Friends of the Earth

Genetically Engineered Wheat:

Risks & Concerns

A new variety of genetically engineered (GMO) wheat called HB4 has been approved by the U.S. government, raising serious concerns for the health of the American public, farmers' livelihoods, and the environment.

GMO wheat has failed to be commercialized and widely grown in the U.S. multiple times due to public opposition and trade risks. Now, consumers, farmers, and food companies must again make it clear that there is no place for GMO wheat in the U.S.

Summary

Human Health: The new GMO wheat is engineered to tolerate a toxic herbicide called glufosinate. Glufosinate is banned in the EU because it poses unacceptable risks to reproduction; exposure to glufosinate during pregnancy negatively impacts fetal development. Glufosinate is also linked to neurotoxicity, kidney toxicity, and potential hormone disruption. HB4 GMO wheat is likely to dramatically increase the use of glufosinate on wheat, a dietary staple in the U.S. and around the world.

Environment: Glufosinate can harm soil organisms and pollinators. It can easily move through the environment and is soluble in water, increasing the risk of water pollution and harm to aquatic life.

Export Risks & Farmer Livelihoods: Wheat is the third most widely grown crop in the U.S. after corn and soy, representing 47 million acres of production.[1] About 44% of U.S. wheat is exported, representing billions in farm sales.[2] Yet, key import countries have rejected and will likely continue to reject GMO wheat, including Mexico, the Philippines, and Japan.[3] U.S. farmers have suffered millions in losses from GMO wheat contamination in the past.[4]

U.S. Approval Relied on Industry Studies

HB4 GMO wheat is engineered to be tolerant to the herbicide glufosinate ammonium[i] and is also marketed as drought tolerant by its developer, an Argentinian company called Bioceres Crop Solutions. It's a transgenic crop, meaning it is engineered to contain genes from different organisms — a soil bacterium and a sunflower.[ii]

U.S. approval of HB4 relied on studies conducted and submitted by Bioceres with no independent testing mandated. The U.S. Food and Drug Administration (FDA) determined that HB4 was "safe" for human consumption and animal feed based on voluntary data provided by the developer.[5] The U.S. Department of Agriculture (USDA) cleared it for commercialization based on a narrow assessment of whether it posed an

i Glufosinate was first registered by the EPA for use as an herbicide in 1993. In 2024, the EPA approved BASF's Mitsui Chemicals Crop & Life Solutions, Inc.'s registrations for a new active ingredient meant for use on glufosinate-tolerant crops called glufosinate-P, which is an increased concentration of the active isomer.

ii The plant derives its glufosinate tolerance from the phosphinothricin aceltyltransferase (PAT) enzyme, which is encoded by the bar gene from the Streptomyces hygroscopicus soil bacterium. Production of this enzyme allows the plant to detoxify glufosinate. It also incorporates the HaHB4 gene from sunflowers, which is associated with sunflowers' ability to adapt to water scarcity conditions and environmental stressors.

"increased plant pest risk" with no analysis of how it might impact farmers' livelihoods or other key agronomic issues.[6] Concerningly, Bioceres was not required to submit any data or seek approval from the U.S. Environmental Protection Agency (EPA) despite the fact that HB4 goes hand-in-hand with use of glufosinate, an herbicide that poses serious risks to human health and the environment.

Drought Tolerance: A Trojan Horse?

Bioceres claims that HB4 GMO wheat is drought tolerant, but there is no independent data supporting that claim. Civil society analyses of company and government data about HB4 report that the variety yields less than conventional wheat, even in drought years.[7,8,9]

To date, GMO crops marketed as drought tolerant have failed to live up to their claims. That's because editing or adding single genes — such as the sunflower gene associated with adaptation to water scarcity and environmental stressors added to HB4 — is an overly simplified approach. Drought tolerance is a complex physiological process in plants governed by a host of genes, biological pathways, and the plant's relationship to its environment.[10] University research and USDA analyses find that traditional, non-GMO plant breeding approaches to drought tolerance perform better than genetic engineering.[11,12]

Bioceres is marketing HB4 as a climate solution, distracting attention from the serious climate, soil health, biodiversity, and human health risks associated with glufosinate herbicide.

Risks & Concerns

Dramatic Increase in Use of Glufosinate

GMO crops are responsible for a dramatic increase in the use of toxic herbicides.[13] To date, 98% of GMO acreage in the U.S. is crops genetically engineered to tolerate herbicides.[14] Although glyphosate is by far the most widely used herbicide associated with GMO crops, glufosinate use is on the rise in the U.S. due to adoption of GMO corn, soybean, cotton, and canola engineered to tolerate the chemical. These crops are marketed under the LibertyLink® trait, which was developed by Bayer and is now sold by BASF.[15,16]

(a)

(b)

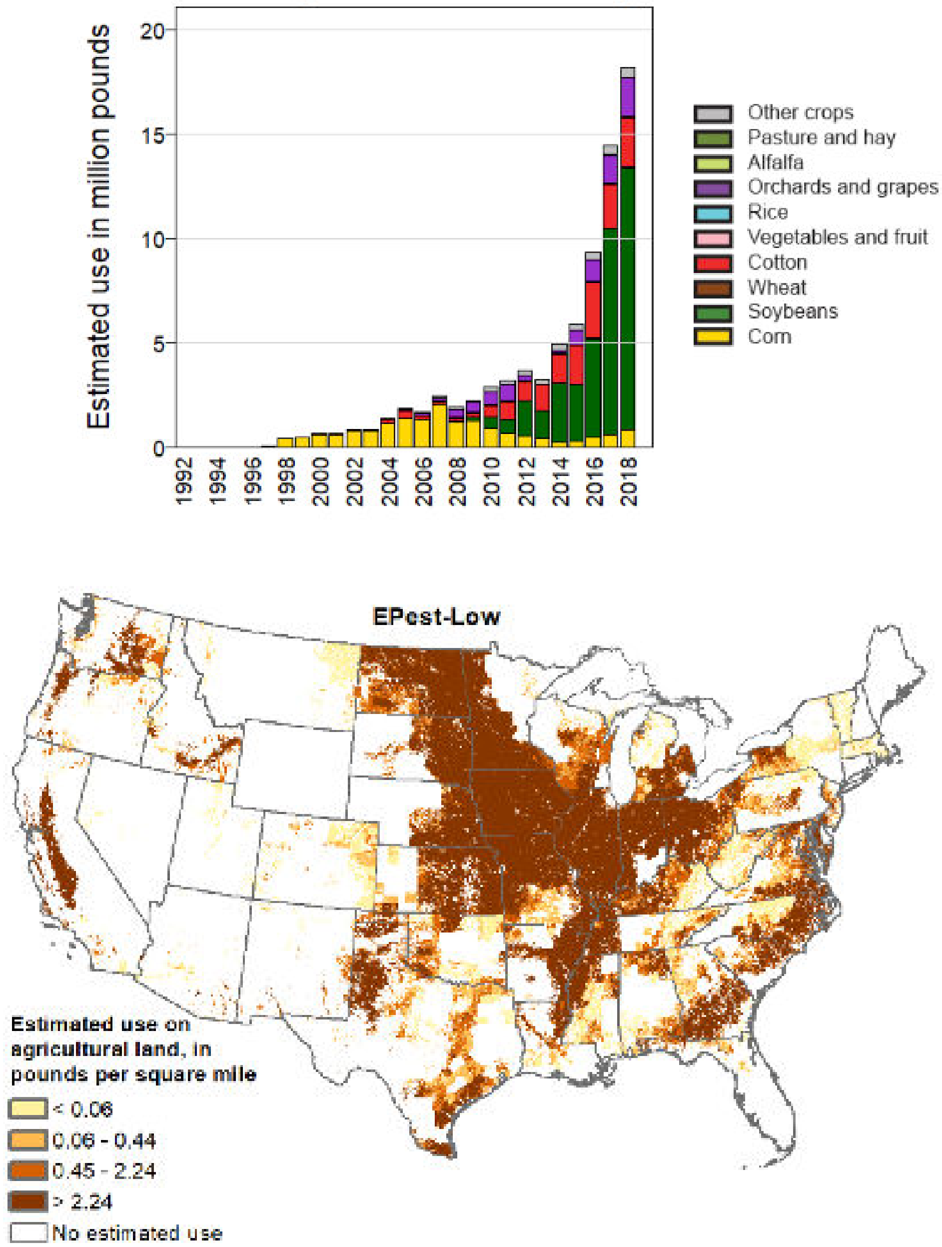

Figure 3: Glufosinate use in the U.S.
Glufosinate use in the U.S. has exponentially increased over the last decade. It is intensively used in the Midwest and Southern regions where genetically engineered glufosinate-tolerant crops are grown. (a) Estimated use by year and crop from 1996 to 2018 in the U.S. (b) Estimated agricultural use of glufosinate in the U.S. in 2018. Source: https://water.usgs.gov.

The lessons learned from three decades of widespread use of herbicide-tolerant GMO corn and soybeans should raise alarm bells about the potential health, environmental, and economic risks of GMO wheat. Glufosinate is associated with harm to human health and the environment, and like GMO corn and soy, the commercialization of GMO wheat risks further reinforcing a corporate agribusiness model that disenfranchises farmers and entrenches harmful chemical-intensive industrial agriculture.

Major manufacturers of glufosinate include Bayer, BASF, Syngenta, and Corteva, along with several Chinese companies that are rapidly expanding their glufosinate production capacity.[17] Glufosinate represents a $2.85 billion market in 2025 and is expected to grow to $4.4 billion by 2030.[18]

Health Concerns

Glufosinate is a highly hazardous herbicide that has been banned in the EU since 2018 due to its links to reproductive toxicity.[19,20,21,22] It chemically resembles glutamine, a molecule used to transmit nerve impulses in the brain.[23]

Glufosinate's harm to reproduction and fetal development are of particular concern. Over two decades of research shows that exposure to glufosinate during pregnancy negatively impacts the developing fetus in mammals. As early as 1988, the EPA determined that glufosinate had "toxic effects on early embryonic development."[24]

Glufosinate is 166 times more toxic than glyphosate — the most widely used herbicide in the U.S. and globally — in terms of long-term, chronic exposure, according to EPA assessment.[iii]

Human health research links glufosinate exposure to:

- **Low birth weight** (which correlates with higher risk of serious health issues)[25]
- **Central nervous system and respiratory toxicity** associated with acute poisoning[26]

Research on other mammals, which share biological pathways with humans, links glufosinate exposure to:

- **Reproductive and developmental toxicity**, including premature births, spontaneous abortion (miscarriage), intra-uterine death (stillbirth), skeletal malformations, delayed bone development, and impaired motor function in offspring[27,28,29]
- **Neurotoxicity**, including autism-like behaviors associated with perinatal exposure (exposures in the womb and during the first year of life)[30,31,32]
- **Kidney toxicity**[33]
- **Lung inflammation** when inhaled[34]
- **Disruption of the gut microbiome**[35]
- **Genotoxicity**[36,37]

Unlike other herbicides and insecticides, the U.S. Centers for Disease Control does not track people's exposure to glufosinate. However, preliminary data from the Heartland Study tracking pregnant women's exposure to herbicides in the Midwest indicate that it may be rising.[38]

HB4 would allow glufosinate to be sprayed directly onto wheat — a use that would be impossible without genetic engineering since the herbicide would kill the plant. This "over-the-top" use of herbicides on GMO crops can result in higher levels of herbicide residues on the food we eat.[39] Since wheat is a core part of many Americans' diets, HB4 could increase herbicide exposure, including for those most vulnerable like pregnant people and children.

iii Chronic toxicity encompasses harm accumulated from long-term exposures to a chemical. The standard metric used in pesticide risk assessments is a chemical's chronic reference dose (cRfD). The EPA's cRfD for glufosinate is 0.006 mg/kg/day and for glyphosate is 1.0 mg/kg/day. Source: [EPA 2021 Human Health Benchmarks of Pesticides]

Environmental Concerns

Glufosinate is highly soluble in water and is classified by the EPA as 'mobile' to 'highly mobile' in soil ecosystems. Glufosinate is toxic to various non-target organisms, including mammals, bees, reptiles, amphibians, and aquatic species. Chronic exposure in mammals has been shown to reduce growth and offspring viability, with effects observed across generations and multiple species.[40]

Harm to soil life: Soil health is key to farmers' resilience to droughts and floods and to drawing carbon down into the soil as a climate mitigation strategy. Studies show that glufosinate can disrupt soil microbial communities,[41,42,43] result in multigenerational reproductive harm to nematodes,[44] and can impact earthworms' survival and reproduction.[45]

Harm to pollinators: Exposure to sublethal doses of glufosinate has been shown to affect honey bee gut microbiota and immunity, indicating that it may increase their susceptibility to pathogens.[46] Glufosinate has also been found to be harmful to other beneficial insects such as spiders, predatory mites, and butterflies.[47]

Water pollution and harm to aquatic ecosystems: Due to high mobility and solubility, glufosinate can move to surface water via runoff or spray drift or to groundwater via leaching.[48] Research shows that it can be highly toxic to oyster and clam larvae[49] and can impair the reproduction of freshwater snails. [50] Studies on freshwater fish and aquatic invertebrates found that glufosinate-P could cause a reduction in post-hatch survival and offspring, respectively.[51]

Superweeds & increasing herbicide use: GMO herbicide-tolerant crops are responsible for a dramatic increase in the use of toxic herbicides in the U.S. Herbicide-tolerant crops allow farmers to spray throughout the growing season. This overuse drives the emergence of "superweeds" that no longer respond to the herbicide in question.[52] The biotech industry has doubled down on this failed approach by developing GMO crops with "stacked" tolerance to multiple herbicides, further intensifying chemical use. With increased use of crops engineered to withstand glufosinate, weeds resistant to the chemical have already been detected in agricultural regions of the U.S.[53]

Genetic contamination: Like other genetically engineered crops, the introduction of HB4 presents the risk of genetic contamination of non-GMO wheat varieties and could compromise genetic diversity.[54]

Economic Risks

Export Risks

The commercialization of GMO wheat in the U.S. could expose farmers to serious export risks. The U.S. is currently the fourth largest producer of wheat globally.[55] In 2024, the total value of U.S. wheat exports stood at $5.8 billion.[56] Of the top wheat import countries, including Mexico, the Philippines, and Japan, none have approved the sale of GMO wheat nor seem poised to do so soon.[57]

Concerns about export market rejection have quashed previous attempts to commercialize GMO wheat in the U.S. In the 1990s and early 2000s, Monsanto terminated field trials of GMO wheat in response to farmers' concerns about the potential for genetic contamination and trade disruption.[58]

The export market risk is two-fold — both direct rejection of GMO wheat, as well as the risk of contamination of the non-GMO wheat supply. Even if farmers don't grow HB4, their wheat could be contaminated by GMO genes from HB4 or by the mixing of GMO and non-GMO wheat in the supply chain.

Two cases are illustrative of the contamination concern. In 2013, after unapproved GMO wheat was discovered in several U.S. states, Japan and South Korea briefly suspended wheat imports, China, Thailand, and the Philippines required heightened inspections on imports, and European partners began conducting additional testing, threatening millions of dollars in losses.[59,60]

A similar and more costly contamination event occurred in 2006 with rice. Shockingly, although it had not been approved for commercial cultivation, Bayer's glufosinate-

tolerant rice trait (called LibertyLink), was detected in the U.S. rice supply. Consequently, numerous countries restricted imports of U.S. rice, with costs to the industry estimated at $1.2 billion.[61] Losses were incurred primarily by farmers.

None of the countries that have approved HB4 for cultivation or consumption are major importers of U.S. wheat. Only three other countries have given the green light for HB4 wheat to be cultivated: Argentina, Brazil, and Paraguay.[62] Australia has approved the crop for field trials while other countries such as New Zealand, Nigeria, South Africa, Colombia, Thailand, and Chile have approved it for food and feed use but not cultivation.[63]

Risks to Farmer's Economic Sovereignty

Ultimately, farmers stand to lose the most with the introduction of GMO wheat in the U.S. GMO crop varieties are subject to strict intellectual property and patent protections for the companies that develop them. This has allowed large corporations to increase their control over the seed supply, lock farmers into restrictive contracts,[64] and pursue predatory lawsuits against farmers.[65] Widespread adoption of GMO wheat would also likely increase consolidation of the wheat seed market — 30% of the global wheat supply is currently dominated by large corporations (Corteva, BASF, and Limagrain) compared to 60% of the overall global seed supply.[66]

What can we do?

Advance Agroecological Solutions

A large body of scientific research shows that it is imperative that we rapidly shift our agricultural systems away from the chemical-intensive industrial model exemplified by GMO herbicide-tolerant crops like HB4 wheat to agroecological approaches to achieve true solutions to the biodiversity, climate, and food security crises we are facing.[67,68]

Farmers' resilience to droughts and floods is not found in adding a single gene to a complex plant, rather, it is deeply tied to building healthy, living soils.[69] What's more, traditional plant breeding for drought tolerance is more effective than genetic engineering because it is rooted in diversity and complexity. It draws from the natural diversity of crops and their wild relatives, which encodes traits that reflect thousands of years of adaptation to complex environments. It can breed for complex *polygenic* (controlled by many genes) traits like drought tolerance, and it "trains" varieties under the very environmental conditions they're expected to face. Traditional breeding has already delivered drought-tolerant wheat, corn, and rice varieties widely adopted by farmers — especially in Africa and Asia. Examples include the Jabal wheat variety, which comes from Morocco, landraces from the northern states of India, and wild emmer wheat.[70,71]

Expand Organic

Organic is the clearest way for consumers to avoid GMOs and toxic pesticides. The USDA organic seal — and organic standards globally — strictly prohibit GMOs in agriculture and food processing. Organic farmers are also prohibited from using glufosinate and over 900 other synthetic pesticides. Organic is among the most comprehensive and time-tested agricultural systems for mitigating and adapting to climate change and protecting biodiversity and human health, and it has the benefit of being enforced through a rigorous legal standard. [72]

Yet, USDA funding for organic agriculture is far below organic's share of the U.S. food market. The gap between organic production and consumer demand in the U.S. is being filled by tens of millions of dollars' worth of imports.[73] We need to dramatically expand federal funding for the National Organic Program to support organic farmers and help make organic food available to all.

U.S. Regulatory Reform

There is a dire need for reform of the regulatory structures governing GMO crops in the U.S. Regulations have not caught up to technological advancements, and oversight is fragmented between three different agencies: USDA, FDA, and EPA, allowing for significant gaps in assessment of risks. Agencies rely on data provided by industry, with limited to no independent testing, and developers are not required to disclose all test results. Risk assessments don't fully evaluate ecological concerns, including herbicide-resistant "superweeds," pollinator loss, and increased pesticide contamination. In addition, regulations governing food labeling are woefully inadequate when it comes to informing consumers about GMO foods in the marketplace.

Regulation of genetically engineered crops should align with the precautionary principle, which calls for thorough assessment of risks, evaluation of alternatives, and a preventative approach in the face of scientific uncertainty to protect the environment and safeguard human health.[74]

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