Genetically Engineered Soil Microbes: Risks and Concerns

Healthy soil is essential to human civilization and much of the life on the planet. We depend on soil — and the tiny creatures that enrich it — for 95 percent of the food we eat. And yet, biotech companies are rushing to commercialize genetically engineered (GE) soil microbes despite potential risks to the soil, our food system, and our health. GE soil microbes are already being used on millions of acres of U.S. farmland without sufficient safety assessment or regulation.

UNDERSTANDING THE ISSUE

- **The soil microbiome plays a vital role in agriculture and the climate.** Healthy soil is packed with billions of tiny living microbes, including bacteria, fungi, and protozoans. These organisms regulate global carbon and nitrogen cycles, build soil structure, provide crops with immunity to pests and diseases, and unlock nutrients in the soil so crops can thrive.
- **Of the billions of species of microbes that make up the living soil, far less than one percent have been scientifically characterized in detail.** We have only begun to scratch the surface of understanding soil microbiomes. What we do know shows that plants and microbes have incredibly sophisticated responses to environmental conditions and to each other. Changes in the microbiome can result in unpredictable impacts on plant growth and insect communities.
- **Scientists recognize that the genetic functioning of microbes is considerably more complex than previously thought.** This is reflected in Pivot Bio's patent for Proven®40, which lists at least 29 different genes and myriad proteins and enzymes related to the ability of the target bacteria to convert nitrogen — a key nutrient in the soil — into a form that plants can use.
- **GE microbes address symptoms, not root causes of environmental problems.** The problems that biotech companies are purporting to solve via GE microbes — such as pest resistance to chemical pesticides and depleted soils lacking fertility — result from industrial farming practices. We cannot engineer our way out of these problems. True solutions require shifting to ecological approaches that regenerate the natural resources we depend on to grow food.
- **The same corporations that control the market for pesticides and GE crops are investing in GE microbes for agriculture** — Bayer-Monsanto, Syngenta, Corteva, and BASF.

KEY CONCERNS

- **Compared to GE crops, the scale of release for GE soil microbes is far larger and the odds of containment far smaller.** An application of GE bacteria could release 3 trillion genetically modified organisms *every half acre*; that's about how many GE corn plants there are in the entire U.S. GE microbes can also travel across state and national boundaries on the wind.
- **Genetic engineering results in a wide range of genetic mishaps.** Unintended genetic consequences in organisms are a common result of genetic engineering, including large deletions and complex rearrangements of genetic material. Research increasingly reveals the genetic havoc that can result from gene editing techniques like CRISPR.
- **Microbes can readily share genetic material with each other, increasing the potential to spread genetic modifications.** The process known as horizontal gene transfer allows microbes to share genetic material far more readily than plants and animals. As a result, the genetic modification inside

·engineered microbes may move between microbes and even across species boundaries in unpredictable ways. Horizontal gene transfer is more likely to occur in organisms that engage in pathogenic and symbiotic relationships — the same categories that are the most common targets of genetic engineering.

- **Biotech and chemical companies are engineering soil microbes to do things that nature has not designed them to do, and we cannot predict the environmental consequences.** As an example, Pivot Bio's patent for Proven®40 details methods to "disrupt" and "short circuit" the cellular nitrogen sensing cascade and "trick" the cells into perceiving a nitrogen-limited state so that they no longer have the ability to down-regulate nitrogen production. We cannot anticipate the repercussions for the health of our soil and climate of releasing trillions of GE microbes with these types of novel, unnatural traits across millions of acres of farmland.
- **There are potential health risks.** GE soil microbes could become human or animal pathogens. The soil microbiome is a known source of some opportunistic pathogens, including members of groups that are targeted for genetic engineering, such as Pseudomonas and Ochrobactrum. Also, as use of GE microbes grows in agriculture, consumers may be exposed to GE bacteria via the food supply. We don't yet have research showing the potential impacts on the human microbiome.
- **Corporate patents and spread of GE microbes pose economic risks for farmers.** In the U.S., microbes cannot be patented unless they are genetically engineered. Patenting soil microbes opens the door for companies to sue farmers if they find unlicensed GE microbes in their soil, similar to how Monsanto aggressively enforced corporate intellectual property rights over GE crops via predatory lawsuits. The high likelihood of genetic drift also poses a threat to organic farmers, who by law are prohibited from using GE organisms.

LACK OF REGULATION

- **The government's outdated regulations do not account for the unique features and risks of GE microbes.** GE microbes are governed by existing regulations meant for chemicals and naturally-occurring microbes.
- **Companies have far too much authority over how their products are regulated.** The U.S. Department of Agriculture allows developers of GE microbes to voluntarily decide that they are exempt from regulation and commercialize their products without submitting risk assessments for potential health or environmental impacts.
- **The regulatory system is incredibly opaque.** Companies can redact almost all details from public view in most regulatory filings as 'Confidential Business Information.' Once products are released, there is no program to surveil the extent of their use or re-evaluate their safety over time.

SUSTAINBLE SOLUTIONS

True solutions require moving from industrial agriculture toward ecological farming systems. Silver bullet technologies like GE microbes are addressing symptoms, not root causes, of the serious environmental and health problems associated with industrial farming systems, such as overuse of pesticides and synthetic fertilizers. According to UN estimates, industrialized farming — which produces greenhouse gas emissions, pollutes air and water, and decimates biodiversity — results in the equivalent of about **US$3 trillion** in environmental costs every year.

In the face of climate change and biodiversity loss, we must shift toward truly regenerative agriculture. Genetically engineering microbes to trick them into acting more like chemicals, by pumping out nitrogen for example, doesn't harness the true power of biology — the complex, living relationships between soil organisms, plants, air, and water which sustain life on earth. We have the knowledge and the tools to farm in accordance with these relationships. Farmers can use the science of ecology to manage pests and build soil fertility naturally, using practices like rotating crops, cover cropping, and composting. Organic farmers already produce abundant food without the use of synthetic nitrogen or toxic pesticides. **Decades of research** show that organic systems achieve better economic, social, and environmental outcomes compared to conventional farming systems. We need greater investment in ecological farming systems rather than risky genetic experimentation

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