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THE SEED 2.0: EVOLVING INTELLECTUAL PROPERTY RIGHTS OF AGRICULTURAL GERMPLASM

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INTRODUCTION

"Let the seed be exhaustless, let life never run out," stated Vandana Shiva in her keynote address at the 2009 Organicology Conference in Portland, Oregon.[1] The conference marked the first bi-annual gathering of the organic food and farming sector to discuss a sustainable food future.[2] Dr. Shiva, along with a growing number of scholars, believes the seed is in danger of commercial monopoly, thereby depriving the public of food resources, plant genetic diversity, and centuries of farming culture.[3] This fear is not unfounded, as five major food companies now nearly dominate the world's food supply.[4] Today, genetically-engineered seeds constitute a substantial portion of the modern global market.[5] Predictably, the expansion of the private seed industry caused an analogous increase in the legal protections of seed 'germplasm' (the genetic composition of an organism).[6]

Despite the historical belief that the seed is a natural resource, recent legal developments over the past century have taken extensive measures to protect seeds that are altered or genetically modified by humans.[7] Scholars and legislators alike have attempted to strike a delicate balance: that of protecting the work product of scientific minds and ensuring easy access to an important genetic resource.[8] The task has not been a simple one.

Inherent in seed law is the idea that human manipulation of a germplasm[9] transforms a natural resource into a patentable human innovation.[10] This idea leads to three essential questions. First, if patent law protects intellectual creation, what

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[1] Vandana Shiva, *The Future of Food and Seed*, VODPOD (Apr. 24, 2011), http://www.youtube.com/watch?v=yYwOTLopWIw

[2] *See id.*; David Kemker, *Earthkeeper Hero: Dr. Vandana Shiva*, MYHERO (Oct. 11, 2009), http://www.myhero.com/go/hero.asp?hero=Shiva.

[3] *See id.*

[4] *See* Dan Morgan, MERCHANTS OF GRAIN: THE POWER AND PROFITS OF THE FIVE GIANT COMPANIES AT THE CENTER OF THE WORLD'S FOOD SUPPLY (iUniverse, Inc. 2000) (analyzing the five companies that dominate the grain trade of the common market).

[5] *See* Keith Aoki, *Weeds, Seeds & Deeds: Recent Skirmishes in the Seed Wars*, 11 CARDOZO J. INT'L & COMP. L.247, 256 (2003) (stating, "Globally, in 2001, an estimated 130 million acres of transgenic crops were planted by 5.5 million farmers, a more than thirty-fold increase since 1996"); Catch Blackledge, *Life Science Firms Will Make Money by Controlling the Whole Food Chain*, EUROPEAN, May 18, 1998, at 20 (explaining that Merrill Lynch has estimated that the global market for genetically engineered seeds is around $6.6 billion).

[6] *See* Aoki, *supra* note 5, at 249 (defining germplasm as "the complement of genes that determine an organism's characteristics"); Blackledge, *supra* note 5, at 20; *see also* Diamond v. Chakrabarty, 447 U.S. 303 (1980); JACK R. KLOPPENBURG, JR., FIRST THE SEED: THE POLITICAL ECONOMY OF PLANT BIOTECHNOLOGY 152 (1988).

[7] *See, e.g.*, Aoki, *supra* note 5.

[8] *See, e.g., id.*

[9] *See* Aoki, *supra* note 5, at 249 (defining Germplasm as "the complement of genes that determine an organism's characteristics.").

[10] *See* Kloppenburg, Jr., *supra* note 6; *see also* Aoki *supra* note 5, at 249.

exactly is *created* through manipulation to justify patent protection?[11] The creation of a particular seed, in its evolutionary entirety, cannot be fully attributed to the work of any one human being. Legal and philosophical scholars postulate that perhaps a "creation" occurs where human intervention causes specific alterations to germplasm.[12] Second, if the creation lies only in the human alteration of a seed, what should the *scope* of ownership rights for that seed be?[13] Is it possible to accurately proportion ownership rights to reflect the amount of labor one individual has contributed toward the final product? Finally, who can be rightly named the *inventor*, to whom the patent confers ownership rights?[14] If humans can be considered inventors of any seed, the history of crop migration and prior domestication by previous farmers or indigenous tribes obscures any clear lines of ownership.

This paper discusses the scope of ownership for seeds that have been selectively bred for traits or genetically modified. Even after thousands of years of agricultural domestication, plant genetic code has never been viewed as a commodity until the past century.[15] In the past, when a farmer harvested or purchased a seed, she also gained the means to produce seeds for future seasons through sexual reproduction.[16] However, technology in the 20th centuries has allowed scientists to manipulate the seed on a genetic level to control its ability to reproduce, as well as its growth cycles and physiological features.[17] On the one hand, such modification can produce substantial benefits, such as exponentially increasing crop efficiency and output. On the other hand, the mass implementation of genetically similar plants increases the risk of crop failure, due to what has been termed "genetic vulnerability."[18] Initially, the United States government heavily subsidized foreign collection and improvement of germplasm.[19] The government later introduced legislation to protect both the intellectual work of agricultural biotechnology companies and the genetic variety of agricultural plants, attempting

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[11] *See* Aoki, *supra* note 5, at 249.

[12] *See id.*

[13] *See id.*

[14] *See id.*

[15] *See id.* at 250 (explaining, "Until recently, germplasm presented structural obstacles to commodification [and] [t]echnologies such as hybridization in the early 20th century and recombinant DNA, protoplasm fusion and cloning in the late 20th century have allowed finely tuned human manipulation of germplasm on a molecular level.").

[16] *See id.*

[17] *See* Leora Broydo, *A Seedy Business: A New "Terminator" Technology Will Make Crops Sterile and Force Farmers to Buy Seed More Often – So Why did the USDA Invent It?*, MOJO WIRE (Apr. 7, 1998), http://www.motherjones.com/news_wire/broydo.html (describing Terminator technology and the process by which plants are genetically modified to be sterile).

[18] H. GARRISON WILKES, *Plant Genetic Resources Over Ten Thousand Years: From a Handful of Seed to the Crop-Specific Mega-Gene Banks*, SEEDS AND SOVEREIGNTY: THE USE AND CONTROL OF PLANT GENETIC MATERIAL, 73 (Jack R. Kloppenburg ed., 1988) (hereinafter SEEDS AND SOVEREIGNTY) (providing examples of the possible catastrophes of crop genetic vulnerability such as the wheat stem rust epidemic of 1954 and the southern corn blight of 1970).

[19] *See* Janice M Strachan, *Plant Variety Protection: An Alternative to Patents*, PROBE Vol. 2(2) (summer 1992), *available at* http://www.nal.usda.gov/pgdic/Probe/v2n2/plant.html.

to address both ends of the spectrum.[20] As control over plant genetic resources tightens, future legislation must continue to weigh the risk of creating a genetic monoculture of crops against the benefits of providing property rights in modified germplasm. Analyzing the past, present and future of seed patent law, it is clear that a balance between the protection of intellectual property and maintaining agricultural genetic health is a tenuous one.

I. PAST: THE COMMODIFICATION OF A NATURAL RESOURCE

a. *Colonialism from the 16th to the 18th Century*

The flow of domesticated plants across the globe began with the advent of international travel.[21] As different regions of the world became accessible by ship, so began the migration of crop plants from different areas of the world.[22] Explorers took plant samples from their travels back home and propagated a whole new food source for their home country.[23] As Thomas Jefferson commented, "[t]o add a new and useful plant is the greatest service you can render this new nation."[24] After Columbus brought maize, beans, potatoes, squash, sweet potatoes, cassava, and peanuts to Europe from North and South America,[25] the world became increasingly dependent on these newly introduced crops.[26] Furthermore, the seeds from these crops proved a unique resource because a small amount could yield a great quantity of product.[27]

Some communities, however, became overly-dependent on the newly-introduced agriculture, creating a food source open to the risk of genetic vulnerability.[28] One of the most catastrophic examples of this vulnerability occurred because of the narrowing of the genetic base of the Irish food supply.[29] England's introduction of one species of potato into Ireland facilitated a national population increase from three million to eight million people.[30] However, the resulting lack of genetic diversity in the Irish potato crop led to country-wide crop failure because of the fungus *Phytophthora Infestans*.[31] The Irish potato famine, exacerbated by English political repression,[32] had devastating consequences,

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[20] *See id.*

[21] *See* Wilkes, *supra* note 18, at 70-73.

[22] *See id.*

[23] *See id.* at 73.

[24] *See id.* at 70.

[25] *See* A.W. CROSBY, THE COLUMBIAN EXCHANGE: BIOLOGICAL AND CULTURAL CONSEQUENCES OF 1492 (1972); Aoki, *supra* note 5, at 262

[26] *See* Wilkes, *supra* note 18, at 73.

[27] *See* Aoki, *supra* note 5, at 262 (explaining, "[...] the value of germplasm to the colonial powers was not proportional to the physical amount taken."); *see also* Wilkes, *supra* note 18, at 70.

[28] *See, e.g.*, Wilkes, *supra* note 18, at 70.

[29] *See id.* at 73-75.

[30] *See id.* at 75.

[31] *See id.*

[32] *See* PETER AND FIONA SOMERSET FRY, A HISTORY OF IRELAND, 231, 233-35 (1988) (explaining, "What probably caused more resentment and despair than anything was the sight of cartloads of grain and other food products being shipped over to England or

resulting in two million deaths and causing another two million Irish citizens to emigrate in search of food and freedom.[33]

During this colonial period, newly discovered plant varieties were not generally considered to be the possession of any one nation or people.[34] Imperial powers freely took germplasm from around the world, and perpetuated the new crops in their colonies around the world.[35] The new crops delivered a wealth of agricultural resources to the European nations, and resulted in significant population increases.[36] This open exchange created the very agricultural crops that most of the world depends on today.[37]

b. *Government Subsidy from the 19th to the Early 20th Century*

The United States government recognized the importance of establishing an agricultural foundation early on.[38] In 1819, the U.S. Treasury Department ordered consular and navy officials to collect germplasm across the globe.[39] This action caught the attention of the Patent and Trademark Office (P.T.O.).[40] In 1836, the P.T.O. began implementing a federal repository for germplasm samples in the form of seeds or cuttings from abroad.[41] By 1857, the P.T.O. had constructed a garden to propagate the foreign germplasm for the purpose of widespread distribution.[42] Because cultivated plants lacked patent protection, private entrepreneurs were not necessarily motivated to invest in selective breeding techniques.[43] However, the P.T.O. arranged to send foreign seed specimens to farmers across the nation.[44] This seed distribution program allowed farmers to selectively breed new germplasm, screening for only the variations that succeeded

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elsewhere from healthy Irish fields while Irishmen, Irishwomen and Irish children starved and slid into slow and premature death because the potato had failed."); Peter Behrens, *'The Famine Plot: England's Role in Ireland's Greatest Tragedy' by Tim Pat Coogan and 'The Graves are Walking: The Great Famine and the Saga of the Irish People' by John Kelly*, THE WASHINGTON POST (Jan. 12, 2013), *available at* http://www.washingtonpost.com/opinions/the-famine-plot-englands-role-in-irelands-greatest-tragedy--by-tim-pat-coogan-and-the-graves-are-walking-the-great-famine-and-the-saga-of-the-irish-people-by-john-kelly/2013/01/12/22971008-3d7b-11e2-a2d9-822f58ac9fd5_story.html.

[33] *See id.*; *see* Wilkes, *supra* note 18, at 75.

[34] *See* Aoki, *supra* note 5, at 263.

[35] *See id.*

[36] *See id.* (explaining that the new crops provided abundant and cheap food to all classes in Europe.)

[37] *See id.*

[38] *See id.* at 264.

[39] *See id.*; *see also* Conrad Zirkle, *PLANT HYBRIDIZATION AND PLANT BREEDING IN EIGHTEENTH CENTURY AMERICA*, AGRICULTURAL HISTORY, Vol. 55, No. 1, 25 (1969).

[40] *See* Zirkle, *supra* note 39, at 25.

[41] *See id.*

[42] *See* NORMAN KLOSE, AMERICA'S CROP HERITAGE: THE HISTORY OF FOREIGN PLANT INTRODUCTION BY THE FEDERAL GOVERNMENT 29 (Iowa State College Press, 1950).

[43] *See id.*

[44] *See id.*; *see also* Aoki, *supra* note 5, at 266-67.

in the local climate and region.[45] In this way, American agriculture incorporated the genes of foreign seeds.[46]

Government action in the late 19th Century encouraged more commercial farmers to propagate the freely distributed seeds. The 1862 Morrill Act established Land Grant Colleges, which encouraged agricultural education and research.[47] In 1887, the Hatch Act instituted a formal system of seed distribution throughout the nation.[48] In addition to government seed distribution, commercial farmers also began to trade seeds widely among themselves.[49] In response, the nascent private seed industry voiced concern that free seed distribution was crippling its commercial business.[50] In 1883, the private industry formed the American Seed Trade Association and began lobbying the government to halt its free seed distribution.[51] The government finally responded in 1924 by discontinuing its seed distribution program, explaining that the private seed industry was more efficient than government efforts and that plant breeding had evolved into a science that required legal protection.[52]

c. *Plant Hybridization in the Early 20th Century*

While the private seed industry was occupied with efforts to eliminate governmental seed distribution, public plant breeders began experimenting with hybridization to increase genetic variability.[53] Reviving Mendelian genetics, these plant breeders transformed plant breeding from an art to a science by selecting and cross-breeding plants with particular traits (increased crop yield, blight-resistant, pesticide-resistant, etc.).[54] Congressional approval of the Purnell Act of 1925 and the Bankhead-Jones Act of 1935 provided increased funding for the U.S Department of Agriculture to expand hybrid-crop programs.[55]

In the 1930s and 40s the hybrid corn industry evolved into a highly successful enterprise.[56] Prior to this discovery, corn farmers were suffering from unstable yields due to drought, insects, and diseases, which affected open pollinates more than hybrids.[57] The hybridized corn variety yielded a significantly higher

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[45] *See* Wilkes, *supra* note 18, at 76.

[46] *See* Kloppenburg, Jr., *supra* note 6, at 56.

[47] *See* JIM HIGHTOWER, HARD TOMATOES, HARD TIMES 8 (1973).

[48] *See id.*; Aoki, *supra* note 5, at 266.

[49] *See* Aoki, *supra* note 5, at 266.

[50] *See* FREDERICK H. BUTTEL & JILL BELSKY, *Biotechnology, Plant Breeding and Intellectual Property – Social and Ethical Dimensions*, OWNING SCIENTIFIC AND TECHNICAL INFORMATION, VALUE AND ETHICAL ISSUES, 110 (Vivien Weil & John W. Snapper eds. 1989).

[51] *See id.*; Aoki, *supra* note 5, at 267.

[52] *See* Aoki, *supra* note 5, at 267 (explaining that the American Seed Trade Association achieved their goal of stopping the government seed distribution program in 1924).

[53] *See id.* at 267-68.

[54] *See id.*

[55] *See id.* at 271-73.

[56] *See* LEONARD STEELE, *The Hybrid Corn Industry in the United States*, MAIZE BREEDING AND GENETICS 29, 29 (D.B. Walden ed., 1978).

[57] *See id.* at 31.

output, with a smaller requirement for land.[58] By 1965, over 95% of land devoted to corn crops was planted with high-yield hybrid seed.[59] The success of the hybrid corn reinvigorated private seed industries to continue carving out a bigger niche for the private industry.

The antagonist relationship between the private seed industry and the government slowly led to a complete separation of the two over the next few decades.[60] In the 1940s, the interests of the governmental Land Grant Colleges and the private seed industry often came into direct conflict, especially in the area of hybrid corn.[61] However, due to the efforts of organizations such as the International Crop Improvement Association and the American Society for Horticultural Science, the boundary between the public and private sectors became even wider.[62] Private-sector spokesmen effectively encouraged public breeders to focus on developing in-bred plant lines while giving the private sector the power to decide how to combine those inbred lines to create hybrids.[63] Thus, publicly-funded seed research became limited to producing only the 'raw' materials from which the private industry used to create a useful hybrid seed product.[64]

d. *US Patent Law: Subject Matter, Novelty, Utility, and Non-Obviousness*

As the seed industry continued to transition from art to science, patent law and the seed industry began to increasingly overlap.[65] Patent law protects new and useful inventions, manufactures, and compositions of matter and processes that are reduced to practice.[66] To acquire a patent, an invention must meet the requirements of novelty,[67] utility,[68] non-obviousness,[69] and subject matter.[70] While both mathematical formulae and laws/products of nature have been viewed as unpatentable,[71] an individual may be able to patent a natural product if she isolated,

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[58] *See id.*

[59] *See* Kloppenburg, Jr., *supra* note 6, at 91.

[60] *See id.* at 106-08.

[61] *See id.*

[62] *See id.* at 109.

[63] *See id.* at 108-109 (noting that "private corn breeders successfully argued that public funds should not be used to pursue activities that attract private investment, that public duplication of private efforts was wasteful, and that a reorientation of public effort would free resources for training and basic research.").

[64] *See id.* at 109-10.

[65] *See* Aoki, *supra* note 5, at 276.

[66] *See id.*; *see also* Diamond v. Chakrabarty, 447 U.S. 303, 303-04 (1980); Gottschalk v. Benson, 409 U.S. 63, 65-66 n.2 (1972); Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve, Inc., 796 F.2d 443 (Fed. Cir. 1986) (examining the non-obviousness requirement for patents).

[67] *See* 35 U.S.C. § 102 (2006).

[68] *See id.* § 101.

[69] *See id.* § 103 (2006); Graham v. John Deere Co., 383 U.S. 1, 4 (1966).

[70] *See* 35 U.S.C. § 101-103, 115-116.

[71] *See* Gottschalk v. Benson, 409 U.S. 63, 71-72 (1972); Funk Bros. See Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948).

purified, or altered the form of that natural product.[72] A patent grants the right to use, make or sell the invention, and to exclude potential patent infringers, for twenty years from the patent date.[73] Once a patent has expired, information that would enable others skilled in the art to make or use the invention is available to others, encouraging a free exchange of ideas in the public domain.[74]

This legal protection was extended to the science of seed design beginning in the early 20th century. As the private seed industry developed, so did the demand for patent protection of hybridized germplasm.[75] Congress reacted by implementing the Plant Patent Act of 1930 (P.P.A), which provided patent-like protection to asexually reproduced plants with the exception of tubers (e.g. potatoes).[76] Obtaining a protection under the P.P.A. was significantly easier than obtaining a utility patent, as an applicant needed only show that the asexually reproduced plant was new and distinct.[77] Sexually-reproduced plants, such as hybrid crops, were excluded from protection because of heavy reliance on staple hybrid-crops.[78] The Plant Patent Act of 1930 indicated an early trend toward privatization of the seed industry.

A second Congressional action increased patent protection of seed lines in the late 20th Century.[79] Due to continued efforts by plant breeders to amend the P.P.A., Congress passed the Plant Variety Protection Act of 1970 (P.V.P.A) to extend patent-like protection to *sexually-reproduced* seed lines.[80] Although this amendment was unsuccessful, statutory protection of sexually-reproduced plants was finally attained through the P.V.P.A..[81] Under the P.V.P.A., a patent applicant could obtain protection seventeen years from the date of issue[82] if the seed line met new requirements of novelty, uniformity, and stability.[83] However, the Act also attempted to find a balance between the rights of plant breeders and those of farmers.[84] The Legislature included a "brown-bag" exception that permitted farmers to save, plant, and resell seeds to neighboring farmers,[85] even if the seeds

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[72] *See* Diamond v. Chakrabarty, 447 U.S. 303, 308 (1980); Merck & Co. v. Olin Mattheison Chemical Corp, 253 F.2d 156, 163 (1958).

[73] *See* 35 U.S.C. § 154(a)(2).

[74] *See In re* Lundak, 733 F.2d 1216, 1219 (Fed. Cir. 1985) (encouraging access to information that enables the public to make and use the invention once the patent issues).

[75] *See* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred International, Inc., 534 U.S. 124 (2001); *see* Aoki, *supra* note 5, at 280.

[76] *See* Strachan, *supra* note 19; *see also* S. REP. No. 315-71, at 4 (1930).

[77] *See* S. REP. No. 315-71, at 4 (1930). *But see* 35 U.S.C. §§ 101, 102, 103 (stating that a utility patent requires that the invention be useful, novel and non-obvious).

[78] *See* Aoki, *supra* note 5, at 280.

[79] *See* 7 U.S.C. § 2402 (2010); Kloppenburg, Jr., *supra* note 6, at 139.

[80] *See* Jim Chen, *The Parable of the Seeds: Interpreting the Plant Variety Protection Act in Furtherance of Innovation Policy*, 81 Notre Dame L. Rev. 105, 121 (2005) (citing 7 U.S.C. § 2402 (clarifying that "The PVPA confers intellectual property on '[t]he breeder of any sexually reproduced or tuber propagated plant variety (other than fungi or bacteria) who has so reproduced the variety.'")).

[81] 7 U.S.C. § 2402.

[82] *See id.* § 2543.

[83] *See id.* § 2402; Strachan, *supra* note 19.

[84] *See* 7 U.S.C. § 2543.

[85] *See* Aoki, *supra* note 5, at 283.

were otherwise protected by the P.V.P.A..[86] Although Congress eliminated the resale exemption in 1994, the Act is still in effect today and has been a major contributing factor to the widening division of labor between government and private industry.[87]

II. PRESENT: SEED WARS

Given the rapid expansion of the private seed industry in the last few centuries, it is not surprising that a variety of legal battles have arisen. Agrichemical giants, such as the Monsanto Company, have brought a multitude of infringement suits against farmers using patented or legally protected seeds.[88] At the same time, many farmers and lobbyists have rallied to overturn what they deem to be overly-exclusive monopolies on staple crops.[89] They argue that widespread genetically-homogenous crops increase the risk of massive crop failure, create detrimental cross-pollination with wild species, cause allergic reactions, heighten resistance to plant anti-biotics, decrease nutritional value, and lead to herbicide and pesticide over-use.[90]

a. *Recent Domestic Cases in Seed Law*

Both the Plant Patent Act of 1930 and the Plant Variety Protection Act of 1970 instigated a series of litigation involving the patent protection of germplasm.[91] Simultaneously, major judicial decisions involving patent law held implications for utility patents in plant germplasm.[92] These landmark cases revolutionized intellectual property and redefined the boundaries of patent-worthy material.

In *Diamond v. Chakrabarty*, the U.S. Supreme Court extended patent protection to living organisms, signifying a momentous shift in patentable subject matter.[93] The case involved the patenting of a bacterium that had been genetically engineered to break down crude oil.[94] A patent examiner had rejected Ananda

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[86] *See* 7 U.S.C. § 2543 (stating that farmers have the "Right to Save Seed" to the extent that such seed saving does not constitute an infringement under subsections (3) or (4) of section 111).

[87] *See* Aoki, *supra* note 5, at 286 (explaining that governmental varietal seed releases ultimately ceased completely in the 1980s).

[88] *See* Monsanto Canada, Inc. v. Schmeiser, T-1593-98 (March 29, 2001), *available at* http://reports.fja.gc.ca/eng/2001/2001fct256.html.

[89] *See* Wilkes, *supra* note 18, at 13 (listing public interest groups and nongovernmental organizations which have "lobbied against plant breeders' rights and the inequities of contemporary plant germplasm exchange.").

[90] *See id.*; *Elain Ingham's Testimony (Executive Summary) before the (New Zealand) Royal Commission on Genetic Modification*, February 2001, *available at* http://userwww.sfsu.edu/~rone/GEessays/Ingham.htm; *see also* David Gutierrez, *Doctors Warn About Dangers of Genetically Modified Food*, NATURAL NEWS (Feb. 2010), *available at* http://www.naturalnews.com/028245_GM_food_side_effects.html; Jeffrey M. Smith, *Genetically Modified Foods Unsafe? Evidence that Links GM Foods to Allergic Responses Mounts*, GLOBAL RESEARCH (Nov. 2007), *available at* http://www.globalresearch.ca/index.php?context=va&aid=7277.

[91] *See* Aoki, *supra* note 5, at 286-04.

[92] *See id.*

[93] 447 U.S. 303, 303 (1980).

[94] *See id.*

Chakrabarty's patent application because the current law dictated that living organisms were not patentable subject matter.[95] However, in a 5-4 decision, Chief Justice Warren Burger held that the organism constituted patentable subject matter because human intervention was a necessary step, signifying that the bacterium did not occur naturally.[96] This emphasis on scientific handiwork permitted a broad re-envisioning of patent law and opened the door to patents on many other life forms.[97]

In the wake of *Chakrabarty*, the possibility of obtaining a utility patent on a living organism caused some confusion concerning whether it preempted or ran concurrent with the P.V.P.A. or the P.P.A.[98] Inventors of modified germplasm preferred the broader protection of utility patents over of the P.V.P.A's certificates of protection, causing a drastic increase in utility patent applications.[99] However, for the next five years, the Patent & Trademark Office rejected all such utility patent applications for germplasm covered under either the Plant Variety Protection Act or the Plant Patent Act, arguing that legislative history showed that Congress intended to treat plants separately.[100]

The P.T.O. responded to this dilemma in *Ex Parte Hibberd*, clarifying that neither the P.P.A. nor the P.V.P.A. precluded inventors from applying for a utility patent.[101] In this case, the P.T.O. had rejected Dr. Hibberd's application for a utility patent on a maize line selected from a tissue culture he developed.[102] The P.T.O. reasoned that utility patents are justifiably preferred because they offer greater legal protection.[103] It further explained that an invention that otherwise met the requirements for novelty, non-obviousness, and usefulness should not be precluded from obtaining a utility patent.[104]

In 1995, the Supreme Court again shaped the scope of seed patent law by limiting the rights of the end-user: the farmer.[105] In *Asgrow Seed Co. v. Winterboer*, Asgrow Seed Co. sued the Winterboers for infringement of their certificate of protection under the P.V.P.A. because the Winterboers were making significant income from sales to neighboring farmers at well below the market price.[106] The Supreme Court attempted to determine whether the P.V.P.A's vague "brown bag" provision permitted a farmer to resell seeds to other farmers *only* in the amount that would be required to replant his own fields.[107] Writing for the majority, Justice Scalia sifted through the provision's ambiguous language and held that the purpose of § 2543 was to save seeds only for reproductive purposes, and

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[95] *See id.*

[96] *See id.*

[97] *See id.*

[98] *See* Stephen A. Bent, *Protection of Plant Material under the General Patent Statute: A Sensible Policy at the PTO?*, 4 BIOTECHNOLOGY L. REP. 105 (1985).

[99] *See id.*

[100] *See id.*

[101] *See id.*; *Ex parte* Hibberd, 227 U.S.P.Q. 443, 444 (Bd. Pat. App. & Inter. 1985).

[102] *See Ex parte Hibberd*, 227 U.S.P.Q. at 443-445.

[103] *See id.*

[104] *See id.*

[105] *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 191-92 (1995).

[106] *See id.* at 182.

[107] *See id.* at 186-88.

not for marketing purposes.[108] The court then determined that the legislative intent behind the brown bag exception was to allow a farmer who has purchased seed for her acreage, and subsequently changed her mind, to resell that quantity of seed to a neighboring farmer.[109] Beyond just setting a limit on the brown bag exception, *Asgrow* also signified that large seed companies were beginning to focus on the activities of their clients rather than their competitors.

These three cases significantly altered the arena of seed law. *Chakrabarty* and *Hibberd* established that inventors may obtain utility patents for plants, regardless of the applicability of the Plant Patent Act or Plant Variety Protection Act. *Asgrow* then extended the P.V.P.A.'s protection by curbing the reach of the brown bag exception.[110] Given this shift toward increased legal protection, over 1,800 patents in plant germplasm were granted by the P.T.O. after *Hibberd*.[111] This rise in patent activity led to rapid development in the field of genetic engineering.[112] Scientists were soon able to genetically tweak crop species by inserting herbicide-resistant genes or eliminating the crop's ability to produce seeds.[113] These scientific advances catalyzed a new barrage of lawsuits involving the 'theft' of these patented modified genes.[114]

In 2001, the Canadian Supreme Court held that a Canadian farmer had infringed on a Canadian utility patent held by Monsanto Canada, Inc. in *Monsanto Canada, Inc. v. Percy Schmeiser*.[115] Monsanto's utility patent covered a modified germplasm resistant to the herbicide, Roundup™.[116] These so called "Roundup Ready" seeds were sold to farmers wishing to use the herbicide to eliminate all plants except the Roundup-resistant crop purchased from Monsanto.[117] This technology was so successful that by the year 2000, it constituted 94% of global land dedicated to genetically modified seeds.[118] However, such technology came at a price. Farmers who purchased ROUNDUP-READY™ seed were required to sign a contract that forbade them from any seed-saving practice obligating them to repurchase seeds from Monsanto every season.[119]

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[108] *See id.* at 187.

[109] *See id.* at 189.

[110] *See id.* at 191-92.

[111] *See, e.g.*, J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U.S. 124 (2001), aff'g 200 F.3d 1394 (Fed. Cir. 2000); Aoki, *supra* note 5, at 289; Haley Stein, *Intellectual Property and Genetically Modified Seeds: The United States, Trade, and the Developing World*, 3 NW. J. TECH. & INTELL. PROP. 160, 166 (2005).

[112] *See* Aoki, *supra* note 5; Rudolf E. Hutz, *Patent Protection for Living Organisms*, 5 Del. Law. 30, 33 (1986); *see also;* ETC Group, *2001: A Seed Odyssey*, RAFI COMMUNIQUE, 1-2 (April 11, 2001), *available at* http://www.etcgroup.org/sites/www.etcgroup.org/files/publication/269/01/com_2001.pdf.

[113] *See* ETC Group, *supra* note 112, at 6.

[114] *See* Monsanto Canada, Inc. v. Percy Schmeiser, [2004] 1 S.C.R. 902; *J.E.M.*, 534 U.S. at 124.

[115] 1 S.C.R. 902; *see Percy Schmeiser's Battle*, CBC NEWS ONLINE, (May 21 2004), http://www.cbc.ca/news/background/genetics_modification/percyschmeiser.html.

[116] *See id.*

[117] *See id.*

[118] *See id.*

[119] *See id.*

In the *Schmeiser* case, canola farmer Percy Schmeiser argued that his neighbors' Roundup Ready canola fields unintentionally fertilized his crop.[120] The resultant outcrossed canola seeds were resistant to Roundup as well, and Schmeiser continued to use these hybrid seeds in subsequent seasons.[121] Despite Schmeiser's insistence that the theft was unintentional, the Canadian Supreme Court held that Schmeiser had infringed on Monsanto's patent.[122] The court reasoned that Schmeiser must have been aware he was using Roundup Ready crops because he continued to propagate and use the Roundup Ready crops after apparently spraying three acres of his field with Roundup.[123] The case remains controversial today, as it constitutes a significant milestone in the move toward heightened patent protection of germplasm.

This steady trend of increased patent protection has been upheld in subsequent litigation.[124] In 2001, *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc.* challenged the legality of the holding in *Hibberd*.[125] Pioneer Hi-Bred International, Inc. alleged that a small seed supply company, Farm Advantage, had infringed on their patent by purchasing and reselling Hi-Bred's hybrid seeds.[126] Farm Advantage responded by challenging the legitimacy of the extension of utility patents to plants in *Ex Parte Hibberd*.[127] Farm Advantage argued that the P.T.O. acted without express Congressional approval because the explicit protection provided by both the P.P.A. and the P.V.P.A. indicated that Congress intended to exclude plants from utility patents.[128]

Justice Thomas wrote for the majority, holding that both Hi-Bred's utility patents and the extension of utility patents to plants were legitimate.[129] He rejected Farm Advantage's argument that plants were excluded from utility patents by emphasizing the evolution of both the law and the technology in this matter.[130] Justice Thomas explained that in the time that the P.P.A. and the P.V.P.A. were written, two reasons precluded plants from full patent protection.[131] First, plants were considered to be products of nature.[132] Second, the requirements for written description were more stringent, making it more difficult to meet for advancements in plant science.[133] Justice Thomas stated that both of these factors were no longer valid reasons.[134] Since *Chakrabarty*,[135] the distinction between patentable and unpatentable material focuses on whether it is the product of nature or human

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[120] *See id.*

[121] *See id.*

[122] *See id.*

[123] *See id.* at 92.

[124] *See* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U.S. 124, 124 (2001).

[125] *See id.* at 131-132.

[126] *See id.*

[127] *See id.*

[128] *See id.*; Aoki, *supra* note 5, at 298.

[129] *See J.E.M.*, 534 U.S. at 124; STEPHEN BRUSH, FARMERS' BOUNTY: LOCATING CROP DIVERSITY IN THE CONTEMPORARY WORLD (2004).

[130] *See J.E.M.*, 534 U.S. at 125.

[131] *See id.*

[132] *See id.* at 125, 134.

[133] *See id.* at 134.

[134] *See id.* at 134-35.

[135] *See id.* at 134.

agency.[136] Furthermore, the writing requirement has relaxed since the P.P.A. and the P.V.P.A., making it easier for plant scientists to satisfy this condition.[137] Justice Thomas has been criticized for side-stepping the otherwise credible argument that Congressional intent indicates excluding plants from utility patents.[138] However, *Pioneer Hi-Bred* did serve to fill the legal gap left by *Chakrabarty* and *Hibberd*, and clarified that utility patents and the PVPA are not mutually exclusive.[139]

b. *International Approaches to Seed Law*

In addition to developments in North America, seed law also gained momentum in the international arena.[140] Global controversies sparked over the acquisition of germplasm in "gene-rich"[141] countries in the southern hemisphere.[142] Further confusion arose regarding the implications of *Chakrabarty* worldwide and the extension of plant utility patents issued by the United States.[143] This uncertainty spawned several key international conventions and agreements, which attempted to address these issues.[144]

In the early 1980's, the United Nations Food and Agriculture Organization (FAO) became a popular forum for international discussion on plant genetic resources.[145] These efforts focused on the debate between the southern and northern hemisphere.[146] Southern countries voiced concern that industrialized "gene-poor" northern countries were siphoning "gene-rich" germplasm within their borders without compensation.[147] They contended that northern countries, like the U.S., were acquiring, patenting and profiting from hybridized or genetically modified products.[148]

In 1983 the FAO adopted the International Undertaking on Plant Genetic Resources (IUPGR), a nonbinding agreement that set out a framework for the international exchange of seeds and plants.[149] This effort proved both hollow and controversial, as it used vague terminology favoring developing countries in the

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[136] *See id.*

[137] *See id.*

[138] *See ICTA analysis of Supreme Court decision in patent case*, CROPCHOICE.COM (Dec. 19, 2001) http://www.cropchoice.com/leadstrya594.html?recid=540; *see also J.E.M.*, 534 U.S. at 147 (J. Breyer dissenting).

[139] *See* Aoki, *supra* note 5, at 304.

[140] *See* Scott Holwick, *Developing Nations and the Agreement on Trade-Related Aspects of Intellectual Property Rights*, 1999 COLO. J. INT'L ENVTL. L. & POL'Y 49, 61 (2000).

[141] *See* Keith Aoki, *Seeds of Dispute: Intellectual-Property Rights and Agricultural Biodiversity*, 3 GOLDEN GATE U. ENVTL. L.J. 79, 105-07(2009) (explaining that gene-rich countries provide the most genetic diversity in terms of plant species).

[142] *See id.* at 107.

[143] *See id.* at 102-04.

[144] *See id.* at 105-23.

[145] *See id.* at 105; *see also* F.A.O. Res. 8/83, U.N. F.A.O., 22d Sess. (Nov. 5-23, 1983).

[146] *See* Aoki, *supra* note 141, at 105.

[147] *See id.* at 107.

[148] *See id.*; Holwick, *supra* note 140, at 61 (describing how FAO Assistant Director-General Obaidulla Khana called U.S. plant patents "biopiracy").

[149] *See* Holwick, *supra* note 140, at 61.

Third World.[150] The IUPGR treated germplasm broadly as the "common heritage of humankind" and argued that commercial plant varieties should be freely accessible to farmers around the globe.[151]

The IUPGR also sought to redefine "raw" material, which was freely accessible, and "worked" material, which was commodified and required purchase.[152] Historically, countries within the southern hemisphere placed no claim on the copious amounts of 'raw' plant or seed exports.[153] Countries in the north would then 'work' this exported seed into a product that receives both legal protection and profit.[154] However, since the creation of gene banks, this flow has actually reversed.[155] So-called "gene-rich" countries in the southern hemisphere have become the major importers of germplasm from supposedly "gene-poor" industrialized countries of North America and Europe.[156] For example, the Svalbard Global Seed Vault, in the Norwegian island of Spitsbergen, is funded entirely by the Norwegian government and provides storage free seed storage and access to germplasm through the depositing gene banks.[157] Thus, it was problematic to characterize either hemispheres as gene-rich or gene-poor.[158] Because of these complications, and because of disagreement between industrialized and developing nations, progress on the IUPGR came to a halt.[159]

After the stalemate following the IUPGR, the international community made a second attempt at consensus during the Keystone Dialogues of 1990.[160] International stakeholders in genetic resources met in Madras (now Chenai) in an attempt to reduce conflict and encourage dialogue.[161] Both developing and industrialized countries were able to agree on three principles.[162] First, the parties recognized valid intellectual property rights by agreeing that protected plants were

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[150] *See* Jim Chen, *Webs of Life: Conservation as a Species of Information Policy,* 89 IOWA L. REV. 495, 583 (2004).

[151] *See id.* (explaining that the Undertaking represented a rejection of seeds as private property).

[152] *See* Holwick, *supra* note 140, at 60-62.

[153] *See id.*

[154] *See id.*

[155] *See* CARY FOWLER & PAT MOONEY, SHATTERING: FOOD, POLITICS, AND THE LOSS OF GENETIC DIVERSITY 8 (1990); *see also* CARY FOWLER, UNNATURAL SELECTION: TECHNOLOGY, POLITICS AND PLANT EVOLUTION xiii (1994).

[156] *See* FOWLER, *supra* note 155, at 185.

[157] *See Svalbard: Global Seed Vault*, THE MINISTRY OF AGRICULTURE AND FOOD, http://www.regjeringen.no/en/dep/lmd/campain/svalbard-global-seed-vault/history.html?id=489075 (last visited Mar. 6, 2012); *see also The history of The Vault, Valbard: Global Seed Vault*, THE MINISTRY OF AGRICULTURE AND FOOD, http://www.regjeringen.no/en/dep/lmd/campain/svalbard-global-seed-vault/history.html?id=489075 (last visited Mar. 6, 2012).

[158] *See* FOWLER, *supra* note 155.

[159] *See* Aoki, *supra* note 141, at 109.

[160] *See* THE KEYSTONE CTR., FINAL CONSENSUS REPORT OF THE KEYSTONE INTERNATIONAL DIALOGUE SERIES ON PLANT GENETIC RESOURCES: MADRAS PLENARY SESSION 7-8, 11 (1990) [hereinafter KEYSTONE FINAL CONSENSUS REPORT].

[161] *See id.*; *see also FR in the Keystone Dialogues,* FARMER'S RIGHTS: RESOURCE PAGES FOR DECISION-MAKERS AND PRACTITIONERS, http://www.farmersrights.org/about/fr_history_part3.html (last visited Jan. 20, 2013).

[162] *See* KEYSTONE FINAL CONSENSUS REPORT, *supra* note 160, at 7-11.

not freely accessible.[163] Second, they conceded that although plant genetic resources may be "the common heritage of mankind," that did not equate to free of charge.[164] Third, the Keystone Dialogues generally recognized the existence of farmers' rights and the centuries of farming that led to modern domesticated crops.[165] Although the agreement did not produce monumental changes, these dialogues represented the nascent stages of agreement regarding international seed law.

In 1992, the Convention on Biological Diversity (CBD) was held to further international discussion.[166] The convention addressed the ecological concerns of waning plant biodiversity and deforestation, but did not focus on germplasm as a food source.[167] To deter these dangers, the CBD suggested a scheme of economic compensation for developing countries that protected their biodiversity as a global resource.[168] The convention also concentrated on the implications of *Chakrabarty*'s grant of legal rights over living organisms, the North-South divide over germplasm distribution, and the technological advances in seed science.[169] For the first time in legal history, countries around the world concurred that the conservation of biological diversity is a common global concern.[170] The CBD therefore differentiated itself from prior international conventions by officially recognizing plant intellectual property rights already in place and by emphasizing the need to acquire informed consent before exploiting a nation's natural resources.[171]

With the international recognition of expanding intellectual property rights, industrialized and developing countries met at the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994 to discuss the future of intellectual property in international trade.[172] At the end of the conference, 125

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[163] *See id.*; *see, e.g.*, *Aoki, supra* note 5.

[164] *See* KEYSTONE FINAL CONSENSUS REPORT, *supra* note 160, at 7-11; KIRIT K. PATEL, FARMERS' RIGHTS OVER PLANT GENETIC RESOURCES IN THE SOUTH: CHALLENGES AND OPPORTUNITIES, INTELLECTUAL PROPERTY RIGHTS IN AGRICULTURAL BIOTECHNOLOGY 97 (F.H. Erbisch & K.M. Maredia eds., 2d ed. 2004).

[165] *See* KEYSTONE FINAL CONSENSUS REPORT, *supra* note 160, at 23.

[166] *See United Nations Conference on Environment and Development: Convention on Biological Diversity* 31 I.L.M. 818 (1992), *available at* www.eoearth.org/article/Convention_on_Biological_Diversity [hereinafter *CBD*].

[167] *See id.* at article 1 (stating "The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.")

[168] *See id.* at article 14; Ranee K. L. Panjabi, *Idealism and Self-Interest in International Environmental Law: The Rio Dilemma*, 23 CAL. W. INT'L L.J. 177, 190-91 (1992).

[169] *See* Aoki, *supra* note 141, at 115; *see, e.g.*, *CBD*, *supra* note 166, at articles 2, 8, 9, 12, 16-19.

[170] *See CBD*, *supra* note 166, at 822.

[171] *See id.*

[172] *See General Agreement on Tariffs and Trade-Multilateral Trade Negotiations (The Uruguay Round): Agreement on Trade-Related Aspects of Intellectual Property Rights, Including Trade in Counterfeit Goods*, 33 I.L.M. 81, 84 [hereinafter *TRIPS*].

countries had signed the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) administered by the World Trade Organization.[173] The binding treaty required signatory states to strengthen their intellectual property rights in various ways.[174] For example, patents must be granted in all technological fields and must extend for 20 years.[175] Furthermore, TRIPS required member countries to accord all other legal protection, like that of the P.V.P.A., which was already in place in a number of nations.[176] Thus, since TRIPS became effective, plant genetic resources are protected in the international context either by patents or by an effective *sui generis* system.[177]

In addition to TRIPS' focus on intellectual property rights, the most recent international movement in seed law sought to reaffirm farmers' rights.[178] In 2004, the International Treaty on Plant Genetic Resources (ITPGR) furthered the efforts of the FAO's 1983 IUPGR by explicitly recognizing farmers' rights.[179] The revision incorporated the subsequent 1992 CBD, which conflicted with the IUPGR's definition of "common heritage."[180] The agreement recognized farmers' rights by protecting traditional knowledge, equitable benefit sharing, and farmer participation in national decisions on plant genetic resources.[181] However, it did avoid addressing the controversial right to use, exchange, and sell farm-saved seed by deferring to the autonomy of each individual nation.[182] By creating a multilateral system, the ITPGR proposed to distribute germplasm with the condition that no claim be made on any intellectual property right to that sample.[183] However, any gene, lines, cells, or compounds derived from that sample could be protected.[184] While the ITPGR proved more comprehensive than the 1983 IUPGR, little effort was made to actually enforce farmers' rights.[185]

III. FUTURE: POTENTIAL APPROACHES TO GERMPLASM

In the face of the apparent trajectory toward commodification, some scholars have recognized several alternative approaches to germplasm. These proposals range from treating germplasm as purely private property (complete commodification) to a blanket prohibition of any legal claims (non-

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[173] *See id.*; Aoki, *supra* note 141, at 118.

[174] *See TRIPS*, *supra* note 172, at 85, 86.

[175] *See id.* at 96.

[176] *See id.* at 84-85.

[177] *See id.*

[178] *See International Treaty on Plant Genetic Resources for Food and Agriculture*, (Nov. 3, 2001) *available at* ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf at 11-12 [hereinafter *ITPGR*].

[179] *See id.*

[180] *See id.*; Gregory Rose, *International Law of Sustainable Agriculture in the 21st Century: The International treaty on Plant Genetic Resources for Food and Agriculture*, 15 GEO. INT'L ENVTL. L. REV. 583, 594 (2003) (explaining that the CBD defined plant genetic resources as sovereign property).

[181] *See* Rose, *supra* note 180, at 594.

[182] *See* Aoki, *supra* note 141, at 122; *ITPGR*, *supra* note 178, at 13, 20, 26, 29.

[183] *See* Aoki, *supra* note 141, at 122-23.

[184] *See id.*

[185] *See id.*

commodification).[186] One comprehensive approach, proposed by Professor Shubha Gosh and adopted by Professor Aoki, applies four models of legal protection for traditional knowledge: (1) the "Public Domain" Model, (2) the Trust Model, (3) the Commercial Use Model, and (4) the Private Property Model.[187] In addition, it is also possible to create hybrid models that balance the costs and benefits of more than one approach. The "Open Source Software Movement" approach constitutes such a hybrid, balancing the Public Domain Model and the Private Property model and providing limited ownership as well as access rights to encourage technological participation.[188] These five models suggest alternative approaches to seed law that the judicial and legislative branches may take in the future.

a. *"Public Domain" Model"*

The formal intellectual property model or public domain model would treat germplasm as a raw material that is not owned but still appropriable.[189] Industrialized nations, such as North America and Europe, have taken this approach to traditional knowledge.[190] Essentially, natural materials are considered the common heritage of mankind and are 'free' to be collected by anyone.[191] The alternative may give rise to severe complications in the international economy. For example, if 'raw' material had a monetary value, whoever "takes" that material would owe a debt to the individuals or governments where those materials originated.[192]

As Jack Kloppenburg indicates in *The Political Economy of Plant Biotechnology*, privatizing the public domain would result in a startling redistribution of global wealth.[193] Kloppenburg points to various examples where American crops benefited enormously from the genetic contributions of countries or groups of people.[194] First, Turkish wheat provided American wheat varieties with genetic resistance to stripe rust.[195] This contribution is estimated to be worth $50 million per year.[196] The American sorghum crop acquired a resistance to green bug from a similar Indian species, yielding a yearly monetary benefit of $12 million.[197] An Ethiopian barley crop gene provided American barley crops with protection from yellow dwarf disease, a savings valued at $150 million per year.[198]

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[186] *See id.*

[187] Shubha Ghosh, Globalization, Patents and Traditional Knowledge, 17 COLUM J. ASIAN L. 108-20, 90 (Fall, 2003); *see* Keith Aoki, *"Free Seeds, Not Free Beer": Participatory Plant Breeding, Open Source Seeds, and Acknowledging User Innovation in Agriculture*, 77 FORDHAM L. REV. 2275, 2293 (2009).

[188] Aoki, *supra* note 187, at 2293.

[189] *See* Ghosh, *supra* note 187, at 112-15.

[190] *See* Aoki, *supra* note 5, at 318; Ghosh, *supra* note 187, at 112-13 (explaining that the term 'public domain' provides that traditional knowledge or intellectual property is freely accessible to everyone).

[191] *See* Ghosh, *supra* note 187, at 112.

[192] *See* Aoki, *supra* note 187, at 2293.

[193] *See* Kloppenburg, *supra* note 6, at 167-69.

[194] *See id.*

[195] *See id.*

[196] *See id.*

[197] *See id.*

[198] *See id.*

As a final example, soybean germplasm from Korea was utilized to decrease processing costs of American soybean crops by $100-500 million.[199] In sum, if the "public domain" of seed germplasm were to be treated as a private resource, the United States would owe billions of dollars across the globe.

The complications of keeping track of seed exchanges between countries, in both the past and present, make it unlikely that the public domain model will disappear. Furthermore, preventing access to germplasm by constructing a fiscal barrier may disadvantage the global population. The country or group of individuals to whom the raw materials 'belong' may not have the resources or desire to cultivate different varieties of crops. Such a barricade might prevent the free experimentation that, as described above, resulted in enormous agricultural advances.

b. *Trust Model*

The second approach described by Professor Ghosh, the Trust Model, assigns rights of traditional knowledge to groups other than the community from which it originated.[200] In this model, seed germplasm would be treated as communal property controlled by a group of "trustees" for the benefit of the "beneficiaries."[201] This group of trustees would most likely be a government or non-governmental organization, which would then have the power to grant or deny individual access to germplasm.[202] The Convention for Biological Diversity suggests designating the government as the trustee.[203] This would require devising a royalty framework, and would distribute royalties among the community from which the raw materials come from.

This model introduces several advantages and disadvantages. It is certainly advantageous to designate an authority with sufficient knowledge and power to manage the "trust" for beneficiaries who may lack such skills.[204] However, attributing sole power to any party, public or private, runs the risk of exploitation of a public resource by the political elite.[205] As Professor Ghosh aptly states, "[...] one's view of the trust model depends heavily on whether one 'trusts' the trustee."[206]

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[199] *See id.*

[200] *See* Ghosh, *supra* note 187, at 117-18.

[201] *Id.* at 109, 117-18.

[202] *See id.* at 117.

[203] *See CBD*, *supra* note 166, at article 15 (explaining that "the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.").

[204] Ghosh, *supra* note 187, at 38.

[205] *See id.*

[206] *Id.* at 39.

c. *Commercial Use Model*

Another approach to traditional knowledge is the Commercial Use Model, which designates ownership rights to any party who commercially used the 'raw' material.[207] In the context of seed law, this approach would provide rights to anyone who made an improvement upon a crop variety that exists in nature.[208] If traditional communities could demonstrate they had altered a crop to increase its commercial success, they could assert rights of ownership.[209] However, this does not prevent outside parties from claiming similar ownership rights for improving upon a crop's commercial success.[210] The Commercial Use Model could therefore result in overlapping ownership rights.

This model also causes ambiguities regarding the definition of "commercial" and some general confusion as to the chronology of improvements.[211] Difficulties can arise in proportioning ownership where a scientist is credited with genetically modifying a crop that a local community cultivated for centuries.[212] What portion of credit is due to the communities whose traditional knowledge has altered improved upon crops for generations? Is this contribution considered sufficiently 'commercial'? The answer to these questions is, at the moment, untenable.[213]

Similar to the Trust Model dilemma, the Commercial Use Model also exposes a local community to potential exploitation by those more knowledgeable in economics, bargaining, and contracts.[214] Furthermore, those who claim ownership rights through commercial use will most likely not contribute proceeds to the benefit of the public, as in the Trust Model. Therefore, while the Trust Model operates under the assumption that a neutral party distributes rights and benefits for the public good, the Commercial Use model provides only benefits to those with economic interests.[215]

d. *Private Property Model*

In contrast to the previous three models, the private property model provides more ownership rights to the traditional knowledge community.[216] This approach views traditional crops not as 'raw' material, but as a product of human

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[207] *Id.*; *see* Aoki, *supra* note 5, at 319.

[208] *See* Aoki, *supra* note 5, at 319.

[209] *See id.*

[210] *See id.*

[211] *Id.*; *see, e.g.*, MICHAEL R. DOVE, *Center, Periphery, and Biodiversity: A Paradox of Governance and a Developmental Challenge*, VALUING LOCAL KNOWLEDGE 57 (1996).

[212] *See id.*

[213] *See* Rosemary Coombe, *Intellectual Property, Human Rights & Sovereignty: New Dilemmas in International Law Posed by the Recognition of Indigenous Knowledge and the Conservation of Biodiversity*, 6 IND. J. GLOBAL LEGAL STUD. 59, 113 (1998).

[214] *See* Aoki, *supra* note 5, at 320.

[215] *See id.*

[216] *See id.* at 321; *see* Coombe, supra note 213, at 91-93, 99, 109.

ingenuity designed by local farmers.[217] Those wishing to use the germplasm of gene-rich geographical areas would be required to either purchase or license the material from local communities.[218] Unlike the Trust Model and the Commercial use Model, the Private Property Model would provide some amount of autonomy and self-protection against exploitation by other nations or industries.[219] However, these ownership rights might simply be sold to the highest bidder, which would still result in a concentration of germplasm ownership in developed countries.[220]

e. *"Open Source" Model*

As a compromise between the Public Domain Model and the Private Property Model, Professor Keith Aoki proposed an alternative licensing scheme based on the principles of the "Open Source Software Movement." The Open Source Software Movement began in the early 1990s with the development of the GNU/Linux operating system.[221] A software programmer named Linus Torvalds began building on Richard Stallman's GNU program, eventually leading to the GNU/Linux operating system.[222] Development of this software began to pick up speed because the operating system was distributed without cost under a General Public License.[223] This promoted a massive programming collaboration, which added other functionalities to the operating system that benefited both user and inventor. The license was also "viral," meaning that if one downloads a copy of the software, that individual is bound by its terms.[224] This essentially 'private' alternative to 'public' copyright law encouraged cooperative and rapid technological development in the community.[225]

Applying this approach to seed law, a party who has developed a particular germplasm could acquire ownership rights, gain royalties from selling General Public Licenses, and permit modification to subsequent buyers.[226] An open source software model would encourage improvement upon previously developed hybrid or genetically-modified crops while simultaneously encouraging genetic diversity.[227] Farmers would be re-envisioned as both users and developers of information technology.[228] Farmers that participate in this cooperative process could also share their success easily using a similar "viral" General Public License

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[217] *See* Aoki, *supra* note 5, at 321.

[218] *See id.* at 322.

[219] *See id.*

[220] *See id.*

[221] *See* Aoki, *supra* note 187, at 2295.

[222] *See id.* at 2295.

[223] *See id.*; GLYN MOODY, REBEL CODE: THE INSIDE STORY OF LINUX AND THE OPEN SOURCE REVOLUTION 26-28 (2001).

[224] *See* sources cited *supra* note 223.

[225] *See* YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM 64-67 (2006).

[226] *See* Aoki, *supra* note 187, at 2295.

[227] *See id.*

[228] *See* Ravi Srinivas Krishna, *Innovations, Commons and Creativity: Open Source, Bio Linux and Seeds*, WACC, http://www.waccglobal.org/lang-en/20031-intellectual-property-rights-and-communication/653-Innovations-commons-and-creativity-Open-Source-Bio-Linux-and-Seeds.html (last visited Aug. 2, 2011).

as in Open Source Software that would automatically bind users by its terms.[229] This approach could show just how necessary increased seed law protection is to incentivize innovation.[230]

CONCLUSION

From a natural resource to a highly protected product of science, the seed germplasm has undergone many transformations in the last few centuries. With the discovery of new countries in the colonial times, developing nations began an era of open germplasm exchange. This exchange led to the fruitful production of innumerable lines of crops that exhibited higher yield and resistance to deadly diseases. A drastic rise in the financial value of these crops led to a corresponding increase in patent or patent-like protection. In addition, *Chakrabarty* transformed the world of intellectual property in the U.S. by permitting the patenting of living things. The monumental case opened the door to plant patents, and a flood of litigation ensued.

In response to the implementation of domestic legal protection, numerous global conventions attempted to secure an international agreement on the matter. These discussions attempted to strike a balance between intellectual property rights for germplasm, the rights of the source state, and the rights of farmers. Thus far, only an unsteady recognition of all three rights exists.

In the future, the government, the legislature and the judicial branch should consider using the four models of traditional knowledge, or a fusion of more than one of these models. The public domain model, the trust model, the commercial use model, the private property model, or a fusion model (such as the open source software movement model) present a comprehensive framework for future seed law concerns. Furthermore, a plurality of models could be considered to permit flexibility in the unpredictable future. Undoubtedly, seed law will undergo many more transformations before the world can agree on how to protect such a valued resource.

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[229] *See* Margaret Kipp, *Software and Seeds: Open Source Methods*, FIRST MONDAY (Sept. 5, 2005), http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1276/1196.

[230] *See* Krishna, *supra* note 228.