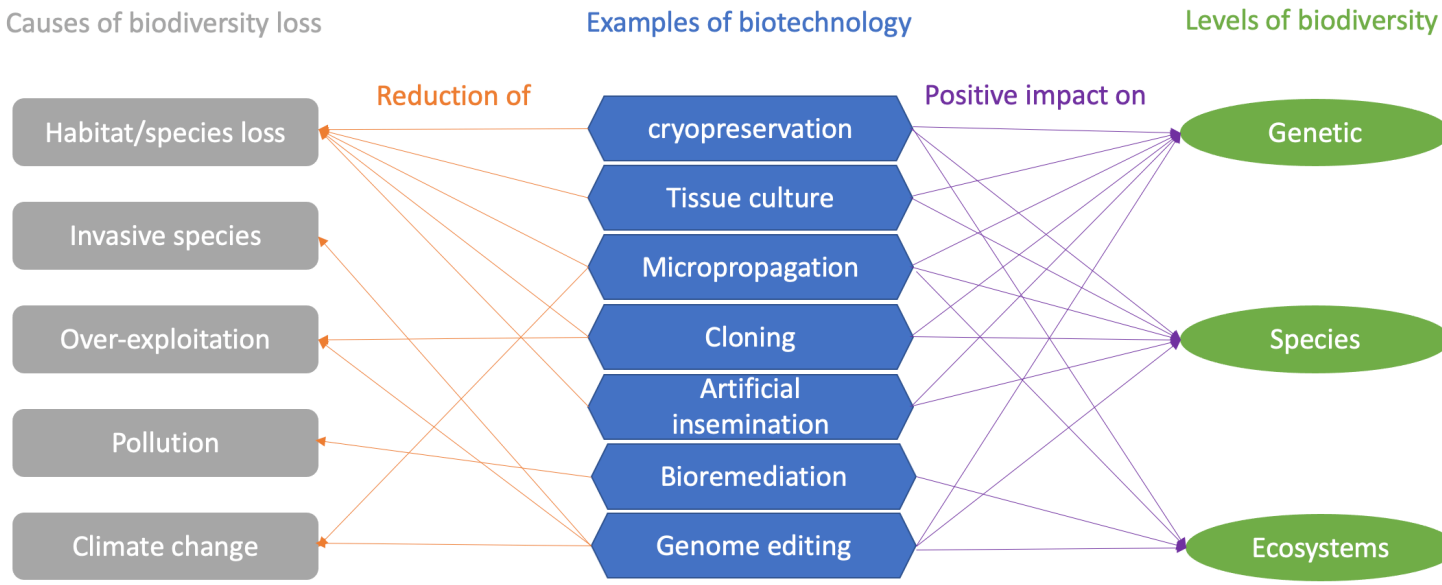
# How biotech aids biodiversity

As the basis for food, housing, clothing, medicine, industrial raw material and potentially many more benefits to human well-being, biodiversity is crucial to our survival and economic development.

Numerous scientific studies show that the use of biotechnology in agriculture can help to protect biodiversity and stem its loss.

The main causes of biodiversity degradation are habitat/species loss, invasive species, over-exploitation, pollution and climate change. Biodiversity conservation has become a global concern requiring a comprehensive and integrated approach. There are different methods and strategies to conserve biodiversity, and biotechnology can play an important role in many of them.

Some biotechnology related methods can be applied directly to species of interest, for example, through cryopreservation of cells, tissues, gametes, oocytes, DNA samples, etc. stored in a genetic databank; a range of in vitro techniques (tissue culture, micropropagation and cloning); and artificial insemination, to mention a few.




Positive effects of biotechnology on the different levels of biodiversity by reduction of the drivers of biodiversity loss. Credit: Alliance for Science

Other biotechnology related methods can be applied to entire ecosystems to address pollution or control invasive species. Since agricultural practices are the second largest contributor to biodiversity loss the changes made to agricultural systems through biotechnology can also have great positive impacts on biodiversity.

Agriculture is practiced in approximately 40 percent of the world's landmass. By replacing natural

ecosystems, it has become the largest terrestrial biome on our planet. Most of the land used to produce crops (~96 percent) is farmed using conventional methods but this trend is shifting. Since the first genetically modified (GM) plants — antibiotic resistant tobacco and petunia — were successfully created in the 1980s, GM/biotech crops have been the fastest adopted crop technology in the history of modern agriculture.



## How GM crops benefit biodiversity

After so many years of production, there is ample scientific literature that demonstrates how GM crops have had a positive impact on biodiversity. Some include:

## Protecting farmland biodiversity

There is a substantial body of literature addressing the potential beneficial impacts of GM crops on the environment in the context of farmland diversity. GM crops preserve varietal diversity in many crops. For example, they can be engineered to resist insect pests, reducing the use of synthetic insecticides and resulting in higher insect biodiversity on farms when compared to planting similar conventional varieties and using synthetic insecticides.

## Reducing pesticide use

Modern biotechnology can help protect the environment from pesticide use. GM crops that are resistant to pests have significantly contributed to the reduction of insecticide sprays around the world. It is estimated insect-resistant crops reduced global pesticide use by 37 percent.

## Reducing toxic levels in herbicide use

Many GM crops produced through modern biotechnology have helped decrease the use of herbicides with acute (or short-term) toxicity and chronic (or long-term) toxicity.

## Decreasing CO2 emissions

The use of some GM crops contributed to tens of millions of acres transitioning to zero-tillage. The reduction in tillage has produced a significant environmental benefit, resulting in 2.4 billion kg fewer carbon dioxide emissions. Moreover, the adoption of GM technology in corn, soybean and cotton reduced agricultural land and input use, saving 0.15 Gt of GHG emissions, equivalent to roughly one-eighth the emissions from automobiles in the US.

## Avoiding farmland expansion

Modern biotechnology can help produce more with less land. Higher yields on cultivated land could reduce the need for additional cropland expansion, thus preserving natural biodiversity. Without the productivity gains from GMOs during recent years, around 25 million hectares of additional farmland would have to be cultivated globally, in order to maintain current agricultural production levels. Farmland expansion is an important contributing factor to biodiversity loss and climate change.

## Addressing climate change

GM crops currently under development have produced evidence that if adopted they could contribute to climate change mitigation and adaptation. Drought-tolerant maize varieties have been reported to perform better than conventional varieties across several countries in eastern and southern Africa. Moreover, GM crops have been proposed as an important part of an integrated strategy to mitigate the effects of climate change, such as drought and potential damage of fall armyworm in Africa.

## Conclusion

Because agriculture is the second-largest driver of biodiversity loss, agriculture must also be a part of the solution to biodiversity loss. Biotech crops are not going to solve all our agricultural problems, but they have shown great promise as noted in the examples above. Cooperation and community involvement will be essential to continue communicating these benefits and helping farmers add this technology to their agricultural tool box.

## References:

Barrows Geoffrey, Steven Sexton, and David Zilberman. 2014. “Agricultural Biotechnology: The Promise and Prospects of Genetically Modified Crops.” Journal of Economic Perspectives, 28 (1): 99-120.

Brookes G. and Barfoot P. 2015 Environmental impacts of genetically modified (GM) crop use 1996–2013: Impacts on pesticide use and carbon emissions, GM Crops & Food, 6:2, 103-133.

Bunn, E., Turner, S. R., and Dixon, K. W. 2011. Biotechnology for saving rare and threatened flora in a biodiversity hotspot. In Vitro Cellular & Developmental Biology – Plant, 47(1), 188–200.

CONABIO. 2017. Capital natural de México. Síntesis: evaluación del conocimiento y tendencias de cambio, perspectivas de sustentabilidad, capacidades humanas e institucionales. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.

Corlett, R. T. 2017. A bigger toolbox: biotechnology in biodiversity conservation. Trends in biotechnology, 35(1), 55-65.

Evans, G. G., and Furlong, J. 2011. Environmental biotechnology: theory and application. John Wiley &

Sons.

Gavrilescu, M. 2010. Environmental biotechnology: achievements, opportunities and challenges. Dynamic biochemistry, process biotechnology and molecular biology, 4(1), 1-36.

Greenthal E, Gaffe G. In The Weeds, Understanding the Impact of GE Crops on Pesticide Use. 2021: Center for Science in the Public Interest

Herrick, J. R. 2019. Assisted reproductive technologies for endangered species conservation: developing sophisticated protocols with limited access to animals with unique reproductive mechanisms. Biology of Reproduction, 100(5), 1158-1170.

Higgins, T.J. 2010. Agricultural Biotechnology, Gene Flow and Biodiversity. Presentation at the "Biodiversity And World Food Security: Nourishing The Planet And Its People" conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia.

Icoz I, and Stotzky, G. 2008. Review: fate and effects of insect-resistant Bt crops in soil ecosystems. Soil Biology Biochemistry 40:559–586

IPCC. 2019. Climate Change and Land. Geneva: Intergovernmental Panel on Climate Change.

Khush, G. S. 2012. Genetically modified crops: the fastest adopted crop technology in the history of modern agriculture. Agriculture & Food Security, 1(1), 1-2.

Kilpatrick, A. M., Salkeld, D. J., Titcomb, G., & Hahn, M. B. 2017. Conservation of biodiversity as a strategy for improving human health and well-being. Philosophical Transactions of the Royal Society B: Biological Sciences, 372(1722), 20160131.

Klümper, W. and Qaim, M. 2014. A meta- analysis of the impacts of genetically modified crops. PLoS ONE, 9: 1–7.

Krishna, V., M. Qaim, and D. Zilberman. 2016. Transgenic Crops, Production Risk and Agrobiodiversity. European Review of Agricultural Economics 43: 137–164.

Kuhad, R. C., and Singh, A. 2013. Biotechnology for environmental management and resource recovery. New Delhi, India: Springer.

Lueders, I., and Allen, W. T. 2020. Managed wildlife breeding-an undervalued conservation tool?. Theriogenology, 150, 48-54.

Nailwal, R. J. T. K., Tewari, L. M., and Shukla, A. 2010. Exploring Biotechnology For Conserving Himalayan Biodiversity. Life Science Journal, 7(3).

National Academies of Sciences, Engineering, and Medicine. 2016. Genetically Engineered Crops: Experiences and Prospects. Washington, DC: The National Academies Press.

Olomola, D., Aguda, S., Olorode, E., Oyediran, R., and Adekunle, E. 2019. The application of biotechnology in biodiversity conservation. International Journal of Advanced Academic Research. Sciences, Technology and Engineering. Vol. 5, Issue 12.

Ortiz-Bobea A, Tack J. 2018. Is another genetic revolution needed to offset climate change impacts for US maize yields? Environ Res Lett 13:124009

Prasanna BM, Huesing JE, Virginia RE, Peschke M (eds). 2018. Fall armyworm in Africa: a guide for integrated pest management, 1st edn. CIMMYT, Mexico, CDMX

Qaim, M. 2017. Globalisation of Agrifood Systems and Sustainable Nutrition. Proceedings of the Nutrition Society 76: 12–21.- 2016. Genetically Modified Crops and Agricultural Development. New York: Palgrave Macmillan. – 2009. The Economics of Genetically Modified Crops. Annual Review of Resource. 2009. The Economics of Genetically Modified Crops. Annual Review of Resource Economics 1: 665–693.

Raman, R. 2017. The impact of Genetically Modified (GM) crops in modern agriculture: A review, GM Crops & Food, 8:4, 195-208.

Reaka-Kudla, M.L., Wilson, D.E. and Wilson, E.O. (editors). 1997. Biodiversity II: Understanding and Protecting Our Biological Resources. Joseph Henry Press, Washington, D.C.

Setimela PS, Zaman-Allah M, Ndoro OF. 2018. Performance of elite maize varieties tested on-farm trials in eastern and southern Africa. CIMMYT.

Sharma, D. K., and Sharma, T. 2013. Biotechnological approaches for biodiversity conservation. Indian Journal of Scientific Research, 4(1), 183-186.

Still, D. 2019. Adding Biodiversity to Agricultural Landscapes Through Ecology and Biotechnology. In Oxford Research Encyclopedia of Environmental Science.

Waberski, D. 2018. Artificial Insemination in Domestic and Wild Animal Species. Animal Biotechnology 1, 37–64.

Zilberman, D., Ameden, H. and Qaim, M. (2007). The impact of agricultural biotechnology on yields, risks, and biodiversity in low-income countries. Journal of Development Studies 43: 63–78.

**Sol Guerrero Ortiz is a Department Member at Cornell University specializing in ethnozoology, ethnobiology and mastozoology.**

**A version of this article was published at Cornell Alliance for Science and is reposted here with permission. You can check out Cornell Alliance for Science on Twitter @ScienceAlly**