

The Plant Variety Protection Act: The Loss of Agrobiodiversity and its Consequences for the American People

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Abstract

There's nothing so important as having variety —Barbara Kingsolver

Variety is the spice of life. It is also fundamental to life itself. Without variety in food, Americans face food insecurity, food instability, and compromised nutrition. In the United States, many Americans struggle to find nutrient-dense foods at affordable prices. The industrial agricultural system has imposed costs on consumers' health, the climate, and on food itself through crop consolidation and application of chemicals. In this thesis, I demonstrate how the Plant Variety Protection Act of the 1970s (PVPA) reduces agrobiodiversity through the patenting of genes. As plant varieties and cultivars are patented, biodiversity struggles to thrive. The resulting reduction of biodiversity has frightening ramifications. For the sake of scientific progress, the United States risks destabilization of the ecosystem, creates nutritional deficiencies in the American people, and destroys the very genetic materials that could save us.

1. Introduction

In a conversation with my aunt, she remarked: "How are we eating less variety of fruits and vegetables? There are things in grocery stores now that I never would have eaten as a kid. Shouldn't Americans be healthier?" I understand my aunt's confusion. There are foods that both she and I never could have consumed without international industrial agriculture. This form of agriculture has created overwhelming choice in affluent grocery stores. Food author, Michael Pollan, offers this mantra to combat the omnivore's dilemma that

arises from this system: "Eat food. Not too much. Mostly plants."⁵⁵

Although the choice may feel overwhelming, this choice is an illusion. According to most recent statistics, four companies alone own the rights to over two thirds of the world's seed and pesticide sales.^{56 57} These companies include Bayer (the owners of Monsanto), Corteva Agriscience (the combination of DuPont and Pioneer Hi-Bred), Syngenta (ChemChina), and BASF (partial owners of Monsanto).⁵⁸ Globally, ninety-eight percent of seeds are owned by these companies.⁵⁹

⁵⁵ MICHAEL POLLAN, *In Defense of Food: An Eater's Manifesto*. (Penguin Books ed., 2009).

⁵⁶ Better Planet Education, *Seed Saving- Who Owns the World's Seeds?*, <https://betterplaneteducation.org.uk/factsheets/seed-saving-who-owns-the-world-s-seeds>. (Last visited Dec. 4, 2024).

⁵⁷ Kristina Kiki Hubbard, *The Sobering Details Behind the Latest Seed Monopoly Chart*, CIVIL EATS (Jan. 11, 2019)

<https://civileats.com/2019/01/11/the-sobering-details-behind-the-latest-seed-monopoly-chart>.

⁵⁸ Romain Royer, *Uncovering the Top Seed Companies*, DORIANE, (Feb. 8, 2024), <https://www.doriane.com/blog/top-seed-companies>.

⁵⁹ BARBARA KINGSOLVER, *Animal, Vegetable, Miracle: A Year of Food Life*, 31 (Harper Perennial ed., 2008).

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So how did America get here? In 1970, Congress passed the Plant Variety Protection Act (PVPA): a win for agricultural behemoths and a loss for Americans. The PVPA grants intellectual property rights to corporations who create new, cultivated varieties of plants for 25 years. In general, the PVPA is fraught with issues for the economy, the climate, and the American people. This paper focuses on the loss of agrobiodiversity—the variety of agricultural plants—that result from the act.

First, I will explain why eliminating the PVPA is essential for preserving the health of the American people. I will explain the historical background of the PVPA and explain its foundation in the Constitution. Then, I will analyze *Diamond v. Chakrabarty* and *Bowman v. Monsanto*: two Supreme Court cases that have strengthened the PVPA and set scientific priorities. These two court cases are the foundation of strength for the PVPA. First, *Diamond v. Chakrabarty* expanded patentable matter, creating opportunities for the biotechnology industry to flourish. Then, *Bowman v. Monsanto* supported the rights of patent owners over preservation of biodiversity, thus leading to the consolidation of crops and American overreliance on high yield modified monocultures. *Bowman* severely limited nature's opportunity to intervene in biotechnology's work. Thanks to *Bowman*, plant patent rights have been extended over a plant's progeny, meaning nature can no longer alter the genetic modification performed by humans.

Finally, I will demonstrate how the PVPA has increased crop consolidation and has wrecked agrobiodiversity. I will show how, because of that lack of agrobiodiversity, Americans' nutritional intake has decreased, our scientific progress has been threatened, and Americans' gut microbiota has become less diverse.

2. The History of the Plant Variety Protection Act of 1970

To understand our present, it is important to understand how and why the Plant Variety Protection Act (PVPA) developed into what it is today.

2.1 Food Industrialization and the Beginning of Industry Influence

Around the end of the 1800's, food became an industry. At the start of industrialization in the United States, food production faced enormous change. As the Civil War ended, people moved into cities and left their local food systems behind. As Americans were pushed into factories, time and land were both in short supply. Thus, Americans had to rely on space away from their homes for the large-scale production of crops. This system of production was made possible with new transportation systems and technological advancements.⁶⁰ As industrial, large-scale agriculture grew, so too did the involvement of oligarchs and corporations.

As food was produced by fewer people and with more mechanical means, the people in control of food began to exert more pressure in legal and economic realms to maintain ideal selling conditions. This influence led to the creation of plant patent rights. Although companies in the 1800's had no knowledge of the term "biotechnology," they did understand "adulteration."

The food industry started to take advantage of "adulteration" for the sake of profit. Adulteration is "the addition of ingredients to modify different properties of food products for economic advantage."⁶¹ Chemical companies began experimenting to see how their wares could be used to benefit food's appearance and shelf-

⁶⁰ *Id.*

⁶¹ Momtaz, Mysha et al. "Mechanisms and Health Aspects of Food Adulteration: A Comprehensive Review." *Foods* (Basel,

Switzerland) vol. 12,1 199. 2 Jan. 2023, doi:10.3390/foods12010199 (last visited Jul. 26, 2025).

life.⁶² Chemicals like formaldehyde, copper sulfate, benzoate, and borax were used to make vegetables greener, meat firmer, and make canned products more stable.⁶³ One of today's largest agrochemical companies, Monsanto, was one of the first to begin putting additives into food.⁶⁴ Although Monsanto did not discover the sugar alternative—benzoic sulfonide—also known as saccharin, the company became its largest producer in the early 1900's.⁶⁵ Although saccharin was one of the safer additives, others were not. Chemical additives, and their effects on the American public, went unstudied until Dr. Harvey Wiley, the United States Department of Agriculture's (USDA) Chief Chemist, tested these chemicals on a group of young men known as "The Poison Squad."⁶⁶

The men that made up the Poison Squad all fell ill from the additives in their food. This study sparked legislators to pass the first federal consumer protections within the food world: the Pure Food and Drug Act of 1906.⁶⁷ Dr. Wiley fought to ensure that "the poorest among us could go to the store and get food that was [not] going to kill them."⁶⁸ Following the Food and Drug Act, passage of other food protection laws ensued, although not without pushback from the food industry.⁶⁹ In response to increasing regulation, chemical companies shifted focus. Adulteration was no longer an option. Instead, these companies turned to a new, unregulated science to develop their profitable enterprise. Enter, biotechnology.

2.2 Biotechnology, Plant Variety, and the

International Union for the Protection of New Varieties of Plants

Biotechnology is the "manipulation of living organisms or their components to produce useful, typically commercial, products."⁷⁰ Around the 1960's and 1970's, biotechnology—agrobiotechnology specifically—was lauded as a way to "relieve world hunger and allow poor farmers in Asia and Africa to stop destroying precious forests and grasslands."⁷¹ This technology was supposed to bring new, diverse varieties of plants that could help us achieve disease-resistant crops, drought-resistant crops, and higher yields. To protect this developing science and its resulting technological advancements, the International Union for the Protection of New Varieties of Plants (UPOV) was created in 1961.⁷² It was from this original convention that the true plant patent right is born.

UPOV's mission is "to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society. The UPOV Convention grants breeders of new plant varieties an intellectual property right: "the breeder's right," to encourage plant breeding.⁷³ This right is important. No longer does the creator of a new plant variety have an arbitrary right to their invention. Instead, the creator's right is backed by the full strength of the signatory nation, as well as the full strength of the International Union for the Protection of New Varieties of Plants. As of February 2, 2024, there

⁶² THE POISON SQUAD (WGBH 2020).

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ Claire Suddath, *Are Artificial Sweeteners Really That Bad For You?*, TIME MAGAZINE (Oct. 20, 2009), <https://www.sciencehistory.org/stories/magazine/the-pursuit-of-sweet/>; <https://time.com/archive/6933926/are-artificial-sweeteners-really-that-bad-for-you/>.

⁶⁶ *Id.*; U.S. Food and Drug Admin., *Harvey Washington Wiley* (Feb. 24, 2020) <https://www.fda.gov/about-fda/fda-leadership-1907-today/harvey-wiley>

⁶⁷ THE POISON SQUAD (WGBH 2020).

⁶⁸ *Id.*

⁶⁹ *Id.*

⁷⁰ *Biotechnology*, Merriam-Webster, <https://www.merriam-webster.com/dictionary/biotechnology> (last visited Dec. 4, 2024).

⁷¹ DANIEL CHARLES, *Lords of Harvest: Biotech, Big Money, and the Future of Food* (Basic Books ed., 2001).

⁷² UPOV., *What is UPOV?*

<https://www.upov.int/overview/en/upov.html> (last visited Dec. 4, 2024).

⁷³ *Id.*

are currently 79 participating members of UPOV: the United States is a signatory to the 1991 Act of the UPOV Convention.⁷⁴ Rather than signing on to the first UPOV treaty in 1961, the United States created its own plant variety protection scheme in 1970.

With an organization this large, the legal right to own a plant is extremely powerful. Creators are guaranteed a legal remedy in a court of law should their right be infringed. This right protects the creator from financial competition. It also protects reproduction of the creator's product without fair compensation. UPOV provides these rights with an honorable goal: to encourage new varieties of plants for the betterment of society. Unfortunately, the right has only created a profitable industry in the United States.

2.3 The Plant Variety Protection Act

The PVPA itself is a patent process that provides certificates for "new, distinct, uniform, and stable varieties of sexually reproduced, tuber propagated, or asexually reproduced plants."⁷⁵ The PVPA allows for corporations to own all varieties of plants. These certificates ensure the creator of a variety or a cultivar has the right "to prevent others from selling the variety, offering it for sale, reproducing it . . . or using it in producing a hybrid or different variety from it."^{76,77} This certificate is important. It functions as powerful legal protection like the UPOV treaty. However, the United States created an even stronger version,

which is more in line with America's general patent protection.

The process to procure a certificate works like this: an application is filed with the Plant Variety Protection Office.⁷⁸ Then, the application is reviewed by the Commissioner subject to oversight from the Plant Variety Protection Board. The board is comprised of individuals from the public and private sectors.⁷⁹ For the application to be approved, the plant must not have been grown within the United States in the last year or outside of the country within the last four years.⁸⁰ Second, the plant must be distinct from any other variety.⁸¹ However, the variety does not need to be genetically distinct, as long as its physical character or processing characteristic, such as the plant's ability to use less water, is new.⁸² Lastly, the variety must be uniform, commercially acceptable, and stable.⁸³ If the certificate is granted, the breeder will have exclusive rights over the plant variety for twenty to twenty-five years.⁸⁴

As biotechnology protections were first blossoming, the United States' plant protection was comparable to UPOV. The original PVPA of 1970 protected three activities, similar to UPOV. First, the language in the PVPA provided that "protected seeds could still be used by anyone for research purposes."⁸⁵ Second, farmers could save the seeds a purchased crop would produce for the farmer's own future plantings.⁸⁶ Lastly, the PVPA provided a public interest provision which provided a mechanism for asserting the public

⁷⁴ U.S. Pat. and Trademark Off., *International Convention for the Protection of New Varieties of Plants* <https://www.uspto.gov/ip-policy/patent-policy/international-convention-protection-new-varieties-plants#> (last visited Dec. 4, 2024).

⁷⁵ 7 C.F.R. § 97.1

⁷⁶ *Id.*

⁷⁷ U.S. DEPT. OF AGRIC., PLANT VARIETY PROTECTION ACT AND REGULATIONS AND RULES OF PRACTICE (2013).

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ *Id.*

⁸¹ Jim Chen, *The Parable of the Seeds, Interpreting the Plant Variety Protection Act in Furtherance of Innovation Policy*, Notre Dame L. Rev. 105, 121-22 (2005).

⁸² *Id.*

⁸³ *Id.*

⁸⁴ If the plant is a vine or a tree, the certificate grants protection of the breeder's rights for 25 years. U.S. Dept. of Agric. *Plant Variety Protection*. <https://www.ams.usda.gov/services/plant-variety-protection> (last visited Dec. 4, 2024).

⁸⁵ Burke Bindbeutel, *The Beans of Wrath: Genetic Patent Holders Reap Further Protection: Monsanto Co. v. Bowman*, 19 J. ENVTL. & SUSTAINABILITY L. 426, 430 (2013).

⁸⁶ *Id.*

good “in the face of monopolistic plant-breeder control.”⁸⁷

To date, these exemptions have been revoked or never utilized: the public interest provision has never been invoked.⁸⁸ Despite the hunger of forty-seven million Americans, there has been no government action to assert the provision for the public good.⁸⁹ Additionally, the original language that allowed farmers to save seeds still required farmers to obtain permission from producers to replant seeds. Permission was rarely, if ever, granted. Also, the exemption that allowed for seeds to be used for research only benefitted agricultural companies in their development of new, patentable crops.⁹⁰

Agrochemical and agricultural biotech companies lobbied for the adoption of the PVPA. These companies wanted the strongest protections for their product, and they wanted exclusive rights to their products for as long as possible. The companies also wanted to control prices of their products as much as possible. When agricultural biotech companies created public policy divisions, Monsanto was one of the strongest voices.⁹¹ Although Monsanto already required farmers to sign contracts when using Roundup-Ready seed—a genetically-modified seed built to withstand direct pesticide application—these contracts were not enough for Monsanto.⁹² Penalty of violating those contracts included the incurment of legal fees and fines, as well as mandatory observation for three years.⁹³ So, beginning in 1983 and 1984, Monsanto held “strategy sessions” where they “wine[d] and

dine[d] politicians” to suggest more favorable regulations.⁹⁴ Monsanto’s legislative affair director, Travis Brown, called State departments and suggested bills.⁹⁵ The director even convinced governments to create registration and reporting requirements for locally run seed cleaners.⁹⁶

Seed cleaners were the most used instrument to save and sort a farmer’s seed.⁹⁷ A machine or “seed cleaner” uses sieves and air to sort out any weeds, debris, or bad seeds contained within the seed that a farmer wants cleaned.⁹⁸ A seed cleaner was often a place of community for rural farmers. Travis Brown, Monsanto’s legislative affair director, created the seed cleaner bills which encouraged farmer-on-farmer reporting. Although Travis Brown created better enforcement of Monsanto’s intellectual property rights, he destroyed farmers’ traditional practices and the culture of trust and sharing.⁹⁹

The legislative efforts of Monsanto, as well as other companies like DuPont, strengthened plant patent rights. In 1995, Congress amended the PVPA, so farmers could no longer sell re-harvested seed from patented products. This amendment was unnecessary to increase effectiveness of research and development according to a study published in the *Review of Agricultural Economics* in 1996.¹⁰⁰ The study, conducted using cross-sectional, field-level data on yields and prices, concluded that a farmer’s right to plant second-generation patented seed, or “bin-run seed”, from their own fields could exist “without decreasing incentives for varietal development.”¹⁰¹ Still, the extra economic protection incentivized

⁸⁷ *Id.*

⁸⁸ Chen, *supra* note 81.

⁸⁹ Feeding America, *Hunger in America*, <https://www.feedingamerica.org/hunger-in-america>, (last visited Dec. 6, 2024)

⁹⁰ Chen, *supra* note 81 at 124-28.

⁹¹ CHARLES, *supra* note 71 at 27-29.

⁹² *Id.* at 185.

⁹³ *Id.*

⁹⁴ *Id.* at 27-29; *Id.* at 91.

⁹⁵ *Id.* at 191.

⁹⁶ *Id.*

⁹⁷ *Id.*

⁹⁸ Giggs Farm LLC, *How a Seed Cleaner Works*, YOUTUBE <https://www.youtube.com/watch?app=desktop&v=8jH68cPW0H0> (last visited July 18, 2025).

⁹⁹ CHARLES, *supra* note 71 at 191.

¹⁰⁰ Mary Knudson, et al., *Property Right Protection of Reproducible Genetic Material*, 18 REV. OF AGRIC. ECON., 403-14 (1996). <https://doi.org/10.2307/1349624>.

¹⁰¹ *Id.*

agrochemical companies to continue research and development. In 1997, just after the passage of the amendment, the New York Times expected the agricultural biotechnology industry to grow from the “almost nothing” in 1997 to 20 billion dollars in 2010. Last year, in 2024, Corteva Agriscience pulled in 9.5 billion dollars in seed sales, while Bayer reported 6.25 billion dollars in crop science profit.¹⁰² Additionally, the 1995 amendment created other opportunities for profit: litigation. Monsanto, as of December 2012, had been awarded \$23,675,820.99 from infringement lawsuit judgements.¹⁰³ This profit does not just materialize. This profit comes as a direct result of the PVPA. It pulls costs out of the pockets of farmers and consumers and places money into the hands of corporations.

The 1995 amendment exacerbated the economic disparities between agrochemical companies and farmers. Farmers experience financial strain when using genetically modified crops because farmers are not allowed to store and use these crops’ next generation of seeds.¹⁰⁴ Furthermore, the USDA has found that “[s]eed prices have risen dramatically in those crops in which patented [genetically engineered] varieties are now predominant, such as corn, soybeans, and cotton.”¹⁰⁵ Since the rise in use of genetically altered seeds, USDA data shows “the average cost

of soybean seed to plant one acre has risen by a dramatic 325 percent . . . cotton seeds spiked 516 percent from 1995- 2011 and corn seed costs rose 259 percent over the same period.”¹⁰⁶

The PVPA has also created financial strain for consumers and producers due to corporate consolidation.¹⁰⁷ Creating a patentable product is expensive. Local farmers cannot afford research and development costs associated with creating new products. Instead, large corporations control the financial resources and buy up any smaller seed companies that do manage to appear. Even a well-known, family-owned company can be wiped out by competitors. In the year 1926, a young Henry Wallace started a company: Pioneer Hi-Bred.¹⁰⁸ The company became a leader in corn.¹⁰⁹ It also became the number one brand of soybeans in North American in 1991.¹¹⁰ Despite these achievements, Pioneer Hi-Bred still fell to the behemoth, DuPont.¹¹¹ It began with an investment. DuPont bought twenty percent of the company for 1.7 billion dollars in 1997.¹¹² In 1999, DuPont pounced and bought all of Pioneer Hi-Bred.¹¹³ After that, another company, Dow, merged with DuPont to become DowDuPont.¹¹⁴ Now, the mega-company, Corteva Agriscience, represents as the official “agriculture division of DowDuPont.”¹¹⁵ This is the world of agricultural industry. If a smaller company creates an

¹⁰² CORTEVA agriscience, *News Release 4Q 2024*, CORTEVA AGRISCIENCE (Feb. 05, 2025), <https://investors.corteva.com/static-files/e5d99b14-6fc1-40c0-9a88-f04c39b4c81b#> (last visited July 22, 2025); Bayer, *Bayer Annual Report 2023: Five Year Summary*, BAYER, (2023), 83 <https://www.bayer.com/sites/default/files/2024-03/bayer-annual-report-2023.pdf>

¹⁰³ Bill Freese, et al., *Seed Giants vs. U.S. Farmers*, CENTER FOR FOOD SAFETY AND SAVE OUR SEEDS, 6 (2013). https://www.centerforfoodsafety.org/files/seed-giants_final_04424.pdf

¹⁰⁴ SEEDS OF FREEDOM (The Gaia Foundation 2012).

¹⁰⁵ Freese, *supra* note 103 at 8-9.

¹⁰⁶ *Id.*

¹⁰⁷ Tonya Mosley, *Journalist says we’re ‘basically guinea pigs’ for the new form of industrialized food*, NPR (Apr. 18, 2024) <https://www.npr.org/2024/04/18/1245541903/journalist-says-were-basically-guinea-pigs-for-a-new-form-of-industrialized-food>; Eric Schlosser, *Do We Really Want a Food Cartel?* THE

ATLANTIC (Apr. 9, 2024).

<https://www.theatlantic.com/ideas/archive/2024/04/food-industry-monopoly-power/678005>

¹⁰⁸ Pioneer Hi-Bred, *History of Pioneer*, <https://www.pioneer.com/us/about-us/our-history.html> (last visited July 27, 2025).

¹⁰⁹ *Id.*

¹¹⁰ *Id.*

¹¹¹ *Id.*; Bloomberg News, *Du Pont to Invest 1.7 Billion in Pioneer Hi-Bred*, THE NEW YORK TIMES <https://www.nytimes.com/1997/08/08/business/dupont-to-invest-1.7-billion-in-pioneer-hi-bred.html> (last visited July 27, 2025).

¹¹² Pioneer Hi-Bred, *supra* note 108.

¹¹³ *Id.*

¹¹⁴ *Id.*

¹¹⁵ *Id.*

impressive product, a large company will use its resources to acquire it. There is little to no opportunity for competition in the world of agricultural biotech.

Additionally, the protection of patent rights imposes costs on our society because patent owners may control their prices without competition.¹¹⁶ With all these costs imposed on American farmers and people, there should be something to show for the enactment of the PVPA. Instead, the protection of developer's rights has led to "no significant improvement of crop quality, crop yields, or any other measure of agronomic performance."¹¹⁷

3. Constitutional Basis and Court Treatment of the Plant Variety Protection Act

Generally, the United States has strong patent protections: in 2019, the United States was ranked as the overall global leader and standard setter for the protection of intellectual property rights.¹¹⁸ These strong protections can be attributed to Article I, Section 8, Clause 8 of the United States Constitution. The clause is one of enumerated powers, granting Congress the right to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."¹¹⁹ The Court has made two important decisions interpreting this mandate's impact on ownership of plant material. The following rulings demonstrate how the Court favors "progress" for agrochemical companies over the economic stability of the farmer.

3.1 *Diamond v. Chakrabarty*: Protection of Patent Rights in the 1980s

The first case the Supreme Court decided in the world of biotech, *Diamond v. Chakrabarty*, expanded patentable subject matter to include living organisms.¹²⁰ Although this case concerned the Plant Patent Act of 1930, (PPA) the legal analysis involved is deeply important to the PVPA. A certificate granted under the PVPA relies on the same legal foundation as the PPA to operate as a federal law.

In *Diamond*, the respondent filed a patent application for an altered bacterium that could break down crude oil.¹²¹ The respondent had altered bacterium's ability: it could now break down crude oil, which was found in no other naturally occurring bacteria.¹²² Yet, the examiner who grants patents denied the respondent's patent claim. The examiner found "micro-organisms are 'products of nature,' and . . . as living things [the bacteria] are not patentable subject matter under 35 U. S. C. § 101."¹²³ Chakrabarty appealed the decision of the patent examiner to the Patent Office Board of Appeals hoping to gain rights over the bacteria.¹²⁴ The Patent Office Board of Appeals agreed: living things not specified in the act could not be patented.¹²⁵ Subsequently, the Court of Customs and Patent Appeals reversed and granted the patent.¹²⁶ The Commissioner of Patents and Trademarks sought a writ of certiorari asking the Supreme Court of the United States to hear the case.¹²⁷ The writ was granted by the Supreme Court. This typically occurs when the case is of national importance and involves an important question of federal law.¹²⁸ Therefore, it is likely the

¹¹⁶ Carlos Scott Lopez, *Intellectual Property Reform for Genetically Modified Crops: A Legal Imperative*, 20 J. Contemp. Health L. & Pol'y 367, 380 (2004).

¹¹⁷ *Id.* at 155.

¹¹⁸ U.S. PAT. AND TRADEMARK OFF., UNITED STATES MOVES UP IN INTERNATIONAL RANKINGS FOR PATENT PROTECTION. (2019).

¹¹⁹ U.S. Const. Art. I, § 8, Cl. 8.

¹²⁰ *Diamond v. Chakrabarty*, 447 U.S. 303, 305 (1980); Bindbeutel, *supra* note 85 at 431.

¹²¹ *Id.*

¹²² *Id.*

¹²³ *Id.* at 306.

¹²⁴ *Id.*

¹²⁵ *Id.*

¹²⁶ *Id.*

¹²⁷ *Id.* at 307.

¹²⁸ *Id.* at 307.

Supreme Court saw how big this case could be in determining the future of patents and biotechnology.

In the Court's analysis of Chakrabarty's case, the court first looked to Congress's power granted under Article 1, Section 8 to "promote the Progress of Science and useful Arts" by securing exclusive rights for creators of such progress.¹²⁹ The Court determined the question regarding the respondent's right could be determined on whether the micro-organism counted as a "manufacture" or a "composition of matter."¹³⁰

The Court's statutory construction was shaped by a powerful guarantee to patent rights. Generally, the Supreme Court cautioned other courts to "not read into the patent laws limitations and conditions which the legislature has not expressed."¹³¹ Because the respondent showed his bacterium to be a "product of human ingenuity" with "markedly different characteristics from any found in nature," the Court concluded the respondent had a patent right over his bacterium.¹³²

This is similar to how the PVPA operates today. To get a certificate, a corporation must show that a plant has been altered by human ingenuity. The variety (or cultivar more scientifically) must have some different characteristic than that of a variety found in nature or created by another corporation.

Interestingly, the Court was not convinced by the Commissioner's arguments about legislative intent.¹³³ The Commissioner claimed the specific language used in the Plant Patent Act (PPA) and the Plant Variety Protection Act should lead the Court to conclude living (animal) things could not be patented.¹³⁴ The Commissioner

explained that Congress had specifically excluded the protection of bacteria from the language in both the PVPA and the PPA. The Commissioner explained that exclusion of the word or concept of bacteria by the drafters of the Act was clearly intentional: the drafters did not want to include bacteria in either the PVPA or the PPA.¹³⁵ Thus, bacteria should not be patentable.¹³⁶

Despite this argument, the Court held that Congress understood the distinction to be between "products of nature" and "human-made inventions" rather than between "living" things and "inanimate things."¹³⁷ Yet, the Court did not have a clear response to petitioner's argument regarding the Plant Variety Protection Act.¹³⁸ The Court merely stated there was no relevant legislative history and found "there is no basis for reading into [Congress's] actions."¹³⁹ Legislative history includes any document or hearing analyzing the passage of an act. However, just because no legislative history was present, does not mean there is not relevant cultural history surrounding the act. In fact, had the Court considered relevant cultural history, it would have noticed that bacteria are essential to the technologies being developed by agrochemical companies.

The Commissioner also argued the Court should not take expansion of plant patent rights into its own hands.¹⁴⁰ However, the Court was not convinced this decision should be handed back to the legislature. Because law already existed on the subject, the Court reminded the parties that "it is the province and duty of the judicial department to say what the law is."¹⁴¹ The Court declared the acts were written in "broad terms to fulfill the . . . goal of promoting 'the Progress of Science and the

¹²⁹ *Id.*; U.S. Const. Art. I, § 8, Cl. 8.

¹³⁰ *Id.* at 307.

¹³¹ *United States v. Dubilier Condenser Corp.*, 289 U.S. 178, 199 (1933).

¹³² Chakrabarty. 447 U.S. at 309-10.

¹³³ *Id.* at 310-11.

¹³⁴ *Id.* at 311.

¹³⁵ *Id.*

¹³⁶ *Id.*

¹³⁷ *Id.* at 313.

¹³⁸ *Id.*

¹³⁹ *Id.* at 314.

¹⁴⁰ *Id.* at 314-15

¹⁴¹ *Id.* at 315.

useful Arts’ with all that means for the social and economic benefits envisioned by Jefferson.”¹⁴² But to whom does the Court wish to grant social and economic benefits to?

The Court’s interpretation of the intellectual property clause shapes how legal scholars view the right to food and environmental safety. While “social and economic benefits” could be construed to imply value for the public good, the Court placed economic rights and scientific progress above social rights instead. In the opinion, the Court acknowledges it has been “warned about technological developments [which] may spread pollution and disease,” “result in a loss of genetic diversity,” and lead to “[genetic research which] may tend to depreciate the value of human life.”¹⁴³ The Court declines to weigh these hazards in its analysis. The Court tries to limit its liability claiming that its only task is the “narrow one of determining what Congress meant by the words it used in the statute.”¹⁴⁴ After that task, the Court claims, “our powers are exhausted.”¹⁴⁵ The Court then explains the only impact this case may have is “whether research efforts are accelerated by the hope of reward or slowed by want of incentives.”¹⁴⁶ Ultimately, the respondent, the new owner of a patent over bacteria, had his rights upheld, and the judgement of the Court of Customs and Patent Appeals was affirmed.¹⁴⁷ Bacteria could be owned, sold, and used to develop profitable products.

The dissent in *Diamond* agrees the Patent Act and Plant Variety Protection Act is strong evidence of a “congressional limitation that excludes bacteria from patentability.”¹⁴⁸ Justice Brennan concludes that whether bacteria should be patented is a question that should go to the

legislature. However, even Justice Brennan believes “the future of scientific research” is not at stake, although public concern over monopolies is.¹⁴⁹

The result of *Diamond* was the expansion of a 1.2 trillion-dollar market.¹⁵⁰ Without the Court’s decision in *Diamond*, the research and development market would not have been nearly as profitable. Perhaps the Court could not have foreseen the consequences from this decision, specifically the loss in agrobiodiversity from the expansion of patent rights, but it certainly should have foreseen the consequences of its actions in *Bowman*. As will be demonstrated below, *Bowman* is the court case that took away any opportunity for biodiversity to persist. By granting lengthy patent rights over the plant’s progeny, *Bowman* elevated the dangerous decision in *Diamond* to a catastrophic one.

3.2 *Bowman v. Monsanto: Building on the patent legacy of Diamond*

In *Bowman*, the Court held that it was constitutional to prevent a farmer from using second-generation patented seeds for commercial use.¹⁵¹ In this case, the respondent, Monsanto, sold “Roundup Ready” soybean seeds with a special licensing agreement which demanded farmers not save the seed for next year’s harvest.¹⁵² The petitioner, Vernon Bowman, typically planted “Roundup Ready” soybean seeds. However, that year, the farmer from Indiana purchased commodity soybeans. Commodity soybeans are typically used as animal feed, but Mr. Bowman instead replanted the commodity seeds in his field to save money.¹⁵³ Because most of the farmers in Mr. Bowman’s area also used Roundup Ready

¹⁴² *Id.* at 315.

¹⁴³ *Id.* at 316.

¹⁴⁴ *Id.* at 318.

¹⁴⁵ *Id.*

¹⁴⁶ *Id.* at 317.

¹⁴⁷ *Id.*

¹⁴⁸ *Id.*

¹⁴⁹ *Id.*

¹⁵⁰ Donald T. Hornstein & Eli D. Hornstein, *Climate Change and Biotechnology*, 25 N.C.J.L. & TECH. 109, 115 (2023).

¹⁵¹ *Bowman v. Monsanto Co.*, 569 U.S. 278, 280 (2013).

¹⁵² *Id.* at 281.

¹⁵³ *Id.* at 282.

seeds, Mr. Bowman knew he was likely to get Roundup resistant seeds.¹⁵⁴ It was a success.¹⁵⁵ Mr. Bowman was able to produce eight generations of Roundup Ready seeds.¹⁵⁶ Unfortunately, Monsanto then sued Mr. Bowman for infringing on Monsanto's patents for unauthorized use of Monsanto's Roundup Ready seeds.¹⁵⁷

In other kinds of intellectual property cases, the Court has held the patent holder's right ends when the patent holder has "received its rewards . . . by the sale of the article."¹⁵⁸ However, in the world of seeds, the Court determined a different approach was needed. Because plants are unique in their ability to generate seeds during each harvest, the Court reasoned that ending patent rights over the first crop of seed would deprive Monsanto the benefits of its licensed monopoly.¹⁵⁹ Rather than protect the economic status of the farmer, this decision prioritized research and development rights for the creator.¹⁶⁰

It is worth mentioning that this decision was based on the Plant Patent Act of 1930 (PPA). That Act is more focused version of the PVPA: it provides rights to the creator only when the product is asexually reproduced.¹⁶¹ That Act also has no public use exemption.¹⁶² However, the Court uses the PVPA to rationalize its decision in *Bowman*. The PPA has a more stringent process for patent rights, so the Court reasoned Congress would have wanted to provide better protections. The majority believed that if a creator could not control a patented seed's progeny, then that creator could not stop "the buyer from selling such seed, which even a PVP certificate owner (who, recall, is supposed to have fewer rights) can usually accomplish."¹⁶³ In sum, the Court heightened protections of intellectual property

rights under the PPA because the PVPA's amendments in 1995 had already prevented sale of a patented seed's progeny.

In response to the argument that Monsanto would be deprived of its rights, Mr. Bowman reminded the Court that seeds are meant to be planted, and that plants naturally reproduce.¹⁶⁴ As one scholar succinctly states: "'Copying' is the definition of agriculture."¹⁶⁵ To extend patent rights for 20 years over the progeny of a seed goes against nature's very way of being. Plants often reproduce from seed. From that seed, virtually the same plant will grow, if that pattern of existence works for the plant. However, with each generation, some plants may have mutations. Nature will embrace those unique traits born from mutations, so long as those traits prove useful.

Intellectual property rights function exactly the opposite. Not only is it illegal for patented plants to naturally reproduce in a farmer's field under the PVPA, but the writers of the PVPA expect the protected plants to never exhibit variation. Protected plant varieties are created to stay the same with no opportunity for evolution. The certificates issued by the PVPA essentially guarantee 20 years of uniform planting. Thus, there is no opportunity for biodiversity to develop. The Supreme Court not only overlooked the way plants work, but it also failed to consider how 20 years of uniform planting would impact the ecosystem.

In the end, because the majority found that Mr. Bowman reproduced Monsanto's patented invention for his own benefit, the Court rules in favor of Monsanto. The Supreme Court affirmed the judgement of the Court of Appeals

¹⁵⁴ Nina Totenberg, *For Supreme Court, Monsanto's Win Was More About Patents Than Seeds*, NPR <https://www.npr.org/sections/thesalt/2013/05/14/183729491/Supreme-Court-Sides-With-Monsanto-In-Seed-Patent-Case> (last visited Jul. 27, 2025).

¹⁵⁵ *Id.*

¹⁵⁶ *Id.*

¹⁵⁷ *Id.*

¹⁵⁸ *Bowman*, *supra* note 151 at 284.

¹⁵⁹ *Id.* at 285.

¹⁶⁰ *Id.* at 285-86

¹⁶¹ 35 U.S.C. § 161

¹⁶² *Id.*

¹⁶³ *Bowman*, 569 U.S. at 286.

¹⁶⁴ *Id.* at 287-88.

¹⁶⁵ Chen, *supra* note 81 at 109.

and expanded patent law privileges beyond any previously recognized right.¹⁶⁶ And Mr. Bowman, the soybean farmer who wanted to save a little money, was ordered to pay 84,000 dollars in damages to Monsanto.¹⁶⁷

The expansion of patent rights by both of these court cases has created a hugely profitable enterprise. However, this profitable enterprise benefits the agrochemical and agribiotech companies, but comes at the cost of agrobiodiversity, as well as Americans' health.

4. How the PVPA Encourages Patented Crops, How Those Crops Damage Agrobiodiversity, and How Those Damages Hurt American Nutrition

After *Diamond* and *Bowman*, intellectual property rights over plants became entrenched in the operations of American society. America's agricultural system has been deeply influenced by the protection of these property rights. By analyzing the loss of agrobiodiversity, I intend to demonstrate how monopolized ownership of plant genes has severe consequences on Americans' quality of life.

The ownership, patenting, and commercialization of plants has severely damaged agrobiodiversity. Agrobiodiversity is defined as "the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture."¹⁶⁸ This can include crops, livestock, forestry and fisheries. It also includes micro-organisms, pollinators, and soil used to support agro-ecosystems.¹⁶⁹ Agrobiodiversity is responsible for creating

healthy, stable farming systems. The variety in an agricultural system protects against diseases. Variety is an important protective measure because some subspecies may be resilient to a particular disease. If none of those varieties are present in an ecosystem, the ecosystem may be destroyed. Additionally, plants feed more than just humans. Fruits and vegetables support pollinators in the area. If all the plants in an area are wiped out by a disease, then the pollinators and insects in the ecosystem will suffer, creating a ripple effect. Furthermore, a biodiverse, healthy system can improve human nutrition by providing medicine, vitamins, and exposing us to healthy bacteria.¹⁷⁰

America's current agricultural system is not agrobiodiverse. Instead, most crops are patented, genetically modified crops grown as monocultures. Monocultures are favored due to the opportunity for mechanization and ease in a harvest.¹⁷¹ A farmer can grow one kind of crop and devote all her resources toward specializing in a profitable, government-subsidized enterprise like corn. This system is sold by agrochemical companies who claim their seed and products will provide an easier harvest, save labor costs and save the farmer's time. This also allows agrochemical companies to develop more products for the farmer to buy, such as chemical fertilizers. Companies may have created an easier system, but it is a much more costly one. Further, this system imposes costs in more ways than one. If a farmer chooses to not participate in this system, she sacrifices the guaranteed yield that patented products promise. In contrast, if she chooses to participate, the farmer can expect to pay a higher price for seed. She also can expect to pay for the fertilizers and pesticides required to

¹⁶⁶ *Bowman*, 569 U.S. at 285; *Id.* at 289.

¹⁶⁷ Totenburg, *supra* note 154.

¹⁶⁸ Food and Agric. Org. of the United Nations, *What is Agrobiodiversity?*, (2004.)

<https://www.fao.org/4/y5609e/y5609e01.htm>

¹⁶⁹ *Id.*

¹⁷⁰ *Id.*

¹⁷¹ Jiquain Peng, et al., *Impact of Agricultural Mechanization on Agricultural Production, Income, and Mechanism: Evidence From Hubei Province, China*, FRONT. ENVIRON. SCI. (Feb. 9, 2022), <https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2022.838686>

grow the patented seed. This puts farmers at an economic loss either way. Costs are not only imposed on the farmer. The climate faces costs from this style of farming as well.

Monocropping replaces the natural heterogeneity of the land.¹⁷² Rather than let the land exist as a diverse mix of local fauna and flora, a farmer uses that land to produce a singular kind of crop. To put it in perspective, over history, humans have consumed over 6,000 different species of plants.¹⁷³ Today, humans only eat nine on average.¹⁷⁴ With greater homogenization comes greater threat of crop losses from pests, disease, and soil deficiencies.¹⁷⁵ This results in higher use of chemical pesticides, insecticides, and chemical fertilizers, which pollutes America's water and degrades America's soil quality.¹⁷⁶ Here, in the United States, farmers mostly grow corn, rice, soybeans, and wheat.¹⁷⁷ Agrochemical companies have genetically altered most of those crops. For example, from 2018 to 2020 Corteva Agriscience and Bayer, two of the largest agrochemical companies, provided more than half of the United States's retail seed sales of corn, soybeans, and cotton.¹⁷⁸ It is dangerous that more than half of the United States's seed sales of these crops come from just two patented cultivars. If one of those cultivars faces disease, that cultivar may go extinct and result in severe economic losses for American farmers. Economic risk is nothing to minimize. Sadly, Americans face even more serious

repercussions if our subsistence crops go extinct, including starvation. As we grow fewer varieties of crops, we lose more genetic material that could keep the American people and American food systems healthy.

In the United States, most varieties of apple have vanished: the varieties cannot be found in either "commercial agriculture or any U.S. gene bank."¹⁷⁹ Apples have more complex DNA than humans do.¹⁸⁰ The Golden delicious has 57,000 genes, more twice as many as the 20-25,000 humans have.¹⁸¹ Because of apples extreme heterozygosity, there used to be around 7,098 apple varieties grown in the United States between 1804 and 1904.¹⁸² Of these 7,098 varieties, "approximately 86 percent have been lost."¹⁸³ Practically, this means that local varieties have been lost to the point that "farmers in Washington now grow the same few apple varieties as farmers in California."¹⁸⁴ In fact, over fifty percent of the apples people eat are from just two cultivars.¹⁸⁵ Apples, like all plant species, have slightly different nutrients between varieties "depending on their type and color."¹⁸⁶ The Red Delicious is known for its polyphenol content, a chemical exclusively found in dark red fruits.¹⁸⁷

The apple has not been the only crop impacted. The USDA has found that "95 percent of the cabbage, 91 percent of the field maize, 94 percent of the pea, and 81 percent of the tomato

¹⁷² Tim. G. Benton, et al. *Food system impacts on biodiversity loss: Three levers for food system transformation in support of nature*, CHATHAM HOUSE REPORT, 17 (Feb. 2021).

https://www.chathamhouse.org/sites/default/files/2021-02/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf

¹⁷³ *We used to eat 6,000 types of plants—now we only eat 9*. THE MINDBODYGREENPODCAST (Jan. 28, 2022).

¹⁷⁴ *Id.*

¹⁷⁵ Benton, *supra* note 172 at 18.

¹⁷⁶ *Id.*

¹⁷⁷ U.S. DEPT. OF AGRIC., CROPS, (Jan. 24, 2022).

¹⁷⁸ U.S. DEPT. OF AGRIC., TWO COMPANIES ACCOUNTED FOR MORE THAN HALF OF CORN, SOYBEAN, AND COTTON SEED SALES IN 2018-20, (Oct. 2, 2023).

¹⁷⁹ Food and Agric. Org. of the United Nations, *The State of the World's Plant Genetic Resources for Food and Agriculture*, 14

(1996),

<https://openknowledge.fao.org/server/api/core/bitstreams/0172f037-db3b-47e8-9f93-26a1701db513/content>

¹⁸⁰ AMY STEWART, *The Drunken Botanist: The Plants That Create The World's Greatest Drinks*. (Algonquin Books of Chapel Hill, 10th anniversary ed.)

¹⁸¹ *Id.*

¹⁸² *Id.*

¹⁸³ *Id.*

¹⁸⁴ Freese, *supra* note 103 at 9.

¹⁸⁵ *Id.* at 20.

¹⁸⁶ Cleveland Clinic, *Which Apples Are Healthiest*,

<https://health.clevelandclinic.org/which-apples-are-healthiest> (last visited Jul. 27, 2025).

¹⁸⁷ *Id.*

varieties apparently no longer exist.”¹⁸⁸ Even if a variety of above crops were to spring forth from nature’s own design, a company may already have a PVPA certificate or a PPA patent on that set of genes. Practically, this means that the company who owns those genes may “enter on to private property and even confiscate that property without the owners’ consent.”¹⁸⁹ Even if companies are not selling that specific combination of genes, the companies may still enforce their rights while depriving society of the potential benefits of that species.¹⁹⁰

4.1 Crop Consolidation and Crop Stability

The United States National Academy of Sciences describes genetic vulnerability as “the condition that results when a widely planted crop is uniformly susceptible to a pest, pathogen or environmental hazard as a result of its genetic constitution.”¹⁹¹ Today, because of the ownership of plants, crops are genetically vulnerable. Without diversity, a crop is much more likely to become extinct or trigger hunger for people who rely on those crops for consumption or profit. The PVPA has encouraged the growth of high-yield monocultures with the use of chemical fertilizers or pesticides. Because most American crops are monocultures, most American crops are genetically vulnerable.

Recall the Irish Potato Famine. This famine was sparked when a fungus, commonly

referred to as “late blight,” led to the deaths of more than one million people from starvation and related diseases.¹⁹² Today, “new, more aggressive strains” of the fungus have appeared.¹⁹³ These strains of fungus are currently fungicide-resistant.¹⁹⁴ In response to the threat of this fungus, there has been a rush to develop a commercial variety that can resist the blight.¹⁹⁵ The process has involved identifying genes and resistant qualities from other subspecies of potato. From this process, scientists have created the variety known as Awn86514-2.¹⁹⁶ Unfortunately, this variety is still six years away from being available for commercial production and consumption.¹⁹⁷ Without genetic diversity, scientists could not have developed a potato resistant to the more aggressive form of blight.

A species at risk of becoming extinct today is the Cavendish banana. Developed in the 1800’s by Sir Joseph Paxton, this banana contains “high levels of vitamins A and C, minerals such as phosphorus, calcium and potassium, and carbohydrates.”¹⁹⁸ The banana flowers are used to treat bronchitis and diabetes, the roots are used to treat digestive problems, and the sap has been used to treat epilepsy, as well as small insect bites and stings.¹⁹⁹ While there are more than 1,000 varieties of bananas available for consumption, the Cavendish banana accounts for ninety-nine percent of the world’s banana consumption.²⁰⁰ Every Cavendish banana is genetically identical, so these bananas are extremely susceptible to

¹⁸⁸ CARY FOWLER, *UNNATURAL SELECTION: TECHNOLOGY, POLITICS AND PLANT EVOLUTION*, (Gordon and Breach Science Publishers 1994).

¹⁸⁹ Lopez, *supra* note 116 at 411.

¹⁹⁰ *Id.* at 380.

¹⁹¹ NATIONAL ACADEMY OF SCIENCES, *Genetic Vulnerability of Major Crops*, (Nat’l Acad. Press ed. 1972).

¹⁹² Marcia Wood, *Potato Offers Resistance to Late Blight Disease*, U.S. DEPT. OF AGRIC. (Dec. 17, 2024), <https://www.ars.usda.gov/news-events/news/research-news/1998/potato-offers-resistance-to-late-blight-disease>; Ireland’s Great Hunger Museum, *Learn About the Great Hunger*, <https://www.ighm.org/learn.html> (last visited Jul. 27, 2025).

¹⁹³ *Id.*

¹⁹⁴ *Id.*

¹⁹⁵ *Id.*

¹⁹⁶ *Id.*

¹⁹⁷ *Id.*

¹⁹⁸ Royal Botanic Gardens Kew, *Cavendish Banana*

<https://www.kew.org/plants/cavendish-banana> (Last visited Dec. 4, 2024).

¹⁹⁹ *Id.*

²⁰⁰ *Unearthed: Journeys into the Future of Food, Foods of the Future*, ROYAL BOTANIC GARDENS KEW (Nov. 16, 2022).

extinction.²⁰¹ Corporations operate large plantations to grow Cavendish bananas. These plantations use pesticides and fertilizers to pump out their identical bananas. This mass-production has already led to extinction of one banana cultivar: the Gros Michel banana.²⁰² The Gros Michel cultivar was replaced by the Cavendish banana because it had a similar flavor profile, and the cultivar was resistant to the fungal infection that wiped out the Gros Michel.²⁰³ Unfortunately, the very same fungal infection now kills off the Cavendish.²⁰⁴ Because the Cavendish is genetically identical, the entire species of banana is likely to go extinct if this new strain of Panama disease spreads. To prevent extinction of the Cavendish, we can encourage diverse consumption of banana varieties and explore the disease resistant traits of the Cavendish's wild cousins. Unfortunately, the genetic material that can help us is at risk.²⁰⁵ Because the Cavendish is grown in vast monocultures, requiring large swaths of land, wild banana species have had their habitats almost completely wiped out.²⁰⁶

Although biotechnology can help us develop new, resistant varieties of a crop, this science relies on diverse genetic material to create advancements. As companies exploit biodiversity and limit its replenishment through patents and commercialization, they limit humanity's ability to provide solutions through biotechnology. Thus, plant patent rights do the opposite of what they are meant to do. Rather than protect plant varieties and the progress of science, plant patent rights limit biodiversity and halt America's social and economic advancements.

Furthermore, intellectual property rights

over genes create economic incentives for quick development. Companies may be compelled to produce new products, regardless of the risk to people or planet.²⁰⁷ Even if new, disease-resistant varieties are developed, they may end up destroying others. For example, corn that was genetically modified accidentally made its way into Mexico.²⁰⁸ Unbeknownst to farmers, the genetically modified corn replaced native varieties.²⁰⁹ This is horrific. Replacement of native varieties and gene introgression could lead to huge alterations of a local ecosystem.²¹⁰ There are risks to a local environment with the introduction of an unknown species. That patented cultivar could rapidly multiply. It could kill off native varieties and the species that rely on those native plants. A local community may suffer the loss of cultural practices if a rogue product overtakes the native varieties they have used for hundreds of years. Protecting the ownership of plant genes has not saved us: it has put us at greater risk.

4.2 Overall Decrease of Nutrition Consumption for the American People on Patented Plants

As crop variation dwindles, the impacts can be seen on the nutrients Americans consume. Companies have not prioritized biotechnology as a tool to increase nutritional value in crops. Instead, they have used biotechnology to create high-yield varieties of crops. The preference for high-yield crops has led to a seventy-five percent reduction of plant genetic diversity as farmers leave behind their local varieties for more uniform, high-yield crops.²¹¹ That loss in genetic diversity leads to less

²⁰¹ *Id.*

²⁰² *Id.*

²⁰³ Royal Botanic Gardens Kew, *Bananas under threat*, <https://www.kew.org/read-and-watch/bananas-threat-extinction> (last visited Dec. 7, 2024).

²⁰⁴ *Id.*

²⁰⁵ *Id.*

²⁰⁶ *Id.*

²⁰⁷ Lopez, *supra* note 116 at 380.

²⁰⁸ Elisabeth Malkin, *Mexico is Warned of Risk from Altered Corn*, THE N.Y. TIMES (Mar. 13, 2004), <https://www.nytimes.com/2004/03/13/world/mexico-is-warned-of-risk-from-altered-corn.html>

²⁰⁹ *Id.*

²¹⁰ Benton, *supra* note 172 at 21.

²¹¹ Food and Agric. Org. of the United Nations, *What is Happening to Agrobiodiversity?*

variety of food, which leads to less varied consumption of vitamins and nutrients. The preference for high-yield crops means Americans only consume about 150 to 200 species of plants.²¹² There are 250,000 to 300,000 known edible plant species.²¹³ While plants contain some of the same nutrients, our preference of these 150 species means we are only consuming about 0.06 percent of the nutrient sources available to us. If we consider only the nine most common species that we consume today, America's consumption rate of diverse species declines further. Americans rely on only about three crops—rice, wheat, and corn—for more than half of our energy intake.²¹⁴ As agrobiodiversity trends down, another set of numbers is trending up: malnutrition deaths have more than doubled “from about 9,300 deaths in 2018 to roughly 20,500 in 2022,” according to the U.S. Centers for Disease Control and Prevention.²¹⁵ If Americans have limited access to a diverse range of species, it restricts Americans' ability to receive the full range of essential nutrients and vitamins.

The high-yield system has other consequences on American's health. Even if we disregard the lack of variety Americans are consuming, high-yield crop varieties have also experienced a general decline in their nutrition value: forty-three of the most common fruit and vegetable varieties have faced a nutritional decline of up to thirty-eight percent from 1950 to 1999.²¹⁶ This comparative study used data collected by the USDA, accounted for changes in moisture content,

and concluded that nutrients have been sacrificed for yield size. Further research is needed to examine nutritional decline of crops from 2000-2025. However, it is clear crops that have been specifically developed for mass production do not perform as well in providing essential nutrients for Americans.

4.3 Genetically Altered Soybeans

Genetically altered soybeans illustrate the degradation of nutritional content of crops modified for profit. In 1994, the USDA approved Monsanto's product: Roundup Ready Soybeans.²¹⁷ The soybeans containing the Roundup Ready gene became available in 1996 and are still in use today.²¹⁸ In fact, genetically altered soybeans now make up around ninety-three percent of soybeans.²¹⁹

These genetically engineered soybeans allow farmers to directly spray soybean plants with the herbicide, Roundup. The Roundup herbicide is also produced by Monsanto, which is a part of the larger agrochemical company, Bayer.²²⁰ Bayer, one of the largest agrochemical companies, claims to provide “health for all, hunger for none.” Bayer does not live up to this promise. Instead, Bayer uses biotechnology to bring in better profit. In this instance, Bayer brings in money from both seed and spray. Bayer used biotechnology to create a soybean that could tolerate glyphosate. Bayer then marketed and sold glyphosate as Roundup. Bayer didn't use biotechnology to create a new variety for the

<https://www.fao.org/4/y5609e/y5609e02.htm> (last visited Dec. 5, 2024).

²¹² *Id.*

²¹³ *Id.*

²¹⁴ Food and Agric. Org. of the United Nations, *Staple foods: What do people eat?* (last visited Dec. 4, 2024), <https://www.fao.org/4/u8480e/u8480e07.htm>

²¹⁵ KFF Health News, *U.S. Malnutrition Deaths Have More Than Doubled*, <https://www.usnews.com/news/health-news/articles/2023-04-13/deaths-from-malnutrition-have-more-than-doubled-in-the-u-s> (last visited Jul. 27, 2025).

²¹⁶ Donald R. Davis, et al., *Changes in USDA food composition data for 43 garden crops, 1950 to 1999*, 23 J. AM. COLL. NUTR. 669, 667-82 (2004).

²¹⁷ D.R. Harper, *Roundup Ready Soybeans: an Overview of the Technology*, MONSANTO CO. 267, 268

<https://dr.lib.iastate.edu/server/api/core/bitstreams/bb6819aa-e5bf-45b3-a17a-37c406c6ba2c/content> (last visited Dec. 5, 2024).

²¹⁸ *Id.*

²¹⁹ Freese, *supra* note 103 at 5.

²²⁰ Cooney and Conway, *Bayer to Pull Roundup from Shelves in 2023 to Avoid Further Lawsuits*, <https://www.cooneyconway.com/blog/bayer-pull-roundup-shelves-2023-avoid-further-lawsuits> (last visited Dec. 5, 2024).

betterment of the American people. The company used biotechnology to increase its profits. Bayer, nor any other agrochemical company benefitting from plant patent rights, has created the nutrient rich and biodiverse America it promised at agribiotech's beginning.

In a study of the nutritional differences between glyphosate-tolerant soy and organic unmodified soy, unmodified soybeans were shown to have the healthiest nutritional profile.²²¹ The organic soybeans contained more total protein and zinc, and they contained less saturated fat than the modified glyphosate tolerant soy.²²² Additionally, the glyphosate soybeans that were cultivated using the conventional chemical regime still contained high residues of glyphosate and aminomethylphosphonic acid (AMPA). Over time, exposure to high levels of AMPA can cause damage to the gastrointestinal and urinary tracts, impact development, and cause damage to the liver.²²³ Humans naturally have AMPA receptors for things like cognition, memory, and learning; however, dysregulation, or imbalance, of the AMPA receptor can lead to neuron damage, excitotoxicity and motor neuron death.²²⁴ Glyphosate itself has been found to be a "probable human carcinogen" by the World Health Organization's International Agency for Research on Cancer.²²⁵

Despite the warnings from the World Health Organization's International Agency for Research on Cancer, glyphosate is the most widely used herbicide in the United States.²²⁶ Its use impacts more than ninety-five percent of soybean

acres.²²⁷ According to Bayer, glyphosate itself is safe, but Bayer will no longer sell the product residentially because of the litigation risk.²²⁸ This choice highlights an interesting question: is the law right, or is Bayer's science, right? Bayer claims its product is safe, but the courts have made multiple findings to the contrary. Furthermore, should we trust the World Health Organization or the company who stands to profit from the sale of glyphosate?

While Bayer may have profited from the sale of efficiency—namely chemicals and patented plants—under the PVPA, the American people have suffered. Something as small as a soybean shows how Americans are harmed by this Act. The PVPA ensures that while the American people are increasingly exposed to a known carcinogen, Bayer makes 6.25 billion dollars in crop science profit. Is this really what we want to protect?

In another matter, Americans' microbiomes are suffering as a result of the patenting of and consolidation of crops under the PVPA. The use of monocultures in agriculture has severely limited American's consumption of multiple varieties of crops. Generally, the greater the diversity of species you eat, the more likely you are to cover all your nutritional bases.²²⁹ As Americans consume less variety of crops, we decrease our consumption of all the amino acids, proteins, and vitamins we need to function as humans. Research has shown that there is a "strong association between dietary diversity and nutritional status, particularly micronutrient density of the diet."²³⁰ Put simply, if we eat a

²²¹ T Böhn, et al., *Compositional differences in soybeans on the market: glyphosate accumulates in Roundup Ready GM soybeans*. 153 FOOD CHEM. 207, 207-15. (2014), doi: 10.1016/j.foodchem.2013.12.054.

²²² *Id.*

²²³ WISCONSIN DEPARTMENT OF HEALTH SERVICES: DIVISION OF PUBLIC HEALTH, AMINOMETHYLPHOSPHONIC ACID (2022).

²²⁴ Philip K-Y Chang, et al., *AMPA receptors as drug targets in neurological disease—advantages, caveats, and future outlook*. 35 EUR. J. NEUROSCI. 1908-1916, (2012). doi: 10.1111/j.1460-9568.2012.08165.x.

²²⁵ Cooney and Conway, *supra* note 220.

²²⁶ U.S. Dept. of Agric., *ERS Charts of Note*, (Jul. 30, 2015) <https://www.ers.usda.gov/data-products/charts-of-note/charts-of-note/?topicId=29bf0f43-e3cd-4b16-8f34-76a69ce2ed48>.

²²⁷ *Id.*

²²⁸ *Id.*

²²⁹ Jessica Fanzo, et al., *Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health*, 1 ISSUES IN AGRIC. BIODIVERSITY SERIES, 2013 at 4. <http://ebookcentral.proquest.com/lib/uoregon/detail.action?docID=1244678>.

²³⁰ *Id.*

greater variety of things, we are filled with a greater variety of nutrients.

The gut microbiome is a collection of microorganisms that line the gastrointestinal tract.²³¹ Over 60 tons of food pass through the gastrointestinal tract in a lifetime.²³² Depending on the foods a person eats, a person will influence which microorganisms—of which there are an estimated hundred trillion of—dominate and flourish in the body.²³³ A healthy gut microbiome is responsible for keeping gut integrity, harvesting energy and protecting the body against pathogens.²³⁴ A person's immune function is dependent on a healthy, diverse gastrointestinal microbiota.²³⁵ As well as keeping us from being sick, a diverse gut microbiota can improve our nutrient absorption. For example, lactic acid bacteria are key for the production of vitamin B12.²³⁶ *Bifidobacteria* are main producers of folate, which is key to metabolic processes including DNA synthesis and repair.²³⁷ Generally, the gut microbiota is responsible for vitamin synthesization in humans, including synthesization of vitamin K, riboflavin, biotin, and thiamine.²³⁸ If the gut microbiota lacks any of these essential bacteria, or if our systems lack these nutrients, our system can become compromised.²³⁹ This compromise has been associated with obesity and type two diabetes.²⁴⁰ In the United States, about forty percent of the population is considered obese, and around 35 million Americans have been diagnosed with type

two diabetes.²⁴¹ Thus, around forty percent of Americans may have compromised gut microbiota.

New Americans demonstrate the impacts of America's laws in their microbiota too. In 2018, researchers collected stool samples, 24-hour dietary recalls, and vitals from Hmong and Karen individuals who lived in Thailand and the U.S., both before and after immigration.²⁴² Researchers also collected data from first-and second-generation immigrants, as well as thirty-six U.S. born European American individuals.²⁴³ Data was collected daily over six months from five hundred and fourteen participants.²⁴⁴ After analyzing the results, researchers concluded that "increased duration of U.S. residence is associated with decreased microbiome diversity."²⁴⁵ Although the study was limited in duration and scope, researchers were able to observe "profound perturbations to the gut microbiome, including loss of native strains, [and] loss of fiber degradation capability."²⁴⁶

As our consumption of diverse food declines, another industry has stepped in to fill the role of gut microbiota nourishment. The probiotic supplement industry has been growing: sales exceeded 35 billion in 2015, and sales are projected to be around 94 billion in 2027.²⁴⁷ Rather than solve the root issue, the probiotic industry profits from solving a symptom. The root issue in this case is the lack of variety caused by loss of agrobiodiversity. This lack of variety in the

²³¹ Elizabeth Thursby, et al., *Introduction to the human gut microbiota*, 474 *BIOCHEM J.* 1823, 1823-36, (2017). doi: 10.1042/BCJ20160510.

²³² *Id.*

²³³ *Id.*

²³⁴ *Id.*

²³⁵ *Id.*

²³⁶ *Id.*

²³⁷ *Id.*

²³⁸ *Id.*

²³⁹ Fanzo, *supra* note 229 at 30.

²⁴⁰ *Id.*

²⁴¹ CENTER FOR DISEASE CONTROL AND PREVENTION, *OBESITY* (2024).

²⁴² Vangay, Pajau et al., *US Immigration Westernizes the Human Gut Microbiome*, 175 *CELL* (2018) 962-972 doi:10.1016/j.cell.2018.10.029.

²⁴³ *Id.*

²⁴⁴ *Id.*

²⁴⁵ *Id.*

²⁴⁶ *Id.*

²⁴⁷ The Nutrition Source, *The Microbiome*, HARVARD T.H. CHAN, <https://nutritionsource.hsph.harvard.edu/microbiome/#diet-microbiota>; Fortune Business Insights, *Probiotics Market Size*, (Nov. 18, 2024), <https://www.fortunebusinessinsights.com/industry-reports/probiotics-market-100083>

American diet is making it harder to get different probiotics and prebiotics.

Rather than pay for a thirty- or fifty-dollar bottle of probiotic supplement, Americans could shift their diet. To create a healthy microbiome, people are advised to eat around 30 different plant varieties per week.²⁴⁸ This would be easier if different varieties were more readily available. Some of those varieties have the actual bacteria that live in our gut or “probiotics”, like yogurt. To get “prebiotics”, the fuel for the bacteria in your gut, Americans can eat “raw versions of . . . garlic, onions, leeks, asparagus, Jerusalem artichokes, dandelion greens, bananas, and seaweed” which are high in prebiotic fiber.²⁴⁹ Prebiotic fiber is a nondigestible compound.²⁵⁰ When that compound is metabolized by the bacteria in your gut, the “composition and/or activity” of the gut microbiota changes.²⁵¹ Eating prebiotic fiber has a positive impact, also known as a “beneficial physiologic effect on the host.”²⁵²

How do we get a beneficial physiologic effect from eating prebiotic fiber? For example, a person may have a decreased risk of osteoporosis and bone fractures by consuming more prebiotic fiber.²⁵³ A decreased risk of bone fractures is particularly critical for adolescent and elderly populations.²⁵⁴ When prebiotic fiber is consumed, that fiber creates chemical changes which trigger acid fermentation and increased absorption of calcium within the distal intestine, the primary site of calcium absorption.²⁵⁵

²⁴⁸ *What to eat (and avoid) for a healthy gut microbiome*, MINDBODY GREEN PODCAST (Mar. 25, 2024).

²⁴⁹ Nutrition Source, *supra* note 247.

²⁵⁰ Bindels LB, Delzenne NM, Cani PD, Walter J., *Towards a more comprehensive concept for prebiotics*. 12 NAT REV GASTROENTEROL HEPATOL (2015) 303–10.

²⁵¹ *Id.*

²⁵² *Id.*

²⁵³ Whisner et al., *Galacto-oligosaccharides increase calcium absorption and gut bifidobacteria in young girls: a double-blind cross-over trial*. 110 BR J NUTR (2013) 1292–303.

²⁵⁴ *Id.*

If America does not preserve diversity, our microbiome health will continue to decline, degrading our resiliency against pathogens and our ability to process essential vitamins and nutrients.²⁵⁶ Thus, America must protect agrobiodiversity to ensure we can keep consuming the variety of plants and nutrients that are essential to maintaining a healthy microbiome.

5. Conclusion

The Plant Variety Protection Act was a promise from the United States to protect new varieties of plants. Instead, the laws that grant patent rights over plants have degraded our agrobiodiversity. As agrobiodiversity disappears, Americans are at greater risk of exposure to carcinogens, malnutrition and potential famine. Americans also lose resources used to advance science and medicine. This paper has demonstrated how the PVPA encourages the growth of genetically engineered crops and limits our utilization of the crops’ more diverse cousins. The PVPA actively risks Americans’ nutrition. The crop consolidation incentivized and caused by the PVPA has also pushed Americans toward death by way of type II diabetes, obesity, and diet-related disease.

Today, more than a million Americans die from diet-related diseases each year.²⁵⁷ The PVPA was supposed to help us become a healthier society. Instead, forty-seven million people in the U.S. are hungry and more than 21,000 people died from malnutrition in 2022.²⁵⁸ Forty-five percent of

²⁵⁵ Carlson, Justin L et al. *Health Effects and Sources of Prebiotic Dietary Fiber*. 2 CURRENT DEVELOPMENTS IN NUT. (29 Jan. 2018) doi:10.1093/cdn/nzy005.

²⁵⁶ *Id.*

²⁵⁷ U.S. FOOD AND DRUG ADMIN., IMPROVING NUTRITION TO TURN THE TIDE ON DIET-RELATED CHRONIC DISEASE (2022). <https://www.fda.gov/news-events/fda-voices/improving-nutrition-turn-tide-diet-related-chronic-disease>

²⁵⁸ Feeding America, *Hunger in America*, <https://www.feedingamerica.org/hunger-in-america>, (last visited Dec. 6, 2024); Diedre McPhillips, *As US life expectancy lags, nutritional deficiency is often an overlooked factor*, CNN <https://edition.cnn.com/2023/12/21/health/nutritional-deficiency-life-expectancy/index.html>

the U.S. population are deficient in vitamin A, forty-six percent in vitamin C, ninety-five percent in vitamin D, eighty-four percent in vitamin E, and fifteen percent in zinc.²⁵⁹

Although the Constitution demands we promote the progress of science and useful arts, we must question whether the PVPA is really helping us achieve that. This author would argue the PVPA has not proven itself effective. If we continue down this path of protecting private property rights over nature's own means of ensuring genetic diversity, it will cost our ecosystem, our stability, and our ability to innovate. We must determine if the protection of plant patent rights is worth the cost of us having no future at all.

If we are to survive, then we must continue to research how to protect plant varieties. It will not be easy to restructure the PVPA. Companies have too much power and too little incentive to change. While we work to amend the PVPA, we should consider what small changes can we afford to make in our lives. Consider these options if you have a pot and some dirt. Plant a vegetable or a fruit like a tomato. Pick an heirloom variety from a local provider if you can afford it. Plant a native flower for the bees in your community. If you only have a glass of water, regrow the green onion you bought from the grocery store. It does not matter what step you take. What matters the most is that you take a step. If the PVPA is not addressed, we will continue to lose precious biodiversity to commercially grown, genetically engineered crops. Keeping this law risks the crops we have left, American nutrition and our quality of life.

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