, scientists used crop biotechnology mainly to grow more food, helping crops resist pests, survive drought, and feed a rising population.¹ Now they are aiming higher: engineering plants that can clean polluted air, pull toxins from soil, store extra carbon, and even sense dangerous chemicals. This emerging field, known as environmental biotechnology, is already becoming a reality.²

C4 Crops

Most crops rely on “C3 photosynthesis,” a process that becomes inefficient in heat because a key enzyme, RuBisCO, mistakenly grabs oxygen instead of carbon dioxide.³ This energy-draining error limits growth, especially in warming climates. In contrast, “C4 photosynthesis,” used by crops such as maize and sugarcane, concentrates CO₂ to bypass this flaw, allowing plants to thrive with less water and higher yields.⁴



To address global food demands, the C4 Rice Project, which involves the International Rice Research Institute, is working to engineer this superior metabolic system into rice.⁴ Early tests are already successful, and if perfected, this technology could boost rice yields by up to 50%. By producing more food on the same amount of land, this breakthrough offers a vital solution for global food security.

Super Trees for Climate Change

As atmospheric CO₂ levels drive the climate crisis, scientists are engineering “super trees” to accelerate carbon sequestration.⁵ By modifying species like poplars and eucalyptus, researchers have created trees that grow faster, store more carbon, and even remediate polluted soil.^{6,7}

While promising, this technology carries significant ecological risks. Massive monocropping of engineered trees could threaten biodiversity, necessitating strict controls to prevent them from

spreading into native ecosystems. Consequently, most experts advocate for a balanced approach: using biotech trees primarily in damaged landscapes where natural forest recovery is not feasible, rather than as a replacement for the vital carbon-capture capabilities of existing, diverse forests.⁸

Plants That Clean Indoor Air

Indoor air quality is often compromised by volatile organic compounds (VOCs) emitted by common household products.⁹ Ordinary houseplants barely remove them, so scientists engineered a common one, the golden pothos, by adding a gene for an enzyme found in mammals that helps break down toxic substances. The Paris-based startup Neoplants pairs engineered plants with helpful microbes to break down pollutants more efficiently, and its Neo P1 kit is already on sale.^{9,10} The company is now working to build air purification directly into a plant’s natural metabolism.





Neo P1, a bioengineered golden pothos houseplant specifically designed to clean indoor air. Photo Source: Neoplants

Cleaning Polluted Soil

Mining, industry, and war have left soil contaminated in many parts of the world, and traditional cleanups are expensive and damaging. Plants offer a greener fix. Some naturally soak up heavy metals, and scientists are engineering them to absorb even more – taking in metals like zinc, cobalt, and lithium that are also useful for modern technology.¹¹ The European startup Genomines goes further, using synthetic biology to supercharge the microbes around hyperaccumulating plants so they can pull metals from toxic, otherwise unusable soils.¹²

Plants as Living Sensors

Some plants are being designed to warn us of danger. Engineered plants can detect chemicals from explosives such as TNT¹³ and respond by changing color, which

could make it easier to spot hazards like landmine fields. Scientists have also modified bacteria to act as tiny living detectors that glow when they meet toxic heavy metals, giving a fast way to identify polluted water or soil.¹⁴

Bioengineered plants are evolving into sophisticated environmental tools that utilize precise genetic modifications and real-time responses to address critical global challenges like climate change and pollution. By integrating advanced genetics with beneficial microbes, researchers are developing a new generation of crops capable of actively restoring and improving their surroundings, offering a promising, innovation-driven path toward a more sustainable future.

References

- 1 Furbank, R. T., Kelly, S., & von Caemmerer, S. (2023). Photosynthesis and food security: The evolving story of C4 rice. *Photosynthesis Research*, 158, 121–130. <https://doi.org/10.1007/s11120-023-01014-0>
- 2 Watts, C. (2024). *Environmental biotechnology*. EBSCO Research Starters. <https://www.ebsco.com/research-starters/engineering/environmental-biotechnology>
- 3 Gimutao, K. (2015). The ultimate green revolution. In *Bugs & quarks: Stories from the Asian Scientist Writing Prize 2015* (pp. 62–66). Wildtype Media Group.
- 4 Ermakova, M., Danila, F. R., Furbank, R. T., & von Caemmerer, S. (2020). On the road to C4 rice: Advances and perspectives. *The Plant Journal*, 101(4), 940–950. <https://doi.org/10.1111/tpj.14562>
- 5 Living Carbon. (2022). *Climate change breakthrough: New research indicates photosynthesis enhanced trees grow faster and capture more carbon* [Press release]. <https://www.livingcarbon.com/press-releases/photosynthesis-enhanced-trees-grow-faster-and-capture-more-carbon>
- 6 RIPE Project, University of Illinois. (n.d.). *To fight climate change, a biotech firm has genetically engineered a very peppery poplar*. <https://ripe.illinois.edu/news/fight-climate-change-biotech-firm-has-genetically-engineered-very-peppery-poplar>
- 7 International Service for the Acquisition of Agri-biotech Applications. (2025, June 25). *From lab to forest: Biotech trees for a sustainable future*. Science Speaks. <https://www.isaaa.org/blog/entry/default.asp?BlogDate=6/25/2025>
- 8 Conservation International. (2024). *New research: Reforestation is more cost-effective than previously understood; study compares reforestation methods*. <https://www.conservation.org/press/new-research-reforestation-is-more-cost-effective-than-previously-understood-study-compares-reforestation-methods>
- 9 National Institutes of Health. (2019). *Genetically modified houseplant cleans indoor air*. <https://www.nih.gov/news-events/nih-research-matters/genetically-modified-houseplant-cleans-indoor-air>
- 10 International Service for the Acquisition of Agri-biotech Applications. (2024, June 5). *Bioengineered super plant that purifies indoor air 30x than regular houseplants goes on sale in the US*. Crop Biotech Update. <https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=20849>
- 11 International Service for the Acquisition of Agri-biotech Applications. (2006). *Pocket K No. 25: Biotech plants for bioremediation*. <https://www.isaaa.org/resources/publications/pocketk/25/default.asp>
- 12 EQT Group. (2025, June 30). *Developing biotechnology to turn plants into metals*. EQT ThinkQ. <https://eqtgroup.com/thinq/library-of-hope/developing-biotechnology-to-turn-plants-into-metals>
- 13 Potera, C. (2011). Can transgenic plants root out pollutants? *Environmental Health Perspectives*, 119(5), A206–A207. <https://doi.org/10.1289/ehp.119-a206a>
- 14 Lee, W., Kim, H., Kang, Y., Lee, Y., & Yoon, Y. (2019). A Biosensor Platform for Metal Detection Based on Enhanced Green Fluorescent Protein. *Sensors*, 19(8), 1846. <https://doi.org/10.3390/s19081846>



Exploring Microalgae as Bioremediation Agents

By Pierangeli G. Vital, PhD, FPAM

What are Microalgae?

Microalgae are unicellular, photosynthetic, microscopic organisms commonly found in diverse aquatic environments, including freshwater, marine, and brackish systems. Certain species are also capable of thriving in extreme temperature habitats such as hot springs and polar regions. To date, approximately 50,000 species of microalgae have been identified, with an estimated additional 30,000 species yet to be characterized.

Microalgae have been extensively studied and cultivated due to their broad range of applications, including biofuel production, wastewater treatment, aquaculture, pigment synthesis, and nutraceutical development. Owing to their morphological variability across different life cycle stages, identification based solely on microscopy often leads to misclassification. Consequently, molecular techniques are increasingly employed to improve the accuracy of microalgal identification.

The Potential of Microalgae in Bioremediation

The growing prevalence of chemical and environmental contamination has prompted the development of various remediation strategies aimed at reducing pollutants in water, soil, and air. Conventional methods such as electrocoagulation, adsorption using synthetic or natural materials, and magnetic field-based treatments have been widely applied. However, these approaches may suffer from limitations, including high operational costs, low efficiency, and the potential generation of secondary pollutants.

Bioremediation has emerged as a promising alternative, utilizing biological systems such as bacteria, plants, algae, and fungi to mitigate environmental contaminants. This approach is considered both environmentally sustainable and cost-effective. Microalgae, in particular, have attracted significant attention



Algae culture cabinet in the Biological Research and Services Laboratory, NSRI, UP Diliman (In photo: PGVital)

due to their rapid biomass production, ability to assimilate both organic and inorganic pollutants, and their role in carbon dioxide fixation.

Numerous studies have demonstrated the efficacy of microalgae in removing contaminants, such as heavy metals, pesticides, and excess nutrients, from wastewater. For example, *Chlorella vulgaris*, one of the most widely studied green microalgae, has been reported to remove up to 99% of phosphorus from wastewater, while simultaneously increasing its biomass, indicating efficient nutrient uptake. Similarly, *Parachlorella kessleri* has been investigated for its capacity to remove heavy metals such as cadmium and chromium.

Microalgae as Bioremediation Agents

In a study published in the *International Journal of Environmental Research*, an indigenous *Chlorella* strain was evaluated for its potential to remove elevated levels of phosphorus from contaminated water. Excess phosphorus is a primary contributor to eutrophication, a process that poses significant ecological and

environmental risks to aquatic systems. Phosphorus concentrations exceeding the threshold limits established by national and international regulatory bodies are considered hazardous due to their detrimental effects on both environmental and public health.

The findings of the study highlight the potential of microalgae as a sustainable and long-term solution for pollution mitigation. Furthermore, the results underscore the importance of accurate identification of microalgal species, particularly when they are intended for application in environmental bioremediation. Continued research in this area is essential to optimize the use of microalgae and to fully harness their capabilities in bioremediation processes.



References

The role of algae in bioremediation of organic pollutants
<https://bit.ly/4dQVEpN>

Bioremediation of wastewater using *Chlorella vulgaris* microalgae
<https://bit.ly/4dX2kfm>

Recent Biotech/GM Crop Approvals Around the World

By Shiela Chavez

Every country has its own way of deciding how genetically modified (GM) crops can be grown, imported, or used for food, feed, and processing. These decisions are guided by their own biosafety frameworks or systems that are designed to assess risks to human health, animals, and the environment. Some countries adopt new technologies quickly, while others take a more cautious approach. This is where databases like the ISAAA GM Approval Database (GMAD) are useful sources of information. GMAD compiles regulatory decisions from around the world into one accessible platform. It serves as a vital tool for researchers, policymakers, professionals, and the public to seek a clearer understanding of global biotechnology developments.

Snapshot of Global Approvals

As of April 2026, GMAD compiles 657 GM events worldwide. Among crops, maize continues to dominate with 311 approvals, reflecting its global importance as a staple being used for food, feed, and processing. Cotton follows with 78 approvals, while soybeans have 60. Notably, cotton has now overtaken soybeans compared to previous years. This shift is likely due to increasing approval of cotton varieties with stacked traits, or crops engineered to combine multiple traits, such as herbicide tolerance and insect resistance.

In recent years, the shift to crops having stacked traits appears to indicate a growing demand to address multiple challenges at once.

Regional Developments

Looking at the trend, there is a steady mix of updates from around the world. In South America, Argentina continues to authorize new GM soybean varieties for commercial cultivation, reinforcing its position as one of the leading exporters of soybeans alongside Brazil and the United States. In Europe, the European Union takes a cautious approach by focusing mainly on import approvals. Recent decisions include maize events and soybean varieties



with stacked traits for food and animal feed. In Asia, China has been expanding its approvals, particularly for staple crops such as maize and soybeans, reflecting a strategic effort to boost domestic agricultural productivity and reduce reliance on imports.

Elsewhere in the region, Pakistan has expanded its approvals for multiple crops, including 2 sugarcane lines, 2 cotton varieties, and 43 GM canola events that are now permitted for import. In other parts of Asia, South Korea has diversified its approved GM crops beyond major staples by allowing the cultivation of a GM potato.

Emerging Approvals and New Directions

In Central America, Costa Rica's National Technical Biosafety Commission approved 3 new cotton events and is now evaluating field trial requests for bananas. Meanwhile, in Africa, Ethiopia granted commercial approval for the cultivation of TELA maize and Bt cotton with a focus on improving yield and drought tolerance. TELA maize has become the country's first genetically modified food crop, suggesting a significant shift after years of cautious policy.

A notable recent regulatory development in Australia, the purple

tomato has been authorized for cultivation and consumption. This GM crop is engineered to produce natural purple pigment and is enriched with anthocyanin compounds that are linked to potential health benefits. Its approval reflects a broader trend toward consumers, not just for agricultural performance. These patterns in GM crop approval mirror differences in agricultural priorities, trade requirements, and regulatory approaches across countries.

Conclusion

Continued updates to regulatory databases such as GMAD help track these developments over time and provide a consolidated view of global activity. This supports a clearer understanding of how different countries are applying biotechnology in agriculture, particularly as new crop traits and technologies continue to emerge.

LEARN ABOUT
ISAAA GMAD
SCAN THIS!

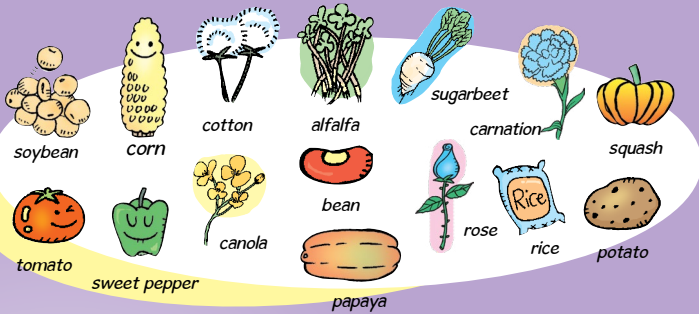


SCIENCE ACTIVITY

Dive into the Biotech sQuizBox with this hands-on science learning activity, featuring selected interactive samples from ISAAA's accordion-type booklets.

Biotech Crops All Over the World

As of today, a number of biotech crops are being planted in 73 countries. The most planted crops are biotech soybean, corn, cotton, and canola.



Aside from these biotech crops, there are still others that are being developed in the lab or tested on the field.



Are biotech crops safe for the environment?

Biotech crops require less fuel and less tillage. In 2014, biotech crops reduced carbon dioxide emissions by 22.4 billion kilograms. This is equal to taking _____ for one year.

Decode the cryptogram below using the table as a guide to fill in the blanks.

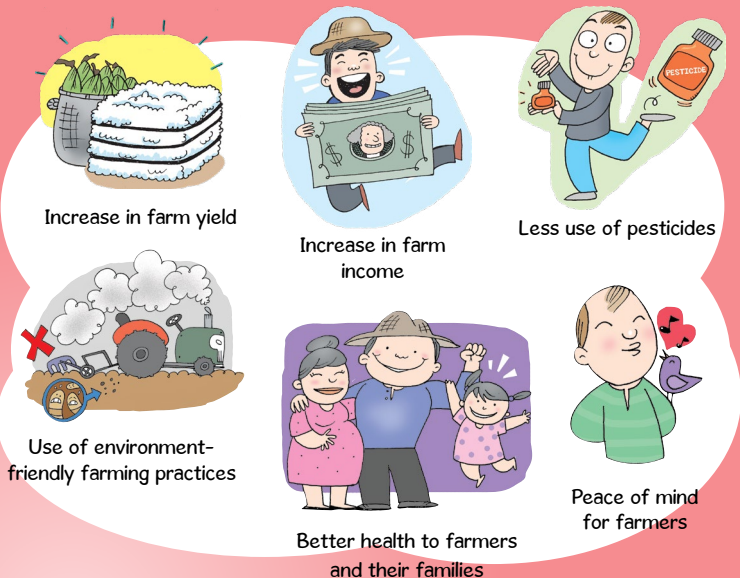
A	B	C	D	E	F	G	H	I	J	K	L	M
		21	20	9			16				22	18
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
	19				12							

E	M	O	S	O	H	E	O	D															
17	9	14	18	7	22	22	7	19	14	21	13	15	12	19	5	5	17	16	9	15	19	13	20

TEN MILLION CARS OFF THE ROAD

Benefits of Biotech Crops

Among the documented benefits of biotech crops are:



How much land is used for biotech crops?

One of the benefits of biotech crops is that less land is needed by farmers to produce the same yield as conventional crops.

Farmer Ted owns 1.6 hectares (ha) of farm. By planting conventional corn on the entire farm, he can only harvest 2 tons. By planting insect resistant Bt corn, he can harvest as much as 7 tons per hectare. How much land does he need to plant Bt corn to produce 2.1 tons only? How much Bt corn can he harvest if he would plant his entire farm with Bt corn?



Ted needs 0.3 ha only to harvest 2.1 tons of corn. If Ted will plant his entire farm with Bt corn seeds, he'll produce 11.2 tons of corn after harvest.

Enjoy more fun science activities with the Biotech sQuizBox. SCAN THIS!

