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Jack and the Beanstalk: Property Rights In Genetically Modified Plants

by

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Jack and the Beanstalk: Property Rights In Genetically Modified Plants

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Introduction

The conversion of domesticated plant species into transgenic plants and their subsequent utilization in the agricultural production of usable crops has created a tension between the farmer, the seed manufacturer, and the public. The farmer desires to save the progeny transgenic seeds from one planting cycle for use in the next and to be autonomous in his decisions regarding the utilization of his land, his financial resources, and his crop. The seed manufacturer desires to make a profit from the transgenic plant. The public desires that the food and fiber produced by the transgenic plants be safe for consumption. While all of these positions are equally valid, discussions among these three parties usually fall into a quagmire of often emotional and irrational arguments. The theory upon which this paper is founded is that each of the parties is merely articulating, sometimes without eloquence, a position derived from the property rights fundamental to each party. Through examination of the property rights of each of the parties, a path to the resolution of the tension will be illuminated. This paper aims to examine the farmer's and seed manufacturers' property rights in genetically modified plants, leaving the public property rights for the time being. The story of Jack and the Beanstalk[2] provides a useful allegory and sets the stage for this discussion.

In the tale of Jack and the Beanstalk, Jack trades a sixpence, which his mother gave him for a magic bean.[3] Jack plants the bean, which produces a vine that reaches up to a magic castle in the clouds. The spectacular growth rate and ultimate size of Jack's beanstalk resulted from the bean's magic. The vine also produced progeny beans. Jack, presuming he was a clever entrepreneur, could have either saved the progeny beans for planting the next year (and hence found another magic castle in the clouds) or sold the beans to others. No legal consequences would have befallen Jack for

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1. J.D. candidate, University of Minnesota Law School, 2002. B.S. Chemical Engineering, Purdue University, 1978. Ph. D. Biomedical Engineering, Louisiana Tech University, 1984. Ph. D. Chemical Engineering, Rutgers University, 1995. I wish to thank Dr. Edward Coen, Professor Emeritus of Economics at the University of Minnesota, for many helpful and constructive discussions on the topics addressed in this work. I also wish to recognize the assistance of the librarians of the University of Minnesota Law School law library. Without their patient assistance this work would never have been brought forward.

2. *See generally* PAUL GALDONE, JACK AND THE BEANSTALK (1974) (published by Clarion Books, New York). The version of the tale of Jack and the Beanstalk written by Paul Galdone was adapted from B. A. T., THE HISTORY OF MOTHER TWADDLE AND THE MARVELOUS ACHIEVEMENTS OF HER SON JACK and published by J. Harris, corner of St. Paul's Churchyard (1807).

3. In the story of Jack and the Beanstalk, Mother Twaddle found the sixpence while cleaning her cottage. She sent Jack to the fair to purchase a goose for dinner. Instead of purchasing the goose, Jack spent the entire sixpence on a single bean. Because of the special properties of the bean, a modern version of the story might posit that the bean was genetically modified.

engaging in either of these two alternatives. With current biotechnology results analogous to the beanstalk's spectacular growth rate and size, Jack's beanstalk could be the result of genetic modification. In modern times, various statutes would protect Jack's genetically modified progeny beans. While an innocent child's story, the tale of Jack and his beanstalk would indeed keep modern day attorneys busy for quite some time. In modern times, Jack, by purchasing the bean, might be subject to restraints imposed by the Plant Variety Protection Act[4] and the Patent Act. By planting the bean and growing the beanstalk, Jack could be infringing the protections afforded by a utility patent granted to the bean's manufacturer. In addition, by harvesting the progeny beans from the beanstalk, Jack might be liable for damages under the Patent Act, the Plant Variety Protection Act, and contract law for violating the terms of a license agreement. The following two examples illustrate that Jack's modern day hypothetical case indeed resembles reality in several aspects.

Percy Schmeiser, a canola farmer in Canada, has been developing a variety of canola suitable for his farming practice for nearly 50 years. Monsanto representatives entered his fields and found plants bearing Monsanto's gene, which confers glyphosate resistance on the canola. Monsanto sued Mr. Schmeiser.[5] The result: Monsanto won. In his decision, Judge W. Andrew MacKay found Mr. Schmeiser guilty of infringing Canadian Letters Patent No. 1,313,830 assigned to Monsanto.[6]

Dallas Thomason is a cotton and beef farmer in Rayville, Louisiana. He also owns a cotton ginning facility. Mr. Thomason purchased "brown-bag" cotton seed from a local commercial seed dealer; however, he did not know that the seeds were Bt cotton seeds. The commercial seed dealer neither asked Mr. Thomason to sign a technology use license nor did Mr. Thomason actually sign such a license. After Mr. Thomason planted the cotton seeds, Monsanto received a tip that the seeds Mr. Thomason had planted were Bt cotton seeds.[7] Monsanto sued because Mr. Thomason did not

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4. Plant Variety Protection Act, Pub. L. No. 91-577, 84 Stat. 1542 (1970) (current version at 7 U.S.C. §§ 2321-2582 (1994 & Supp. II 1996)).

5. Monsanto has also levied a heavy fine against farmers who have genetically modified plants on their land without a valid license agreement. Once Monsanto finds that a farmer is allegedly growing an unlicensed crop, it sends a letter to the farmer demanding payment of a fine. One of these letters, made available on the Internet, was sent to Mr. Edward Zielinski of Mikado, Saskatchewan, on November 12, 1998 and signed by Mr. Keith A. MacMillian, Director of Legal Affairs of Monsanto Canada, Inc. Mr. Zielinski had obtained the seeds at issue as the result of a trade with a farmer from Prince Albert. *See* http://www.tv.cbc.ca/national/pgminfo/canola. The letter stated that Monsanto Canada had "very good evidence to believe that Roundup Ready canola was planted on approximately 250 acres of land identified as SE 28-30-2, NE 28-30-2 and SE 19-30-2 in violation" of propriety rights which Monsanto had in the Roundup Ready canola. The letter further stated that before "making any final decision as to what steps we will be taking, and in an attempt to resolve this issue in a timely and economical manner, we are prepared to refrain from commencing any legal proceedings against you subject to the following" conditions: first, that a fine be paid to Monsanto in the amount of $28,750.00; second, that "Monsanto has the right to take samples from all of your owned or leased land and storage bins for three years from the date of this letter"; and third, that Mr. Zielinski "agree not to disclose the specific terms and conditions of this Settlement Agreement to any third party." This letter is *available at* http://www.tv.cbc.ca/national/pgminfo/canola/docz1.html.

6. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/ 2001fct256.html.

7. Evidently, the person who sold Mr. Thomason the Bt cotton seeds also informed Monsanto that Mr. Thomason was using those same seeds without the technology use license. Telephone Interview with Mr. Dallas Thomason, Farmer, Rayville, Louisiana (July 3, 2001) [hereinafter Interview: Thomason].

obtain a technology use license before planting the seeds. Monsanto won.[8] Dallas Thomason was found guilty of patent infringement and violation of the provisions of the Plant Variety Protection Act in a pre-trial decision by Federal Magistrate Kirk. The trial jury, deciding on the question of damages only, found Mr. Thomason liable to Monsanto for $401.00 per acre for infringing the patent, and liable to Delta and Pine Land for $100.00 per acre for violating the PVPA. Typically, Mr. Thomason retained neighboring farmers' cotton seeds as consideration for ginning their cotton. Most of these seeds he sold for animal feed and oil extraction, while retaining the balance for planting his own fields. Even if the case against Mr. Thomason concerned these particular seeds, he would still have been found guilty of infringement and violation of the Plant Variety Protection Act because he would be using the Bt cotton seeds without a license.

The fictional case of Jack and the Beanstalk and the real cases involving Percy Schmeiser and Dallas Thomason intrinsically involve property rights in genetically modified plants. This Note discusses the mechanism by which the seed manufacturers retain property rights in genetically modified plants while denying the farmer property rights in both the progeny seed that he has grown on his own land and the land upon which the genetically modified plants are grown. In Part I, the foundation of property rights in genetically modified plants is discussed. In Part II, the development of the law with regard to property rights in genetically modified plants, and how the seed manufacturers who develop the seeds retain those rights is discussed. In Part III, the provisions of the law that remove the property rights from the farmer and allocate those rights to the seed manufacturer are discussed. Also, the mechanisms by which the farmer can retract those same property rights are discussed in this section.

This Note argues that the current state of judicial interpretation of property rights in genetically modified plants weighs heavily in favor of the seed manufacturers, and that such an interpretation is justified if only the costs to the seed manufacturers are considered. This Note proposes that the farmer is an integral part of agricultural biotechnology and must be accounted for when statutes granting property rights are interpreted. Such an interpretation would strike a balance between the needs and costs incurred by the seed manufacturers and the needs and costs incurred by the farmers.

I. BACKGROUND

"Labor, for a fair remuneration, whether of the brain or hand, should be the glory of America; besides, there is true dignity in labor, especially in cultivating the soil."[9]

A. Agricultural Biotechnology

Farming is a business, and as such, the entrepreneurs engaged in it are driven to maximize profit

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8. *See Grower Fined for Saving Bollgard Seed*, PROGRESSIVE FARMER, October 2000, at 10.

9. Isaac Newton, *Report of the Commissioner of Agriculture for the Year 1862*, 1862 U.S.D.A. ANNUAL REPORT 1, 15 (1863) (also published as: ISAAC NEWTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1862, H.R. EXEC. DOC. NO. 37-78, at 15 (3d. Sess. 1863)).

by increasing productivity[10] while minimizing labor and financial input. Since the early stages of cultivating crops, improvements in productivity were obtained by one of two mechanisms: artificial selection and plant breeding. Artificial selection functions on the genetic variability of plants and appears to have been the first method successfully employed for increasing productivity. The earliest farmers would have selected those plants with the most favorable traits, such as the largest or most abundant fruits. Early on, the gains realized by artificial selection could have occurred rapidly and required only a rudimentary understanding by the farmers that the most favorable traits would have been found in the each succeeding generation. It is not surprising then, that since the beginning of recorded history (and perhaps before that time in certain societies[11]) farmers have been artificially selecting plants[12] for the most desirable characteristics in each planting cycle.[13] Seeds from plants that displayed these characteristics were saved and used in a subsequent planting cycle.[14]

Through artificial selection, plants that were deemed suitable for agricultural purposes were eventually domesticated. The domestication of plants was a long-term process that had evolutionary consequences for many species. From the agricultural viewpoint, the result of the domestication process was the creation of a relatively narrow set of plants that now serve human needs.[15] In some species of domesticated plants, artificial selection has altered the genetic construct to the extent that no wild relatives exist with which to cross breed the domesticated plant in order to expand its genome.[16] There can be no doubt that traditional agricultural practices narrowed the range of species

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10. From nearly the beginning of the development of genetically modified plants it was recognized that productivity from the genetically modified plant was significantly lower than from similar but non-genetically modified plants. *See* BOARD ON AGRICULTURE, NATIONAL RESEARCH COUNCIL, GENETIC ENGINEERING OF PLANTS: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS 45 (1984) (program of the convocation on genetic engineering of plants published by the National Academy Press) [hereinafter BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS]. Now, over a decade and a half later, the farmers have become keenly aware that the genetically modified plants do not out produce traditional hybrid lines despite assurances by the seed manufactures that the plants would do so. Therefore, those farmers who employ genetically modified plants may remain competitive only by minimizing input costs and labor, not by gaining an improvement in productivity.

11. *See* KONRAD SPINDLER, THE MAN IN THE ICE (1994) (published by Harmony Books).

12. It is essential to understand the difference between natural and artificial selection. Charles Darwin argued that a species currently in existence had evolved from an ancestral species as the result of environmental factors. This evolution was termed, by Darwin, as "natural selection". *See generally* CHARLES DARWIN, THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION (D. Appleton and Co., New York 1890) (1848). Artificial selection is the result of human intervention in the process of the "natural" evolution of a species whereby humans select, for breeding, the next generation of a particular species from a particular subset of the current generation of that same species. *See* NEIL A. CAMPBELL, BIOLOGY 399 (4th ed. 1996). It might be noted that humans have been engaged in artificial selection of not only plant species, but also human and non-human animal species for millennia. *See generally* Manspeizer, *infra* note 145.

13. *See* NEIL A. CAMPBELL, BIOLOGY 399, 407 (4th ed. 1996).

14. *See id.* at 399 ff.

15. *See generally* TRANSGENIC PLANTS AND WORLD AGRICULTURE (Washington, D.C., National Academy Press 2000), *at* http://www.nap.edu/html/transgenic [hereinafter TRANSGENIC PLANTS].

16. It is known that certain traits can be bred into a domesticated plant only by the use of a non-domesticated "wild" close relative plant species. For example, the insertion of atrazine resistance into canola was accomplished by cross breeding domesticated canola with the atrazine-resistant weed wild turnip (*Bassica*

employed in providing food and fiber for humans. However, the continued practice of artificial selection can have the effect of expanding the genetic diversity within a particular species. Through artificial selection, those plants that exhibit some trait that is different than the characteristics exhibited by other plants of the same species and is the result of genetic variation created by environmental factors, can be used as progenitor plants for a new variety. The multi-millenia old practice of artificial selection is still employed at the outset of the twenty-first century, even by "modern" farmers. For example, Mr. Schmeiser, a Canadian canola farmer, has been developing his own variety of canola, suitable for the soil and environmental conditions in his region, for over a half century. His practice has involved exclusively the technique of artificial selection. While the practice of artificial selection may not be suitable for all crop species, the practice still must be preserved and continued because it exerts an expanding pressure on the genetic diversity in the domesticated plant species.

The process of artificial selection by farmers became an agricultural institution at this country's beginnings and continued as a core function of agricultural production up through the early part of the twentieth century.[17] In early America, very few native plant species were suitable for agricultural production. Plant species imported from England and Europe were likewise unsuitable for agricultural production in North America. The early non-indigenous farmers realized that these imported plant varieties were not immediately well suited for large-scale agricultural production in North America[18] due to the continent's unique climate and soil.

Consequently, these early farmers soon determined that seeds and plants had to be selected which were best adapted to the climate and local environment of North America.[19] The farmer was the only instrument by which agricultural techniques including domesticated plants, that were suitable for the soil, climate, and population of the (eventual) United States were developed. The farmer was responsible for the adaptation of native species for domestic purposes, the adoption of species already domesticated by indigenous peoples for commercial purposes, and the development of new varieties of agricultural plants from those plants familiar in Europe. The early American farmers' process of adoption and adaptation of plants for American agriculture involved testing different seed varieties and saving seed from those plants with the most favorable characteristics for the next planting cycle.[20] Thus, the farmers established artificial selection as a central principle of agricultural practice early in the development of this country.

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campestris). *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 10, at 42. The report summarizes the discussions of the convocation for examination of the potential contribution of genetic manipulation to agricultural productivity.

17. The advent and introduction of hybrid crop varieties effectively halted the practice of artificial selection by the farmers. The hybrid qualities, which were desired in the first generation plants, would not necessarily be transmitted to progeny plants.

18. *See* JACK RALPH KLOPPENBURG, JR., FIRST THE SEED: THE POLITICAL ECONOMY OF PLANT BIOTECHNOLOGY, 1492-2000 51 (1988).

19. *See id.*

20. *See id.* at 51-52.

Through the practice of artificial selection, a base of germplasm[21] was developed which eventually became well suited to large-scale agriculture in North America.[22] The process of germplasm development, and the farmer's role in that process, was well established before the independence of the United States, even though the product of the process was nowhere near mature in nature.[23]

The process of artificially selecting plan varieties did not benefit all farmers uniformly. Certain farmers practiced artificial selection through the late eighteenth century on private or communal farms.[24] However, not all farmers possessed the skill or resources to mount an effective program of plant variety development.[25] A few wealthy landowners, including Thomas Jefferson and George Washington, could afford to import exotic seeds[26] and adapt those seeds to local conditions. Seeds from these privately grown varieties that performed well and exhibited desired characteristics were distributed among the members of agricultural societies to which the grower belonged.[27] As a result, members of agricultural societies were able to develop successful farms and plantations while simultaneously broadening the germplasm available in the United States.[28] Because the common farmer could not gain membership to these agricultural societies he had either no or limited access to these new and exotic varieties.[29] The common farmer was then economically disadvantaged in a

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21. The collective genetic stock of a species of plant is the called its germplasm. *See* JOHN MILTON POEHLMAN, BREEDING FIELD CROPS 4 (3d ed. 1987).

22. The roles of the government, industry, and farmers in the development of the germplasm base in the United States has been detailed in a recently published article. *See* Debra L. Blair, *Intellectual Property Protection and Its Impact On The U.S. Seed Industry*, 4 DRAKE J. AGRIC. L. 297 (1999). Since certain aspects of the interaction between the government, industry, and farmers are central to the analysis presented here, and since some of these points are inadequately treated by Blair, it is necessary to review the background on the development of the germplasm base given in part by Blair.

23. An excellent history is given by Cary Fowler, *The Plant Patent Act Of 1930: A Sociological History Of Its Creation*, 82 J. PAT. & TRADEMARK OFF. SOC'Y. 621 (2000).

24. *See* KLOPPENBURG, *supra* note 18, at 52-53.

25. George Washington recognized that successful agriculture would not advance by following "the ordinary farm routine which his neighbors practiced." ALFRED CHARLES TRUE, *A History of Agricultural Education in the United States*, 36 U.S.D.A. MISC. PUB. 14 (1929). Because of this observation, Washington devoted considerable resources to agricultural experiments aimed at improving varieties and introducing exotic species of plants. *See id.* at 15.

26. *See* KLOPPENBURG, *supra* note 18, at 52.

27. *See id.*

28. *See id.*

29. The stature of those who organized and were members of the agricultural societies leads one to the conclusion that the societies were not meant for the common farmer. A few examples illustrate the point. The South Carolina Society for Promoting and Improving Agriculture and Other Rural Concerns was established in 1784. In the rules of the society it was recommended that the farmer set aside a portion of his lands upon which agricultural experiments would be conducted. Further, written records of the experiments should be maintained and reported to the society. *See* ALFRED CHARLES TRUE, *A History of Agricultural Experimentation and Research in the United States*, 251 U.S.D.A. MISC. PUB. 6-7 (1937). The Philadelphia Society for Promoting

system that granted an exclusive interest to those who could afford to develop the plant varieties best suited to agriculture in the United States.

Maintaining control of the nation's germplasm base in the hands of a few wealthy merchants and farmers had the effect of limiting the agricultural productivity of the significantly larger number of common farmers. To aid agricultural productivity in general and to continue broadening the germplasm available to American farms, Secretary of the Treasury William H. Crawford requested in 1819 that ambassadors and military officers retrieve seed from countries around the world and supply that seed to American farmers.[30] The project initiated by Crawford had the effect of initializing the process of centralizing the maintenance and extension of the available germplasm base with the United States government.[31] Such centralization had the effect of providing new varieties of seed to all farmers rather than to only those farmers wealthy enough to belong to exclusive agricultural societies. To solidify centralization of control of the germplasm base with the government, the Commissioner of Patents, Henry Ellsworth, in 1839 obtained federal funding for the collection and distribution of new plant varieties to the farmers.[32] The collection and distribution efforts were

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Agriculture was organized in 1785 by Judge Bordley and "23 distinguished citizens of that city" and whose first president was "Samuel Powel, a graduate of the College of Philadelphia, and twice mayor of that city." *See* TRUE, *supra* note 25, at 7. The society set goals similar to the other agricultural societies for its members and added the lure of premiums for the best agricultural experiments. *See id.* The New York Society for the Promotion of Agriculture, Arts, and Manufactures was established in 1791 for the communication of results of experiments in agriculture, the useful arts and manufacturing. *See id.* at 7. The Society for Promoting Agriculture in the State of Connecticut, formed in 1794, invited its members "to make experiments in the various departments of Agriculture," *id.* at 9 (quoting E. H. Jenkins, HISTORY OF CONNECTICUT), the results of which were to be freely communicated to the society. The Albemarle Agricultural Society was formed in 1817 by 30 men under the leadership of Thomas Jefferson. *See* TRUE, *supra* note 25, at 15. Careful examination of the history of the agricultural societies indicates that a common thread running through all of the early agricultural societies is that the membership was limited to those who could engage in the gentlemanly endeavor of "scientific agriculture" and who could accurately record and report the results of that endeavor to the membership of the society. Indeed, the common farmer most certainly lacked the resources to engage in such endeavors and therefore would not be able to benefit from the seed-sharing programs of the agricultural societies.

30. *See* NELSON KLOSE, AMERICA'S CROP HERITAGE: THE HISTORY OF FOREIGN PLANT INTRODUCTION BY THE FEDERAL GOVERNMENT 26 (1950) (describing the introduction of exotic plants into the United States, and roles that the federal government, farmers, and seed manufacturers had in developing modern plant agriculture).

31. Because the project was unfunded, it was not immediately successful. However, because naval officers had an inherent interest in collecting exotic species, during their travels around the world, for their own use, the germplasm did arrive in the United States as a result of the program. *See* KLOPPENBURG, *supra* note 18, at 55. More importantly, however, was the recognition that the collection and introduction of new varieties and species into the United States and the successful adaptation of those exotic plants for agricultural purposes in the United States was beyond the capacity of individuals. Rather the efforts must be accomplished by the collective efforts available through the federal government. *See id.* at 54.

32. *See* KLOSE, *supra* note 30, at 39. By 1837, Commissioner Ellsworth had clearly recognized the importance of instituting a seed collection and distribution program under the purview of the federal government. Specifically, Commissioner Ellsworth stated that husbandry might derive assistance "from the establishment of a regular system for the selection and distribution of grain and seeds of the choicest varieties for agricultural purposes." HENRY ELLSWORTH, REPORT FROM THE COMMISSIONER OF PATENTS FOR THE YEAR 1837, H.R. EXEC. DOC. NO. 25-112, at 5 (3d. Sess. 1838). As early as 1835, Ellsworth was collecting and distributing various types of agricultural seeds from the Patent Office. In his own words:

> [t]he Patent Office is crowded with men of enterprise, who, when they bring the models of their improvements in such implements [of husbandry], are eager to communicate a knowledge of every other kind of improvement in agriculture, and especially new and valuable varieties of seeds and

eventually assigned to the Patent Office. With congressional funding, by 1847 the Patent Office was distributing approximately 60,000 packets of seed to farmers free of charge.[33] The program of collecting and distributing seed continued to expand so that more than one million packages of seed were distributed by 1855.[34] While the government played an important role as collector and distributor of seed, the farmer remained an essential functionary in the process of refining and developing the available germplasm in the United States.[35]

Through the process of screening and selecting those plants and seeds that gave superior yields, the farmers in partnership with the federal government had created a well-developed germplasm base

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> plants. Hence, the undersigned [Commissioner] has been led to receive and distribute, during the last two years, many articles of this kind which have been committed to his care; and experience has induced him to believe that there is no spot in the Union so favorable to this object as the seat of Government.
>
> The great disideratum at the present time seems to be, that some place should be designated and known as the depository of all articles of this kind, and from whence they may be dispensed to every part of the United States.

Id. at. 5. Thus, Commissioner Ellsworth urged upon Congress the concept that agricultural productivity could be assisted to a considerable extent in the United States if the management of the seed collection and distribution program were to be formalized within the federal government. Ellsworth supported his position with a set of well articulated examples. The first concerns the production of wheat:

> [a] short time since, the most eastern State of our Union was, in a measure, dependent on others for her bread-stuffs. That State is now becoming able to supply its own wants, and will soon have a surplus for exportation; and this is effected by the extensive introduction of spring wheat. Among the varieties of this wheat, however, there is great room for selection: there is at least 20 per cent. Difference, if regard is paid to the quality and quantity of the crop.

Id.

The second concerns experiments on the production of maize:

> [f]rom experiments made the last summer, there can be no doubt that the crop of Indian corn [maize] may be improved at least one-third, without any extra labor; and this, effected by a due regard only to the selection of seeds.
>
> And here it may be mentioned, that an individual has devoted twenty-five years to this single object; and, from our common Indian corn, has produced a new variety, which, if *distributed as it ought to be*, may prove a great benefit to the husbandman and to the country.
>
> From samples transmitted to the Patent Office, especially from the shores of lake Superior, there is a moral certainty of a good crop of corn in the higher latitudes, if proper attention is paid to the selection of seeds.

Id. at 5-6 (emphasis added). Thus, it appears that Ellsworth understood that the development of new varieties by a single person or by individual agricultural societies would be of little use to agricultural production in the United States without a well designed, and federally backed, seed collection and distribution system. He certainly recognized that individual farmers could play a critical role in the distribution system, but also certainly was not promoting the distribution program merely to benefit the welfare of the farmers.

33. *See id.*

34. *See* KLOPPENBURG, *supra* note 18, at 56.

35. *See id.*

by the start of the Civil War.[36] To rationalize and continue the centralized control of germplasm development and distribution, Congress in 1862 established the United States Department of Agriculture (USDA)[37] to "acquire and to diffuse among the people of the United States useful

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36. *See* J. C. FORBES & R. D. WATSON, PLANTS IN AGRICULTURE 212 (1992) [hereinafter FORBES & WATSON].

37. The United States Department of Agriculture was created in 1862 with Isaac Newton appointed as the first Commissioner of Agriculture. *See* Isaac Newton, *Report of the Commissioner of Agriculture for the Year 1862*, 1862 U.S.D.A. ANNUAL REPORT 1, 3 (1863) (also published as: ISAAC NEWTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1862, H.R. EXEC. DOC. NO. 37-78, at 3 (3d. Sess. 1863)). The Department of Agriculture, with Isaac Newton as its first Commissioner, started operation on July 1, 1862, with a budget allowance of $60,000 of which $34,342.27 was spent by the end of the year. *Id.* at 21. Commissioner Isaac Newton articulated the objectives of the Department of Agriculture as follows:

> Collecting, arranging, publishing, and disseminating, for the benefit of the nation, statistical and other useful information in regard to agriculture in its widest acceptation, embracing, not only the usual cultivation of the soil, but orcharding, plain and ornamental gardening, rural embellishment, the veterinary art, and household economy. In this connexion the department whould aim to teach or recommend authoritatively, by concentrating the ripest agricultural experience and scholarship, the best methods of culture, the choicest plants, vegetables, and fruits, the most valuable grains, grasses, and animals, domestic and otherwise, and the most improved implements of husbandry.
>
> Collecting, from different parts of our own and foreign lands, such valuable animals, cereals, seeds, plants, slips, and cuttings as may be obtained by exchange, purchase, or gift, with information as to their modes of propagation, culture, preservation, and preparation for market, and distributing the same throughout the country. Through our postal franking privilege at home, and our foreign ministers, consuls, merchants, missionaries, travellers, and the officers of our naval and merchant fleet, the government enjoys unusual facilities for carrying out this project.
>
> Answering inquiries of farmers and others on all matters relating to agriculture, at the same time stimulating inquiry, inviting discussion, and rewarding research by publishing agricultural statistics of various States and sections of States in order to guard against the excess or diminution of given products, thereby saving much time, labor and capital to farmers. And as this department has been created and is sustained for their benefit, they are earnestly invited to correspond with it in order that a proper selection of subjects may be afforded for publication.
>
> Testing, by experiment, the value of different agricultural implements and their adaptation to the purposes intended, as well as testing the value of cereals, seeds, and plants, and their adaptation to our soil and climate, before transmitting them to our farmers. In order to carry out this object the department should have under its control a model farm.
>
> Analysis, by means of a chemical laboratory, of various soils, grains, fruits, plants, vegetables, and manures, and publishing the results for the guidance and benefit of agriculturists.
>
> Establishing a professorship of botany and entomology. It is well known that insects are annually destroying a vast amount of the products of our soil, and that their ravages appear to be on the increase. If the damage done to our wheat crop alone could be prevented, millions of money would be saved to the country.
>
> Establishing an agricultural library and museum. In this library the most valuable works would gradually accumulate by exchange, gift and purchase, forming a rich mine of knowledge. The museum would embrace models of all the most approved implements of husbandry; specimens of soils, rocks, \&c.; samples of the various productions of garden, field, and forest; varieties of grain in straw, and in sample, now generally cultivated or recently introduced into the country, with explanations respecting their soils, climates, weight, yield per acre, and their value as food. Here should be arranged specimens of the component parts of soils, manures, and all the products of agriculture, showing especially the values of different kinds of food. On the walls of this museum should hand the portraits

information in subjects connected with agriculture in the most general and comprehensive sense of that word, and to procure, propagate, and distribute among the people new and valuable seeds and plants."[38] The establishment of the USDA in effect institutionalized within the government the artificial selection model of plant evolution, which had previously been conducted by individual farmers.[39] After the Civil War, the development and testing of new varieties of domestic crop species were conducted primarily by the land grant colleges in conjunction with the USDA and the resulting seeds were distributed free of charge to the nation's farmers.[40] Efforts by the USDA and land grant colleges, however, did not reach vegetable and plant varieties intended for domestic use as these varieties were already marketed to the farmer and home gardener through a small private seed trade.[41] The growth of the collection and distribution program was so extensive that by 1878 approximately one-third of the department's budget was committed to the project.[42] By the end of the nineteenth century the program had become exceedingly successful, and the germplasm was as well developed as possible given the limited understanding, by both the farmer and applied scientist, of plant genetics. From a business perspective, the government-farmer relationship was in prime condition for the newly founded seed companies to replace the government and exploit the well developed germplasm base. In order to affect the replacement, the seed manufacturers found a sympathetic ear and a powerful friend in the then Secretary of Agriculture J. Sterling Morton.

Mr. M. Fagan, Chief of the Seed Division under Secretary Morton, considered the gratuitous distribution of seed as a program that "has outlived its usefulness, and that its further continuance is an infringement of the rights of citizens engaged in legitimate trade pursuits"[43] and in 1893 called for

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of animals of the most celebrated breeds, and under its roof should be gathered whatever would tend to attract and instruct persons of the highest taste and education.

Id. at 20-1.

38. Act of May 15, 1862, ch. 72, 12 Stat. 387 (the act is entitled: "An Act to establish a Department of Agriculture"). *See* KLOPPENBURG, *supra* note 18, at 59 (quoting GLADYS L. BAKER ET AL., CENTURY OF SERVICE: THE FIRST ONE HUNDRED YEARS OF THE DEPARTMENT OF AGRICULTURE 13 (1963)). *See also* Isaac Newton, *supra* note 37 at 3.

39. *See* Frederick H. Buttel & Jill Belsky, *Biotechnology, Plant Breeding, and Intellectual Property: Social and Ethical Dimensions*, *in* OWNING SCIENTIFIC AND TECHNICAL INFORMATION, VALUE AND ETHICAL ISSUES 110 (Vivian Weil & John W. Snapper eds., 1989) [hereinafter Buttel & Belsky].

40. *See* Rick Weiss, *Seeds of Discord: Monsanto's Gene Police Raise Alarm on Farmers' Rights, Rural Tradition*, WASH. POST, Feb. 3, 1999, at A6.

41. *See* Buttel & Belsky, *supra* note 39, at 113.

42. *See* KLOSE, *supra* note 30, at 62

43. M. E. Fagen, *Report of the Chief of the Seed Division*, *in* 1893 U.S.D.A. ANNUAL REPORTS 389, 391 (1894) (also published in: REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1893, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 389-91 (2d. Sess. 1894)). Mr. J. Sterling Morton, in the same year, called the gratuitous seed program one of "unwieldy, unnecessary, and extravagant proportions," J. STERLING MORTON, *Report of the Commissioner of Agriculture*, 1893 U.S.D.A. ANNUAL REPORTS 7, 19 (1894) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1893, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 389-91 (2d. Sess. 1894)), that was an "enormous expenditure, without compensatory benefits, [that] ought to be abolished." *Id*. at 20. Then, as now, proponents of monopolization by a particular sector of the business community argue that such monopolization is to protect "the rights of citizens engaged in legitimate trade pursuits" (that is the businessmen). What these proponents fail to realize is that the prior legal structure already protected the interests of persons engaged in a "legitimate trade pursuit" (that is the farmers) as well as building a stronger community. That special interests could not enter into the market arena is neither the fault of the

the end of the project.[44] Despite Morton's claims of infringement and his belief that the gratuitous distribution of the seed was "antagonistic to the seed as a commodity-form and in direct competition with the private seed trade,"[45] Congress refused to halt the program.[46] Morton failed to veil his contempt for the gratuitous seed program devised to aid the farmers and to help feed the American people.[47] Since Congress refused to halt the seed program,[48] Morton took it upon himself to not only

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farmers (they were engaging in the economically sound practice of maximizing output while minimizing input of labor and capital) nor of the nation, but rather their own inability to compete in a market which favors the public welfare rather than the welfare of a select group of businessmen. Kloppenburg also employed this quote, although in a different context. *See* KLOPPENBURG, *supra* note 18, at 62.

44. *See* KLOPPENBURG, *supra* note 18 at 62-63.

45. *Id.* at 63.

46. *See id.*

47. Mr. J. Sterling Morton, in his report for 1894, stated that: "[t]he extravagance and inutility of these disbursements are apparent to any person who will investigate the results of the expenditure." J. Sterling Morton, *Report of the Secretary of Agriculture*, 1894 U.S.D.A. ANNUAL REPORTS 5, 69 (1895) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1894, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 69 (3d. Sess. 1895)). He further argues that those to whom the seeds were distributed were not only ungrateful, but indifferent as well. Identifying that the newly established agricultural experiment stations "are in charge of scientific men" who are "particularly well equipped for the trial, testing, and approval or condemnation of such new varieties as may be introduced from time to time," his position was that the responsibility of artificial selection of new varieties should fall to these experiment stations. *See id.* at 69-70. Since Secretary Morton was closely aligned with the emerging private seed manufacturing industry (*see* KLOPPENBURG, *supra* note 18, at 61-65), his argument, contained in his annual report for the year 1894, clearly indicated that he expected the United States government to continue funding agricultural research and that the private seed manufacturers would later have an opportunity to reap some monetary benefits from that research. It is ironic that Morton expressed his desired for the agricultural experimental stations to have control of the discovery and introduction of new varieties in light of his well-articulated contempt for both the land grant universities and the agricultural experiment stations. *See* J. Sterling Morton, *Report of the Secretary of Agriculture*, 1893 U.S.D.A. ANNUAL REPORTS 7, 8 (1894) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1894, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 8 (2nd. Sess.1894)). Based upon his conservative federalist views, Morton believed that both the university system and the experimental stations were the responsibility of the several States. Because of his close alignment with industry, Morton was apparently blinded to the fact that agriculture problems and developments to solve those problems do not end at the state line. He was also unable to understand that no single state could be completely self supporting in any manner, and that federally guided programs that encouraged the production and dissemination among the peoples of the several States of knowledge and technology is the critical factor to continued development of the nation. It is fortunate that Commissioner Morton did not succeed in defeating the land grant university program or the agricultural experiment station program. This is because the agricultural industry has and continues to benefit from both public institutions. *See generally* Donald N. Duvick, *Biotechnology in the 1930s: The Development of Hybrid Maize*, 2 NATURE REVIEWS GENETICS 69-74 (Jan., 2001).

48. The stated duty of the USDA was to collect and disseminate information, seeds, and plants for the advancement of agriculture in the United States. *See supra* note 37. However, members of Congress found the gratuitous seed distribution so politically attractive that, by 1878, Commissioner William LeDuc found it necessary to remind Congress that by statute the distribution of seed was exclusively the duty of the USDA. *See* William G. LeDuc, *Report of the Commissioner of Agriculture for the Year 1878*, 1878 U.S.D.A. ANNUAL REPORT 5, 32-9 (1879). LeDuc admonished Congress stating that: "[o]nly by obeying the organic law, which requires the *Commissioner of Agriculture* to distribute to *agriculturist* the seeds which invite them, can we hope to obtain these reports with any degree of certainty. This law is mandatory and must be obeyed until Congress shall see fit to amend the same, and thus permit or prescribe some other method of distribution." *Id*. at 34. Commissioner LeDuc then instituted a program whereby he wrestled control of the program from the members

terminate the seed distribution program in 1894, but also to completely eliminate the USDA's ability to ever engage in the distribution program again. [49] Not only did Secretary Morton openly display his contempt for the gratuitous seed distribution program in 1894,[50] but he also openly demonstrated his disgust for Congress'[51] decision to continue the program by turning to United States Attorney General Richard Olney in 1894 for a *non-judicial* interpretation of the statute which established the United States Department of Agriculture. Secretary Morton believed that Attorney General Olney had stated that the Secretary of Agriculture reserved the right to determine whether government was obliged to continue the gratuitous seed program. Consequently, Secretary Morton rejected three bids in response to a limiting advertisement for seeds in an overt move to eliminate the gratuitous seed program in fiscal year 1895.[52] Such an outcome is hardly surprising given the members of the board

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of Congress. By 1879, LeDuc's program had gained the approval of agricultural organizations, several newspaper editors, and some members of Congress. *See* William G. LeDuc, *Report of the Commissioner of Agriculture for the Year 1879*, 1879 U.S.D.A. ANNUAL REPORT 5, 21 (1880). Evidently, some Congressmen found the political benefits of the largesse attendant to the gratuitous seed distribution program so attractive that, by 1885, two-thirds of all seeds, plants, and cuttings distributed through the gratuitous seed program were actually being distributed by members of Congress. *See* Norman J. Colman*, Report of the Commissioner of Agriculture for the Year 1884*, 1884 U.S.D.A. ANNUAL REPORT 5, 25-6 (1885). Even in the case of a program meant to benefit all of society, by increasing and diversifying the germplasm base, members of Congress seemed to have no compunction over using that program for their own political benefit.

49*. See* J. Sterling Morton, *Report of the Secretary of Agriculture*, 1894 U.S.D.A. ANNUAL REPORTS 7, 67-70 (1895) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1894, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 67-70 (3d. Sess. 1895)).

50. In 1895, Commissioner Morton reminded Congress that in 1893 he: "recommend[ed] that the purchase of seed for gratuitous and promiscuous distribution be utterly abolished, and that not one cent be appropriated for such distribution." J. Sterling Morton, *Report of the Secretary of Agriculture*, 1894 U.S.D.A. ANNUAL REPORTS 7, 67 (1895) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1894, H.R. EXEC. DOC. NO. 53-1, pt. 6, at 67 (3d. Sess. 1895)). To buttress his position, Secretary Morton included in his report for 1894 a report from Mr. Enos S. Harnden, Special Agent for the Purchase of Seed for the United States Department of Agriculture. Mr. Harnden stated that: "[i]n the light of my experience as a former seedsman, however, I consider the free distribution of seeds by this Department as an infringement upon and interference with a legitimate business, and I believe it should be abolished." *Id*. at 211. Further, Mr. Harnden stated that: "this Department has no moral right to interfere with this or any other legitimate business interest by a free political distribution of garden seeds . . . or any other commodity the subject of legitimate trade." *Id*. Conceding that "years ago the seed division did much for the agricultural interests of the country in introducing new and improved cereals and other field seeds," *id*. at 212, Harnden argues that "the recipients, as a rule, want to obtain good seeds for the least possible money," *id*., and suggests "that the purchase of seeds for free distribution by this Department be discontinued," *id*. at 213.

51. Perhaps the contempt that Mr. Morton felt for Congress was the consequence of the result of a hearing held before the Committee of Elections of the House of Representatives in 1862. *See* MR. DAWES, J. STERLING MORTON VS. SAMUEL G. DAILY, HOUSE COMM. OF ELECTIONS, H.R. REP. NO. 37-69, at 1-18 (2d. Sess. 1862) [hereinafter DAWES]; *see also* MR. VOORHEES, J. STERLING MORTON VS. SAMUEL G. DAILY: VIEWS OF THE MINORITY, HOUSE COMM. OF ELECTIONS, H.R. REP. NO. 37-69, at 1-15 (2d. Sess. 1862) [hereinafter VOORHEES]. The election for the pertinent seat in the House of Representatives was held on October 9, 1860 in the Territory of Nebraska. Between Mr. Morton and Mr. Daily, the initial election results were in favor of Mr. Morton by 14 votes (2957 for Mr. Morton, 2945 for Mr. Daily). *See* DAWES, *supra*, at 1. Upon contest of the election results by Mr. Daily, the governor of the Territory of Nebraska revoked the certificate of election (initially given in favor of Mr. Morton) and granted it to Mr. Daily. The ground upon which the governor reversed the election was alleged voter fraud in the vote counted for Mr. Morton. *See* DAWES, *supra*, at 1. The Committee reviewed extensive testimony on the question, found instances of voter fraud in favor of Morton, and consequently upheld the certificate of election in favor of Mr. Daily. *See* DAWES, *supra*, at 18.

52*. See* J. Sterling Morton, *Report of the Secretary of Agriculture,* 1895 U.S.D.A. ANNUAL REPORT 5, 53-5 (1895) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR

were seedsmen, including Mr. Enos S. Harnden.[53] The space previously occupied by the Seed Division of the USDA was "speedily transformed into apartments for the Division of Entomology and the Division of Ornithology and Mammalogy, and immediately occupied by the chiefs and clerks thereof."[54] Further, arguing that the introduction of exotic species and varieties was the duty of the agricultural experiment stations, Secretary Morton urged Congress to "materially and profitably reduce[]" the "appropriation for the care of the thirty-five acres of grounds about" the USDA which were previously used as grounds for the cultivation of plants for home use and for distribution.[55]

Notwithstanding Morton's use of the Attorney General as an authority on the meaning of the statute, Congress clearly felt that Morton had overstepped his authority by terminating the seed program. In 1895, Morton grudgingly reinstated the seed distribution program.[56] This is one of the clearest examples of a government officer using the power vested in his office to destroy the long-established business practice of a large group of people in order to create a new business practice which benefits only a small group of favored individuals. Despite Secretary Morton's efforts, the gratuitous seed distribution program had grown and was so pervasive that by 1897 the USDA was distributing approximately one billion packets of seed per year.[57]

1895, H.R. EXEC. DOC. NO. 54-6, at 53-5 (1st. Sess. 1895)).

53. Secretary Morton quoted a report from Mr. Harnden as stating that: "we have opened and examined the bids received and find that the same do not meet the requirements of the advertisement as printed, and therefore respectfully recommend that all bids be rejected." *Id*. at 55.

54. *Id*. at 55.

55. *Id*. at 56.

56. *See* J. Sterling Morton, *Report of the Secretary of Agriculture,* 1896 U.S.D.A. ANNUAL REPORT v (1896) (also published as: J. STERLING MORTON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1896, H.R. EXEC. DOC. NO. 54-6, at v (2nd. Sess. 1896)). Commissioner Morton stated that if the garden area planted by the gratuitous seed were a strip of ground a single rod in width, it would stretch around the globe one and one-half times. He also argued that: "[t]he 10,125,000 packets of vegetable seeds cost the Government $75,000, while the transportation of the same through the mails added the sum of $74,520," a cost "paid for by money raised from all the people, and bestowed upon only a few people." *Id*. at xxxix. The computation reported by Commissioner Morton was provided by Mr. Harnden. *See* Enos S. Harnden, *Report of the Special Agent on Seed Distribution*, *in* 1896 U.S.D.A. ANNUAL REPORTS 155-57 (1896) (also published in: REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1896, H.R. EXEC. DOC. NO. 54-6, at 155-57 (2nd. Sess. 1896)). Mr. Harnden, maintaining an unwavering contempt equaled only by that of Commissioner Morton for both the gratuitous seed distribution program and for Congress, complained in 1896, following reinstitution of the seed distribution program, that "[e]stimating each Congressional quota on a basis of 450 equal parts, each Senator, Member, and Delegate would receive sufficient seed to plant a trifle more than 163 1/2 acres to garden truck," and that if this land was accumulated into a patch 1 rod in width, "a fast express train traveling at the rate of 60 miles per hour along this garden patch would require fifty-one days three hours and fourteen minutes to pass from one end to the other." *Id*. at 156. Only due to the greed for political power exhibited by the members of Congress was the centralized institution of agricultural management preserved for another 28 years for the benefit of the farmers and the peoples of this nation.

57. *See* KLOPPENBURG, *supra* note 18, at 64-65.

Without the government seed program and the efforts of American farmers, the germplasm[58] base present in the United States by the end of the nineteenth century, would certainly not have been developed. The underlying purpose of the government's gratuitous seed program was to expand the germplasm available and to allow farmers to develop varieties that were particularly well suited for the local environment.[59] The seed manufacturers' main goal was to develop the minimum number of varieties that would maximize sales to the grower and hence maximize profits. Development of a multitude of seed varieties is both costly for a single entity and may not be an optimal business strategy. Thus, the gratuitous seed program's purpose is antithetical to that underlying the seed manufacturers' business strategy. The government's intention of expanding the available germplasm base, of increasing the number of varieties of exotic and native seeds used by the farmers, and of adapting new varieties to the local environments found in the United States, was a resounding success.[60] The process of artificial selection by the farmer had become a well-established agricultural practice[61] in part because the farmer was well equipped to carry out the simple program required for successful artificial selection. As such, the farmer was a "researcher", a "plant breeder",[62] and his practice of artificial selection was a "natural right" possessed by him before the framing of the Constitution.

By 1897, the Department of Agriculture's attitude had changed significantly with the appointment of Mr. James Wilson as Secretary of Agriculture. Recognizing that the "country has profited by introducing new seeds and plants,"[63] but that the progress was made without a clear scientific basis, the Secretary appointed a scientist to "have charge of seed and plant importation,"[64] and to bring a scientific basis to the importation and adaptation of plants for use in the United States. The Secretary was careful to recognize that the "law requires that the seeds, plants, bulbs, etc., be rare and valuable,"[65] and thus urged Congress that "more of the appropriation given for seeds should be

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58. *See* NATIONAL RESEARCH COUNCIL, MANAGING GLOBAL GENETIC RESOURCES: THE U.S. NATIONAL PLANT GERMPLASM SYSTEM 1 (1991) (published by the National Academy Press). The USDA has an ongoing and active program to preserve the germplasm diversity by storing seeds of all known plant varieties at the National Seed Storage Laboratory in Fort Collins, Colorado.

59. Kloppenburg argues that members of Congress had an the ulterior motive of maintaining "a convenient means of ingratiating themselves with their constituents." *See* KLOPPENBURG, *supra* note 18, at 63. While this argument may be valid, the ultimate support for the program must have been predicated upon the demand by the farmers and consumers for the gratuitous seed provided by the government. *See id.*

60. *See id.* at 61.

61. *See id.* at 65.

62. See *infra*, Parts II.B.3, for an analysis of why the farmer may be both a researcher and a plant breeder.

63. JAMES WILSON, *Report of the Secretary of Agriculture*, 1897 U.S.D.A. ANNUAL REPORTS v, vii (1897) (also published as: JAMES WILSON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1897, H.R. EXEC. DOC. NO. 55-6, at vii (2nd. Sess. 1897)).

64. *Id*.

65. *Id*. at xxxvi

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available for the introduction of what is new and rare."[66] While Congress was obviously reluctant to decrease funding for the politically popular gratuitous seed program, it appropriated $130,000 for the program in 1897 and $20,000 for distribution of the seeds and for discovering and importing new and rare varieties in the same year. For fiscal year 1899, Congress appropriated $130,000 for the "purchase and distribution of valuable seeds."[67] Of that amount, $70,978.36 was used for the purchase of seeds to be distributed through the Members of Congress.[68] Under Secretary Wilson, the program of discovering, importing, and adapting new and rare varieties of seed constituted "[q]uite a large percentage of the $130,000 appropriated" by Congress.[69]

Even though Secretary Wilson urged Congress to appropriate larger sums to the importation and adaptation of new and rare varieties, the seed manufacturing industry was still pressing Congress to discontinue the gratuitous seed program. Secretary Wilson recognized that the Department of Agriculture's distribution of seeds that compete directly with the seed manufacturers' sales was a questionable practice (particularly when no experimental feature existed, and "no intelligent direction regarding the use of the seeds beyond that which is provided by dealers"[70]). However, he also recognized that the Department of Agriculture's distribution of seeds and plants served a very valuable commercial and social purpose. In particular, he stated that: "[t]he introduction of these and many other seeds and plants, entirely beyond the ability of private individuals to compass, in order that such seeds and plants may eventually enter the commercial class and be handled by seedsmen, is the aim of the Department of Agriculture in seed distribution at the present time."[71] Obviously, by 1899 the seed manufacturing industry had made little progress against the Department of Agriculture's gratuitous seed distribution program.

By the beginning of the twentieth century, the seed manufacturing industry had gained only a small fraction of the market for field crop seeds, a market that was almost exclusively dominated by on-farm production of the seed and sale of the seed through inter-farm commerce.[72] During the last forty years of the nineteenth century, the seed manufacturing industry was, however, able to make substantial inroads into the flower and vegetable seeds market. This is because the seed sets in most vegetables and flowers develop when the plant is mature and after the crops are harvested,[73] thus, the home gardener was disinclined to produce flower and vegetable seeds for himself. There

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66. *Id*.

67. *See* JAMES WILSON, *Report of the Secretary of Agriculture*, 1899 U.S.D.A. ANNUAL REPORTS, ix, lv (1899) (also published as: JAMES WILSON, REPORT OF THE COMMISSIONER OF AGRICULTURE FOR THE YEAR 1899, H.R. EXEC. DOC. NO. 56-6, at lv (2nd. Sess. 1899)).

68. *Id*.

69. *Id*. at lvi.

70. *Id*. at lvi

71. *Id*.

72. *See id.* at 61.

73. *See id.*

was, therefore, very little competition between the seed manufacturing industry and the individual farmers for the production and sale of garden plant variety seeds. This market, however, was threatened by the expansion of the government's gratuitous seed program into the area of garden vegetable and flower seeds.[74] The seed manufacturing industry, not surprisingly, responded to this threat by pressuring the USDA to halt its seed program. Due to this pressure, during the late nineteenth and early twentieth centuries, the government eventually relinquished control of the nation's germplasm base, including both field and garden crop varieties, to the private seed manufacturing companies. The process by which control was ceded is outlined below.

Before 1900, the farmer had several options for obtaining seed for planting: he could grow the seed himself or obtain the seed through the inter-farm commerce system; purchase the seed from fledgling seed manufacturers; or, obtain the seed stock gratis from the USDA. Obtaining seed for a subsequent planting cycle either from his own crop or through inter-farm commerce usually involved crop improvement through either artificial selection, or in certain limited situations, crop-breeding.[75] Because the farmer could obtain new seed stocks gratis from the USDA, there was no incentive for him to pay for the seed from seed manufacturers. The disincentive was sharpened in light of the relative quality and productivity of varieties available through the seed manufacturers and available to the farmer through other channels.[76] The consequence of the long-term practice of artificial selection and inter-farm commerce can easily be determined as follows.

Upon examination of the agricultural productivity before 1900 in general, and for maize in particular, it is clear that productivity in the United States was stagnating.[77] While new varieties of

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74. *See id.*

75. *See* Edmund Burke, *Report of the Commissioner of Patents,* ANNUAL REPORT OF THE COMMISSIONER OF PATENTS; FOR THE YEAR 1847 1, 131, (1849) (also published as: EDMUND BURKE, ANNUAL REPORT OF THE COMMISSIONER OF PATENTS, FOR THE YEAR 1847, H.R. EXEC. DOC. 30-54, at 131 (1st Sess. 1848). Commissioner of Patents Edmund Burke reported that:

> [a]n interesting experiment, in which a fine variety was secured, by blending two or three dissimilar ones, is mentioned in the Columbia Advocate of South Carolina. The corn produced is stated to have measured, in some cases, from twelve to thirteen inches in circumference, and from twelve to fourteen inches in length, having from forty to forty-eight rows of grain in an ear. This was, however, the yield of a single ear to a stalk; the ears which were from stalks bearing five or six ears, even of those stalks would each measure, when shelled, nearly twice as much as the largest ear of common corn. It was mostly of the white gourd seed, but the varieties from which selection had been made were thus described: The one was remarkable only for the length of the cob, but extremely slender. Either of these varieties, regarded singly or separately as to its properties, would have been considered hardly worth the planting. By attention, and suitably blending these varieties, he obtained the valuable one which has been mentioned above, and which might be truly called a mammoth corn. The ground on which it was raised is described as being an exhausted plantation near Monticello, on the red hills of Little river, but the mode of cultivation is not given.
>
> Many instances might be mentioned of the uncommon *size* of single ears or large crops of corn. A few, however, will be all that we shall quote to shew the capabilities of this most valuable grain.

Id.

76. *See* KLOPPENBURG, *supra* note 18, at 8 (discussing the quality of seeds distributed by the early seed manufacturers).

77. *See id.* at 66. The production and economic trends surrounding the recent and current development and

plants were initially rapidly and successfully introduced to American agriculture through the traditional practice of artificial selection, the stagnation in agricultural productivity near the end of the nineteenth century required the introduction of alternative practices of developing new varieties. Although hybridization[78] technology was becoming important in agricultural research,[79] and hybrid varieties were being developed, commercial or production scale use of hybrids did not exist.[80] While the farmer was able to perform the function of simple artificial selection, and more sophisticated farmers were able to perform simple cross-breeding, it is not clear that the individual farmer was capable of engaging in the more sophisticated plant breeding techniques required to produce a uniform and consistent hybrid variety. Simply put, the farmers were not skilled enough in research and plant breeding methods to undertake developing hybrid varieties for themselves. The fledgling seed manufacturing industry evidently was incapable of engaging in the level of research required to significantly alter the stagnation in agricultural productivity. Thus, the nearly simultaneous creation of the USDA[81] and land grant colleges[82] set the stage for shifting the development of new varieties from the farmer to research establishments staffed and operated strictly by state agricultural colleges and funded by the USDA.[83] Before 1900, these efforts were unable to yield the much-needed revolution in

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deployment of genetically modified plants is analogous to the production and economic trends surrounding the deployment of hybrid seed varieties in the United States between 1933 and 1946. See Appendix A for a discussion of the economics of maize production in during the years between 1933 and 1946, and Appendix B for a discussion of the methods of data analysis used to develop the discussion in Appendix A.

78. *See* Buttel & Belsky, *supra* note 39, at 114. Hybridization is an artificial selection technique where plants are the result of interbreeding of two distant and distinct lines of the same plant species. Ricard A. Steinbrecher and Patric Mooney, *Terminator Technology: The Threat to World Food Security*, 28 THE ECOLOGIST 276 (1998) [hereinafter Steinbrecher & Mooney]. The hybrid resulting hybrid seeds will incorporate the desirable characteristics of the parental lines whilst suppressing the undesirable characteristics. *See id.* The seeds from the first generation hybrid plants will not be able, in general, to express the desirable qualities, resulting in a loss of yield, and plant variability. *See* Lewontin, *infra* note 127, at 72. Because the quality "hybridized" into the seed would generally be lost after the first generation, the development of hybridization technology prevented farmers from saving the seeds from one crop for planting the following crop cycle. As a result, the plant breeders were able to capitalize on the development of new seed varieties. *See* Steinbrecher & Mooney, *supra* at 276. While the hybridization technique has been technically and economically feasible for corn, cotton, sunflowers and tomatoes it cannot be applied to important crops such as soybeans and wheat. *See id.* Furthermore, the hybridization technology cannot always be used to introduce specific characteristics into the plant. *See id.*

79. *See generally* Diane B. Paul & Barbara A. Kimmelman, *Mendel in America: Theory and Practice, 1900-1919,* in THE AMERICAN DEVELOPMENT OF BIOLOGY 281 (Ronald Rainger, Keith R. Benson & Jan Maienschein eds. 1988) [hereinafter Paul & Kimmelman].

80. See Appendix A for a discussion of the economics of maize production in during the years between 1866 and 2001, and Appendix B for a discussion of the methods of data analysis used to develop the discussion in Appendix A.

81. *See generally* Newton, *supra* note 37.

82. The Morrill Land-Grant Act establishing the land grant colleges was signed by President Lincoln on July 2, 1862. *See* TRUE, *supra* note 25, at 106. The purpose of these colleges was to "claim the authority of teachers to announce facts and fix laws, and to scatter broadcast that knowledge which will be useful in building up a great nation." *See id.* at 107.

83. While the establishment of state agricultural experiment stations precedes the establishment of both the USDA and land-grant colleges (*see* TRUE, *supra* note 29, at 67-130), the Hatch Act, signed on March 2, 1887 by President Cleveland, formalized the establishment of federally funded agricultural experiment stations in the

agricultural practices. Such a revolution took the form of extraordinary developments in science and a shift in control of the nation's germplasm base.

In the years between 1883 and 1924 three significant events brought change to the dynamic between the government, the farmer, and the seed industry: the establishment of the American Seed Trade Association in 1883; the discovery and publication of Mendel's works in 1900; and, the termination of the gratuitous seed program in 1924.

In 1883, the American Seed Trade Association was formed in New York City by representatives of thirty-four seed manufacturing companies.[84] The purpose of the American Seed Trade Association was to promote the seed companies' interests to the United States Government.[85]

The rediscovery and publication of Mendel's laws in 1900 lead to the rationalization of crop-breeding science. In the crop-breeding technique, the farmer or plant breeder selects two plant varieties, each of which has some particular set of desired traits for cross-breeding.[86] When crossed, the first generation progeny may exhibit the desired traits of both parents, depending upon which traits are recessive and which are dominant. The technique was initially unsuccessful because farmers and plant breeders did not understand the mechanism for transmitting traits and, therefore, were unable to predict the likely outcome of the cross of two particular plant varieties.

The basis of inheritance of a particular trait by the first generation progeny from two cross-bred progenitors was not well understood until the Mendel's work was "rediscovered." By studying peas in his monastery garden in the 1860's, Gregor Mendel deduced that the inherited traits were stored in discrete units that are now called genes.[87] Mendel published his observations in 1866.[88] However, between the time when Mendel's observations were first published and the turn of the twentieth century, his work was largely ignored[89] for reasons that are not entirely clear. In 1900, Mendel's work

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United States. *See id.* at 129.

84. *See* KLOPPENBURG, *supra* note 18, at 62.

85. *See id.*

86. Edmund Burke gave early reports of successful crop-breeding experiments in 1847. *See* Burke, *supra* note 75 (reporting that a variety of maize "secured" by blending two or three dissimilar ones, is mentioned in the Columbia Advocate of South Carolina).

87. *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16, at 6.

88. Gregor Mendel, *Versuche über Pflazen-Hybriden*, 4 VERHANDLUNGEN DES NATURFORSCHENDEN VEREINES, ABHANDLUNGEN, 4 Brünn 3 (1866). The English translations appear in THE ORIGIN OF GENETICS: A MENDEL SOURCE BOOK, (Curt Stern & Eva R. Sherwood, ed.) (1966) [hereinafter Stern & Sherwood]; J. H. BENNET, EXPERIMENTS IN PLANT HYBRIDIZATION, (1965); and JAMES ARTHUR PETER, CLASSIC PAPERS IN GENETICS, (1959).

89. "Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant attainments become lost in the mass of the inconsequential." Vannevar Bush, *As We May Think*, THE ATLANTIC MONTHLY 101 (July 1945).

was "rediscovered"[90] by three botanists: Hugo de Vries[91] of Amsterdam, Carl Correns[92] of Tubingen, and Eric von Tschermak[93] of Esslingen, Austria. Shortly following the "rediscovery," the geneticist William Bateson stated "[a]n exact determination of the laws of heredity will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be foreseen."[94] Indeed, in the first decade of the twentieth century, Mendel's investigations stimulated an enormous amount of work in the science of genetics.[95] As a result, biologists in the early 1900's discovered how genes were assorted in the process of cell division and how the properties of the progeny are determined. Using the science of genetics, plant breeders were able to cross-breed plants with precision, manipulating the genome to successfully produce new varieties with desired traits.[96]

The early hybridization experiments, conducted mainly at government and university experimental stations,[97] resulted in improved varieties through the introduction of a single trait or selected traits from one variety, crossed into another variety through backcrossing.[98] This practice constitutes hybridization in the more expansive sense of the word, whereas hybridization to produce a hybrid maize plant, for example, represents a narrower construction of the word.[99] Through the early 1900s,

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90. *See* Daniel L. Hartl & Vitezslav Orel, *What Did Gregor Mendel Think He Discovered?*, 131 GENETICS 245 (1992).

91. *See* Hugo de Vries, *The Law of Separation of Characteristics in Crosses*, 25 J. ROYAL HORTICULTURAL SOCIETY 243 (1900) (arguing that specific characteristics of the plants must be regarded as "sharply separated quantities," *id*. at 243, independent from all the other quantities); Hugo de Vries, *On Crosses With Dissimilar Heredity*, 25 J. ROYAL HORTICULTURAL SOCIETY 249 (1900) de Vries discloses the observation that false hybrids, *cenothera muricata*, follow Mendel's laws, *see id.* at 255.

92. *See* Carl Correns, *G. Mendel's Regel Über das Verhalten der Nachkommenschaft der Rassenbastarde*, 18 BERICHTE DER DEUTSCHE BOTANISCHEN GESELLSCHAFT 158-68 (1900). For an English translation, see: Leonie Kellen Piternick, *G. Mendel's Law Concerning the Behavior of Progeny of Varietal Hybrids*, 35 SUPPLEMENT TO GENETICS NO. 5, PT. 2 33-41 (1950); and Stern & Sherwood, *supra* note 88, at 119-32.

93. *See* Eric von Tschermak, *Über künstliche Kreuzung bei Pisum Sativum*, 18 BERICHTE DER DEUTSCHE BOTANISCHEN GESELLSCHAFT 232-39 (1900). For an English translation, see Aloha Hannah, *Concerning Artificial Crossing in Pisum Sativum*, 35 SUPPLEMENT TO GENETICS NO. 5, PT. 2 42-47 (1950).

94. William Bateson, *Problems of Heredity as a Subject for Horticultural Investigation*, 25 J. ROYAL HORTICULTURAL SOCIETY 54, 54 (1900) (a lecture presented at the Royal Horticultural Society on Mendel's work in order to persuade its members to adopt and use the laws of heredity to improve the understanding of the transmission of genetic traits).

95. Hybrid technology was already well advanced by 1900. *See generally* R. Irwin Lynch, *The Evolution of Plants,* 25 J. ROYAL HORTICULTURAL SOCIETY 54-61 (1900). However, the developments were progressing slowly because of a lack of understanding of the transmission of genes from progenitor to progeny plants.

96. *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16, at 6.

97. *See* Paul & Kimmelman, *supra* note 79.

98. *See* KLOPPENBURG, *supra* note 18, at 78-81.

99. *See id.* at 68.

the field crop seeds produced by cross-breeding different varieties were open pollinated[100] varieties,[101] which meant that a progeny plant would closely resemble the progenitor plant. While these early breeding experiments, which took place before the rediscovery and widespread acceptance [102] of Mendel's works,[103] created new plant varieties with traits which were of interest to the farmers, commercial seed manufacturers still faced the inherent problem that the seed a farmer planted for one growing cycle would create a sufficiently similar progeny seed for that farmer to plant during the subsequent growing cycle.[104] In addition, because there were no legal protections in place for the seeds that the commercial seed manufacturer produced, the farmer was free to sell progeny seed to his neighbor farmers. In fact, there were no legal constraints prohibiting the farmer from growing sufficient progeny seed to establish his own seed business. Before the use of Mendel's work to establish the hybrid seed industry in the United States, it was precisely this problem which inhibited the growth of the commercial farm-crop seed industry. This is because without legal protection for varieties that were created by the seed manufacturers, it would be difficult to obtain an adequate return on the investment in order to research and develop the new varieties.[105] Today, commercial seed manufacturers still employ this same argument to justify bringing the full weight of their legal departments against any farmer whom they perceive might be stealing their profits through "nefarious dealings." Given the advance in techniques for producing new varieties, such a position by commercial seed manufacturers may be supported only by clear and convincing evidence of the cost of bringing a variety to market and the profits gained from that variety. Such an accounting has yet to be produced by commercial seed manufacturers.

Between 1915 and 1925, government researchers' efforts at many United States agricultural experiment stations were directed toward the development and evaluation of inbred seed lines and hybrid seed varieties.[106] Inbred seed lines are so genetically stable, or homozygous, that when allowed to self-fertilize, the resulting progeny seed will grow a plant that is nearly identical to the progenitor plant.[107] It is precisely these germplasm lines that farmers and governmental plant breeders had worked since the early nineteenth century to develop. By cross-breeding the inbred seed lines to each other (a single cross) or by cross-breeding the single-cross progeny plants to each other (double-cross), the resulting progeny plants had a mix of genetic material that produced far

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100. *See* POEHLMAN, *supra* note 21, at 20.

101. *See* CURTIS NORSKOG, HYBRID SEED CORN ENTERPRISES: A BRIEF HISTORY 69 (Maracom Corp. 1995).

102. Bateson presents an excellent discussion on the importance of Mendel's works. *See* BATESON, *supra* note 94.

103. *See* Paul & Kimmelman, *supra* note 79.

104. *See* KLOPPENBURG, *supra* note 18, at 71.

105. *See id.* at 81.

106. *See* ARNEL R. HALLAUER ET AL., CORN BREEDING AMERICAN SOC'Y OF AGRONOMY, INC. ET AL., AGRONOMY PUB. NO. 18, CORN AND CORN IMPROVEMENT 463, 463-464 (George F. Sprague & John Wesley Dudley eds., 3d ed. 1988); *see generally* Paul & Kimmelman, *supra* note 79.

107. *See generally* FORBES & WATSON, *supra* note 36, at 224-227.

more vigorous progeny plants with much higher yields than the progenitor plants exhibited.[108] The discovery of the new hybrid vigor,[109] or heterosis, was of considerable benefit to the farmer who desired an increased yield, however, the discovery also brought an even greater benefit to the commercial seed manufacturers.[110] Once the first generation hybrid plant was grown and allowed to open pollinate, the genetic construct of the progeny hybrid plant was such that the hybrid vigor and productivity began to diminish.[111] Due to the diminished productivity, the farmer was disinclined to save the progeny seeds from hybrid progenitor plants for replanting. The inbred seed lines, which were used to create the first generation hybrid plant, could remain a trade secret held by the seed manufacturer because only the progeny hybrid seeds were sold.[112] Thus, if the farmer wished to maintain a profitable level of productivity and remain competitive, he was forced to abandon his traditional practice of saving seed to plant in the next crop cycle and instead become reliant on the

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108. *See generally* POEHLMAN, *supra* note 21, at 239-46.

109. The court in *Pioneer Hi-Bred Intern., Inc. v Holden Foundation Seeds, Inc.*, 1987 WL 341211 (S.D.Iowa 1987) gave an unusually clear discussion of hybrid vigor. Specifically, the court stated that:

> [t]he number of inbred lines that are used to produce the hybrid sold to the farmers has varied. In the early days, there were double crosses, which meant that the hybrid sold to the farmer was a cross of two F sub1 hybrids. (Tr. 3018). The companies preferred single-cross hybrids because of ease of production and economic advantages. By the 1960s, single-cross hybrids became dominant. (Tr. 3018). Each parent of a single-cross hybrid is an inbred. (Tr. 3018). However, in many cases, modified single crosses are used in which one or the other parent of the hybrid is a backcross rather than a 100% pure inbred. In order to create a hybrid seed, a company typically plants four to six rows of a particular parent referred to as a female, and alongside of it two rows of a parent referred to as the male. All plants in the female rows are detassled so that no pollen from those plants can fertilize the silks on those same plants.
>
> Seed fields are usually planted in isolation from other corn. Thus, the only pollen that can fertilize the female rows is from the male rows planted alongside. The seed on the ears in the female rows is the F sub1 hybrid seed. The male rows self pollinate, have no value in the further breeding process, and are either chopped out or harvested separately and fed to livestock or commingled with other corn at elevators.
>
> The parent or inbred material may often have rather small-even deformed-ears. However, when one such parent is crossed with another parent as above described, the result of mixing the genes, called "heterosis," . . . is such that if the proper parents are selected, the resulting hybrid seed produces a splendid crop, i.e., a large ear, a higher yield, and other sought-after characteristics.
>
> To put it another way, if an inbred line-called A-with small stalks, small ears and low yield, is crossed with itself or another inbred line essentially the same as A, all you are going to get are plants that are small, have small ears and low yield. Similarly, an inbred line called B, crossed with itself or a similar inbred line will produce only plants much like those of inbred line B. However, if you crossed inbred line A with inbred line B each with small stalks, small ears and low yield, sometimes if you have the right cross, the hybrid of inbred A times inbred B will produce plants of great vigor, good ears and outstanding yield. This phenomenon is called hybrid vigor.

Id. at 2-3.

110. *See id.*

111. *See generally* FORBES & WATSON, *supra* note 36, at 231.

112. *See generally* POEHLMAN, *supra* note 21, at 239-46.

seed manufacturing industry. The seed manufacturer's market for the first generation hybrid seed line had two sources: first, the biological fact that open pollination of hybrid progenitor plants yield progeny with reduced vigor and productivity; and second, the seed manufacturers controlled the inbred germplasm lines necessary to create the first generation hybrid seed lines.[113] Aside from these two sources, there was no way to protect their seeds.

With the benefit of hindsight, one can see that the "rediscovery" of Mendel's work at the beginning of the twentieth century caused the demise of the farmer as a plant breeder and the rise of the dominance of commercial seed manufacturers in creating and distributing both field and garden crop seed varieties. The transition from the farmer-based artificial selection program to the seed manufacturer-based plant-breeding program occurred over a half-century span between the 1880's[114] and the 1930's.[115] The end result was that the farmer no longer had the partnership with the government that was responsible for giving the United States its germplasm base which the commercial seed manufacturers eventually used to breed seeds to sell to farmers.[116]

The agricultural stagnation of the late nineteenth and early twentieth century combined with the newly available "scientific" approach to plant breeding, caused the business community to pressure Congress to create resources for basic agricultural research. This political pressure exerted by the seed manufacturing industry pushed the USDA into basic agricultural research.[117] Once this had been accomplished, the ASTA, the American Breeders Association and the seed manufacturers were

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113. There is a yet another manner in which hybrid seeds afford seed manufacturers property right protection. Recently, a seed manufacturer developed a molecular technique for producing fertile hybrid seed. The method and product appear to be patentable. *See* Steven F. Fabijanski, Diego Albani, Laurian S. Robert & Paul G. Arnison, *Molecular Methods of Hybrid Seed Production*, U.S. PAT. NO. 6,013,859 (issued Jan. 11, 2000).

114. *See* Paul & Kimmelman, *supra* note 79.

115. By the late 1930's, the adoption of hybrid seed varieties was nearly complete such that by 1946 nearly 100 percent of corn, wheat, and soybeans planted in the Midwest were of hybrid varieties. *See* U.S.D.A., *Table 46.-Hybrid Corn: Percentage of Total Corn Acreage Planted With Hybrid Seed, by States, 1933-1945*, 1945 U.S.D.A. AGRICULTURAL STATISTICS 42 (1945); Table U.S.D.A., *47.-Hybrid Corn: Percentage of Total Corn Acreage Planted With Hybrid Seed, by States, 1937-1946*, 1946 U.S.D.A. AGRICULTURAL STATISTICS 41 (1946).

116. The acceptance of the hybrid maize seed lines was nearly complete in the corn belt states by 1946. However, the increase in yields from the fields planted to the hybrid maize lines did not start to rise significantly until the early 1950's. *See* Appendix A, *infra*. This is due primarily to the introduction and use of synthetic nitrogen fertilizers starting in the early 1950's, as well as other advances in agricultural technology. These advances include the use of chemical herbicides starting in the early 1950's and the use of more efficient planting and harvesting machinery. *See* Donald N. Duvick, *Biotechnology in the 1930s: The Development of Hybrid Maize*, 2 NATURE REVIEWS GENETICS 69-74, 71 (January 2001). One might argue that had the traditional varieties been used with the new agricultural technology, then the advances in yield observed starting in the early 1950's would still have been observed. To simplify, the argument holds that the increase in yield is not due to the hybrid but rather to the farming practices. This argument is incorrect on two points: first, the hybrid varieties produce a more uniform ear at a more uniform height from the ground and the hybrid varieties do not lodge. Hence, the hybrid varieties are readily and more efficiently harvested by modern machinery. *See id*. at 73. Second, the hybrid varieties are more resistant to drought, disease, insects, and environmental stress, *see id.* at 71, as well as the stress of high production levels under conditions of high fertilizer usage, *see id*. at 73. Therefore, the hybrid varieties were necessary to permit the development and deployment of technological advances in agriculture since the early 1950s.

117. *See* Paul & Kimmelman, *supra* note 79.

in a position to force the USDA out of the business of seed distribution. In 1924, the gratuitous distribution of seeds and plants by the USDA was terminated.[118] It is interesting to note that the cooperation between the USDA and agricultural colleges continued to improve the understanding of plant genetics,[119] an effort that vastly assisted the seed manufacturers in their exploitation of their new found market in seeds and plants.

The farmer, by the mid 1920's, had lost control of and access to the inbred lines, and lacked the expertise and resources necessary to create first generation hybrid seeds. The farmer could only maximize his yield by purchasing first generation hybrid seeds from the commercial seed manufacturer.[120] Because the hybrid seeds afforded the seed manufacturing industry some protection for their market advantage, the emergence of the hybrid seed technology helped facilitate the dominance of the seed production and distribution by the seed manufacturers.

The government's exit from the program of collecting, producing and distributing seed varieties left the market open to commercial seed manufacturers. While it was not of interest to either the government or university researchers to obtain protection for the intellectual property in the germplasm lines that they had produced, the commercial seed manufacturers believed that such protection was critical. Legal prohibitions on propagation of the variety are a prerequisite to successful marketing of plant varieties that are not amenable to hybridization or inbred lines.

The seed manufacturers were faced with a set of difficult problems. First, the seed manufacturers would market a variety (non-hybrid) of seeds to the farmer and since the progeny crop was nearly identical to the parent crop, the farmer could sell the progeny to his neighboring farmers[121] through the mechanism of inter-farm commerce.[122] Second, the seed manufacturer would employ certain farmers to grow the seed crop and if the seed company failed to take the entire crop from the farmer, the farmer could sell the excess to his neighboring farmers.[123] Without intellectual property protection, and without the natural protection afforded through the hybrid seed lines, the seed manufacturers were creating their own competition in the farmers.[124]

While all new seed varieties represented the intellectual property of the seed manufacturers, the hybrid seed represented, in addition, a means for protecting that intellectual capital. The introduction of hybrid seed, while not eliminating the need for legal intellectual property protection, certainly reduced the possibility that the farmer would be a direct competitor to the seed manufacturer. The introduction of hybridization technology also accompanied the movement from the dependence upon

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118. *See* KLOPPENBURG, *supra* note 18, at 71.

119. *See* TRUE, *supra* note 29, at 255-60.

120. *See generally* FORBES & WATSON, *supra* note 36, at 231.

121. *See* KLOPPENBURG, *supra* note 18, at 72.

122. *See id.* at 47 and 61.

123. *See id.* at 72.

124. *See id.*

a centralized public institution for germplasm maintenance to privatization of the seed and plant industry. During the transition phase (in the early decades of the twentieth century) the farmer was left in the position of either depending upon the government for both inbred and hybridized seed lines[125] for both the first and subsequent generations of seeds, or, depending upon the commercial seed manufacturers, which would provide only the hybrid seeds.[126] The later option left the farmer in the unfamiliar territory of being unable to save seed from one planting cycle for use in the next planting cycle.[127] The result was that the farmer, by necessity, had to purchase new seed each planting cycle[128] and the well-established practice of saving seed for planting the next crop cycle had to be abandoned for most field crops; that the process of artificial selection and adoption of new and exotic plant species and varieties was effectively terminated; and the informal inter-farm commerce in most seeds ceased to exist.

Had the gratuitous seed program not existed, the seed manufacturers would have had incentives to expand earlier than they eventually did.[129] The seed manufacturers would have been motivated to develop techniques for protecting their market share from inter-farm commerce.[130] The result would have been that the development of the germplasm base would have been in the hands of the seed manufacturers and the vast array of individual farmers, with there first hand knowledge of plant husbandry, would have been excluded. The landscape of American agriculture might very well have looked considerably different today had the seed manufacturers been given an earlier entrance into the management of the American germplasm base-certainly to the detriment of agriculture in this country.

Between 1924 and 1970, three pieces of legislation were enacted which permanently changed the manner in which the seed and plant manufacturing industry operated. First, in 1924, Congress enacted legislation that terminated the gratuitous distribution of seeds to farmers by the federal government, causing the farmers to rely exclusively on private seed manufacturers.[131] Second, the Plant Patent Act of 1930[132] granted patent protection for asexually[133] reproduced plants. The Plant Patent Act of 1930 did not include sexually reproduced plants because it was thought that plants could not be reliably reproduced from seeds. Third, in 1970 Congress enacted the Plant Variety

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125. *See generally* Buttel & Belsky, *supra* note 39.

126. *See id.* at 114.

127. *See* R. C. Lewontin, *The Maturing of Capitalist Agriculture: Farmer as Proletarian*, 50 MONTHLY REV. 72-84 (July/August, 1998).

128. *See id.*

129. *See* KLOPPENBURG, *supra* note 18, at 54.

130. *See id.* at 61.

131. *See* Buttel & Belsky, *supra* note 39, at 113.

132. Plant Patent Act, Pub. L. No. 71-245, 46 Stat. 376 (1930) (current version at 35 U.S.C. § 161 (1994 & Supp. III 1997)).

133. Asexually reproduced plants are those which are the product of either grafting of part of one plant onto another, or the result of growing up cuttings from a parent plant.

Protection Act that provided intellectual property protection for sexually reproduced seed.[134] Subsequently, in 1980 the Supreme Court recognized patent protection in living organisms under 35 U.S.C. section 101.[135] The seed manufacturers now have the full weight of the law to apply against any farmer who would attempt the traditional practice of artificial selection of crop varieties.

Although the seed manufacturers were willing to take the profits that accrued when the federal government cancelled the program of collecting and distributing seeds, the manufacturers certainly were, and are, unwilling to bear the cost of research necessary to develop technologies underlying the new varieties. Such a position was clearly articulated by Renvan Sacher, then director of biological research at Monsanto Co., in his statement that by coupling the research talent available in American universities "with the development skills of American industry in general" the United States can remain at "the leading edge in biotechnology."[136] Sacher related Monsanto's position that "it is 'inconceivable' that industry support [for university research] will exceed 6 or 7 percent," with the balance coming from the government.[137] This position was codified into legislation enacted in the 1980's, which encouraged cooperation between federal agencies and private seed manufacturers.[138] The result of this cooperation between federal agencies or universities and the seed manufacturers is that the seed manufacturers have been able to enjoy a substantial profit margin from seeds developed with government assistance.[139] In the meantime, the farmer is left completely marginalized and subject to commercial and legal exploitation of the seed manufacturers.

B. Genetically Manipulated Plants

Genetic manipulation[140] has been most successfully employed[141] to create herbicide[142] and

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134. *See* Buttel & Belsky, *supra* note 39, at 113.

135. *See generally* Diamond v. Chakrabarty, 447 U.S. 303, 308-10 (1980).

136. *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16, at 63.

137. *See id.* at 64.

138. *See* Weiss, *supra* note 40, at A1.

139. *See* Melvin John Oliver, Jerry Edwin Norma Lee Glover Trolinder & Don Lee Keim, *Control of Plant Gene Expression*, U.S. PATENT NO. 5,723,765 (issued Mar. 3, 1998). The terminator seed technology, which is the subject of '765, was developed during collaboration between the government and Delta and Pine Land, Inc. The assignees were: "Delta and Pine Land Co. (Scott, MS) and The United States of America . . . (Washington, DC)." *Id.*

140. This author prefers the more precise term "genetic manipulation" to the more obtuse terminology "genetic engineering". Genetic engineering is, to the best of this author's ability to determine, the practice of applying engineering principles to genetics; very much as the terminology "chemical engineering" has been used to describe the practice of applying engineering principles to chemistry. Traditionally, the result of the practice of chemical engineering was the mass production of chemical compounds for the consumer market. The situation is significantly different in the case of "genetic engineering" where the focus of the practice is to insert a gene into the genome of an organism. Such activity more closely resembles the science of chemistry than the practice of engineering. "Genetic manipulation", by distinction, is far more descriptive of what actually occurs when the genome of an organism is manipulated in such as way as to introduce a particular gene.

insect[143] resistant field crops, although genetically modified plants resistant to certain other plant pathogens have been created.[144] Genetic manipulation involves harvesting a gene, or ideally multiple genes, from the donor organism and inserting the gene, or set of genes, into the target cell.[145] In the case of plants, the cell is induced[146] to produce a mature adult plant[147] in which the cellular machinery is caused to produce the desired protein or other molecule.[148] In the case of animals, it is not yet possible to produce an adult animal from a single donor cell in an *in vitro* culture system.[149] At the core of genetic manipulation technology lies the DNA molecule.

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141. Other applications of genetic manipulation technology have recently been employed. *See* Gerard F. Barry, Jan Willem de Weerd, Ganesh Murthy Kishore, Gerard Francis Barry & Marcia Lee Weldon, *Expression of Sucrose Phosphorylase in Plants*, U.S. PAT. NO. 6,222,098 (issued Apr. 24, 2001).

142. *See* Dilip M. Shah, Creve Coeur, Stephen G. Rogers, Robert Horsch & Robert T. Fraley, *Glyphosate-Resistant Plants*, U.S. PAT. NO. 4,940,835 (issued Jul. 10, 1990); Dilip M. Shah, Stephen G. Rogers, Robert B. Horsch & Robert T. Fraley, *Glyphosate-Resistant Plants*, U.S. PAT. NO. 5,188,642 (issued Feb. 23, 1993); Robert T. Fraley, Robert B. Horsch & Stephen G. Rogers, *Chimeric Genes for Transforming Plant Cells Using Viral Promoters*, U.S. PAT. NO. 5,352,605 (issued Oct. 4, 1994); Robert T. Fraley, Robert B. Horsch & Stephen G. Rogers, *Chimeric Genes for Transforming Plant Cells Using Viral Promoters*, U.S. PAT. NO. 5,530,196 (issued June 25, 1996).

143. Stephen G. Rogers, Leslie Brand, Robert B. Horsch, Robert T. Fraley, James Scott Elmer & David Bisaro, *Plant Vectors*, U.S. PAT. NO. 6,147,278 (issued Nov. 14 2000); Uwe Sonnewald, Marcus Ebneth & Ralf-Michael Schmidt, *Leaf-Specific Gene Expression in Transgenic Plants*, U.S. PAT. NO. 6,229,067 (issued May 8, 2001); Camille Deluca-Flaherty, Victor J. Chan, Liliana E. C. Scarafia & Karen J. Brunke, *Thiol Protease Inhibitor*, U.S. PAT. NO. 5,629,469 (issued May 13, 1997); Thomas Malvar and Amy Jelen Gilmer, *Hybrid* Bacillus thuringiensis *δ-endotoxins With Novel Broad-Spectrum Insecticidal Activity*, U.S. PAT. NO. 6,156,573 (issued Dec. 5, 2000).

144. *See* Brian J. Staskawics, Karen S. Century, Allan Shapiro, Peter P. Repetti & Douglas Dahlbeck, *Composition and Method for Plant Pathogen Resistance*, U.S. PAT. NO. 6,166,295 (issued Dec. 26, 2000).

145. *See generally* David Manspeizer, *The Cheshire Cat, the March Hare, and the Harvard Mouse: Animal Patents Open Up a New, Genetically-Engineered Wonderland*, 43 RUTGERS L. REV. 417 (1991).

146. *See* CAMPBELL, *supra* note 13, at 390.

147. *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16, at 33-39.

148. *See generally* Dan L. Burk, *Biotechnology and Patent Law: Fitting Innovation to the Procrustean Bed*, 17 RUTGERS COMPUTER & TECH. L. J., 1 (1991).

149. *See generally* Timothy A. Stewart, Erwin F. Wagner & Beatrice Mintz, *Human δ-Globin Gene Sequences Injected into Mouse Eggs, Retained in Adults, and Transmitted to Progeny*, 217 SCIENCE 1046-48 (1982). Leder and Stewart demonstrated that foreign gene sequences can be inserted into a mammalian genome, that after birth of the animal, the foreign gene sequences are present, expressed, and transmissible in mammals. A patent was issued for "transgenic non-human mammals." *See* Philip Leder & Timothy A. Stewart, *Transgenic non-human mammals*, U.S. PAT. NO. 4,736,866 (issued Apr. 12, 1988). *See also* I. Wilmut, A. E. Schnieke, J. McWhir, A. J. Kind & K. H. S. Campbell, *Viable Offspring Derived From Fetal and Adult Mammalian Cells*, 385 NATURE, 810-12 (1997); GINA KOLATA, CLONE: THE ROAD TO DOLLY, at 27-28 (1998) (examining the creation of Dolly and the future of mammalian cloning).

The double helical structure of the deoxyribose nucleic acid (DNA) molecule,[150] which carries the genetic information of the cell, was revealed in 1953 by Watson and Crick.[151] DNA consists of a sequence of nucleotides,[152] the exact linear sequence and expression of which determines the organism's characteristics.[153] A sequence of nucleotide triplets constitute a gene; multiple genes are in turn connected to form a chromosome. The creation of a successful transgenic plant requires, at least initially, that three identifications be completed: first, the identification of the plant pathology (whether fungal, parasitic, insect or herbal); second, the identification of the molecular compound that is key to resolving the pathology; and third, the identification of the genetic code (the gene) which ultimately leads the plant to express the desired compound or resistance.[154]

Transgenic organisms are produced by using the gene from a donor organism and placing it into the genome of the host organism. Neither the genus nor the species of the host organism necessarily need be the same as either the genus or species of the donor organism. The technology involved in transferring a gene from a donor organism to a host organism is known as recombinant DNA technology.[155] Recombinant DNA technology is comprised of several techniques: first, the use of

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150. It has since been discovered that DNA does not have a single unique helical structure, but has a set of stable structures depending upon environment, amongst other factors. *See* WILLIAM H. ELLIOT & DAPHNE C. ELLIOT, BIOCHEMISTRY AND MOLECULAR BIOLOGY 244 (1997).

151. *See* Francis Crick & James Watson, *Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid*, 171 NATURE 737 (1953).

152. For a comprehensible description of the construction and functioning of DNA in the cell, *See* Note, *Altering Natures Blueprint for Profit: Patenting Multicellular Animals*, 74 VA. L. REV. 1327, 1330-1333 (1988). Because the basic structure of the DNA molecule is of some import to this discussion, a brief review of the essentials follows. A single nucleotide consists of a backbone of sugar and phosphate molecules. *See* ELLIOT & ELLIOT, *supra* note 150, at 239. The phosphate-sugar backbone is connected to one of four base molecules: adenine (A), thymine (T), cytosine (C), and guanine (G). *See id.* at 240. The bases hydrogen bond to form pairs, A-T and C-G, with the phosphate-sugar backbone on the outside and the base pairs on the inside. *See id.* at 242. The phosphate-sugar backbone then form a polymer sequence, which naturally forms a double helical structure. Genes are groups of nucleotides, which are not necessarily contiguous. The encoding of a single amino acid, which is the building block of peptides and proteins, is found in each triplet of bases in the gene. *See* CHRISTOPHER K. MATHEWS AND K. E. VAN HOLDE, BIOCHEMISTRY 119 (1990).

153. It is known that not all of the nucleotides in the cellular DNA of an organism are "expressed", that is they do not all encode for proteins that are actually constructed by the cell. For instance, *Agrobacterium tumefaciens* was genetically manipulated by incorporating into its genome the nod and nif genes from the bacteria *Rhizobium*. While the transformed *Agrobacterium tumefaciens* infected the roots of an alfalfa plant and induced the formation of both root nodules and infection threads, the gene for nitrogen fixation failed to be expressed. *See* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16, at 51.

154. Introduction of a gene from one genus and species into another genus and species does not necessarily imply that the gene will be expressed. In fact, the plant cellular machinery requires a different nucleotide composition for expression than does the insect or animal genome. Therefore, the introduction of the *Bacillus thuringiensis*, a gram-positive bacterium, δ-endotoxin gene into maize may yield a genetically modified plant that does not express the desired δ-endotoxin. *See generally* Koziel, *infra* note 173.

155. Insertion of the donor DNA fragment into the host cell may be accomplished by a number of techniques. *See* generally BRUCE ALBERTS ET AL. MOLECULAR BIOLOGY OF THE CELL 199 (1983) (published by Garland

restriction enzymes to specifically cleave the DNA molecule at particular locations to extract the gene; second, identification of the desired sequence of DNA by its ability to bind a complementary nucleic acid sequence; third, amplifying, by cloning, the amount of the desired specific DNA sequence by integrating that sequence into a genetic element which is capable of rapid expansion, such as a plasmid or virus, and cloning that element in yeast cells or bacteria; and fourth, extraction of the desired cloned DNA sequence from the amplification culture; and sequencing of the nucleotides in a cloned DNA fragment.[156] These steps form only a small, but key, fraction of the steps involved in recombinant DNA technology. They are, however, by no means trivial and do not always succeed. Because gene expression depends upon a number of cellular level factors beyond the mere presence of the gene,[157] the gene may not function normally, if at all, in the host organism, and hence, will not produce the desired product.[158]

Advances in biotechnology have yielded techniques[159] for the introduction of genes from a non-plant species[160] into the genome of a plant species where the transformed cells of the plant species are able to produce fully fertile plants.[161] A favored technique in producing transgenic maize is the particle bombardment of embryonic maize cells.[162] These cells are then grown to yield fully fertile adult plants. These adult transgenic plants are crossed with non-genetically modified elite lines to produce the final, marketable seed product. By introducing the non-plant genes into elite maize lines, the time required to develop commercial transgenic hybrids can be significantly reduced.[163]

Altering the genetic construct of plants has been difficult despite the rapid advances in genetic manipulation technology.[164] Three primary reasons lie behind the slow progress of genetic manipulation of plants: first, identifying particular genes of interest is a complex and time-consuming

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156. *See id.*

157. *See generally* BOARD ON AGRICULTURE: AGRICULTURAL RESEARCH OPPORTUNITIES AND POLICY CONCERNS, *supra* note 16.

158. *See* Manspeizer, *supra* note 145, at 424.

159. *See generally* HOUSE COMM. ON JUDICIARY, TRANSGENIC ANIMAL PATENT REFORM ACT, H.R. REP. NO. 888, 100th Cong., 2d Sess. 28-35 (1988); Booth, *Simple Gene-Altering Method Claimed*, WASH. POST, June 2, 1989, at A3, col. 1; Schmeck, *Simplified Gene Transplant Method Reported*, N. Y. TIMES, June 2, 1989, at A1, col. 2.

160. *See* J. S. Feitelson, J. Payne & L. Kim, Bacillus thuringiensis*: Insects and Beyond*, 10 BIO/TECHNOLOGY 271 (1992).

161. *See* W. J. Gordon-Kamm et al., *Transformation of Maize Cells and Regeneration of Fertile Transgenic Plants* 2 PLANT CELL 603 (1990).

162. *See* Paul Christou, Dennis McCabe, William F. Swain & Kenneth A. Barton, *Particle-Mediated Transformation of Soybean Plants and Lines*, U.S. PAT. NO. 5,015,580 (issued May 14, 1991).

163. *See* KOZIEL, *infra* note 173, at 168.

164. *See* CAMPBELL, *supra* note 13, at 390.

process;[165] second, gene expression may change when the gene is placed into the host cell;[166] and third, some desirable traits require the transfer of multiple genes which yields extremely difficult genetic manipulation problems.[167] Despite the difficulties involved in genetic manipulation technology, the products of genetic manipulation technology are extremely profitable for seed companies.[168] This profitability and the use of genetically manipulated seeds by farmers appears to have permanently altered the agricultural landscape.[169]

C. Development of Transgenic Plants

The most significant systematic source of yield loss in world agricultural crops is insect pests.[170] For example, the loss in the North American maize crop due to the European corn borer, *Ostrinia nubilalis* (Hübner) is in excess of $1 billion annually.[171] Some crop species or varieties express natural insect resistance,[172] which provides at least some protection for that particular species or variety.[173] When the resistance is found to be endogenous to a particular variety of a crop species, it

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165. *See id.*

166. *See* David Ehrenfeld, *A Techno-Pox Upon the Land*, 295 HARPER'S MAG. 13-17 (Oct. 1, 1997).

167. *See* CAMPBELL, *supra* note 13, at 390.

168. *See* Scott Kilman & Susan Warren, *Old Rivals Fight for New Turf*, WALL STREET J., May 27, 1998, at B1.

169. Indeed, genetically modified seeds appear to have been widely accepted by farmers in the United States. Given the global resistance to genetically modified crops, the lower yields and higher herbicide use associated with the use of these plants, the contamination of the human food chain with crops not approved for human consumption, and questions regarding the safety and environmental impact of genetically modified plants it is not clear that acceptance of the current generation of genetically modified plants by farmers will continue to be the rule. Even in light of the admonition by Chief Justice Warren E. Burger that "the genetic research and related technological developments may spread pollution and disease, that it may result in a loss of genetic diversity, and that its practice may tend to depreciate the value of human life," *Diamond v. Chakrabarty*, 447 U.S. 303, 316 (1980), genetically modified seeds have had, and will continue to have, an enormous impact on American agriculture. Perhaps Justice Burger was correct in stating that, "it is sometimes better to bear those ills we have than fly to others that we know not of." *Id.* (internal quotation marks omitted).

170. *See* TRANSGENIC PLANTS, *supra* note 15, at 4, 12.

171. *See* J. F. Witkowski et al., *Bt Corn & European Corn Borer*, NCR PUBLICATION 602 (Univ. of Minnesota Extension Service, St. Paul, MN, 1997) (K. R. Ostlie, W. D. Hutchinson, and R. L. Hellmich, eds.). This manuscript is also *available at* www.extension.umn.edu/distribution/cropsystems/ DC7055.html (last visited Apr. 2 2001).

172. *See* COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS, GENETICALLY MODIFIED PEST-PROTECTED PLANTS: SCIENCE AND REGULATION 55 (2000) (report on the science and regulation of plants which have been genetically manipulated for increased pest resistance) [hereinafter COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS].

173. *See* Michael G. Koziel et al., *Transgenic Maize for the Control of European Corn Borer and Other Maize Insect Pests*, 792 ANNALS N. Y. ACAD. SCI. 164 (1996). This paper presents the scientific developments behind the production of a maize resistant to European corn borer and is directed towards an audience of scientists working in the areas of plant molecular biology, and as such is virtually impenetrable by laypersons. Since understanding the work is important in developing our argument for property rights in genetically manipulated plants, a review, reduced as much as possible to lay terms, is presented here. The study of this example is useful because the method is similar to that used to transfect other varieties or species to confer desired

may be moved to another variety through traditional plant breeding techniques. This is true whether the resistance is to plant pathogens, insects, or to herbicide since what is actually being moved by conventional cross-breeding techniques is the gene, or genes, which confer the resistance. While successful in some cases, the traditional plant breeding technique for moving the resistance between varieties of the same plant species is counter-indicated on three points: first, the traditional breeding technique is often time-consuming and can take as long as ten years to yield the final product;[174] second, the genes that carry the resistance may be tightly linked with other genes which, when transferred with the desired gene, may have a deleterious effect on yield from the final plant product; and third, the desired gene conferring the resistance simply does not exist in the particular plant species. In most cases, these three situations are neither exclusive nor independent. Therefore, the desired resistance cannot, in general, be obtained in a particular plant variety by traditional plant breeding techniques. Alternative routes of control include insecticides for control of insect pests in agriculture, and herbicides for control of weeds. Broadcasting herbicides may be problematic because many herbicides are unable to distinguish between the desired plant and the noxious plant. Chemical insecticides have proven valuable for controlling insect pests in most areas. However, insecticides are expensive, and can adversely affect human health as well as the environment.[175] These factors militate an increase in the use of insecticides in agricultural practice. Early efforts of producing transgenic plants were motivated by the need to reduce the use of herbicides and insecticides and increase the overall yield per acre of crops. That is, the motivation for creating transgenic crops was to increase productivity and reduce inputs, which is similar to the motivation for using the process of artificial selection and plant breeding. Through genetic manipulation, the plant can be induced to produce its own resistance.[176] One of the most successful examples of this strategy is genetically modified corn, or maize.

Maize is one of the most important crops in the United States. Through traditional breeding practices, the yields of modern maize varieties have seen substantial improvements in the course of the last century.[177] As previously mentioned, maize is subject to insect pests, in particular the European corn borer, *Ostrinia nubilalis*. The European corn borer has two generations per year in most growing regions in the United States. The first generation larvae feed on the tissue in the corn

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resistance characteristics.

174. While the argument that the time required to create transgenic plants that express particular traits should be shorter than that required for traditional breeding methods is popular, it is essentially without merit. In fact, the time required to produce a transgenic plant product is nearly the same as that required to produce a plant product using traditional breeding techniques. *See* Ronald L. Meeusen, *Commercialization of Transgenic Seed Product: Two Case Studies*, 792 ANNALS N. Y. ACAD. SCI. 172 (1996).

175. *See* TRANSGENIC PLANTS, *supra* note 15, at 5.

176. *See, e.g.*, R. B. Horsch, J. E. Fry, N. L. Hoffmann, D. Eichholtz, S. G. Rogers & R. T. Fraley, *A Simple and General Method for Transferring Genes into Plants*, 227 SCIENCE 1229 (1985) (describing a method for transferring the nopaline synthase gene and the chimeric NOS/ NPTII/ NOS gene for kanamycin resistance into *Nicotiana tabacum* Samson, *N. tabacum* Havana 425, F_1 hybrid of Petunia hybrida and L-2 tomato plants using *Agrobacterium tumefaciens* strain (GV3Ti11SE)).

177. See Appendix A for a discussion of the economics of maize production in during the years between 1866 and 2001, and Appendix B for a discussion of the methods of data analysis used to develop the discussion in Appendix A.

whorl and then bore into the stalk, where they continue to feed and grow.[178] These larvae then pupate within the stalk and subsequently emerge as adult moths. The second generation of larvae feed on the pollen that has accumulated in the leaf axials, sheath, and collar tissue before boring into the stalk. In the stalk these larvae repeat the same cycle as the first generation larvae. The European corn borer spends most of its life cycle in the corn stalk; consequently disrupting the normal physiologic plant processes.[179] The result can be between three and seven percent yield loss for each insect in each plant.[180] Traditional breeding techniques provide limited success in producing hybrid, or inbred, maize lines which control the European corn borer in general and the second-generation European corn borer larvae in particular.[181] The use of conventional chemical insecticides has proven to be of limited value in controlling the European corn borer because the insect spends very little time feeding on the exterior of the plant.[182] Also, those exterior plant tissue regions which are favored by the first and second generation European corn borer are difficult to reach with chemical insecticide sprays.[183] Recently, biologic insecticides have been developed which have been proven to be of some limited efficacy in controlling insect pests. The most common of the biologic insecticides are those based on microbial sprays that employ the fermentation of gram-positive bacterium, which is typically *Bacillus thuringiensis* (Bt). However, the biologic insecticidal sprays face the same practical constraints as do the chemical insecticidal sprays.[184] In addition to the problems discussed above, several other points lead to early attempts to induce maize to produce its own insecticide.

It was observed that the δ-endotoxins produced by Bt have a high specific activity towards a relatively narrow spectrum of insect pests,[185] including the European corn borer. Early in the process of developing techniques for plant transformation,[186] it was determined that a possible method of controlling boring insects would induce the plants to express the δ-endotoxins.[187] Biotechnology provided the tools that allow the insertion of specific genes into the genome of the target, or host, cells. Once the gene[188] is inserted into the genome, the trait related to that particular gene may be

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178. *See generally* Witkowski, *supra* note 171.

179. *See id.*

180. *See generally* R. E. Lynch, European Corn Borer: *Yield Losses in Relation to Hybrid and Stage of Corn Development*, 73 J. ECON. ENTOMOL. 159 (1980).

181. *See generally* Koziel, *supra* note 173.

182. *See generally* Witkowski, *supra* note 171.

183. *See generally* Koziel, *supra* note 173.

184. *See id.*

185. *See generally* Witkowski, *supra* note 171.

186. The first reports of plant transformation were presented at the Miami Winter Symposium in January 1983. *See generally* Meeusen, *supra* note 174.

187. *See generally* Meeusen, *supra* note 174; *See generally* Lynch, *supra* note 180.

188. A gene consists of deoxyribonucleic acid, which is a hetero-polymer of nucleotides. A nucleotide is composed of a backbone of sugar and phosphate molecules, to which one of four bases is attached. The four different types of bases are: adenine (A), thymine (T), cytosine (C), and guanine (G). Every three bases in order

expressed as any other trait of the plant. Thus, insect resistance may be conferred upon the maize plant by inserting the relevant gene, or genes, into the plant genome. In the case of maize, the δ-endotoxin of early interest was CryIA(b) from the *Bacillus thuringiensis kurstaki* strain HD-1.[189]

The CryIA(b) δ-endotoxin protein is approximately 130 kDa in size and the amino-terminus half of the protein is proteolytically active in the insect midgut.[190] Insertion of the native gene for a δ-endotoxin into the genome of plants[191] has been successful in some circumstances,[192] but has been determined to depend, in part, upon the particular promoters employed for expression[193] and, in part, upon the particular codon usage preference of the plant.[194] When the native gene for *Bacillus thuringiensis kurstaki* kurhd1 δ-endotoxin CryIA(b) was inserted into maize, the endotoxin was not expressed.[195] When a synthetic gene for only the active region of the CryIA(b) protein, which contained approximately 65 percent G-C content as compared with approximately 37 percent in the native form, was inserted into maize, high levels of CryIA(b) δ-endotoxin protein were expressed.[196]

To create the final maize product, the synthetic gene was fused with several promoters[197] inserted

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are called a codon, and each codon codes for a specific amino acid (of which there are 24). For example, the sequence CTA-AGG-GTC codes for the amino acid sequence leucine-arginine-valine. Amino acids make up all proteins, and proteins, in turn, are responsible for the manufacture of every molecule that comprises an organism. *See* Note, *Altering Nature's Blueprint for Profit: Patenting Multicellular Animals*, 74 VA. L. REV. 1327, 1330-33 (1988).

189. *See* M. S. Geiser, S. Schweitzer & C. Grimm, *The Hypervariable Region in the Genes Coding for Entomopathogenic Crystal Proteins of* Bacillus thuringiensis*: Nucleotide Sequence of the* kurhd 1 *Gene of Subsp.* kurstaki *HD-1*, 48 GENE 109 (1986).

190. A nice brief discussion of the mechanism of activity is given by Robert Shields. *See* Shields, *infra* note 204, at 12.

191. *See* M. Vaeck et al., *Transgenic Plants Protected From Insect Attack*, 328 NATURE 33 (1987).

192. *See* K. A. Barton et al., Bacillus thuringiensis*delta-endotoxin expression in transgenic Nicotiana tabacum Provides Resistance to Lepidopteran Insects*, 85 PLANT PHYSIOL. 1103, (1987); D. A. Fischhoff et al., *Insect Tolerant Transgenic Tomato Plants*, 5 BIO/TECHNOLOGY 807 (1987).

193. *See* N. B. Carozzi et al., *Expression of a Chimeric CaMv 35S* Bacillus thuringiensis *Insecticidal Protein Gene in Transgenic Tobacco* 20 PLANT MOLECULAR BIOLOGY 539 (1992); G. W. Warren et al., *Field Evaluation of Transgenic Tobacco Containing a* Bacillus thuringiensis Insecticidal *Protein Gene*, 5 J. ECON. ENTOMOL. 1651 (1992); X. Delannay et al., *Field Performance of Transgenic Tomato Plants Expressing the* Bacillus thuringiensis *var.* kurstaki *Insect Control Protein*, 7 BIO/TECHNOLOGY 1265 (1989).

194. *See* E. E. Murray, J. Lotzer & M. Eberle, *Codon Usage in Plant Genes*, 17 NUCLEIC ACIDS RES. 477 (1989).

195. *See generally* Michael G. Koziel et al., *Field Performance of Elite Transgenic Maize Plants Expressing an Insecticidal Protein Derived from* Bacillus thuringiensis, 11 BIO/TECHNOLOGY 194 (1993).

196. *See* Koziel, *supra* note 173, at 166.

197. *See generally* R. L. Hudspeth & J. W. Grula, *Structure and Expression of the Maize Gene Encoding the Phosphoenolpyruvate Carboxylase Isozyme Involved in C4 Photosynthesis*, 12 PLANT MOLEC. BIOL 579 (1989); C. J. Thompson et al., *Characterization of the Herbicide-Resistance Gene Bar from Streptomyces hygroscopicus* 6 EMBO J. 2519 (1987).

into the genome, and the progeny plants were cross-bred with several different pristine elite maize inbred lines using traditional breeding techniques.[198] Because the promoter sequence may be tissue type specific,[199] it is theoretically possible to limit the tissues within the maize plant in which the δ-endotoxin protein is actually expressed, even though every cell in the plant may contain the gene coding for the protein. It is possible, then, to develop transgenic maize plants that do not express the transgenic protein in the edible portion of the plant.[200] However, such a transgenic plant has yet to be produced. Because the transgenic maize is an article of manufacture, the European corn borer resistant maize expressing the CryIA(b) δ-endotoxin protein is protected under utility[201] patent.[202]

A central concern to farmers, seed manufacturers, the Environmental Protection Agency,[203] and the public[204] is the development of Bt δ-endotoxin protein resistance in targeted insect types.[205] One

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198. *See generally* KOZIEL, *supra* note 195.

199. *See generally* KOZIEL, *supra* note 173.

200. *See* M. E. Fromm et al., *Inheritance and Expression of Chimeric Genes in the Progeny of Transgenic Maize Plants*, 8 BIO/TECHNOLOGY 833 (1990).

201. *See* U.S. Congress Office of Technology Assessment, NEW DEVELOPMENTS IN BIOTECHNOLOGY: PATENTING LIFE-SPECIAL REPORT 13 (1989).

202. *See* Gregory W. Warren Michael G. Koziel, Martha A. Mullins, Brian Carr, Nalini M. Desai & Kristy Kostichka, *Pesticidal Proteins and Strains*, U.S. PAT. NO. 5,840,868 (issued Nov. 24, 1998) ("The present invention is drawn to pesticidal strains and proteins. Bacillus strains which are capable of producing pesticidal proteins and auxiliary proteins during vegetative growth are provided. Also provided are the purified proteins, nucleotide sequences encoding the proteins and methods for using the strains, proteins and genes for controlling pests." *Id.* at 1.); Gregory W. Warren, Michael G. Koziel, Martha A. Mullins, Gordon J. Nye, Brian Carr, Nalini M. Desai, Kristy Kostichka, Nicholas B. Duck & Juan J. Estruch, *Pesticidal Proteins and Strains*, U.S. PAT. NO. 5,849,870 (issued Dec. 15, 1998) ("The present invention is drawn to pesticidal strains and proteins. Bacillus strains which are capable of producing pesticidal proteins and auxiliary proteins during vegetative growth are provided. Also provided are the purified proteins, nucleotide sequences encoding the proteins and methods for using the strains, proteins and genes for controlling pests." *Id.* at 1.); Gregory W. Warren Michael G. Koziel, Martha A. Mullins, Gordon J. Nye, Brian Carr & Nalini M. Desai, *Pesticidal Proteins and Strains*, U.S. PAT. NO. 5,872,212 (issued Feb. 16, 1998) ("The present invention is drawn to pesticidal strains and proteins. Bacillus strains which are capable of producing pesticidal proteins and auxiliary proteins during vegetative growth are provided. Also provided are the purified proteins, nucleotide sequences encoding the proteins and methods for using the strains, proteins and genes for controlling pests." *Id.* at 1.); Gregory W. Warren, Martha A. Mullins & Annick J. de Framond, *Pesticidal Proteins and Strains*, U.S. PAT. NO. 5,888,801 (issued Mar. 30, 1999) ("The present invention is drawn to pesticidal strains and proteins. Bacillus strains which are capable of producing pesticidal proteins and auxiliary proteins during vegetative growth are provided. Also provided are the purified proteins, nucleotide sequences encoding the proteins and methods for using the strains, proteins and genes for controlling pests." *Id.* at 1.); Gregory W. Warren, Michael G. Koziel, Martha A. Mullilns, Gordon J. Nye, Brian Carr, Nalini M. Desai, Kristy Kostichka & Juan J. Estruch, *Nucleotide sequences encoding pesticidal proteins*, U.S. PAT. NO. 5,889,174 (issued Mar. 30, 1999) ("The present invention is drawn to pesticidal strains and proteins. Bacillus strains which are capable of producing pesticidal proteins and auxiliary proteins during vegetative growth are provided. Also provided are the purified proteins, nucleotide sequences encoding the proteins and methods for using the strains, proteins and genes for controlling pests." *Id.* at 1.).

203. *See* COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS, *supra* note 172, at 100.

204. *See* Robert Shields, *Towards Insect-Resistant Plants*, 328 NATURE 12-13 (1987) (raising the issue of whether "widespread use of plants depending on a single gene encoding pest resistance" could be inviting the rapid development of insecticide resistance in insect pests, *id*. at 12).

argument holds that the concerns are based upon projections obtained from computer models that are sensitive to various parameters in the models.[206] The same argument also holds that where resistance has been observed in field situations or in the laboratory, the resistance was developed in isolated populations of insects that were exposed to sub-lethal concentrations of δ-endotoxin protein for relatively short periods.[207] It is further argued that the transgenic plants express high concentrations of δ-endotoxin protein to which the insects are exposed for an extended period.[208] Therefore, the argument concludes, the development of resistance in insects to Bt δ-endotoxin protein will not develop.[209] Recent reports have indicated that such a dismissive attitude toward the development of insect resistance to Bt δ-endotoxin protein is indeed misplaced.[210]

Because the selection among insect communities[211] for resistance to Bt δ-endotoxin protein is intense due to the large amount of transgenic plants being employed in the United States, the development of resistance[212] is, arguably, a given certainty. The U. S. Environmental Protection

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205. *See* W. H. McGaughey & M. E. Whalon, *Managing Insect Resistance to* Bacillus thuringiensis *Toxins*, 258 SCIENCE 1451 (1992).

206. *See* Koziel, *supra* note 173, at 168. This statement by Koziel is either disingenuous or based upon ignorance regarding the development and use of valid models. A central tenant of theoretical model development is that the essence of the system, which is being modeled, is captured in as simplistic a mathematical theory as possible with the fewest possible number of parameters. Within this last constraint, the model must incorporate as many known parameters as are available, thus reducing the number of unknown parameters to the bare minimum. Those parameters that are highly correlated (the correlation between the model parameters can be readily determined by considering the matrix product $J^T J$, where J is the jacobian matrix) should be redefined to eliminate the correlation, and those parameters that influence the variability in the independent parameters should be eliminated entirely. The resultant model, then, will have only a few parameters; the remaining parameters will be uncorrelated, and small variances in the resulting parameters will have a significant affect upon the predicted value of the independent variable. Given these basic rules, then, it is easy to see that Koziel's dismissal of the predicted development of δ-endotoxin tolerance by the European corn borer, because such predictions are based upon the sensitivity of parameters in the model, is equivalent to a complete dismissal of the basic rules underlying theoretical model development. Alternatively, such a dismissal is simply a statement that if Koziel claims that δ-endotoxin tolerance will not develop in the European corn borer, then that is the way that reality actually works. The conclusion to be drawn from the first analysis is that the dismissal is based upon ignorance regarding the area of theoretical model development and use; the conclusion to be drawn from the second analysis is that such dismissals are disingenuous. In fact, the predictions of a well-developed theoretical model can be quite accurate and should be seriously considered.

207. These conditions constitute the so-called "acute" exposure selection.

208. *See* Koziel, *supra* note 173, at 166.

209. *See id.*

210. *See generally* F. Huang et al., *Inheritance of Resistance to* Bacillus thuringiensis *Toxin (Dipel ES) in the European Corn Borer*, 284 SCIENCE 965 (1999).

211. *Bacillus thuringiensis* δ-endotoxin resistance has been observed in approximately fifteen laboratory colonies of insect pests, including: Indian meal moth, tobacco budworm, beet armyworm, pink bollworm and Colorado potato beetle. Also, *Bacillus thuringiensis* δ-endotoxin resistance has been observed in the diamondback moth in field populations of cole crops in Hawaii and Florida. *See generally* Witkowski, *supra* note 171. There are a growing number of observations of insect resistance to the *Bacillus thuringiensis* δ-endotoxin in the field, requiring spraying with traditional insecticides.

212. An understanding of the development of resistance to Bt protein has been developed through studies of

Agency (EPA) has recognized this possibility and has taken an active role in developing resistance management programs[213] to secure the long-term utility of the Bt technology.[214] The currently employed management strategy is the "high-dose[215] /refuge"[216] strategy[217] in which approximately 20 percent of the farmer's fields are to be planted with a non-genetically modified variety of the species.[218] The refuge area serves as a breeding ground for non-resistant insects. Assuming that the insect genes promoting resistance are recessive or partially recessive,[219] those rare insects, which

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resistance development in many insects and through studies of *Bacillus thuringiensis* δ-endotoxin resistance by tobacco budworm and diamondback moth in particular. Specifically, in any given population of European corn borers a fraction of the insects will have no copies of the gene for *Bacillus thuringiensis* δ-endotoxin resistance (ss), a fraction will have one gene (rs), and a small fraction will have two genes (rr). Those (rr) and (rs) individuals could survive and produce offspring after feeding on Bt corn. With an increase in the acreage of Bt corn, increase in time of exposure of an increasing population of resistant individuals, more (rs) or (rr) larvae could survive to adulthood. The fraction of the European corn borer population which carry Bt resistance genes would increase until a control failure occurs. At that point, the population of Bt resistant insects would be similar to those levels found in non- *Bacillus thuringiensis* fields. *See id.*

213. *See generally* B. E. Tabashnik, *Evolution of Resistance to* Bacillus thuringiensis, 39 ANNU. REV. ENTOMOL. 47 (1994).

214. *See generally* McGaughey & Whalon, *supra* note 205; EPA and USDA Position Paper on Insect Resistance Management in Bt Crops, (1999) *available at* http://www.epa.gov/pesticides/biopesticides/otherdocs/bt-position-paper-618.htm. *See also* COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS, *supra* note 172, at 97-101.

215. The Bt crops, particularly corn, were designed to produce levels of Bt δ-endotoxin protein in concentrations that are much higher than levels found on corn treated with endogenous Bt insecticides. It is presumed that with such high concentrations of Bt δ-endotoxin protein, those individuals with no resistance gene and those with a single resistance gene would not survive to adulthood. If the level of Bt δ-endotoxin protein is not sufficiently high, and if (rs) individuals survive, then they would mate with other (rs) individuals or with (rr) individuals. The result would be a population of individuals that are resistant to the Bt δ-endotoxin protein. *See* Witkowski, *supra* note 171.

216. The second prong of the resistance management strategy is the use of refuges. The refuge provides a population of insects that are not exposed to either plants expressing Bt protein or to Bt insecticides, which could mate with individuals from the non-refuge areas that are resistant to the Bt protein. Since the population of non-resistant insects produced by the refuge areas is considerably higher than the population of resistant insects produced by the non-refuge areas, then the probably of two resistant moths mating and producing a resistant progeny is very small. For this strategy to work, the resistant and non-resistant insects must emerge into adulthood at the same time, and the two populations must be close enough to mate. Most plans are designed so that approximately 20-30% of the fields are non-Bt corn, and the non-Bt corn is immediately adjacent to the Bt corn fields. *See id.* at 15.

217. *See* McGaughey & Whalon, *supra* note 205.

218. Whether the refuge strategy is actually employed by the farmers is subject to serious doubt. Mr. Dallas Thomason was found guilty of not employing the refuge strategy for the Bt cotton that he planted without a technology-use license. Evidently, failure to employ the refuge strategy is a common practice, even amongst farmers who have signed the technology-use license requiring the refuge area, because it is too cumbersome to implement. It is a sad irony that Monsanto pursued Mr. Thomason so aggressively as to drive him into bankruptcy for, in part, engaging in exactly the same practice, of failing to use the refuge strategy, that his neighboring farmers employ. *See* Interview: Thomason, *supra* note 7.

219. *See generally* F. Huang, R. A. Higgins, and L. L. Buschman, *Baseline Susceptibility and Changes in Susceptibility to* Bacillus thuringiensis *subsp.* kurstaki *Under Selection Pressure in European Corn Borer* (Lepidoptera: Pyralidae), 90 J. ECON. ENTOMOL. 1137 (1997).

manage to survive a high-dose of Bt δ-endotoxin protein would be highly unlikely to find a Bt resistant mate.[220] Rather, it would be highly likely that their mate would be non-resistant. Assuming that the gene conferring Bt resistance is recessive, the gene would not be expressed in the progeny from the mating of the resistant and non-resistant insect.[221] There would be either no or minimal growth in the population of resistant insects. To function properly, the "high-dose/refuge" strategy requires first, that the heterozygotes for Bt resistance be killed by highly toxic plant tissue; second, that the resistant alleles are very rare; third, that non-resistant insects are within an effective mating distance for resistant insects[222] such that when the resistant adults emerge from the Bt plants and the susceptible adults emerge from non-Bt plants synchronously there is a high probability that the resistant adults will find a susceptible adult with which to mate. If developmental asynchrony occurred in the field, then assortive mating among *Bacillus thuringiensis* δ-endotoxin resistant moths would accelerate the evolution of resistance.[223] That the resistance to Bt δ-endotoxin protein in the European corn borer, *Ostrinia nubilalis*, is incompletely dominant rather than recessive[224] raises serious doubts about the efficacy of the currently employed "high-dose/refuge" strategy for managing Bt resistance in insects. Further, in the near future transgenic plants containing *Bacillus thuringiensis* δ-endotoxin will be ineffective against insect pests with probability unity. A similar phenomenon will occur in the case of herbicide resistant field crops. In that case, however, it is the noxious weeds that become resistant and may require the development of new, more potent herbicides to kill the weeds, or return to the use of traditional herbicides such as 2,4-D.

D. Intellectual Property and Its Protection by Patent Law

Currently, intellectual property includes intangible goods such as copyrights, trademarks, and patents, as well as that information retained in the private mind. This perspective on intellectual property leads to confusion,[225] muddled analyses, and imprecise conclusions[226] when defining

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220. *See* McGaughey & Whalon, *supra* note 205.

221. *See* Huang, *supra* note 219.

222. *See* Tabashnik, *supra* note 213.

223. *See* Yong-Biao Liu, Bruce E. Tabashnik, Timothy J. Dennehy, Amanda L. Patin & Alan C. Bartlett, *Development Time and Resistance to Bt Crops*, 400 NATURE 519 (5 August 1999).

224. *See* Huang, *supra* note 210.

225. For example, an essay published by the United States Department of State states that intellectual property includes "patents, trademarks, copyrights, and trade secrets" which, the essay pronounces, are "collectively referred to as intellectual property" (internal quotations deleted). *See* Laurence R. Hefter and Robert D. Litowitz, *What is Intellectual Property*, *available at* http://usinfo.state.gov/products/pubs/intelprp. The authors further state that the "intellectual property owner has the right to prevent the unauthorized use or sale of the property." *Id*. It is well established in trade secret law that others may indeed use or sell the trade secret provided that they discovered the subject matter of the trade secret by themselves or obtained the subject matter using "good faith" methods. This is because once others have knowledge of the subject matter of the trade secret then it is "public knowledge" and is no longer secret. *See* B. F. Goodrich Co. v. Wohlgemugh, 192 N. E.2d 99 (C. A. Ohio 1963) (stating that the "subject matter of a trade secret must be secret, and matters of public knowledge or of general knowledge in an industry cannot be classified as trade secrets," *id*. at 104). Therefore, the statement that the provisions of trade secret law and patent law uniformly "prevent the unauthorized use or sale of property" is not only misleading and confusing, but also patently incorrect.

property and property rights in inventions in general[227] and with regard to genetically modified plants in particular. In order to avoid such a morass, it is important to be precise in defining intellectual property[228] as the collection of inherent exclusive rights, granted by law, which are vested in an individual as the result of the physical manifestation of his original thought.[229] A physical manifestation of the original thought is required because it is the only manner by which the originator of the thought can present proof positive of the thought. It is all too easy to claim, after others have created a physical manifestation of that original thought, that one was the originator of the thought when there is no proof of such an assertion. The preceding definition prevents such unsubstantiated claims. The rights of property vest to the owner of the physical manifestation of the original thought, at the time that the physical manifestation occurs.[230] When the property rights vest, the intellectual

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226. By starting with the fundamental definition that "[p]atents, copyrights, trademarks and related interests are known as intellectual property," Thomas G. Field, *Intellectual Property: Some Practical and Legal Fundamentals*, 35 IDEA: J. L. AND TECH. 79 (1994), the analysis may lead to the very imprecise conclusions that patents are property, *see id.* at 93; copyrights are property, *see id.* at 101; trade secrets are property, *see id.* at 110; and that trademarks are property, *see id.* at 123. Any such conclusion is imprecise because it is not clear what, if anything may be protected by a cause of action. Indeed, it is a useless endeavor to "protect" patents, copyrights and trademarks when it is the physical manifestation of the original thought that the inventor wishes to protect (i.e. the intellectual property).

227. *See generally* Clare K. Hare, *Towards an Ontology of Intellectual Property* (1999), *at* http://wings.buffalo.edu/philosophy/farber/hare.html. The discussion by Hare was presented at the Conference on Ontology, which was held at University of Buffalo, New York. Hare argues, incorrectly, that the current "legal system puts almost every aspect of intellectual property into" either patent law, copyright law, or trademark law. *See id.* Further, Hare states, again incorrectly, that there "are currently two legal documents which define the limits of patent protection." *See id.* Hare continues to argue that the current ontology of intellectual property has lead to the current situation in which "there are categories of ideas and their expressions which are excluded from protection . . . no matter how useful or unique" including business methods. *See id*. Using this as a motivation, Hare presents and defends a new ontology for intellectual property which she asserts will lead to broader protection for new and developing technologies. The motivational basis of Hare's new ontology can be easily defeated: first, it is erroneous to classify patent, copyright and trademark protection as "intellectual property." Rather, patent, copyright and trademark law are vehicles for protection of intellectual property. Secondly, to state that the United States Constitution is a legal document which "define[s] the limits of patent protection" is to ignore the entire body of constitutional law. Indeed, Article I, of which Useful Arts Clause is part, grants powers to Congress to act in certain enumerated areas. The limits of the protection are defined in statute, which the Constitution grants Congress the power to enact. Third, usefulness and uniqueness (new) are only a subset of the elements that must be satisfied before a physical manifestation of original thought may be granted protection through patent law. Thus, the confusion with regard to intellectual property has little to due with ontology (and hence a new ontology is unnecessary) but with the lack of understanding amongst the judiciary as to what constitutes intellectual property and a lack of understanding about the interaction between the intellectual property and patent, copyright and trademark law.

228. Intellectual property has been defined as the inherent exclusive rights in the work and invention of the inventor which were developed by statutes and which are not lost by publication of the work or invention. *See* Frank D. Prager, *The Early Growth and Influence of Intellectual Property*, 34 J. PAT. OFF. SOC'Y. 106, 108 (1952). Before intellectual property may exist, there must be the creation of a physical manifestation of the original thought; and if the physical manifestation is an improvement on a prior physical manifestation, the improvement must be of some considerable merit. *See id.* at 139.

229. Manifestation of an original thought in physical form appears to be a required element for the courts to protect the property. For instance, the court in *Bowen v. Yankee Network, Inc.*, 46 F. Supp. 62 (D. Mass 1942), stated that original thought, or "[i]deas not reduced to concrete form are not protected." *Id.* at 63.

230. Such a position was clearly articulated by Mr. Justice Gray in *Peabody v. Norfolk*, 98 Mass. 452, 458 (Supreme Judicial Court, Mass 1868) as: if the inventor "invents or discovers, and keeps secret, a process of

property comes into being. The intellectual property is a creation of the law and does not exist until the law acts to bring it into being.[231] Under this construction, intellectual "property" is the collection of rights that define the relationship between the individual (or entity) and the physical manifestation of the original thought and, therefore, has the full protection of the Takings Clause of the Constitution.[232] Unlike tangible objects in which a single property right may vest only to a single entity at any given point in time, a single intellectual property right may vest in multiple entities at the same point in time.[233] When two or more entities reduce an original thought to physical form, and the original thought of each party was generated independent of all other parties, then property rights vest in each entity except the right to exclude others from using that original thought or its physical manifestation. However, if the knowledge of one party is "obtained by any breach of confidence" by another party, then disclosure by the acquiring party may be enjoined by the court.[234]

Under common law, intellectual property included the right to possess, use, and alienate the subject matter, but did not include the right to exclude others from possession, use, or alienation.[235] Early statutory patent law in the United States, preserved the common law rights and supplemented those rights with the right to exclude others from making, using, or alienating the subject matter of the physical manifestation.[236] Under modern statutes in the United States, intellectual property is defined and protected by several bodies of law depending on the type of intellectual property. This includes state trade-secret law[237] as long as the state trade-secret law does not conflict with Congress' constitutionally granted power to legislate protections for intellectual property,[238] patent,[239] copyright

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manufacture" then "he has a property in it, which a court of chancery will protect against one who . . . undertakes to apply it to his own use, or to disclose it to third persons." *Id.*

231. *See* Jeremy Bentham THE THEORY OF LEGISLATION (C. K. Ogden ed. 1931). Bentham takes the position that natural property does not exist, rather "it is entirely the work of law." *Id.* at 111. "Property and the law are born together, and die together. Before laws were made there was no property; take away laws, and property ceases." *Id.* at 113.

232. The Supreme Court in *United States v. General Motors Corp.*, 323 U.S. 373, 377-78 (1945), stated that the term property, as used in the Takings Clause of the Constitution, was used "to denote the group of rights inhering in the citizen's relation to the physical thing, as the right to possess, use and dispose of it." *Id.*

233. This distinction may very well have been apparent to Mr. Judge Gray when he stated that even though the property right is recognized, the inventor is not afforded, at common law, an "exclusive right to it as against the public, or against those who in good faith acquire knowledge of" the invention. *See* Peabody v. Norfolk, 98 Mass. 452, 458 (Supreme Judicial Court, Mass 1868).

234. *See* Thum Co. v. Tloczynski, 72 N.W. 140, 142 (Mich. 1897) (secrets confided in an employee may not be divulged to others upon termination of employment if a condition of the employment was that the employee should maintain the secret).

235. *See Norfolk*, 98 Mass. at 460.

236. *See* AN, *infra* note 243.

237. *See, e.g.*, Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 475-76 (1974) (stating that trade secret law protects the holder of the trade secret against disclosure by another through surreptitious means).

238. *See* Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 152 (1989). While the Florida statute at issue, extending "patent-like" protection to unpatented boat hull designs, was analyzed with respect to federal patent laws, the principle may naturally be extended to any state law defining and protecting intellectual property

and trademark law.[240] While the modern patent statute has eliminated the exclusive right of making, using, and selling of the invention, the intellectual property rights under modern patent statutes continue to embody the common law notions that the intellectual property vests when the original thought is manifest in its physical form.[241]

Pursuant to Article I, section 8 of the Constitution,[242] in 1790 Congress[243] created the United States patent[244] system.[245] Several policy arguments underlie the patent laws. One argument states that the patent laws were intended to give inventors an incentive to invent by granting protection for their original thought.[246] Another states that the public benefits from the disclosure of the intellectual property's subject matter.[247] This argument also includes the notion that patent protection

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which conflicts with federal laws that define and protect the same intellectual property.

239. *See, e.g.*, Aronson v. Quick Point Pencil Co., 440 U.S. 257, 259 (1979) (stating that the design of the keyholder "was so simple that it readily could be copied unless it was protected by patent").

240. It is recognized that trade secret law, copyright and trademark law are only peripheral to the discussion at hand, but they are included only to identify them as legal vehicles for protecting intellectual property.

241. *See* Frank D. Prager, *A History of Intellectual Property from 1545 to 1787*, 26 J. PAT. OFF. SOC'Y. 711 (1944) (arguing that the patent statute should be interpreted as declaratory of the common law doctrine of intellectual property).

242. "The Congress shall have power . . . to promote the progress of science and the useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." U.S. CONST. art. I, § 8, cl. 8.

243. Act of April 10, 1790, 2 ANNALS OF CONG. 2212, ch. 7, 1 Stat. 109 (1790). The 1790 Act, approved on April 10, 1790 by the First Congress, provided that "upon petition of any person or persons to the Secretary of State, the Secretary for the Department of War, and the Attorney General of the United States" either of the Secretary of State, Secretary of the Department of War or the Attorney General, or any two of them, may "cause letters patent to be made out in the name of the United States." Act of April 10, 1790, 2 ANNALS OF CONG. 2212 (1790) (the act is entitled: "An Act to Promote the Progress of Useful Arts"). The debates and proceedings of the First Congress were collected and printed by Gales and Seaton in THE DEBATES AND PROCEEDINGS IN THE CONGRESS OF THE UNITED STATES, (1834). The collection is also available through the American memory project at http://lcweb2.loc.gov/ammem/amlaw/lwac.html. The granting of power to three persons was eliminated by the Second Congress in 1793 such that only the Secretary of State could be petitioned for granting of letters patent. *See* Act of February 21, 1793, ch. 111, 1 Stat. 318-23 (1793) (the act published as: An Act to promote the progress of Useful Arts, and to repeal the Act heretofore made for that purpose, ANNALS OF CONG. 1431-35 (1793) (2d Cong. Sess. 2)).

244. It is imprecise to label the 1793 Act the "Patent Act" since the 1793 Act referred only to "Useful Arts" in its title, and because the word "patent" did not enter into the title of an act codifying the provision of Article I, § 8, cl. 8 of the Constitution until 1800. *See* Act of Apr. 17, 1800, 6 ANNALS OF CONG. 1473 (1800) (The act is entitled: "An Act to Extend the Privilege of obtaining patents for useful discoveries and inventions to certain persons therein mentioned, and to enlarge and define the penalties for violating the rights of patentees." It is collected and printed by Gales and Seaton in THE DEBATES AND PROCEEDINGS IN THE CONGRESS OF THE UNITED STATES, (1851)).

245. A complete discussion of the genesis of intellectual property protection by statute in the United States is given by BRUCE W. BUGBEE, THE GENESIS OF AMERICAN PATENT AND COPYRIGHT LAW 1 (1967). It seems unnecessary to review the genesis at this point.

246. *See id.* at 9.

247. *See* Andrew Beckerman-Rodau, *Are Ideas Within the Traditional Definition of Property?: A*

encourages, regulates, and manages competition amongst inventors.[248] Perhaps the clearest summary of the policy basis for patent protection rests upon two presumptions: that creative and original thought benefits society in general through the development and deployment of new technologies and improvement in existing technologies; and that individuals are stimulated to creative thought as a result of a government grant of limited exclusive property rights as incentives.[249]

Under modern federal statutes,[250] the Patent and Trademark Office (PTO) is authorized to grant a patent to an inventor for an invention. The subject matter[251] of a patentable invention is defined in 35 U.S.C. section 101.[252] Because section 101[253] extends patentability to a broad range of subject matter, it provides the primary incentive for an inventor to invent.[254] While section 101 is expansive in its definition of patentable subject matter, the corpus of patent law restricts the range of patentable subject matter. The invention must have "utility," that is, the function of the invention must be useful.[255] Neither the demonstrated perfection of operation nor commercial success of the invention

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Jurisprudential Analysis, 47 ARK. L. REV. 603, 649 (1994).

248. *See id.*

249. *See* BUGBEE, *supra* note 245, at 9. The common argument for the patent system is that the grant of exclusive rights in the patented invention acts as a stimulus for creativity. Consideration of the history of science indicates that this argument is without merit. Because of space constraints, we shall consider, briefly, only a single case. This case is chosen because the creativity of the patentee was already well known before the patent was granted. On September 15, 1594, Galileo Galilei was granted a patent in the Venetian Republic for a machine to raise water. *See id*. at 24. The motivation for Galileo to seek the patent was to prohibit the invention from becoming public property, and to permit him to accrue a pecuniary gain. *See id*. Galileo's creativity and genius are now legendary. In fact, Galileo clarified the mechanical structure of the solar system using relatively simple mechanics, see GALILEO GALILEI, DIALOGUE CONCERNING THE TWO CHIEF WORLD SYSTEMS, (1630) (translated by Stillman Drake and published in 1967). Also, Galileo developed the foundation of dynamics (the study of the motion of bodies) and the foundation of solid mechanics (the resistance of solid bodies to fracture by external forces), GALILEO GALILEI, DIALOGUE CONCERNING THE TWO NEW SCIENCES (Henry Crew ed. & trans., Dover Press 1954) (1638). Galileo faced considerable obstacles to publishing and distributing the results of his genius. In his later years, Galileo was certainly driven by *ad plenioren scientiam* rather than by pecuniary gain. Thus, the grant of a patent cannot be the underlying motive for his creativity. That Galileo did not patent either his telescope or the method of his observations tends to indicate his desire to further *scientiam* rather than enlarge his own wealth.

250. 35 U.S.C. sections 100-211, Patentability of Inventions and Grant of Patents.

251. *See* Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 152 (1989).

252. *See* 35 U.S.C. § 101 (1994).

253. The 35 U.S.C. § 101 definition of patentable subject "remained essentially unchanged for approximately 200 years." David Burke, *Animal Legal Defense Fund v. Quigg: Renewed Challenge to Animal Patents*, 59 UMKC L. REV. 409, 412 (1991).

254. In Kewanee Oil Co. v. Bicron the Court stated that: "[n]o patent is available for a discovery, however useful, novel, and nonobvious, unless it falls within one of the express categories of patentable subject matter of 35 U.S.C. § 101." *See* Kewanee Oil, 416 U.S. at 475-76.

255. *See* Application of Jacques George Pottier, Patent Appeal No. 7790, 376 F.2d 328 (C. C. P. A. 1967); E. I. du Pont de Nemours & Co. v. Berkeley & Co., 620 F.2d 1247, 1260 n.17 (8th Cir. 1980).

need be shown.[256] Patents cannot be granted for the discovery of fundamental laws of nature, physical phenomena, or abstract ideas[257] because such discoveries "are manifestations . . . nature, free to all men and reserved exclusively to none."[258] The subject matter of the patent must be novel and nonobvious.[259] Finally, the inventors must file a complete, full, and exact description[260] of the invention sufficient to enable any person skilled in the pertinent art to make and use the claimed invention.[261]

In return for the patent disclosure, the inventor is granted an exclusive right to use his invention for a period of years.[262] The Court stated, "[w]hen a patent is granted and the information contained in it is circulated to the general public . . . such additions to the general store of knowledge are of such importance to the public wealth that the Federal Government is willing to pay the high price of" twenty years after the filing of the patent application "of exclusive use for its disclosure, which disclosure, it is assumed will stimulate ideas and the eventual development of further significant advances in the art."[263] Disclosure of knowledge by the inventor to the public is one of the most important functions of the United States patent law system.[264] Furthermore, disclosure of the invention also encourages

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256. *See* E. I. du Pont de Nemours & Co. v. Berkeley & Co., 620 F.2d 1247, 1260 n.17 (8th Cir. 1980).

257. HOUSE COMM. ON JUDICIARY, 100TH CONG., 2D SESS. TRANSGENIC ANIMAL PATENT REFORM ACT, H. R. REP. NO. 888, at 40 (1988).

258. Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948) (internal quotation marks omitted).

259. *See* 35 U.S.C. § 102 (1994) (subsection (e) amended Nov. 29, 1999, Pub. L. No. 106-113 § 1000(a)(9), 113 Stat. 1501A-565 (S. 1948 § 4805); subsection (g) amended Nov. 29, 1999, Pub. L. No. 106-113 § 1000(a)(9), 113 Stat. 1501A-590 (S. 1948 § 4806)) and § 103 (1994) (amended Nov. 1, 1995, Pub. L. No. 104-41, § 1, 109 Stat. 3511; subsection (c) amended Nov. 29, 1999, Pub. L. 106-113, § 1000(a)(9), 113 Stat. 1501A-591 (S. 1948 § 4807)).

260. The Court has clearly stated that the "ultimate goal of the patent system is to bring new designs and technologies into the public domain through disclosure." *See* Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 151 (1989).

261. *See* 35 U.S.C. § 111-113 (1994). *See also In re* Moore, 439 F.2d 1232, 1236 (C.C.P.A. 1971). In the case of biotechnology, a full written description may be difficult if not impossible. Therefore, a sample of the genetic material (i.e. an aliquot of cells frozen in liquid nitrogen) must be deposited with a registered depository. *See generally In re* Lundak, 773 F.2d 1216 (Fed. Cir. 1985).

262. In *Kewanee Oil Co.*, the Court stated that the patent laws have fostered "a positive effect on society through the introduction of new products and processes of manufacture into the economy, and the emanations by way of increased employment and better lives for our citizens." Kewanee Oil, 416 U.S. at 481.

263. *Id.*

264. Justice Story once stated that:

> [p]atents for inventions are now treated as a just reward to ingenious men, and as highly beneficial to the public, not only by holding out suitable encouragements to genius and talents and enterprise; but as ultimately securing to the whole community great advantages from the free communication of secrets, and processes, and machinery, which may be most important to all great interests of society, to agriculture, to commerce and to manufacturers, as well as to the cause of science and art.

Blanchard v. Sprague, 3 F. Cas. 648, 650 (No. 1,518) (C.C.D. Mass. 1839).

other inventors to either improve on or design around the subject matter.[265]

The argument is established that an invention or discovery, which is a physical manifestation of an original thought, is the property of the person who made the invention or discovery. The property is his to dispose of as he pleases. However, once the invention or discovery is published to the general public, the person to whom it belonged may no longer assert property rights in the invention or discovery under common law. The inventor then has two alternatives: either keep the invention secret and use it as a trade secret or release it to the general public. If the discovery is used as a trade secret, then the inventor runs the risk that others, in good faith, may discover the invention. Once the invention is released to the public, the inventor may no longer control the intellectual property. If the invention is published, then the public benefits from the knowledge and others may use the knowledge to advance technology. However, the inventor is no longer able to profit from the exclusive use of the invention.

Through the grant of a patent, the inventor, or patentee, may retain his property rights in the invention while the public gains the benefit of the invention. The inventor benefits in several ways from the publication of his intellectual property in the form of a patent. First, when the intellectual property is published through the grant of a patent, the patentee retains exclusive property rights in that intellectual property. When the inventor chooses to keep his ideas and thought processes (the invention) secret, then he runs the risk that another will obtain the invention through either good faith observation of the physical manifestation or cleverness of another by independent original thought and work. In either case, the invention is published to the general public and the original inventor no longer retains any common law property rights in the invention. When a patent is granted then the inventor intentionally and purposefully publishes his invention as consideration for the retention of exclusive property rights in that invention. As a result, any other person who in good faith discovers the invention is prohibited, by statute, from enjoying the benefit of that discovery without the permission of the patentee.[266]

The second benefit, which accrues to the inventor by a patent grant is that the inventor retains control over the intellectual property. Because the inventor retains control, he may choose to either use the invention strictly for his own benefit or may license or sell the invention to others. The control is enforced because the statute authorizing the granting of a patent provides for a private right of action against any person who infringes the patent. That is, should any other person discover, by any means, or attempt to exercise the exclusive property rights granted to the patentee, then that person is an infringer and is subject to a private right of action brought by the patentee.

The public benefits from the publication of the intellectual property in the form of a patent for several reasons. First, the general public will have access to the ideas and thought processes behind the physical manifestation which will permit those interested to either use the invention to make, use, or sell the physical manifestation after the termination of the patent term; or to incorporate the thought

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265. *See* R. G. Adler, *Biotechnology as an Intellectual Property*, 224 SCIENCE 35, 358 (1984).

266. In the case of genetically modified plants, the holder of the patent grants the farmer permission to use and reproduce the genetically modified seed through a technology-use license. Failure to obtain the license subjects the farmer to liability that may be very large.

processes into their own inventive activity before the termination of the patent term. Second, by having access to the mental processes behind the physical manifestation, other inventors are encouraged, some by a profit motive, to "design-around" the old invention to create a new invention.[267] The process of designing around an old invention advances technology that advances commerce. Should the ideas and thought processes be kept secret and hidden from public view, then each inventor would necessarily have to go through the same, or substantially similar, thought processes to reach the same conclusion.[268] Such a system would be inefficient to the point of severely restricting the advancement of the "useful arts."

E. Property Rights

This discussion, focuses on the property rights attendant to genetically modified plants. To the seed manufacturers, these rights include the right to make a profit, the right to develop technology, and the right to exclude others from making a profit on that same technology. To some seed manufacturers, the property rights also appear to include the right to enter the premises of the farmer to test his plants (which requires taking some of the plants[269]), the right to pollute the farmer's fields,[270]

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267. It might be argued that the motive to design around a patent is strictly the profit motive associated with advancing science and technology. However, some consideration must be given to the validity of such an argument. Consider a doctoral student in chemical engineering who requires the use of a particular process for the extraction of a particular compound from biomass. It turns out that the compound and the process for extracting it are patented; and the patentee is charging a prohibitive amount for both the compound and licensing of the extraction process. Further, the compound is to be derivatized in the plant (biomass before harvesting) before extraction. The director of the laboratory and the University both believe that the patent is invalid and unenforceable; however, neither has the resources to either fight an infringement case nor pay the licensing fees. Further, the doctoral student simply does not have time to await resolution of the case before proceeding with his work (only to possibly encounter a similar obstacle in the near future).
Only two alternatives remain open to the director of the laboratory and doctoral student: either design around the patent; or abandon that particular line of inquiry. The latter alternative is being embraced at a worrisome rate in the academic arena. The former, while time consuming, can yield some progress with the project. However, whether the doctoral student or the director of the laboratory actually "profit" from the design around is open to serious debate. Certainly the design around may minimize the cost of advancing the inquiry, but unless the fruits of the inquiry are marketable, then the direct profitability of designing around the patent does not exist.

268. The strategy of relying on "trade secret" as a mechanism for protecting intellectual property would restrict advancements in science and engineering as well as inventive activity. The scientific and engineering fields rely on open and free exchange of ideas, data, and conclusions: which accounts for the voluminous scientific and engineering literature. The data, observations, and conclusions obtained by one investigator supports those of all other investigators working in either the same or closely connected fields of study (more frequently in recent years, the work of an investigator in one field may prove of considerable value to an investigator in a completely unrelated field even if the work is of only minor importance in its original field of study). It is the free exchange of data (that is the intellectual property) and ideas, which is the engine advancing modern science and engineering. Any mechanism that serves to restrict the free flow of data, ideas, conclusions in the scientific and engineering communities will eventually halt progress in these communities. While such mechanisms may profit those who impose them in the short term, the general public will be harmed in the long term because technological advancements will stagnate.

269. In the case of Mr. Dallas Thomason, agents for Monsanto entered his cotton fields and took samples of his cotton plants. Evidently, this entry and taking was committed without a valid warrant and without the permission of Mr. Thomason. *See* Interview: Thomason, *supra* note 7. Even if Monsanto had obtained a court order requiring Mr. Thomason to allow Monsanto to collect plant samples from his fields, Monsanto may still not exercise authority to enter and take the plants. Such an authority must rest only with the government and any permission for Monsanto to do so is relinquishing the police authority of the government to a corporation. An analogous situation is where representatives of a company enter a private residence because the company

and the right to the value of the farmer's crop after having polluted his fields.[271] To the farmer, these rights include the right to engage in the legitimate business practice of maximizing profit while minimizing input capital and labor costs, the right to save and replant seeds, and the right to dispose of his property as he deems fit. It may be argued[272] that there is no common law basis for the farmer to save and replant seeds from his own fields. The analysis leading to such a conclusion was based upon the common law doctrines of real property including: the prescriptive easement; the public trust doctrine; the doctrine of customary rights; and reliance by the public upon access to the property. These doctrines of property law are briefly reviewed here, as they will be useful in the ensuing analysis.

1. Legal Theories

It is textbook doctrine that rights in property dictate the relations between persons with regard to control of that property.[273] The law protects the rights of individuals in their property, including the liberty to use; the right to exclude others; the right to alienate; immunity from damage to the property; and immunity from expropriation.[274] Further, property law doctrine teaches that all rights in property do not necessarily vest in the same person at the same time, and that the property rights are not absolute.[275] In fact, it is common for the property rights to be shared between several different people depending upon the temporal epoch of the property.[276] In the case of genetically modified plants,

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suspects that stolen property may be found there. Such authority to enter and search must rest only with the government through its police power and not with a corporate entity.

270. Mr. Percy Schmeiser maintains that the wind will easily carry the canola seed across long distances. Sufficiently far, in fact, that genetically modified canola plants wind up dispersed in fields where it was never planted and, evidently, was blown a considerable distance by the wind from a road heavily traveled by trucks carrying canola seeds. In another case, genetically modified canola was found in a field where the farmer neither planted canola nor wanted such canola. The genetically modified plant when neither planted by the farmer nor desired by the farmer is defined as genetic pollution. The seed manufacturer, evidently, neither can nor desires to control such pollution. Telephone Interview with Mr. Percy Schmeiser, Farmer, Saskatchewan, Canada (July 6, 2001) [hereinafter Interview: Schmeiser{July 6, 2001}].

271. Federal Judge MacKay neither considered nor cared to consider the source of the genetic pollution found on Percy Schmeiser's land. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256, paragraph 31 (Fed. Ct. Canada 2001) *available at* http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html. Judge McKay further stated that: "[y]et the source of the Roundup resistant canola in the defendants' 1997 crop is really not significant for the resolution of the issue of infringement which relates to the 1998 crop." *Id.* ¶ 112. Judge McKay agreed with Monsanto's argument that the presence of the glyphosate-resistant plants on Mr. Schmeiser's farm was sufficient to find him guilty of patent infringement.

272. *See* Jeremy P. Oczek, *In the Aftermath of the "Terminator" Technology Controversy: Intellectual Property Protections for Genetically Engineered Seeds and the Right to Save and Replant Seed*, 41 B. C. L. REV. 627 (2000).

273. *See* JOSEPH WILLIAM SINGER, PROPERTY LAW: RULES, POLICIES, AND PRACTICES 3-4 (1997).

274. *See id.* at 4-5.

275. *See* JESSE DUKEMINIER & JAMES E. KRIER, PROPERTY 86 (3d ed. 1993).

276. *See* Joseph William Singer, *The Reliance Interest in Property*, 10 STAN. L. REV. 611, 665 (1987).

property rights in both the plant and the seed are shared between several distinct entities or individuals at any given moment in time.

There are several issues to be resolved regarding property rights in genetically modified plants. One is whether the farmer may dispose of the seeds and plants that he has grown in a manner he deems necessary. Oczek considered several legal theories and concluded that there is no common-law right for the farmer to save and replant seeds.[277] By arguing that common-law property doctrines relate only to real property, Oczek states that, "common law property right for farmers to save seed is difficult to recognize."[278] Such a conclusion is against the basic doctrine of property law in the United States, that personal and real property are treated essentially the same.[279] The law of property is left to the purview of the states under the United States Constitution,[280] and it is anticipated that variations will exist in the substantive law depending upon the state in which the cause of action is brought. Nonetheless, through study of the same property law doctrines used by Oczek, and by introducing a small aliquot of public policy argument, it is possible to come to a conclusion contrary to that arrived at by Oczek.

Oczek employed the doctrine of customary rights in his analysis of the farmer's right to save and replant seeds.[281] The doctrine of customary rights requires that a customary right be acquired only if seven elements are satisfied.[282] The acquisition of customary rights require that the right must be ancient, "exercised without interruption", "peaceable and free from dispute", reasonable, certain (which may be satisfied by visible boundaries to the use), obligatory (meaning the landowner does not have the option of deciding whether the property is used by the general public), and the use must not be inconsistent "with other customs or with other law."[283] Where the public has relied upon access to the property and has relied upon the allowance by the property owner of such access, the doctrine grants to the public an interest in continued use of the property.[284] The doctrine has been adopted

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277. *See* Oczek, *supra* note 272, at 651-52.

278. *Id.* at 652.

279. *See* ROGER A. CUNNINGHAM ET AL., THE LAW OF PROPERTY 11-12 (2d ed. 1993). Interests in cultivated crops are treated as either real property or personal property depending upon the circumstances. *Id.* With the merger of personal and real property law the distinction of whether cultivated crops are real property or personal property seems quaint at best and misleading at worst.

280. *See* Stevens v. City of Cannon Beach, 114 S. Ct. 1332 (Mem) (1994) (Justice Scalia and Justice O'Connor dissenting from the denial of certiorari. Case below was Stevens v. City of Cannon Beach, 854 P.2d 449 (Or. 1993)).

281. *See* Oczek, *supra* note 272, at 652.

282. *See* Erin Pitts, *The Public Trust Doctrine: A Tool for Ensuring Continued Public Use of Oregon Beaches*, 22 ENVTL. L. 731, 737 (1992) (recommending the use of the public trust doctrine over the doctrine of customary rights in protecting access to beaches in Oregon, and possibly elsewhere).

283. State *ex rel.* Thorton v. Hay, 462 P.2d 671, 676-78 (Or. 1969) (referring to Blackstone's traditional criteria for customary rights).

284. *See id.*

only by a small number of states[285] and in a narrow range of circumstances.[286]

The public trust doctrine was also considered by Oczek with the aim of resolving the issue of the farmer's right to save and replant seeds.[287] Historically, the scope of public trust law includes the land area below the low-water mark along the ocean coasts[288] and the coasts of the Great Lakes.[289] The purpose of the public trust doctrine is to have the public authority hold title to the land so that the people of the state "may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing therein freed from the obstruction or interference of private parties."[290] The Wisconsin Supreme Court articulated a clear definition of the public trust doctrine in a set of five factors.[291] These factors are:

> (1) the use of the affected area will be controlled by public bodies; (2) the affected area will remain open to the public and it will be devoted to public purposes; (3) the affected area will be small in comparison with the whole of the area held in public trust; (4) no one of the uses of the whole of the area held in public trust "will be destroyed or greatly impaired"; and (5) "[t]he disappointment of those members of the public who may desire" to use the affected area is "negligible when compared with the greater convenience to be afforded to those members of the public who use" the entire area held in public trust.[292]

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285. The doctrine of customary rights has been, most notably, adopted by Texas and Florida. In Texas, the public retained a right to use the beach above the high-water mark even though the original line of vegetation had been moved as a result of hurricane damage. *See* Matcha v. Mattox, 711 S.W.2d 95 (Tex. Civ. App. 1986). In Florida, continuous use by the public of the dry-sand portion of the beach resulted in a public interest in private land through the doctrine of customary rights. *See* City of Daytona Beach v. Tona-Rama, Inc., 294 So. 2d 73 (Fla. 1974).

286. *See generally* Pitts, *supra* note 282.

287. *See generally* Oczek, *supra* note 272, at 647-53.

288. *See* Pollard's Lessee v. Hagan, 44 U.S. (3 How.) 212 (1845) (the dominion and jurisdiction over navigable waters and land under these waters belongs only to the state within its territorial jurisdiction and only that state has the constitutional authority to exercise the dominion and jurisdiction); Weber v. Harbor Commissioners, 85 U.S. (18 Wall.) 57, 66 (1873) (the state reserves the right to dispose of all soils under tide waters subject to the "paramount right of navigation over such waters" as required by the necessities of commerce between the several states and with foreign nations).

289. *See* Illinois Cent. R.R. Co. v. Illinois, 146 U.S. 387, 437 (1892) (holding that the doctrine of public trust applies to equally to the "dominion and sovereignty over and ownership of lands under the navigable waters of the Great Lakes" and to the "dominion and sovereignty over and ownership of lands under tide waters on the borders of the sea").

290. *Id.* at 452.

291. *See* Wisconsin v. Pub. Serv. Comm'n, 81 N.W.2d 71 (Wis. 1957) (the city of Madison, Wisconsin proposed to fill part of a lagoon on Lake Wingra for construction of a public parking lot granted property use rights but not the property itself, and reserves all property rights for the state).

292. *Id*. at 73-74.

Although useful as a guide to application, the precise doctrine that the court adopts is of far less import than the attitude that that court takes towards the inadequacies of the democratic process in protecting public interests.[293] This is because the public trust doctrine is meant to protect the public and is applicable in those "situations in which diffuse public interests need protection against tightly organized groups with clear and immediate goals."[294] While the traditional application of the doctrine has been quite narrow, the principle underlying the doctrine may be employed in controversies relating to subject matter beyond soils below the low-water mark and natural resources.[295]

To obtain an easement by prescription requires the exercise of the rights of ownership against the actual owner for a defined period of time without obtaining the permission of the actual owner who has had notice.[296] A prescriptive easement arises from the open, notorious, adverse, and continuous use of the servient estate for a period years.[297] In a prescriptive easement the actual owner retains title in the property while the claimant obtains a limited right to make use of the property. Any positive easement may be obtained as a prescriptive easement.[298] However, a prescriptive easement cannot be obtained against public property that is not alienable. Also, a prescriptive easement cannot be obtained on non-governmentally owned property where there is a public interest that affects the property.[299]

2. Application of the Theories

The background section demonstrated that the development of domesticated plants currently in use in the United States was the result of efforts on the part of private individuals initially, on the part of farmer-government cooperation later, and on the part of the researchers in agricultural research stations funded by the federal government still later. It has also been demonstrated that the development of the agricultural genome was mature before the arrival of the seed manufacturing industry. A review of the history of American agricultural research and development leads to a

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293. *See* Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 521 (1970) (arguing for an extension of the doctrine of public trust beyond the traditionally narrow applications in matters of land below the low-water mark).

294. *Id.* at 556.

295. *See id.* at 556-57. For instance, New Jersey employed the public trust doctrine to allow public access to beaches, by both residents and non-residents, by extending the doctrine to land above the low-water mark. *See* Neptune City v. Avon-by-the-Sea, 294 A.2d 47, 54-55 (N.J. 1972) (holding that municipalities may charge for the use of their beaches, but that discrimination between residents and non-residents is not permissible); Matthews v. Bay Head Improvement Ass'n, 471 A.2d 355 (N.J. 1984) (extending the public trust doctrine: to include "bathing, swimming and other shore activities," *id.* at 363, because those activities are "consonant with and furthers the general welfare," *id.*; and to the use and enjoyment of the upland beach for the purposes of bathing and swimming below the mean high water mark, *id*. at 364), *cert. denied*, 469 U.S. 821 (1984).

296. *See* 7 THOMPSON ON REAL PROPERTY, THOMAS EDITION § 60.03(b)(6)(i) (David A. Thomas ed., 1994).

297. *See, e.g.* Goodall v. Whitefish Hunting Club, 528 N.W.2d 221, 223 (Mich. Ct. App. 1995).

298. *See* 7 THOMPSON ON REAL PROPERTY, THOMAS EDITION § 60.03(b)(6)(iii) (David A. Thomas ed., 1994).

299. *See id.* at § 60.03(b)(6)(iv).

conclusion that public funds went to the development of an agricultural genome suitable for agricultural practices in the United States and for the benefit of the American people.[300] Because public funds paid for the development and deployment of the agricultural genome, then that genome belongs to the general public as public property. It is natural, then, to raise the issue of whether a single person may obtain an interest in the agricultural genome in general, and in a plant genome in particular. If the public owns the plant genome, then a private party cannot gain an interest in the property under the prescriptive easement doctrine because the private party may not obtain a prescriptive easement against public property. Due to the limited jurisdictions that have adopted the doctrine of customary rights, and due to the narrow range of circumstances to which it has been applied, it is a fruitless endeavor to attempt to use the doctrine in analyzing the public interest in the genome of the plant. Because a diverse public interest exists in the availability and maintenance of the plant genome[301] and because one clear and immediate goal of the seed manufacturers would be to establish dominion over the genome, the doctrine of public trust may apply to the genome. In this case, it is possible that the public trust doctrine would allow alienation of the public interest in the plant genome, but the legislature must be very clear of its intent to do so.[302]

Whether the farmer may use the genome to produce a crop for sale, and whether he may save and plant seeds in the next crop cycle, turns upon a point of public policy. A fundamental requirement of a strong nation is that its people are properly nourished. Nourishment requires food to eat. Without the farmer, the country would have a dearth of food. Therefore, the public has a strong interest in allowing the farmer free access to the agricultural genome to produce crops for (eventual) human consumption. The farmer and the public are able to form a mutually beneficial contract: the farmer gives his labor and the crop as consideration and the public gives the genome and cash as consideration. Whether the farmer may save and replant the genome in the form of seeds turns upon matters of convenience to members of the public.

As discussed earlier, the farmer traditionally provided his own plant genome through a save-and-plant program, or the government provided it gratis. In modern times, it is inconvenient for members of the public to provide the requisite genome to the farmer, therefore, the seed manufacturer may be used as an agent of the public to provide the plant genome. Alternatively, the farmer may be allowed to save and plant the genome that he produces on his own lands because he is given a license to do so by the public. Therefore, contrary to the conclusion drawn by Ozcek, a legal basis does exist for the common law to protect the right of a farmer to save seeds from a crop for planting in the next planting cycle.

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300. *See generally* TRUE, *supra* note 29.

301. *See generally* NATIONAL RESEARCH COUNCIL, DESIGNING AN AGRICULTURAL GENOME PROGRAM 1 (1998) (published by the National Academy Press); NATIONAL RESEARCH COUNCIL, MANAGING GLOBAL GENETIC RESOURCES: THE U.S. NATIONAL PLANT GERMPLASM SYSTEM 1 (1991) (published by the National Academy Press).

302. *See* SAX, *supra* note 293, at 486-89.

II. ANALYSIS

The man who makes two blades of grass grow where but one grew before is a benefactor of his race.[303]

Three sets of rights attach to the design, manufacture, and use of genetically modified plant tissue. The seed manufacturers claim the right to develop the technology, the right to exclude others from making a profit on that technology, and the right to make a profit for themselves from the technology. The farmers claim the right to engage in the legitimate business practice of farming, the right to business autonomy, and the right to use and dispose of their property (both personal and real) as they see fit. The farmer also has the right to have his crop free of unwanted transgene contamination. The public claims the right to a stable and safe fiber and food supply and the right to minimum impact on the environment in producing the fiber and food. Where Jack's purchased seeds have been genetically modified, a clash exists between his property rights and those of the owner of the grant of protection on the seeds. The tension between the rights of the farmer and of the seed manufacturer must be resolved in light of the rights of the public in genetically modified plants. The seeds may be protected under either the Plant Variety Protection Act or the Patent Act; by license; or, by a contract Jack may have entered into for production of the bean crop.[304] The ultimate form of protection of the seeds is by biochemical means through the terminator technology. The beans Jack planted, which eventually led him to the magical kingdom in the clouds, could have been derived by a number of techniques: deliberate engineering by technicians working for the seed manufacturer; the harvesting of progeny seeds generated from parent seeds which in turn were generated by deliberate engineering; or, cross pollination where the pollen was transported to the progenitor non-modified plants from remote genetically modified plants. While this mode of acquiring the genetic material for his magic beans at first glance appears to fall under the purview of tort law, it actually implicates two sets of rights including Jack's right to have his plants free from the genetic material which confers the magical qualities, and Jack's neighbors' right to grow the beans with this material. The seed manufacturer's position regarding Jack's beans, is that the source of the seeds or plants is irrelevant, rather, that the plants or seeds were found on Jack's land is relevant. This position leads the seed manufacturer to conclude that Jack is infringing its property rights in the seed. Such a simple answer may be neither statutorily correct nor just. What is taken from the farmer by statute must be given back by reason of justice.

A. The Taking From The Farmer

In this modern version of the tale of Jack and the Beanstalk, the seed manufacturers sue Jack for infringement of their patent, for violation of the conditions of the license agreement, and for violation of the provisions of the PVPA. What result? The answer depends upon how the beans are protected, and is independent of whether Jack signed a license agreement for the beans.

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303. OWEN LOVEJOY, CHAIRMAN OF THE COMM. ON AGRICULTURE, DEPARTMENT OF AGRICULTURE, H.R. REP. NO. 37-21, at 4 (1862). This statement is the clearest articulation of the goal of agricultural biotechnology. It remains to be seen whether such a lofty goal can, indeed, be attained using genetic manipulation techniques.

304. *See generally* Neil D. Hamilton, *Why Own The Farm If You Can Own The Farmer (And The Crop)?: Contract Production And Intellectual Property Protection Of Grain Crops*, 73 NEB. L. REV. 48 (1994).

1. Property Rights Under the Plant Variety Protection Act

Consider the case in which Jack purchased the magic beans from a seed manufacturer who had obtained protection for the beans under the Plant Variety Protection Act of 1970, and who intended to sexually reproduce the beans. The Plant Variety Protection Act grants to the owner of a certificate of protection the attribute of personal property in the protected plant variety[305] which means that the owner of the certificate has the "right to exclude others from selling the variety, or offering it for sale, or reproducing it, or importing, or exporting it, or using it in producing . . . a hybrid or different variety therefrom."[306] When Jack purchased the beans, the seller retained certain property rights while certain rights were transferred to Jack. Before 1995, Jack could have reproduced the seed and sold it to his neighbors for reproductive purposes. However, since 1995 the situation has changed.

The seed manufacturers, whom we presume hold either rights under the Plant Variety Protection Act, or patent protection, or both,[307] are limited under the Plant Variety Protection Act as previously discussed. Of relevance to the current discussion is the crop exemption which allows the farmer to save progeny seed from a planting of the variety of seed protected by the Plant Variety Protection Act, and to use the seed without compensating the holder of the Plant Variety Protection Act certificate. The right to save and plant the seed in the next crop cycle, the limitations on selling to others for reproductive purposes, and the right to either hybrid or new variety development is called "the crop exemption." Without the crop exemption, the Plant Variety Protection Act would be meaningless because no farmer would buy Plant Variety Protection Act protected seeds and invest the labor and expense required to grow a crop if he could not profit from the crop by at least selling it for non-reproductive purposes. While the crop exemption was written into the Plant Variety Protection Act to protect farmers from increased costs, Congress clearly did not intend that it would provide the farmer with an unlimited right to save, sell, and dispose of protected seed as he saw fit.[308]

The central question is: exactly what property rights does the crop exemption afford the farmer? The Court in *Asgrow*[309] answered this question under the statute as it stood in 1995. When the

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305. *See* 7 U.S.C. § 2531(a) (1997).

306. 7 U.S.C. § 2483(a)(1) (1997).

307. The United States Court of Appeals for the Federal Circuit stated *in dictum* that a seed or seed produced plant may enjoy protections under both the Plant Variety Protection Act and patent, under Title 35 of the United States Code. *See* Pioneer Hi-Bred Int'l, Inc. v. J. E. M. Ag Supply, Inc., 200 F.3d 1374, 1378 (Fed. Cir. 2000). The defendant argued that Pioneer held both patents under Title 35 and certificate of protection under the Plant Variety Protection Act, and that simultaneous protection could not be afforded because these two statutes are in conflict. The Federal Circuit stated that:

> The district court observed, correctly, that the asserted conflict is simply the difference in the rights and obligations imposed by the two statutes. It is not unusual for more than one statute to apply to a legal or property interest. For example, an ornamental design may qualify for protection under both copyright and design patent law. The fact that the laws are of different scope does not invalidate the laws.

Id.

308. *See* Delta and Pine Land Co. v. Peoples Gin Co., 694 F.2d 1012, 1015-16 (5th Cir. 1983).

309. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 192 (1995) (held that "a farmer who meets the

Supreme Court decided *Asgrow*, 7 U. S. C. section 2541 defined the crop exemption as follows: "it shall not infringe any right hereunder for a person to save seed produced by him from seed obtained" by the "authority of the owner of the variety for seeding purposes and use such saved seed in the production of a crop for use on his farm, or for sale as provided in this section."[310] Subsections (3) and (4) of section 2541 provide respectively, that it is a violation of the Plant Variety Protection Act to: (3) "sexually multiply the novel variety as a step in marketing (for growing purposes) the variety"; and (4) "use the novel variety in producing (as distinguished from developing) a hybrid or different variety therefrom."[311] The Plant Variety Protection Act, as it stood in 1994, could reasonably be interpreted as granting the farmer the right to save progeny seed from Plant Variety Protection Act certificated progenitor seeds and plant those progeny seeds on his own farm. However, apparently the farmer could not reproduce a Plant Variety Protection Act certificated progenitor seed with the intent of selling the progeny seed to others, nor could the farmer use a Plant Variety Protection Act certificated progenitor seed to produce either a hybrid seed or a different variety of seed. The statute was not clear on the extent to which the farmer's rights, in light of the crop exemption, in his own progeny seed extended.

In *Asgrow*,[312] plaintiff Asgrow Seed Company was the holder a Plant Variety Protection Act certificate[313] on each of two varieties of soybean seed that it had developed.[314] The certificate granted

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requirements set forth in the proviso to § 2543 may sell for reproductive purposes only such seed as he has saved for the purpose of replanting his own acreage"). The first sentence of 7 U.S.C. § 2543 states that "it shall not infringe any right hereunder for a person to save seed produced by the person from [protected] seed . . . and use such saved seed in the production of a crop," and that the crop may be used "on the farm of the person," or sold as provided in the PVPA. 7 U.S.C. § 2543 (1997). The *Asgrow* Court stated that the "first sentence of § 2543 allows seed that has been preserved for reproductive purposes . . . to be sold for such purposes." 513 U.S. at 190. The Court articulated the meaning of the crop exemption as being that "a farmer saves seeds to replant his acreage, but for some reason changes his plans, he may instead sell those seeds for replanting under the terms set forth in the proviso" of § 2543. *Id.* at 191.

310. 7 U.S.C. § 2543 (1994).

311. 7 U.S.C. § 2541(a)(4) (1997). A sexually reproduced plant is one which is reproduced from seed, 7 U.S.C. § 2401(a)(6) (1997), and an asexually reproduced plant is reproduced by either propagation or by grafting.

312. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179 (1995).

313. *See* 7 U.S.C. § 2421 (1994) (application for a certificate of recognition of plant variety rights); 7 U.S.C. § 2481 (2001) (issuance of certificate of recognition of plant variety rights); 7 U.S.C. § 2483 (2001) (rights granted by certificate of recognition of plant variety rights). The owner of the novel plant variety sought to be protected applies to the Secretary for the Department of Agriculture for a certificate of plant variety protection. 7 U.S.C. § 2421. If the application meets the examination requirements, 7 U.S.C. § 2441, of the Plant Variety Protection Office, 7 U.S.C. § 2321, then the Secretary of the Department of Agriculture "shall issue a notice of allowance of plant variety protection," 7 U.S.C. § 2441 (2001), for the seed. The holder of the certificate of plant variety protection "has the right, during the term of the plant variety protection," which is 20 years from the date of issuance of the certificate of plant variety protection, 7 U.S.C. § 2483(b)(1), "to exclude others from selling the variety, or offering it for sale, or reproducing it, or importing it, or exporting it, or using it in producing . . . a hybrid or different variety therefrom." 7 U.S.C. § 2483(a)(1) (2001). The language which dictates the protections afforded to the holder of the certificate of plant variety protection is similar to the language dictating the protections afforded to the holder of a patent. *See* 35 U.S.C. § 154(a) (1994) (amended Oct. 11, 1996, Pub. L. 104-295, § 20(e)(1), 110 Stat. 3529). Therefore, the protections afforded to the holder of a certificate of plant variety protection under the Plant Variety Protection Act are indeed similar to those granted to the holder of a patent under the Patent Act.

to Asgrow Seed Company "patent-like protection to [its] novel varieties of sexually reproduced seed."[315] Defendants purchased seed from plaintiff, planted it, harvested seed, cleaned it, and sold it to neighboring farmers.[316]

Defendant Winterboer admitted that the seeds were protected under the Plant Variety Protection Act and that they had sold the seeds. However, he argued in defense, that the sales were exempt under the Plant Variety Protection Act because their primary farming occupation consisted of growing crops for purposes other than sale in the seed market for reproductive purposes.[317] The trial court rejected the defendant's arguments[318] and held that the farmer may sell for reproductive purposes only that quantity which he has saved for replanting his own fields.[319] The trial court justified the narrower interpretation of "saved seed" by stating that Congress' intent "in enacting the Plant Variety Protection Act was to encourage companies to develop improved varieties of seed and to provide for these developers the right to protect this seed from unauthorized sales by others."[320] The court

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314. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 181 (1995).

315. *Id.*

316. *See id.* at 181-82. During 1990, defendants planted 265 acres of the protected soybean and sold the entire saleable crop of 10,529 bushels neighboring farmers for reproductive purposes. *See id.* The seed from the 265 acres was enough to plant approximately 10,000 acres. *See id.* at 182. Asgrow, acting upon suspicion that defendants were deriving substantial profits out of selling the protected soybean, sent an agent to defendant's farm and determined that the defendants were indeed selling Asgrow's protected soybean variety. *See id.* at 182. The Winterboers sold the two varieties of soybeans, which they labeled A1938 and A2235, for an average price of $8.70 per bushel where Asgrow sold the two varieties, A1937 and A2234, for between $16.20 and $16.80 per bushel. *See id.* The total revenue lost by Asgrow was approximately $173,728. Asgrow sued the defendants, seeking damages and a permanent injunction against selling the protected variety of seed. *See id.*

317. *See* Asgrow Seed Co. v. Winterboer, 795 F. Supp. 915, 916-17 (N.D. Iowa 1991). The issues before the *Asgrow* trial court were:

> (1) that defendant Winterboer sold Plant Variety Protection Act protected seeds without authorization from Asgrow Seed Company, 7 U.S.C. § 2541(1); (2) that defendant Winterboer sexually multiplied the varieties as a step in marketing the varieties, 7 U.S.C. § 2541(3); and (3) defendant Winterboer distributed the seed for reproductive purposes without notice that the seed is protected by a Plant Variety Protection Act certificate, 7 U.S.C. § 2541(6).

Id. The defendant did not dispute that the soybean varieties that they had planted, harvested, cleaned and sold for reproductive purposes were indeed protected under the Plant Variety Protection Act. *See id.* at 917. Pointing to the language in 7 U.S.C. § 2451 regarding the farmer exception, "[t]his section provides that no infringement occurs if: . . . a person, whose primary farming occupation is the growing of crops for sale other than reproductive purposes" sells the "saved seed to other persons so engaged, for reproductive purposes," defendant argued in defense that the sales were allowed under the crop exemption of the PVPA, because since almost 80 percent of their crop was sold for other than reproductive purposes then the sale was within the farmer exception. *See id.* at 917.

318. *See id.* at 918. The court stated that "[i]n 7 U.S.C. § 2543 Congress specifically protected the historical and traditional right of small farmers like the Winterboers to make seed sales to fellow farmers." *Id.* Indicating that Congress intended for limitations in § 2543, the court further stated that, "the intent of Congress in enacting the Plant Variety Protection Act was not to give a farmer an unrestricted right to sell seed." *Id.*

319. *See id.* at 918-19.

320. *Id.* at 919.

reasoned that if defendant were allowed to make unauthorized sales of Plant Variety Protection Act certificated seed to fellow farmers beyond the amount required for planting his own fields, then Congress' intent would be "thwarted when a developer's sales of such seed is diluted by the lower priced sales by those who have contributed nothing to the development of the novel variety."[321]

The Supreme Court affirmed the trial court and rejected the reasoning of the Court of Appeals for the Federal Circuit,[322] holding that the farmer may sell for reproductive purposes only that quantity he has saved for replanting his own fields.[323] Specifically, the *Asgrow* Court held that a farmer who satisfied the crop exemption requirements could engage in "brown-bag" sales of the protected seed for reproductive purposes, but could sell only that quantity of protected seed necessary to replant his own fields.[324]

The Supreme Court in *Asgrow* considerably narrowed the scope of the "crop exemption" by prohibiting the practice of saving more seed than is necessary to replant one's own fields with the intent of selling the seeds to others for reproductive purposes. Because it was not before the Court in *Asgrow*, the question of whether a farmer may save the seeds from his own farm and then plant that seed on another farm in the following year remains unanswered. The question is of some considerable practical import, especially in circumstances in which one farmer, who is a member of a cooperative or partnership, grows Plant Variety Protection Act certificated seeds and then distributes those seeds to other members of the cooperative or partnership.[325]

It is common practice for a farmer to rent fields from another farmer for the purpose of planting. Typically, the renter farmer will enter into a "share cropper" arrangement where the renter farmer agrees to supply the seed, fuel, and labor necessary to plant the seeds. The profit from the harvest is then split with the land's owner. The arrangement is dynamic in that the total number of acres

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321. *Id.* at 920.

322. *See* Asgrow Seed Co. v. Winterboer, 982 F.2d 486 (Fed. Cir. 1992). The Court of Appeals for the Federal Circuit reversed the trial court and stated that if a "farmer grows more crop from a protected seed variety for sale to consumers than for sale to other farmers for planting, that farmer qualifies under [the crop exemption] to buy or sell saved seed." *Id.* at 490.

323. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 192 (1995).

324. *See id.* The term "brown-bag" is derived from the traditional practice of farmers selling seed, which had originally been obtained from the seed manufacturer, planted, harvested, and cleaned on their own farm, to other farmers in nondescript brown bags. *See id.* at 182. Although apparently insignificant, the aggregate effect of brown-bag sales of protected seed varieties can significantly decrease the profit of a seed manufacturer. *See* Hamilton, *supra* note 304, at 95. In 1989, Pioneer Hi-Bred International discovered that only eight percent of the variety of red winter wheat grown in Kansas had been raised from seed actually purchased from Pioneer, with the illegal brown-bag market accounting for the balance of that particular variety. As a result, Pioneer Hi-Bred International ceased sale of its red winter wheat variety in Kansas. *See id.* at 95. Hence the "brown-bag" sales, in aggregate, can have a crippling effect on the seed manufacturers. The long-term result is that the available seed will diminish in quality as the "brown-bag" seeds diminish in integrity.

325. Such a situation is very similar to that practiced by the early agricultural societies as discussed previously.

involved may change from year to year. In the event that the renter farmer has a good yield on some of the fields using protected seed, then he would be inclined to save a portion of the seed for subsequent planting (part of the artificial selection process which has produced many of the agricultural crops in use today). Since the Court in *Asgrow* specified that the farmer may save only that amount necessary to replant his own fields, the planting of an expanded number of fields not his own might be precluded.

The trial court in *Asgrow* stated, in dictum, that the farmer might be allowed to save seed from one planting cycle to plant a larger number of acres in the next planting cycle. Specifically, the trial court stated that the crop exception "allows a farmer to save, at a maximum, an amount of seed necessary to plant his acreage for the subsequent crop year."[326] It is not clear, unfortunately, whether the Supreme Court will adopt the trial court's dictum regarding how much Plant Variety Protection Act certificated seed the farmer may save from one planting cycle for replanting the next planting cycle.

The Plant Variety Protection Act, however, may illuminate the answer. The statute states that it is not an infringement for "a person to save seed produced" from the protected seed for "use on the farm of the person." Construing this last phrase strictly, it would seem that the crop exemption granted the property right of use for planting to the farm of the person who originally purchased the protected seed. A far more reasonable wording for the second quoted phrase is "use by the person" which would remove the restriction that the purchaser had to actually own the land upon which the progenitor, protected seeds are planted or upon which the progeny seeds are planted.[327] Under the interpretation suggested here, the crop exemption would confer the property right of use for planting upon the farmer, rather than leaving it with the seed manufacturers. In addition, it would permit the seed manufacturers to dictate to the farmer which fields may be planted with certificated seeds (whether progenitor or progeny). The farmer may then plant the saved seed upon any field of his choosing. To interpret the statutory language any other way would be to deny the farmer the property right of using his property (that is, the seeds grown on his own lands) as he sees fit, and would defy Congress' intent (of protecting the right of farmers to save and replant) when it passed the crop exemption of the Plant Variety Protection Act.

The farmer's right to save and replant Plant Variety Protection Act certificated seed can also be

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326. Asgrow Seed Co. v. Winterboer, 795 F. Supp. 915, 919 (N.D. Iowa 1991).

327. Our interpretation flows naturally from the decision in *Asgrow*. The *Asgrow* trial court reasoned that allowing a farmer to save enough seed to satisfy his planting needs in the next planting cycle would comport with the intent of Congress in enacting 7 U.S.C. § 2543. *See id.* at 918. The result, however, could have potentially devastating impact upon the seed manufacturers. Under the preferred interpretation of 7 U.S.C. § 2543, a single farmer or farming entity could purchase a small amount of protected seed for planting in the first year. The farmer or farming entity, under both the *Asgrow* trial court decision and 7 U.S.C. § 2543 (1997), would be entitled to save that quantity required to replant his farm during the next growing season. This would be of great benefit to the single farmer since he would realize considerable savings in seed for subsequent planting cycles. The benefit would also be realized by corporate farmers who farm many hundreds, if not thousands, of acres. Farm cooperatives or partnerships of farms would also be able to take advantage of the preferred interpretation, articulated here, since the crop would not belong to a single farmer but to the cooperative or partnership. This last construct avoids the problems confronted in *Delta and Pine Land Co. v. Peoples Gin Co.*, 694 F.2d 1012, 1016 (5th Cir. 1983), because the co-operative or partnership would not be acting as an intermediary, but rather as original owners of the right to use for planting. The net result would certainly be a substantial decline in profits to the seed manufacturers.

considered under the doctrine of alienation of property. The owner of property (including a patented article) is free to dispose of that property as he deems necessary.[328] Since the farmer grew the crop on his own land with the investment of his own time and money, it would seem reasonable that the progeny seeds produced would be his own property[329] independent of the status of ownership of the progenitor seeds.[330] Since the progeny seeds are the farmer's own property, he should be able to dispose of the progeny seed at his own discretion. Such an interpretation would be consistent with both the Supreme Court precedent[331] of "viewing restraints on alienation of property with disfavor,"[332] and with Congress' intent to protect the farmer against increased seed costs.

The precedent explicitly states that because of "that absolute power which a man possesses over his own property," then, "he may make any disposition of it which does not interfere with the existing rights of others."[333] The doctrine disfavoring restraints on alienation of personal property, as set forth by Chief Justice Marshall,[334] states that the alienation of property will be considered valid "if it be fair and real"[335] with only those limitations "which are prescribed by law."[336] Justice Stevens' dissent in *Asgrow*[337] argues that the Federal Circuit's decision in *Asgrow*[338] is supported by the doctrine disfavoring restraints on the alienation of personal property.[339] The *Asgrow* Court, however, indicated that such reasoning is clearly misguided.[340] The majority of the Court in *Asgrow* disposes of the dissent's argument by stating that "[a]pplying the rule disfavoring restraints on alienation to

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328. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 194 (1995) (Stevens, J., dissenting). The majority does not reject this well-established point of law. However, the majority does take issue with the application of this point in the context of the Plant Variety Protection Act.

329. Recall that this article has described a seed as real property when still connected to the plant, which is growing or standing on the farmer's field. The seed becomes personal property when harvested. For simplicity, this article follows the modern trend in property law and merges the concepts of real and personal property and speaks of them as "property".

330. The language of the Plant Variety Protection Act indicates that through certification, plants and seeds attain statutory protection as property of the certificate holder. As we will describe later, such a reference is imprecise because it does not allow clear identification of the rights of certificated plants.

331. *See generally* Sexton v. Wheaton, 21 U.S. 229, 242 (1823) (opinion of Marshall, C.J.).

332. Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 194-5 (1995) (Stevens, J., dissenting).

333. *See* Sexton v. Wheaton, 21 U.S. 229, 242 (1823).

334. *See id.*

335. *Id.*

336. *Id.*

337. *See supra* text accompanying note 309.

338. *See generally* Asgrow Seed Co. v. Winterboer, 982 F.2d 486 (Fed. Cir. 1992).

339. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 194-5 (1995) (Stevens, J., dissenting).

340. *See id.* at 188 n.3.

interpretation of the Plant Variety Protection Act is rather like applying the rule disfavoring restraints upon freedom of contract to interpretation of the Sherman Act."[341] The Court's use of such an obtuse analogy to dispose of a clear argument for retaining the doctrine in the context of seeds grown by the farmer on his own farm indicates a refusal to recognize the very important limitation imposed by Chief Justice Marshall. The doctrine requires that if the alienation of personal property is within the limitations set by law, then the disposition of the property will be viewed as valid.

Before the issue of whether the disposition of the progeny seed of a Plant Variety Protection Act certificated progenitor seed is lawful can be addressed, it is necessary to carefully answer the central question of what property rights the farmer retains in his own seeds.[342] If he retains the right of alienation, then the dissent in *Asgrow* must be correct and *Asgrow* must have been incorrectly decided. However, if the farmer retains a limited right of alienation, then Congress has taken a property right without compensation and appropriated that property to the holder of the Plant Variety Protection Act certificate. It would appear from the language of the PVPA[343] that propagation of the progeny seeds constitutes infringement of the rights of the owner of the certificate of protection. However, the language in § 2451(d) stands in stark contrast with § 2541(e)[344] and § 2543.[345] In order to reconcile the statute's language and give effect to the statute as a whole, it is necessary to conclude that the farmer retains only the right of alienation of the progeny seed for non-reproductive purposes; that the farmer retains the right to use the propagating material from a certificated seed for reproductive purposes only if the crop produced is used upon his own farm; that the farmer does not retain the right to alienate the progeny seed from the certificated progenitor seed for reproductive purposes; and that the farmer does not retain the right to alienate the second generation progeny seed from the certificated progenitor seed for either non-reproductive or reproductive purposes.

The Court in *Asgrow* sidestepped articulating the exact rights granted to the owner of a Plant Variety Protection Act certificated seed and those rights granted to the farmer who has produced progeny seeds on his own farm. The Court does, however, explain that the Plant Variety Protection Act creates a "valuable property in the product of botanical research by giving the developer the right to exclude others from selling the variety, or offering it for sale, or reproducing it, or importing it, or exporting it, etc."[346] This comment, made by the Court in dictum, cannot be squared with the

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341. *Id.*

342. Since a definition of property rights in progeny seeds of statutorily protected progenitor seeds is required under both the Patent Act and the Plant Variety Protection Act, and since the discussion of these rights will be enriched by analysis of the protection afforded to the holder of the statutory protection, the discussion of the property rights will be deferred until later. Instead, this article will concentrate on identifying the statutory protections under the Plant Variety Protection Act and identifying the ambiguities associated with the statutory protections.

343. *See* 7 U.S.C. § 2541(d) (1997).

344. It is not an infringement of the rights of the owner of a Plant Variety Protection Act certificate to perform any act with the propagating material harvested with a certificated seed, if it is "done privately and for noncommercial purposes." *See* 7 U.S.C. § 2541(e) (1997).

345. So long as the act does not violate 7 U.S.C. § 2543 (3)-(4), the farmer may save progeny seed for "production of a crop for use on the farm of the person." 7 U.S.C. § 2543 (1997).

346. Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 188 n.3 (1995) (quoting, in part, 7 U.S.C. § 2543 (1994)).

language identified above in § 2541 and § 2543, and does little to clarify the rights of either the farmer or the holder of the Plant Variety Protection Act certificate. In fact, the statutory language in § 2541 states that "any act concerning propagating material of any kind" is deemed to not be infringement of the rights of the owner of the certificate "unless the act involves further propagation of the variety."[347] In addition, the language in § 2541 permits reproduction of the certificated seed for private and noncommercial purposes.[348] Finally, § 2543 contemplates sale of the progeny seed, of certificated progenitor seed, for non-reproductive purposes.[349] Nowhere in § 2541 or § 2543 is language found "giving the developer the right to 'exclude others from selling the variety, or offering it for sale, or reproducing it, or importing it, or exporting it,' etc."[350] Nor is language found that vests control of such rights in the holder of the Plant Variety Protection Act certificate.

The Court in *Asgrow* seems to have clarified relatively little with regard to infringement of the rights of the holder of a Plant Variety Protection Act certificate. What is certain, then, is that if the farmer grows the protected seed variety for the purpose of selling the seeds for replanting by another, the farmer loses the protection afforded in § 2543 of the Plant Variety Protection Act. However, if the farmer sets aside a portion of his crop from the first year with the intent of using that "saved seed" to replant his farm the following year and then changes his mind, then the farmer may sell the "saved seed" for reproductive purposes to another.[351] In *Asgrow,* the Court seems to be signaling that the individual farmer does not "own" the seeds he produces on his own farm in the sense that he holds all of the property rights in those seeds. In fact, it is the position of the Court that by creating the genetically modified seed, the seed manufacturer holds the property right of transfer of the property.[352] The farmer is restricted to two options: selling his crop for non-reproductive purposes and retaining a portion for replanting his fields, or selling that part he retained for reproductive purposes and selling what remains for non-reproductive purposes. After *Asgrow,* it appears that in using genetically modified, protected seeds, the farmer loses the property right of selling his entire crop for reproductive purposes.

Shortly before *Asgrow* was decided, Congress amended the crop exemption provided in 7 U. S. C. § 2543 by removing the "brown bag" exemption, thus making only sales for non-reproductive purposes eligible under the crop exemption.[353] Because the amendment took effect after the

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347. *See* 7 U.S.C. § 2541(d) (1997). Furthermore, the language specifically states that export of the protected seed is permitted if the "exported material is for final consumption purposes." *Id.*

348. *See* 7 U.S.C. § 2541(e) (1997).

349. *See* 7 U.S.C. § 2543 (1997). The precise language is: "[a] sale for other than reproductive purposes, made in channels usual for such other purposes, of seed produced on a farm either from seed obtained by authority of the owner for seeding purposes . . . shall not constitute an infringement." *Id*.

350. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 188 n.3 (1995) (quoting 7 U.S.C. § 2483 (1994)).

351. With the "terminator technology," this entire problem is moot because the seeds cannot be sexually reproduced beyond the first generation. *See generally* Jeremy P. Oczek, *In the Aftermath of the "Terminator" Technology Controversy: Intellectual Property Protections for Genetically Engineered Seeds and the Right to Save and Replant Seed*, 41 B.C. L. REV. 627 (2000).

352. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 188 n.3 (1995).

353. *See* Plant Variety Protection Act Amendments of 1994, Pub. L. No. 103-349, 108 Stat. 3142, 3144

Supreme Court decided *Asgrow*, the Court held that brown-bag sales of only that seed sufficient to replant the farmer's own fields were permissible under the "crop exemption."[354] Were *Asgrow* decided today, it would come out differently because farmers would be totally prohibited from selling seed for reproductive purposes.[355] The substantive law now indicates that a farmer may not sell Plant Variety Protection Act certificated seed that he has grown on his land for anything other than non-reproductive purposes.[356] Also, the Plant Variety Protection Act allows farmers to save the Plant Variety Protection Act certificated seed from one planting cycle for use in a subsequent planting cycle.[357] It is precisely for this reason that the seed manufacturer would be motivated to seek a utility patent under 35 U.S.C. for the seed rather than Plant Variety Protection Act certification.

The current value of the Plant Variety Protection Act should be seriously questioned for the following reason: Congress' stated intent of protecting the certificate holder's profits and rights was circumvented by permitting the farmers to save and replant certificated seed. In addition, the patenting and subsequent licensing of new varieties has made Plant Variety Protection Act protection unattractive. When Congress enacted the Plant Variety Protection Act in 1970, it expressly stated that its purpose in enacting the Act was to encourage research and marketing for eventual public benefit.[358] Of course, lawmakers raised concerns that the new law would impose higher costs on farmers that would ultimately be passed on to consumers.[359] Even though § 2543 was added to exempt sales of seeds between individual farmers[360] to lessen the potential rise in certificated seed prices, Congress recognized that a price rise was inevitable.[361] Recognizing that the Act would clearly

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(1994). The Supreme Court decided Asgrow shortly after the 1994 amendment of the crop exemption, but before the effective date of the amendment.

354. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 188 n.2 (1995).

355. *See generally* Asgrow Seed Co. v. Winterboer, 513 U.S. 179 (1995).

356. *See* 7 U.S.C. § 2543 (1997).

357. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 188 n.2 (1995); Plant Variety Protection Act Amendments of 1994, Pub. L. No. 103-349, 108 Stat. 3136, 3142 (1994); 7 U.S.C. § 2543 (1994); 7 U.S.C. § 2543 (1997).

358. Specifically, the language is: "[i]t is the intent of Congress to provide the indicated protection for new varieties by exercise of any constitutional power needed for that end, so as to afford adequate encouragement for research, and for marketing when appropriate, to yield for the public the benefits of new varieties." 7 U.S.C. § 2581 (1970).

359. *See generally* 116 CONG. REC. 40,295-40,303, 40,295 (daily ed. Dec. 8, 1970) (statement of Rep. Poage).

360. *See* Delta and Pine Land Co. v. Peoples Gin Co., 694 F.2d 1012, 1017 (5th Cir. 1983) (holding that the crop exemption contemplates only direct sales between individual farmers without the participation of a third party).

361. Representative Poage stated that:

> I do not think there is any doubt that it will mean if somebody produces a seed that gives better results than anybody else's seed, and if he is the only one who can sell that seed, then he will get more for it . . . . This is the only way we know to get people to invest their time and money. It is expensive to

benefit the seed manufacturers through competition, it became clear that the farmer could not be insulated from the negative economic side effects of the Plant Variety Protection Act, notwithstanding § 2543.[362] Since a farmer can replant seed produced on his farm from Plant Variety Protection Act protected seed without liability,[363] the seed manufacturer loses a potential sale each time a farmer does replant. Despite the prohibition on sale of protected seed between individual farmers, the crop exemption of the Plant Variety Protection Act runs counter to the Act's express purpose because the farmer can still replant his fields with protected seed that he has grown on his own land. Therefore, in order to prevent significant financial loss to the seed manufacturers, the Plant Variety Protection Act must be amended to remove this exemption as articulated in § 2543.

2. Property Rights Under the Patent Act

Section 101 of Title 35 of the United States Code defines patentable subject matter. The Supreme Court stated in *Chakrabarty*[364] that statutory subject matter "include[d] anything under the sun that is made by man" including man-made life forms. Living organisms are considered patentable because they are either articles of manufacture or compositions of matter.[365] The Board of Patent Appeals and Interferences addressed the question of whether either the Plant Patent Act of 1930[366] or the Plant Variety Protection Act of 1970[367] were the exclusive forms of protection for plants, or whether protection could be afforded by 35 U. S. C. § 101 in addition to either the Plant Patent Act or the Plant Variety Protection Act.[368] Based on the analysis set forth in *Chakrabarty*, the Board found that neither the Plant Patent Act nor the Plant Variety Protection Act narrowed the scope of patentable subject matter under 35 U. S. C. §101. While the question was not directly before the Board in the case, the Board stated that genetically modified plants, seeds, and plant tissue are patentable[369] under the principles set forth in *Chakrabarty*. The Court of Appeals for the Federal Circuit in *Pioneer Hi Bred International, Inc. v. J.E.M. Ag Supply, Inc*.[370] clearly stated[371] that a novel plant variety might

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develop such seeds. So in the end, we believe there will be beneficial results for the producers and farmers.

116 CONG. REC. at 40,296.

362. *See* Delta and Pine Land Co. v. Peoples Gin Co., 694 F.2d 1012, 1016 (5th Cir. 1983).

363. *See* 7 U.S.C. § 2543 (1994).

364. Diamond v. Chakrabarty, 447 U.S. 303, 310 (1980).

365. *See id.* at 309-10 (quoting *Hantranft v. Wiegmann*, 121 U.S. 609, 615 (1887)).

366. *See* 35 U.S.C. § 161 (1994).

367. *See* 7 U.S.C. § 2321 (1994).

368. *See generally Ex parte* Hibberd, 227 U.S.P.Q. (BNA) 443 (Bd. Pat. App. & Interf. 1985) (holding that a maize plant variety which produced a high level of tryptophan was patentable under 35 U.S.C. § 101 and may be certificated under the Plant Variety Protection Act).

369. *See id.* at 443, 447-48.

370. *See* Pioneer Hi Bred International, Inc. v. J.E.M. Ag Supply, Inc., 200 F.3d 1374, 1378 (Fed. Cir. 2000).

371. While the statement was made in *dictum*, it is a clear representation of the position of the United States

Court of Appeals, Federal Circuit, and is a position that the Supreme Court has taken as well. As this manuscript was entering the final editing stage for publication, the Supreme Court decided the case of *Pioneer Hi-Bred Inc. v. J.E.M. Ag Supply, Inc.* Because of the importance of the case, a brief review is given here.
In *Pioneer Hi-Bred International Inc. v. J.E.M. Ag Supply, Inc.*, 49 U.S.P.Q.2d (BNA) 1813 (N.D. Iowa 1998), the District Court of the Northern District of Iowa denied a motion for summary judgment brought by defendants in favor of Pioneer Hi-Bred on the question of patentability of plants. Specifically, the issue before the district court, upon the motion for summary judgment, was whether "the Plant Variety Protection Act is the exclusive federal statutory mechanism for granting patent like protection for sexually reproducing plants to the exclusion of the general patent law." *Id.* at 1814. An interlocutory appeal was made to the Court of Appeals for the Federal Circuit. *See* Pioneer Hi-Bred Intern. Inc. v. J.E.M. Ag Supply, Inc., 200 F.3d 1374 (Fed. Cir. 2000). Judge Newman wrote the opinion, for the panel consisting of Judges Mayer, Newman and Lourie, affirming the denial of summary judgment by the district court. On December 10, 2001, the Supreme Court upheld the denial of summary judgment on writ of certiorari to the United States Court of Appeals for the Federal Circuit in *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc.*, 122 S. Ct. 593 (2001). The case was the first opportunity for the Supreme Court to decide the issue of patentability of plants since the Board of Patent Appeals and Interferences, of the United States Patent and Trademark Office, held that plants were patentable under 35 U.S.C. § 101. *See Ex parte* Hibberd, 227 U.S.P.Q. (BNA) 443, 444 (Bd. Pat. App. & Interf. 1985). The Supreme Court held "that utility patents may be issued for plants." *J.E.M. Ag. Supply*, 122 S. Ct. 593, 596 (2001). The question before the Supreme Court was whether "utility patents may be issued for plants under 35 U.S.C. § 101," *J.E.M. Ag. Supply*, 122 S. Ct. 593, 596 (2001), or whether the Plant Patent Act and the Plant Variety Protection Act are the exclusive means "of obtaining federal Statutory right to exclude others from reproducing, selling, or using plants or plant varieties," *id.* J.E.M. Ag Supply had purchased bags of hybrid corn seeds bearing a limited label license and resold those same bags to farmers. J.E.M. Ag Supply was not a licensed agent of Pioneer Hi-Bred International. Pioneer Hi-Bred brought a cause of action against J.E.M. Ag Supply for patent infringement and J.E.M. Ag Supply counterclaimed patent invalidity. *See id.* at 597. The District court for the Northern District of Iowa held that plant life is patentable under 35 U.S.C. § 101. *See* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc., 122 S. Ct. 593, 597 (2001); Pioneer Hi-Bred International Inc. v. J.E.M. Ag Supply, Inc., 49 U.S.P.Q.2d (BNA) 1813 (N.D. Iowa 1998). Significantly, the district court stated that the seed was not removed from the Pioneer Hi-Bred seed corn bags, was not rebagged, and "the markings on the Pioneer bags have not been altered." Pioneer Hi-Bred International Inc. v. J.E.M. Ag Supply, Inc., 49 U.S.P.Q.2d (BNA) 1813, 1814 (N.D. Iowa 1998). The Court of Appeals for the Federal Circuit affirmed both the reasoning and the decision of the district court. *See* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc., 122 S. Ct. 593, 597 (2001); Pioneer Hi-Bred Intern. Inc. v. J.E.M. Ag Supply, Inc., 200 F.3d 1374 (Fed. Cir. 2000). The Federal Circuit stated that: "[n]either Congress nor the courts excluded new plant varieties from the patent statute; the enactment of the PVPA did not effect such an exclusion." Pioneer Hi-Bred Intern. Inc. v. J.E.M. Ag Supply, Inc., 200 F.3d 1374, 1378 (Fed. Cir. 2000). The Supreme Court affirmed the decision of the Federal Circuit, and thus the case must be tried to a jury in the Northern District of Iowa on the question of patent infringement. Specifically, the Supreme Court held that "newly developed plant breeds fall within the terms of §101." *J.E.M. Ag. Supply*, 122 S. Ct. 593, 606 (2001). Two unresolved issues are immediately apparent: first, even if "newly developed plant breeds" are patentable under 35 U.S.C. § 101, whether the patent is valid in light of obviousness and prior art; and second, whether the first sale doctrine applies to seed that has been purchased from the seed manufacturer such that it can be resold without being reproduced under *United States v. Univis Lens Co., Inc.*, 316 U. S. 241, 249 (1942). The first of these issues is briefly discussed here; the other is discussed elsewhere in this article.

The first immediately apparent issue is whether the patent, issued on a plant variety, is valid. 35 U.S.C. § 101 provides that: "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." 35 U.S.C. § 101 (1994 & Supp. III 1997). In 1980, the Supreme Court concluded that living things were patentable under 35 U.S.C. § 101 because "the relevant distinction was not between living and inanimate things, but between products of nature, whether living or not, and human-made inventions." Diamond v. Chakrabarty, 447 U.S. 303, 313 (1980). The issue upon which *Chakrabarty* turned was whether a "composition of matter" included living things. The Supreme Court in *Diamond v. Chakrabarty* stated that: "[i]n choosing such expansive terms as 'manufacture' and 'composition of matter,' modified by the comprehensive 'any,' Congress plainly contemplated that the patent laws would be given wide scope." Diamond v. Chakrabarty, 447 U.S. 303, 308 (1980). Because the Court viewed living things as compositions of matter, then it held, in *Diamond v. Chakrabarty,* that living things were patentable. The Supreme Court extended this logic to plants in *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc.* However, reliance by the

Supreme Court upon the decision by the Board of Patent Appeals and Interferences, in *Ex parte Hibberd*, 227 U.S.P.Q. (BNA) 443 (Bd. Pat. App. & Interf. 1985), as to whether plants are "compositions of matter" and hence patentable under §101 is misplaced. This is because of three interconnected concepts: (a) the term "plant" is ambiguous; (b) the plant cell is actually a biological machine; and (c) naturally occurring mutations in the plant variety genome preclude a clear definition of exactly what legal estate is actually protected by the letters patent. While these concepts will be considerably expanded elsewhere, space limitations permit only the briefest exposition of them here.

When the Court states that "plants" are patentable, it does nothing to clarify the state of the patent law with respect to genetic manipulation of the plant genome. This is because the term "plant" is ambiguous. While common sense dictates that a "plant" is that item that we can perceive using our five senses, a clear definition of the term "plant" such that the force of patent law may be engaged is certainly not in hand. Turning to the plain meaning canon of construction, a plant is defined as: "any living thing that cannot move voluntarily, has no sense organs, and generally makes its own food by photosynthesis; a vegetable organism, as distinguished from an animal organism; any tree, shrub, herb, etc." WEBSTER'S NEW TWENTIETH CENTURY DICTIONARY 1373 (1983). While this moves us further toward what the term "plant" means for patenting purposes, the movement is only incremental. This is because, as indicated earlier, 35 U.S.C. § 101 provides that: "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." Thus, for "plants" to be patentable, the inventor must have either invented or discovered the "plant" or "any new and useful improvement" of the "plant" (accepting for the time being that a "plant" is included in the "composition of matter" category). That is, the inventor must have either invented or discovered an inanimate object devoid of senses and voluntary movement, which generates its own food by photosynthesis, or "any new and useful improvement thereof." 35 U.S.C. § 101 (1994). One can easily make the argument that indeed by inserting a transgene into the genome of a plant variety, the criteria articulated in the previous sentence are indeed satisfied. However, the inanimate object devoid of senses and voluntary movement, which generates its own food by photosynthesis, existed before the inventor inserted the transgene. The only difference between the inanimate object before the inventor inserted the transgene and after the transgene was inserted is that after the transgene was inserted the cells of the inanimate object produce the protein or chemical specifically encoded for by the transgene (presuming, of course, that the transgene is completely expressed by those same cells). The inventor did not change the physical form of the inanimate object, except, possibly, for a scaling in size, (which accounts for the lack of ability of the average farmer to know whether genetically manipulated plants exist on his fields by mere visual inspection) nor did the inventor change the function of the cells of the inanimate object. Because nothing changed about the inanimate object upon insertion of the transgene, except for the production of a single chemical species, the inventor did not either invent or discover an inanimate object devoid of senses and voluntary movement, which generates its own food by photosynthesis, or "any new and useful improvement thereof," *id.*, then the inventor did not invent a "plant." In order for the physical manifestation of the inventor's original thought to be protected by the granting of a letters patent the term "plant" must be replaced by a term that correctly describes the nature of that physical manifestation.

The Supreme Court considers the combination of the transgene and the plant genome a "plant" which it places within the statutory subject matter "composition of matter." 35 U.S.C. § 101 (1994). As discussed elsewhere, labeling the aforementioned inanimate object/transgene a "composition of matter" is to use clever language of form to mask the reality of function. A plant is composed of cells. Each cell is a biological machine that uses the information stored in the plant genome (the cellular DNA) to produce a myriad of chemical compounds (some of which are more useful to the plant than others). That is, the expression of a gene, contained in the plant genome, causes the cell (the biological machine) to produce a particular chemical compound. If the codons of the gene are altered, through either natural mutations or through insertion of foreign codons, then the chemical compound produced by the cell will be altered. If a given naturally occurring gene is replaced by a foreign gene, which may be a transgene, then the cell will (or may) not produce the original chemical compound but will generate a different compound. If the plant genome is supplemented by the insertion of a transgene (a gene that is from a sexually incompatible species) then the cell of the plant will produce a new chemical compound in addition to the previous set of chemical compounds (presuming, of course that the transgene is completely expressed, and that insertion of the transgene does not inhibit normal expression of the native genes). The cell of the plant, that is the biological machinery, is not altered by the presence or expression of the transgene and the biological machinery is not changed by the presence of the chemical compound encoded for by the inserted transgene. To give a concrete analogy, consider a manufacturing plant that initially produces green widgets. A change in instructions to the machinery of the plant to produce blue widgets does not change

be protected under both Title 35, Section 101 of the United States Code and the Plant Variety Protection Act. Thus, a seed manufacturer may obtain a patent on a variety of genetically modified seed as well as certification under the Plant Variety Protection Act. Furthermore, the case history indicates that a particular variety of plant may be protected under both Section 101 and Section 161 of Title 35.[372] Because Section 161 of Title 35 relates to asexually reproduced plants while the Plant Variety Protection Act relates to sexually reproduced plants, and since "variety" is defined differently under each statute, a plant cannot be protected under both the Plant Patent Act and the Plant Variety Protection Act.

In Jack's case, statutory protection for the beans could have been obtained by a utility patent on that particular bean variety.[373] The statute states that the utility patent protection may be obtained for "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof."[374] In exchange for creating Jack's beans and making full public disclosure of the invention, the seed manufacturer is granted patent protection.[375] In order to obtain a patent on

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the machinery of the manufacturing plant, only the color of the product produced by that machinery. So it is for the biological machinery of the plant cell. The biological machinery is not altered by the expression of the transgene, only the type of chemical compound produced.

While the presence of the chemical compound, encoded for by the inserted transgene, in the cells of the plant may be new, and may confer useful characteristics upon the plant, the inventor has neither invented or discovered "any new and useful" biological machinery nor has the inventor invented "any new and useful improvement thereof." 35 U.S.C. § 101 (1994). The most that the inventor has done is to take a previously existing biological machine and instructed it to produce a different chemical compound.

Finally, as discussed elsewhere in this paper, the plant genome is public property. Therefore, even if a patent is granted for a "transgenic plant," the genome of the plant is public property and the patent is not infringed because to hold otherwise would be to allow adverse possession against public property.

While it is the position of the author that patents on "transgenic plants" cannot be valid (even given that the Supreme Court held that "plants" are patentable), it is also the position of the author that valid patents may be obtained to protect the rights in intellectual property of inventors who genetically manipulate plants. To see this, consider the statement of the Supreme Court, in *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc.*, that: "advances in biological knowledge and breeding expertise have allowed plant breeders to satisfy § 101's demanding description requirement." J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc., 122 S. Ct. 593, 600 (2001). When a transgene is inserted into the plant genome, current biological techniques can be used to determine that: (a) the complete transgene has been inserted; (b) the introns can be both identified and their location within the transgene can be precisely determined; (c) the transgene is completely expressed by the cell; and (d) the chemical compound encoded for by the transgene is both produced and is produced as a direct result of the expression of the transgene by the cell. Thus, the physical manifestation of the original thought of the inventor can be completely characterized sufficient to meet the patenting standards of 35 U.S.C. § 101 (1994) and 112, ¶ 1 (1994). Thus, a claim that covers the transgene satisfying the criteria enumerated in (a) through (d) above is not only patentable, but indeed valid. In fact, such a claim may be all that is required to fully protect the interests of the inventor in his legal estate.

372. *See generally Ex parte* Hibberd, 227 U.S.P.Q. (BNA) 443 (Bd. Pat. App. & Interf. 1985).

373. *See generally* 35 U.S.C. § 101 (1994). "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." *Id.*

374. *Id.*

375. *See* Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental*

Jack's beans, the seed manufacturer must convince the Patent and Trademark Office[376] that the pertinent requirements of Title 35 of the United States Code have been satisfied.[377] Once this demonstration has been made the Patent and Trademark Office will issue a patent on the beans, which protects the invention for a period of twenty years after the date of filing the patent.[378] As discussed *infra*, the granting of a patent on an invention creates rather broad and exclusive rights to exclude others from producing, selling, using, or offering for sale the invention within the United States.[379] When infringement of the patent occurs,[380] the patent holder has a cause of action against the infringer.[381]

Since Jack purchased the seeds, he may plant them and reap the harvest[382] from the magical kingdom in the clouds. The question is what may Jack legally do with the beans produced by his mighty beanstalk?

The grant of a patent by the United States Patent and Trademark Office creates a legal estate in the patentee for a statutorily specified period. Similar to other legal estates, equitable interests may be incident to the estate created by the patent, and these interest may be conveyed by either contract or by operation of law. The person to whom the patent is issued, the patentee, holds a present interest in the legal estate, which descends to his heirs or assigns.[383] The interest, which the holder of

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Use, 56 U. CHI. L. REV. 1017, 1022 (1989).

376. In order to obtain a patent, the inventor must show that the invention is useful and novel, 35 U.S.C. §§ 101 (1994), and non-obvious, 35 U.S.C. § 103(a) (1994 & Supp. III 1997). Also, the patent holder must enable the invention, meaning that the inventor must provide sufficient information about the invention to enable "others skilled in the art" to replicate the invention. 35 U.S.C. § 111 (1994 & Supp. III 1997); 35 U.S.C. § 112 (1994 & Supp. III 1997).

377. Since the beans are presumed to have been obtained by sexual reproduction, the Plant Patent Act provisions of Title 35 are not applicable. The seed manufacturer may only obtain a utility patent on the beans it sold to Jack.

378. *See* 35 U.S.C. § 154(a)(2) (1994 & Supp. III 1997).

379. *See* 35 U.S.C. § 154 (1994 & Supp. III 1997).

380. Infringement of the patent may occur in a number of ways, including imitation of the invention, see *Warner-Jenkinson Co. v. Hilton Davis Chemical Co*., 520 U.S. 17 (1997), and independent invention after the original invention was made.

381. *See* 35 U.S.C. § 271(b) (1994).

382. While it is common sense that Jack should be able plant the beans and to reap the harvest from the plants, in light of the patent statute, it is not so clear what rights Jack has in his beans.

383. *See* 35 U.S.C. § 154(a)(1) (1994 & Supp. III 1997). The patentee holds a present interest in a legal estate, which his heirs or assigns may take either by contract or by operation of law. The patentee, however, need not be the inventor because the inventor may have assigned the patent to the patentee either before the invention was completed or before the patent was issued. *See* 35 U.S.C. § 261 (1994). When the invention has been assigned by the inventor, the patent will issue to the assignee. *See* 35 U.S.C. § 152 (1994 & Supp. III 1997) ("Patents may be granted to the assignee of the inventor of record in the Patent and Trademark Office, upon the application made and the specification sworn to by the inventor, except as otherwise provided in this title.") When the patent is granted to the assignee, the interest in the legal estate becomes vested in the assignee, and the assignee becomes the patentee of the invention. Since the entire interest in the legal estate

the legal estate possesses, is only the power to exclude others from "making, using, [or] offering for sale"[384] the invention for a period of 20 years from the date of filing of the patent application in the United States.[385]

In order to analyze the interests held by the patentee, it is necessary to look at the Patent Act because the statute "regulate[s] the whole subject of transferring or subdividing the exclusive right vested by the patent in the patentee,"[386] and the transfer and subdivision are not regulated by common law.[387] The statutory provision recites that the patents "shall be assignable in law by an instrument in writing."[388] The statute addresses only the legal estate vested in the patentee. That is, the statute recognizes an exclusive right, vested in the patentee, which can be conveyed to another only in the form of writing. The statute provides that either the whole or part of the vested exclusive right may be conveyed[389] to another and that the conveyed exclusive right may cover either the

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is vested in the patentee, upon granting of the patent, the inventor cannot, and does not, hold an interest in the legal estate; hence the inventor is divested of title to any interest in the legal estate.

In the case that the inventor assigned his title in the legal estate before the patent was granted, the assignee does not take possession of title to the legal estate until the patent has actually issued. Between the time that the assignment was made by the inventor and the issuance of the patent, the assignee holds only the right to obtain title to the legal estate and the right to pursue remedies, in both law and equity, against the inventor and third parties. A question arises as to whether the right to obtain the title to the legal estate can be conveyed to another before the invention is perfected. That is: is a conveyance of the right to take title to the legal estate valid before either conception or reduction to practice of the invention? The answer is no. The statute mandates that "[a]pplications for patent, patents, or any interest therein, shall be assignable in law." 35 U.S.C. § 261 (1994). Since constructive reduction to practice occurs when the application for patent is filed, and the invention is presumed to exist when the patent is granted, then the statute appears to contemplate assignment of title to the legal estate of completed inventions. Since the invention must exist before title may be assigned, then an assignment of an incomplete or inchoate invention is not valid. However, a contract to convey the exclusive interest in a legal estate of a future invention may be enforced by a bill of specific performance. *See* Nesmith v. Calvert, 1 Wood. & M. 34, 18 F. Cas. 2 (C.C.D. Mass. 1845) (No. 10,123). The conveyance of interest in the legal estate can only operate when the device or process has been either conceived or reduced to practice and is suitable subject matter for an application for a patent. A contract may be negotiated between the inventor, or his heirs or assigns, and the party who is to take legal title to the invention before the invention has been perfected. However, the contract to convey the interest in a future invention or an improvement to be made to an existing invention will not, standing by itself, authorize the party who is to take legal title to take the patent upon issue.

384. 35 U.S.C. § 154(a)(1) (1994 & Supp. III 1997).

385. *See* 35 U.S.C. § 154(a)(2) (1994 & Supp. III 1997).

386. George T. Curtis, A TREATISE ON THE LAW OF PATENTS FOR USEFUL INVENTIONS 162 (1867).

387. Gayler v. Wilder, 51 U.S. (10 How.) 477 (1850) (the court stated that: "the monopoly granted to the patentee . . . is created by the act of Congress; and no rights can be acquired in it unless authorized by statute, and in the manner the statute prescribes," *id*. at 494).

388. 35 U.S.C. § 261 (1994).

389. If a contract or covenant has been made that the inventor will convey his exclusive interest in the legal estate to a party, in whose favor the contract operates, then equity holds that the inventor is compelled to make the conveyance, including any improvements made to the invention after the patent application has been filed. *See* Nesmith v. Calvert, 1 Wood. & M. 34, 18 F. Cas. 2 (C.C.D. Mass. 1845) (No. 10,123).

"whole or any specified part of the United States."[390]

The statutory grant of an exclusive right in the patentee is peculiar to patent law because the interest, as stated above, is the "right to exclude others from making, using, offering for sale, or selling the invention throughout the United States."[391] In addition, the interest relates spatially to various regions of the United States. This means that the patentee may, by a written instrument, convey to any other person the right to exclude others from "making, using, etc." within any particular part of the United States. The patentee retains all other rights in the legal estate.[392] The statute does not, however, act to create an exclusive interest in a legal estate which includes the right to make, use, offer for sale, or sell the "invention throughout the United States,"[393] but rather, the exclusive interest is the right to exclude others from doing so.

The statute relates solely to the conveyance of the exclusive interest in the legal estate created by the grant of a patent within a particular territory of the United States. After the conveyance, the patentee retains no interest in the legal estate within that particular territory of the United States. Consider an instrument, which conveys a limited and non-exclusive right to exercise some of the privileges secured to the patentee by the grant of a patent within a limited territory or the whole of the United States. The statute does not relate to such an instrument of conveyance because the instrument is a license, and no language can be found in the statute relating to the conveyance of less than the exclusive interest. The formalities attending the conveyance of exclusive interest must be reduced to "an instrument in writing."[394] The conveyance may operate as either an assignment or a license. To distinguish, recognize that to operate as an assignment, the instrument must convey to the grantee the exclusive interests which the patentee, or inventor, holds in the legal estate.[395] Therefore, the patentee may partition his legal estate as he sees fit.[396] Of course, the marketability of a limited interest in a legal estate may be inhibited. Once the interest has been assigned, it is not revocable.[397] The statute contemplates that the interest is divisible into two parts: first, the "patent, or any interest therein" is "assignable in law";[398] and second, an exclusive right under the patent can be granted to any specified part or the whole of the United States.[399] The conveyance of the exclusive

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390. 35 U.S.C. § 261 (1994).

391. 35 U.S.C. § 154(a)(1) (1994 & Supp. III 1997).

392. *See* Gayler v. Wilder, 51 U.S. (10 How.) 477, 494 (1850).

393. 35 U.S.C. § 154(a)(1) (1994 & Supp. III 1997). *See also* 35 U.S.C. § 261 (1994 & Supp. III 1997).

394. 35 U.S.C. § 261, ¶ 2 (1994 & Supp. III 1997).

395. The patentee has the right to exclude others from making, using, selling, or offering to sell the invention; further, in granting to others an interest in his legal estate, the patentee also retains the right to limit the interest granted.

396. *See* Steam Cutter Co. v. Sheldon, 10 Blatch. 1, (C.C.D. Vt. 1872).

397. *See id.* at 12.

398. *Id.*

399. *See id.*

interest in the legal estate created by the patent must be recorded with the Patent and Trademark Office.[400]

Three classes of conveyances of exclusive interest must be recorded with the Patent and Trademark Office: first, an assignment of the whole exclusive interest must be recorded; second, an assignment of an undivided part of the exclusive interest must be recorded; and third, the exclusive interest to exclude others from making, using, or selling the invention within a specified part or the whole of the United States must be recorded.[401] One can see that the conveyance to be recorded must divest the patentee of his entire interest in such part of the legal estate, or in such part of the United States, as the instrument affects. If the instrument vests an exclusive interest in the grantee such that the patentee is no longer able to exert control over that interest in law or equity, then that instrument must be recorded with the Patent and Trademark Office.

The instrument conveys a license, and as such, is not required to be recorded with the Patent and Trademark office if the instrument permits the patentee to exercise control over that interest which the instrument affects, and vests in the grantee the privilege to be free from liability if the grantee chooses to make, use, sell, or offer to sell the invention patented.[402] Whether the conveyance is an assignment of exclusive interest (either in whole or in part of the legal estate created by the patent grant) or a license is to be determined by the following: an "inquiry into the fair meaning and intention of the parties;"[403] the nature of the transaction; the type and quantity of consideration; and extrinsic circumstances indicating that an assignment was conveyed.[404] If the patentee holds the interest to make, use, sell, or offer to sell within a particular part or the whole of the United States with the grantee, then the instrument of conveyance will certainly be a license, which need not be recorded with the Patent and Trademark Office.

To be precise, an assignment relates to the interest in the patent whereas the license relates to the mere right to not be liable for infringement of the patent should the grantee use the patented invention or practice the invention. The license does not grant to the grantee the primary interest in the legal estate; that is, the right to exclude others from making, using, offering for sale, or selling the

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400. *See* 35 U.S.C. § 261, ¶ 3 (1994 & Supp. III 1997).

401. *See id.*

402. *See* Brooks v. Byam, 2 Story 256, 4 F. Cas. 258 (C.C.D. Mass. 1840) (No. 1,947); Pitts v. Whitman, 2 Story 609, 19 F. Cas. 767 (C.C.D. Me. 1843) (No. 11,196). The precise result derived from the cited cases is that: if the instrument permits the patentee to exercise control over that interest which the instrument affects, and vests in the grantee the privilege to make, use, or sell the invention free of liability then the instrument of conveyance is a license and as such is not required to be recorded with the Patent and Trademark Office. This result cannot be reached under modern patent law because the patentee is granted, by letters patent, the exclusive right to exclude others from making, using, offering for sale or selling the invention patented. Since the only interest, of present concern, in the legal estate is the right of the patentee to exclude others then the only interest that can be conveyed is the right to not be liable when the grantee chooses to infringe the patent.

403. Dorsey Revolving Harvester Rake Co. v. Bradley Mfg. Co., 12 Blatch. 202, 208, 7 F. Cas. 946, 948 (C.C.N.D.N.Y. 1874) (No. 4,015).

404. *See id.*

invention patented. The assignment necessarily diminishes *pro tanto* the interest that the patentee holds in the legal estate, while the interest of the patentee remains unencumbered by the rights conveyed by the license. The licensee cannot acquire an exclusive interest in the patented invention, and hence takes no part of the legal estate. For example, consider a composition of matter as the subject matter of the invention. If the patentee authorizes another to make and sell a composition of matter, the grantee becomes a licensee and has no authority to grant to other parties the right to make and sell the composition of matter.[405] The patentee retains the exclusive interest of granting to the other parties such a right.[406] Thus, the licensee has the authority to exercise only those privileges contemplated by the patentee when the license was conveyed and the exclusive interest in the legal estate remains with the patentee.

Having described in detail that which is created when a patent is granted, this Note will now examine the nature of the legal estate with respect to genetically modified plants. There can be no doubt that the current status of the law holds that genetically modified plants are patentable subject matter under 35 U. S. C. § 101 (they may also be certificated under either the Plant Variety Protection Act or the Plant Patent Act). In fact, the Supreme Court decided on December 10, 2001, just as this work was in the last stage of the editing process, that plants are patentable subject matter.[407] The question of patentability of Roundup Ready[408] canola was also raised by the defense in the case of *Monsanto v. Schmeiser*.[409] The corpus of the legal estate is defined by the patent's language. It

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405. *See* Brooks v. Byam, 2 Story 256, 4 F. Cas. 258 (C.C.D. Mass. 1840) (No. 1,947).

406. *See* Gayler v. Wilder, 51 U.S. (10 How.) 477, 495 (1850) (holding: "the legal right in the monopoly remains in the patentee, and he alone can maintain an action against a third party who commits an infringement upon it"). *See also* Woodworth v. Wilson, 45 U.S. (4 How.) 712 (1846); Wilson v. Rousseau, 45 U.S. (4 How.) 646, 686, 688 (1846).

407. *See* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc., 122 S. Ct. 593 (2001). The case clarifies relatively little, and in fact may have actually set the stage for a multitude of problems for the seed manufacturers in the future. A brief discussion of the case is presented *supra*, note 371.

408. Roundup® and Roundup Ready® are trademark names of products produced and marketed by Monsanto. For simplicity, these trademark names will be used throughout the text, unless a specific quotation is identified, without the symbol ®.

409. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fctcf.gc.ca/fct/2001/2001fct256.html. In discussing the validity of the patent which Mr. Schmeiser was accused of infringing, Mr. Judge MacKay stated in paragraph 83 that:

> [m]oreover, the fact that replication of the gene may occur in the natural course of events, without human intervention after insertion of the gene in the original plant cells, and plants, produced for seed, and that this may result in differences between individual canola plants does not in itself preclude registration, under the Patent Act, of the invention, that is, creation of the gene and the process for inserting the gene. Not all progeny from pollen of Roundup Ready plants will be Roundup tolerant if outcrossing with Roundup susceptible plants occurs, but only use of those plants containing the gene can be subject to Monsanto's claims as patent holder.

Id. Because this paragraph may be dispositive in determining liability for contamination of a non-licensed farmer's fields through genetic pollution and because it is determinative in assessing liability for patent infringement by Mr. Schmeiser (and similarly situated farmers), it warrants some consideration. The conclusion that "only use of those plants containing the gene can be subject to Monsanto's claims as patent holder" is both drawn on a faulty analysis of the relevant plant genetics and plant biochemistry, discussed *infra*, and leads to a serious undercutting of Monsanto's legal position, of the farmer's legal position, and puts the court in a position that it very well might not want to be. The court's analysis appears to hinge on the presumption that the

exhibition of Roundup resistance in a variety implies that the transgene is present in that variety. The court's conclusion is that the right of Monsanto to protect its interest in the transgene follows the transgene independent of where that transgene might be found. Thus, the court appears to desire to find that any farmer who has the transgene in plants on his fields, without a license, is guilty of infringement of Monsanto's patent.

Several possible outcomes are immediately apparent as a result of the court's conclusion that Monsanto's right to protect its interest in the transgene is independent of where the transgene is found. Provided the court was correct in its assertion that "[n]ot all progeny from pollen of Roundup Ready plants will be Roundup tolerant if outcrossing with Roundup susceptible plants occurs," which it was not, then a case could exist in which the transgene is present in the progeny (of the originally Roundup Ready progenitor variety) but not be expressed, and hence the progeny would be Roundup sensitive. Unless Monsanto performed a careful DNA analysis on the progeny variety it would be unable to determine whether the transgene was present in the progeny (that is, Monsanto could not simply rely on the grow-out test it used to determine whether Roundup Ready canola was growing on Mr. Schmeiser's fields). In this case, it would not be economically, or practically, feasible for Monsanto to obtain the probable cause to believe that the transgene was present on the farmer's fields. Further, because the court is equating the presence of the transgene with Roundup tolerance, if Monsanto attempts to claim infringement of a patent where the transgene is found on the farmer's field when the transgene is not expressed, under the court's statement it cannot do so (because the plants are Roundup sensitive). When the transgene is present in the plants on the farmer's fields but not expressed, the farmer has no way of knowing of the existence of the transgene until testing of the crop occurs prior to selling that crop into a premium market (such as for human consumption). Here, the farmer has two options: first, to not sell into the premium market and hence eliminate the need for testing for the presence of the transgene; second, to attempt to sell into the premium market and run the dual risk associated with testing for the presence of the transgene. The first risk is that his crop will not be suitable for sale into the premium market and hence he will lose his premium price. The second risk is that Monsanto will find out about the presence of the transgene on the fields of the farmer and sue the farmer for patent infringement. Finally, if the farmer is producing a crop to be sold into the premium market for reproductive purposes, and that crop is contaminated by the transgene unbeknownst to the farmer, then the farmer has the same dual risk just identified.

The second possible outcome may result when the transgene is both present and expressed in the progeny (of originally Roundup sensitive progenitor variety) plants. The result concerning the farmer, as discussed in the previous paragraph, will occur in this case. The current case is the strongest case for Monsanto because when it is observed that the progeny both has the transgene present in its genome and the transgene is (apparently) expressed, then the court will conclude that the farmer is guilty of infringement. There are several problems with this outcome. First, as discussed *infra*, the presence of the transgene and the exhibition of Roundup tolerance by the progeny variety is not sufficient to conclude infringement of the patent. Second, it necessarily denies the farmer his right to not have the transgene in the plants on his fields. Third, it denies Monsanto the possible defense of disclaiming all interest in the transgene when the transgene has polluted the farmer's fields.

The third possible outcome may result when the progeny (of an originally Roundup sensitive progenitor variety) exhibits Roundup resistance but the underlying biochemical and genetic basis for the resistance is not certain. Because the court is equating Roundup tolerance with the presence of the gene, then the court must necessarily conclude that whenever Roundup tolerance is found then the transgene is present. This is problematic for Monsanto on several levels: first, if the progeny of originally Roundup sensitive weeds exhibit Roundup tolerance, then the court must conclude that the transgene is present in the noxious weeds. In this case, Monsanto may be liable for genetic pollution and creation of a nuisance and may not be able to use the defense that the progeny noxious weeds lack the transgene. Second, if a progeny plant (of an originally Roundup sensitive plant variety) that is Roundup tolerant occurs in the farmer's field, then the farmer will be unable to use the defense that the tolerance was naturally developed because the court must conclude that the tolerance is the result of the transgene's presence on the farmer's fields. Also, should the farmer sue Monsanto for genetic pollution, then Monsanto will be unable to argue that it has no interest in the gene (that has caused the plant to exhibit Roundup tolerance) and, simultaneously, Monsanto may successfully sue the farmer for infringement of the patent (because the court has held that Monsanto's interest in the legal estate containing the transgene travels with the transgene independent of where that transgene may be found). Because the court fails to separate the existence of Roundup tolerance from the presence of the gene, its statement that "only use of those plants containing the gene can be subject to Monsanto's claims as patent holder" undercuts Monsanto's legal position with respect to the farmer; undercuts the farmer's legal position with Monsanto; and puts the court into the position of coming to unjust conclusions (as it did in the Schmeiser case). The court

came to this untenable position because it failed to recognize the basics of plant genetics and plant biochemistry.

Stating that "[n]ot all progeny from pollen of Roundup Ready plants will be Roundup tolerant if outcrossing" occurs, clearly mixes the concepts underlying the areas of plant genetics and plant biochemistry while failing to understand the biochemistry of gene expression. The court in paragraph 83, quoted *supra*, is making two highly questionable assumptions: first, that the presence of the transgene is a necessary condition for the plant to exhibit commercially useful Roundup resistance; and second, that outcrossing with a Roundup sensitive variety may lead to the existence of the transgene in the progeny without being expressed and that the transgene simply may not be transferred at all. The presence of the transgene is not conclusive as to whether the plant exhibits Roundup resistance. If the gene is not properly expressed or is not expressed at all, then the plant may not exhibit Roundup resistance. Further, the presence of the transgene might not be necessary for the plant to exhibit Roundup resistance (as is amply demonstrated by the development of Roundup resistance in noxious weed species). The transgene (conferring Roundup resistance) was designed to be dominant; that is, both present and expressed in the progeny plant. In fact, Robert Horsch, under cross-examination at trial in the case of *Monsanto v. Schmeiser*, "agreed [that] a dominant gene, such as the Roundup resistant gene transferred to canola plants, would be present in any pollen from that plant and could be incorporated by nontransgenic plants." Murray Lyons, *Farmer's Reapings No Fluke, Court Told: Schmeiser Planted Roundup Ready Canola Knowingly*, THE SASKATOON STARPHOENIX at A1 (June 6, 2000), *available at* http://www.biotech-info.net/no_fluke.html.

Since the transgene is neither recessive nor quasi-dominant, outcrossing between a Roundup resistant variety and a sexually compatible Roundup sensitive species or variety will yield a progeny plant with the transgene present (with the caveat discussed below). Because the biochemistry of the Roundup sensitive variety determines, in part, whether the transgene will be expressed, an *a priori* conclusion of transgene expression in the progeny plant is far from certain. In addition, because a transgene designed to have a less than unity probability of expression in the progeny of Roundup resistant progenitor plants would be useless, the probability of the transgene failing to express in the progeny plant of a Roundup sensitive plant is vanishingly small. Further, those progeny plants in which the transgene is present but not expressed will be Roundup sensitive. Those progeny plants will not survive treatment with Roundup, and hence their variety of genome will be eliminated. One might say that, with probability near unity, outcrossing with a Roundup sensitive variety will yield a Roundup resistant progeny.

In exceedingly rare circumstances, the transgene for Roundup resistance is present in the progeny of an originally Roundup sensitive variety, but is not expressed. The reason for this event may be due only to prohibitive plant biochemistry, not plant genetics. Monsanto is as acutely aware of this fact as any other entity. When Koziel, who was and is working for Monsanto, inserted the native gene for *Bacillus thuringiensis kurstaki* kurhd1 δ-endotoxin CryIA(b) into *Zea mays* L., the endotoxin was not expressed. *See* MURRAY, *supra* note 194 and associated text; KOZIEL, *supra* note 195 and associated text; KOZIEL, *supra* note 173 and associated text. This is because the codon usage of the native gene was not compatible with the biochemistry of *Zea mays* L. *See* MURRAY, *supra* note 194 and associated text; KOZIEL, *supra* note 195. If a gene is expressed that confers Roundup resistance on a particular variety which is not a transgene, then that plant does not infringe the patent. Further, that particular gene may be recessive or quasi-dominant and hence may not be either be present or expressed when the Roundup resistance variety is outcrossed with a Roundup sensitive variety. The remaining possibility is the case in which the transgene is both present and expressed. In this case, the progeny of the originally Roundup sensitive variety will be Roundup resistant. In this case, the plant genetics dictate the presence of the transgene and the plant biochemistry dictates the expression of the transgene. One needs to recognize at this point that the Roundup sensitive variety may contain a gene that would confer Roundup resistance if it were expressed, but the variety is Roundup sensitive because that particular gene is not expressed. Employing techniques that have the effect of upregulating that gene, or set of genes, would confer Roundup resistance on that variety.

Two conclusions are then readily available. First, outcrossing between a Roundup resistant variety and a Roundup sensitive variety will produce a progeny that both contain the transgene and that transgene is expressed (that is, the progeny variety is Roundup resistant). The case where the transgene is present but not expressed would be exceedingly rare and due only to the plant biochemistry of the Roundup sensitive progenitor variety. Second, evidence of Roundup resistance in the progeny variety is not, and cannot be, conclusive that either the transgene is present and completely expressed or that part of the chimeric gene

would not serve to examine the claim language of all the current plant patents for purposes of this analysis. Therefore, emphasis is given to examining the language of a few representative claims.

Representative language, of interest to the current discussion, may be found in a patent issued to Monsanto Company and Ecogen, Inc. for insect-resistant transgenic plants.[410] The patent claims,[411]

(comprised of the transgene), is not responsible for the upregulation of a previously existing (that is, native) gene that would have conferred Roundup resistance had it been expressed.

Thus, to show infringement of the patent, Monsanto must shew that: (1) the transgene is present; (2) the transgene is completely expressed (that is, the variety exhibits Roundup resistance); and (3) the exhibition of Roundup resistance is due to complete expression of the transgene rather than upregulation of a native gene by part of the chimeric gene.

In summary, the court, in making the statement that "[n]ot all progeny from pollen of Roundup Ready plants will be Roundup tolerant if outcrossing with Roundup susceptible plants occurs," assumes that the transgene is recessive, or at most quasi-dominant, rather than understanding that the transgene is necessarily fully dominant by design. Further, the court assumes that no mechanism exists for exhibiting Roundup resistance other than the presence of the transgene and that the lack of Roundup resistance necessarily implies the lack of the transgene. By continuing with the statement that "only use of those plants containing the gene can be subject to" infringement, the court is equating transgene expression (Roundup resistance) with transgene presence in the progeny plant. Thus the court has unnecessarily mixed independent concepts and has only muddled the legal conclusion that should have been drawn.

Since the court appears to have been interested in finding in favor of Monsanto, and since the court is interested in preserving the claimed patent rights of Monsanto in the future, the statement discussed *supra* should have been written differently. By recognizing that outcrossing to Roundup susceptible varieties can happen, the court is precluding itself from agreeing with Monsanto in a future genetic pollution case that outcrossing cannot happen, or that outcrossing with remote fields of Roundup sensitive varieties cannot happen. Also, the court weakens a future claim by Monsanto that if the transgene exists then the plant will be Roundup resistance. Further, the statement that "only use of those plants containing the gene" are subject to claims of infringement puts Monsanto into the position of proving that the transgene exists (in such a case, merely showing Roundup resistance is not sufficient) and that the farmer "used" the plant containing the transgene. But most importantly, in the single phrase "only use of those plants" the court has completely obliterated, obviously unwittingly, its own position in the case at hand. As discussed elsewhere in this work, "use" requires a volitive act and the plant (while an ambiguous term as used here) can be readily construed as that object produced by the seed and not necessarily containing the progeny seed. Therefore, the court has concluded that Monsanto must shew that the accused infringer (Mr. Schmeiser in the case at hand) committed a volitive act with the plant (which may exclude the seeds) for there to be an infringement. The position in which the court has placed Monsanto leads to nowhere because Monsanto is interested in volitive acts committed with the seed, not the plant. Also, the plant has no value. Thus, even if the court could find infringement there can be no damages.

The far superior statement by the court would have excluded the preamble phrase and merely concluded that: "[t]he making, use, offering for sale, or selling of seeds containing the transgene constitutes infringement of the claim in Monsanto's patent." This statement clearly articulates the law of patent infringement and leaves Monsanto in the position of proving infringement of a claim upon which substantial damages can be collected.

410. *See* Leigh H. English, *Insect-Resistant Transgenic Plants*, U.S. PAT. NO. 6,023,013 (issued Feb. 8, 2000) (assignee: Monsanto Company (St. Louis, MO) and Ecogen, Inc. (Langhorne, PA)). [the '013 patent]

411. The relevant claims of the '013 patent are: (1) "A transgenic plant having incorporated into its genome a transgene that encodes an amino acid sequence selected from the group consisting of . . . ."; (2) "A transgenic plant having incorporated into its genome a transgene comprising a nucleic acid sequence selected from the group consisting of . . . ."; (3) "A progeny or seed from the transgenic plant of claim 1 or claim 2 comprising a modified cry3B* gene"; (4) "A seed from the progeny of claim 3 comprising a modified cry3B* gene;" (5) "A plant from the seed of claim 3 or claim 4 comprising a modified cry3B* gene." *Id.*

"[a] transgenic plant having incorporated into its genome a gene."[412] This language is excessively broad. Recognize, of course, that in the case of a pioneer invention, the claims of the patent are interpreted very broadly, in recognition of the extraordinary contribution that such an invention makes to the progress of technology.[413] However, the '013 patent is not a "pioneering" patent because a number of patents were issued before it which involved claims of a genome with a transgene included.[414] For the patent to be "pioneering" in the sense of being among the first to claim a transgenic plant, no other patents would exist before the issuance of the '013 patent.[415] Since other patents claiming a "transgenic plant" were issued before the '013 patent, the '013 patent cannot be a "pioneering" patent. Hence, the legal estate created by granting the '013 patent cannot be a "transgenic plant" with a transgene incorporated. Therefore, further examination is needed to determine what constitutes the legal estate.

The specification of the '013 patent defines the term "transgenic plant" as "a plant that has incorporated DNA sequences, including but not limited to genes which are perhaps not normally present," or "any other genes or DNA sequences which one desires to introduce into the non-transformed plant, such as genes which may normally be present in the non-transformed plant but which one desires to either genetically engineer or to have altered expression."[416] Such a definition of "transgenic plant" may very well include nearly all plants on the planet because all that is required is the *desire* to introduce into a plant, or alter the expression of, a gene which is already in the plant. Although one may "desire[] to introduce [the gene] into the non-transformed plant" or one may "desire[] to either genetically engineer or to have altered expression" of a gene in a plant, it may not be possible, using the techniques put forth in the '013 patent, to do so. Also, even if the gene is successfully inserted into the plant, the disclosed methods in the '013 patent cannot guarantee that the gene will be expressed. Now, consider the language "including but not limited to genes which are perhaps not normally present." A gene is either normally or not normally present in the plant. If there are no genes, which are not normally present, then the specification of "transgenic plant" can only be

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412. *Id.*

413. *See* Grubman Eng. & Mfg. Co., Inc. v. Goldberger, 47 F.2d 151 (2d Cir. 1931) The court stated that the "latitude we give does indeed depend upon how far the inventor has stepped forward; he may be a 'pioneer.' When he is, we stretch his claims to the breaking point." *Id*. at 153.

414. *See, e.g.*, Dilip M. Shah, Stephen G. Rogers, Robert B. Horsch & Robert T. Fraley, *Glyphosate-Resistant Plants*, U.S. PAT. NO. 4,940,835 (issued July 10, 1990) (claiming a "glyphosate-resistant dicotyledonous plant" in Claim 29); Camille Deluca-Flaherty, Victor J. Chan, Liliana E. C. Scarafia & Karen J. Brunke, *Thiol Protease Inhibitor*, U.S. PAT. NO. 5,629,469 (issued May 13, 1997) (claiming the "transgenic plant of claim 9 wherein said plant is maize" in Claim 15 and teaching in Claim 9 "[a] transgenic plant comprising a foreign gene which encodes a peptide according to claim 1").

415. Presumably, Agracetus, a small biotechnology company, obtained a pioneering patent on genetically engineered cotton in the United States in 1992. *See* NATIONAL RESEARCH COUNCIL, INTELLECTUAL PROPERTY RIGHTS AND PLANT BIOTECHNOLOGY 17 (1997) (proceedings of the forum on "Intellectual Property Rights and Plant Biotechnology" held at the National Academy of Sciences, November 5, 1996). Indeed, the patentee claimed a "[c]otton seed capable of germination into a cotton plant comprising in its genome a . . . chimeric gene construction being effective in the cells of the cotton plant to express a cellular product coded by the foreign gene" in Claim 1 and "[c]otton plants germinated from the seeds of claim 1" in Claim 1. *See* Paul F. Umbeck, *Genetic Engineering of Cotton Plants and Lines*, U.S. PAT. NO. 5,159,135 (issued Oct. 27, 1992).

416. English, *supra* note 410, at § 2.6.

referring to the native genome of the plant. The native genome of the plant is naturally occurring and has been part of this country's germplasm base since its beginnings. The only way that the language, "a plant that has incorporated" can retain any meaning within the patent context is if it means "a plant that has incorporated DNA sequences not normally present." However, even this would be overly broad because it would include all genomes with naturally occurring mutations (the mutations occur by alterations in the DNA sequences). Thus, in order to retain meaning, the language can only mean "a plant that has incorporated a gene not normally present." Since the definition of "transgenic plant" disclosed in the specification is so broad as to be meaningless because it includes all plants on the planet now or in the future, then the definition of "transgenic plant" claimed in the '013 patent cannot be supported by the disclosure in the specification.[417]

It must be recognized that the courts do not interpret the claims strictly. In fact, while claim interpretation requires the same formalistic approach used to interpret other legal documents, such a method of interpretation requires close scrutiny of the language of the claims and analysis of both the file history and prior art.[418] Likewise, it is a principle of law that to give value to the patent grant, the patent claims are not limited by the precise details of the disclosure in the specification.[419] However,

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417. For cases in which patents were found invalid due to overly broad claims and definitions, see: Consolidated Elec. Light Co. v. McKeesport Light Co., 159 U.S. 465, 474 (1895) (the objective of the disclosure "is to apprise the public of what the patentee claims as his own, the courts of what they are called upon to construe, and competing manufacturers and dealers of exactly what they are bound to avoid"); *In re* Fisher, 427 F.2d 833 (C.C.P.A. 1970); Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200 (Fed. Cir. 1991); *In re* Goodman, 11 F.3d 1046 (Fed. Cir. 1993); *In re* Wands, 858 F.2d 731 (Fed. Cir. 1988).

418. In an earlier case, the Second Circuit stated that:

> [o]n the one hand, therefore, the claim is not to be taken at its face—however freely construed—but its elements may be treated as examples of a class which may be extended more or less broadly as the disclosure warrants, the prior art permits, and the originality of the discovery makes desirable. On the other, it is not to be ignored as a guide in ascertaining those elements of the disclosure that constitute the "invention," and without which there could no patent at all. It is obviously impossible to set any theoretic limits to such a doctrine, which indeed its origin forbids, since it is in misericordiam to relieve those who have failed to express their complete meaning. Somewhat the same process is indeed inherent in the interpretation of any verbal expression, and perhaps the best that can be said is that in the case of patent claims much greater liberties are taken than would be allowed elsewhere. Each case is inevitably a matter of degree, as so often happens, and other decisions have little or no value. The usual ritual, which is so often repeated and which has so little meaning, that the same result must follow by substantially the same means, does not help much in application; it is no more than a way of stating the problem. Any decision is therefore bound to have an arbitrary color, as in all close cases of interpretation, and it is difficult to give it greater authority than an appeal to the sympathetic understanding of an impartial reader.

Claude Neon Lights, Inc. v. E. Machlett & Son, 36 F.2d 574, 576 (2d Cir. 1929). Later, the principle was stated as:

> [n]o doubt the interpretation of patent claims depends more upon the advance made by the inventor than upon the words used, and in spite of protestations to the contrary, courts do at times play fast and loose with them as they do not with other formal documents. It is therefore always proper, and generally necessary, to look at the prior art in order to learn how closely it presses upon the disclosure.

Cole v. Malleable Iron Fittings Co., 70 F.2d 686, 687 (2d. Cir. 1934).

419. Judge Learned Hand stated that:

> [a]n inventor is, of course, not confined to the exact details of his disclosure, else his patent would be of small value. The extent to which he may generalize it depends, not only upon the surrounding pressure

the language of the claims define the "metes and bounds" of the invention and cannot be disregarded in interpreting the scope of the invention. The language of the claims necessarily must be malleable, stretching to preserve the entire scope of the invention,[420] and shrinking to limit the claim to allow the invention to survive a challenge.[421] The language should be filled "as full as it will bear without bursting," or pressed "so long as it will not quite break," while recognizing that "of course the words have their limits."[422] When the word is defined in the specification, then that word must be given the same meaning in the claims.[423] Since the words in the specification and claims must have the same meaning, and to allow "transgenic plant" to be an element of the claim would be to defeat the claim for lack of enablement,[424] the phrase "[a] transgenic plant having incorporated into its genome" must be read as the preamble to the claim and not as an element of the claim.[425]

Because claim language of the form "[a] transgenic plant having incorporated into its genome"[426] cannot be interpreted as an element of the claim, the claim must relate to either the transgene which was inserted into the genome and expressed, or, at most, to the composition of the matter constituting the transgene which is expressed, and the original genome into which the gene was inserted.[427] In

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> of the art, but the extent to which the variations which he wishes to cover in his claims, are themselves within the initiative of a journeyman in the art. For the inventor's contribution must be a sufficient guide in itself, and its extent is limited to such substitutes for any disclosed element, as the art needs no help to find.

H. Ward Leonard, Inc. v. Maxwell Motor Sales Corp., 252 F. 584, 588 (2d Cir. 1918).

420. *See* Gibbs v. Triumph Trap Co., Inc. 26 F.2d 312, 314 (2d Cir. 1928).

421. *See* Herz Straw Co., Inc. v. Smith, 52 F.2d 32, 34 (2d Cir. 1931).

422. *Gibbs*, 26 F.2d at 314.

423. *See* Page Machine Co. v. Dow, Jones & Co., 235 F. 121, 123 (2d Cir. 1916).

424. *See* 35 U.S.C. § 112 (1994). The disclosure in the specification of the '013 patent does not teach one of ordinary skill in the art how to "desire" the "transgenic plant" in existence, or what "DNA sequences" must be incorporated that already exist in the plant genome in order to create the transgenic plant.

425. Also, to allow a broad and expansive interpretation of the language would cause an infringement of earlier patents. For example, patent number 5,159,135 recites in claim 5 "[a] cotton plant comprising in the genome of at least some of its cells" and in claims 6 and 7 "[a] cotton plant comprising in its genome at least two . . . ." *See* Paul F. Umbeck, *Genetic Engineering of Cotton Plants and Lines*, U.S. PAT. NO. 5,159,135 (issued Oct. 27, 1992). Similar language claiming a plant with a gene inserted into its genome is found in the following examples: Paul F. Umbeck, *Genetic Engineering of Cotton Plants and Lines*, U.S. PAT. NO. 5,004,863 (issued Apr. 2, 1991) (application filed December 3, 1986); Kenneth A. Barton, *Insecticidal Cotton Plants*, U.S. PAT. NO. 5,608,142 (issued Mar. 4, 1997) (application filed January 23, 1989; based upon prosecution in action since December 3, 1986); Gregory W. Warren, Michael G. Koziel, Martha A. Mullins, Gordon J. Nye, Brian Carr, Nalini M. Desai & Kristy Kostichka, *Genes Encoding Insecticidal Proteins*, U.S. PAT. NO. 6,066,783 (2000); Ronald C. Lundquist, David A. Walters & Julie A. Kirihara, *Fertile Transgenic Corn Plants*, U.S. PAT. NO. 6,160,208 (issued May 23, 2000) (filed March 20, 1996; the application was in the process of prosecution between Jan. 22, 1990 and its issue date in 2000).

426. English, *supra* note 410.

427. Permitting the legal estate to include the composition of matter constituting the transgene and the original genome is going further than the comfort level of the author permits. In the view of the author, labeling the product of the genetic manipulation a "composition of matter" is merely relabeling an intrinsically unpatentable invention such that it conveniently falls within the scope of 35 U.S.C. § 101 (1994). To be concrete, the plant cell is a biological machine that uses the instructions encoded into the DNA of the genome to carry out its

either case, the insertion must have occurred by genetic manipulation technology.[428] However, it is improper to claim the balance of the genome because it was neither created by the hands of man[429] nor extracted, purified, and completely characterized as part of the genetic modification.[430] Under the law, as it currently stands, it is possible to make a claim for the composition of the gene and the genome but not for the genome itself.[431]

Two situations may arise subsequent to the composition of the transgene and the plant genome: first, the plant genome may mutate; second, the transgene may mutate. While these two possibilities present a divergence from this article's path that would be of some interest to follow, they shall be examined only briefly due to their relevance to present discussion. Once the genome or transgene has mutated, either or both may be expressed to give new characteristics to the plant, which did not previously exist. Although it is not entirely certain in any given plant variety how many of the base pairs must be mutated in order to give rise to a new expression of different characteristics than were originally expressed in the progenitor plant, once the set of characteristics has changed, then the composition is no longer the same as when the patentee invented it.

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normal operations. By genetic manipulation, the set of instructions is altered such that the cellular machinery produces a compound that it did not previously produce, or produce a compound that it did previously produce, at a higher rate or to a higher concentration. By altering the set of instructions that the cellular machinery uses is neither creating a new composition of matter (as the compound newly produced by the cellular machinery or produced at a higher level than was previously the case) nor is it creating a new machine (the cellular machine still operates as it did without the transgene). Also, the cellular machinery is not "improved," it is merely acting as it always has; only it is producing a new type of compound. The analogous situation is found in a weaving loom operated by a program contained in a deck of Hollereth cards. If a small set of cards is inserted into the original deck of Hollereth cards the weaving loom will generate a new pattern of fabric and colors, but the weaving loom goes on as it did with the original deck of Hollereth cards. Simply providing a new subset of instructions does not entitle the operator of the weaving loom to claim that he has a new invention that entitles him to a patent for the weaving loom. On its face then, the act of inserting a small subset of instructions into the instruction set for the plant cell does not entitle the seed manufacturer to the right to claim the entire plant cell. Because the seed manufacturer cannot claim the cellular machinery as discussed above, clever relabeling of that cellular machinery must not lead to a contrary conclusion.

428. *See id.* at § 2.1 The patent specifies the technique required for the gene insertion as "[s]uch modifications to primary nucleotide sequences to enhance, target, or optimize expression of the gene sequence in a particular host cell, tissue, or cellular localization" and the technicians who are capable of carrying out the techniques as being: "those of skill in the art of protein engineering and molecular biology, and it will be readily apparent to such artisans, having benefit of the teachings of this specification, how to facilitate such changes in the nucleotide sequence to produce the polypeptides and polynucleotides disclosed herein." *Id.*

429. *See generally* Diamond v. Chakrabarty, 447 U.S. 303 (1980).

430. *See* Ingo Potrykus et al., *Genetic Engineering of Crop Plants*, *in* AGRICULTURAL BIOTECHNOLOGY 119-59 (Arie Altman ed., 1998) (describing several techniques for inserting a particular gene into the complete, intact nuclear genome of the plant cell).

431. A very candid discussion of an attempt to claim both the composition and the individual elements in an infringement case was presented by Justice Grove in *Westinghouse v. Lancashire and Yorkshire Railway Co.*, 4 DIGEST OF THE PATENT CASES REPORTED IN VOLUME I OF THE REPORTS OF PATENT CASES 230, 246 (1884). Justice Grove stated that: "[s]o that every element of the combination, although all are old . . . is to be claimed in aid of including an infringer; but to be disclaimed and to be treated only as a particular combination of five or six elements when you come to treat the question of the safety of the patent and the question of whether the patent is new or not." The word must be used "rationally and in the same sense" in both situations. *Id*. at 246.

It is a fundamental principal of patent law that the claims are the most important part of the patent and that the claims are the patent grant.[432] Recognize that the elements of the claim can extend no further than to the composition of a genome constituting a transgene, inserted by genetic manipulation techniques, which is expressed. Therefore, the legal estate created by the granting of the claim is either to an expressed transgene, inserted into the plant genome by genetic manipulation techniques or, at most, to the composition of the plant genome with the expressed transgene inserted by genetic engineering techniques. The exclusive interest of the patentee is the right of the patentee to exclude others from making, using, selling, or offering to sell a genome constituting an expressed transgene, inserted by genetic engineering techniques.

This definition of the legal estate in which the patentee has an interest excludes genomes other than the one employed by the patentee, and excludes transfer of the transgene by methods other than by genetic engineering techniques. As discussed earlier, "a genome" may reasonably be interpreted as being one genome from all possible plant genomes. The patentee did not disclose insertion of the transgene into each of the possible plant genomes.[433] In fact, the patentee did not disclose insertion of the transgene into the genome of each variety of plant within a species and successful expression of that transgene.[434] Based upon the available reports, the most that can be attributed to the patentee is that the transgene was successfully inserted into a particular plant cell and expressed by the variety of plant grown from that cell. Thus, the most that could have been contemplated by the patentee is that the transgene was inserted into a single unitary genome and not any one of the set of all possible genomes. Therefore, the genome used by the patentee is exclusive, not inclusive, of all other genomes.

In Arie Altman's book,[435] many fine discussions are presented on methods by which a transgene may be in the genome of a particular variety of plant. Those that may qualify under the classification of "genetic engineering techniques" necessarily involve human intervention.[436] All other methods for

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432. *See* Frank F. Smith Metal Window Hardware Co. v. Yates, 216 F. 361 (S. D. N. Y. 1914) (the court stated that a "change in the claims is as bad, if not worse, than a change in the disclosure, for the patent especially lives in the claim," *id.* at 363-4).

433. The difficulty attendant to inserting a transgene into a plant genome and having it successfully expressed is well known. *See* POTRYKUS, *supra* note 430; *See* Koziel, infra note 434. Thus for any given genome the inventor would have to perform a considerable amount of experimentation, possibly an excessive amount, to determine the precise method for successfully inserting the transgene into the plant genome and having it expressed.

434. Koziel admitted that insertion of a transgene into cells of the same variety of maize yielded different varieties (called "events") of plants each with a different characteristic expression of the transgene depending on the promoter used for the transgene. *See* Michael G. Koziel et al., *Transgenic Plants for the Control of Insect Pests*, *in* AGRICULTURAL BIOTECHNOLOGY 283, 287-88 (Arie Altman ed., 1998) (describing research and developments in expressing *Bacillus thuringiensis* δ-endotoxin in both dicotyledonous and monocotyledonous plants). Based upon the information available, it may reasonably be concluded that in most cases the transgene was either not successfully inserted or was not successfully expressed. *See id. See also* Potrykus, *supra* note 430.

435. *See generally* AGRICULTURAL BIOTECHNOLOGY (Arie Altman ed., 1998).

436. In fact, if the transgene is inserted by any method other than by human intervention neither the method of translocation nor the resultant composition is patentable under the standard articulated in *Chakrabarty*. *See* Diamond v. Chakrabarty, 447 U.S. 303 (1980).

translocating the transgene necessarily do not involve the direct intervention of man. Because the current standard for patentability of subject matter is that it be "anything under the sun made by man,"[437] then, under the current state of the law, only a composition created by genetic engineering may be patentable.

The patentee cannot claim a composition of any genome and the transgene because the patentee did not contemplate the set of all genomes,[438] has not enabled one of ordinary skill in the art to insert the transgene into any one given genome of the set of all possible genomes,[439] and has not enabled one of ordinary skill in the art to have the plant express the transgene. Therefore, the legal estate is at most only the combination of the particular genome (or limited set of genomes) actually employed by the patentee and the transgene. All other genomes are necessarily excluded, including those that differ from the contemplated genome only in the expression of certain genes. Now that the legal estate has been established, it is necessary to determine what rights the seed manufacturers may assert against Jack.

Plants and seeds constitute a particular problem for utility patent protection because of the possibility of replicating the seed to a very large number of progeny. In fact, it is the reasonable expectation of both the patentee and the purchaser of the seed that the seed will be reproduced. Unlike hybrids, where the genome of the seed is notoriously unstable, genetically modified seeds will produce plants that in turn produce seeds with exact copies (presumably) of the genetic code artificially inserted into the progeny plant. Jack then, obtains a free copy of the genetically modified variety of seed from his crop. At this point, Jack has two possible alternatives for disposition of the progeny genetically modified beans. He may sell all of the beans for non-reproductive purposes. He may sell part of the seed for non-reproductive purposes and retain the balance of the seed for either planting during the next growing cycle or selling to his neighboring farmers. Whether Jack may engage in either of these alternatives depends, to a large extent, on the interpretation of the utility patent as applied to plants.

First, consider whether Jack may sell his crop of beans for non-reproductive purposes. The Plant Variety Protection Act has a crop exemption that specifically states that the protected seed may be reproduced to a very large number of progeny seeds, which may be sold for non-reproductive purposes. Without the crop exemption, the protection of the seed would render it useless. The plant patent act specifically states that the patentee has the "right to exclude others from asexually reproducing the plants"[440] and any plant so reproduced cannot be offered for sale or sold. Section 101 of Title 35 of the United States Code does not have a crop exemption analogous to that found in

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437. *Id*. at 309.

438. The doctrine underlying this statement is articulated in *Consolidated Elec. Light Co. v. McKeesport Light Co.*, 159 U.S. 465, 474 (1895). The patentee must identify "some general quality, running through the whole" set "which distinguishe[s] it from every other, and g[ives] it a peculiar fitness for the particular purpose." *Id*. In this case, "the man who discovered such quality might justly be entitled to a patent." *Id.* at 475.

439. "If the description be so vague and uncertain that no one can tell, except by independent experiments, how to construct the patented device, the patent is void." *Id.* at 474.

440. 35 U.S.C. § 163 (1994 & Supp. III 1997).

the Plant Variety Protection Act.[441] If the variety of beans is certificated under the Plant Variety Protection Act, then Jack may sell the progeny beans for non-reproductive purposes only. If the plant is protected under the Plant Patent Act, then Jack may plant the seeds to yield the mighty beanstalk and both sell the progeny beans for non-reproductive purposes and save seeds from crop for planting in the next crop cycle. This is because the only act constituting infringement of a plant patent, issued under section 161 of Title 35, is the asexual reproduction of the ancestral plant. If a patent has issued on the variety of beans under section 101, of Title 35, then Jack may purchase the seeds, but he may not reproduce the plant from which the beans originated, either asexually or sexually.[442] That is, Jack may not plant the seeds to grow the mighty beanstalk. Even if Jack does sexually reproduce the beans, he has no interest in the beans, which allows him to dispose of the progeny seeds as he sees fit. Such a conclusion is also independent of whether Jack knew that a patent existed that protects the interests of the patentee in the beans. This result seems contrary to common sense because the beans are meant to be reproduced and because, typically, when a person purchases something, the right to use that thing is implied in the sale.

According to the first sale doctrine of patent law,[443] once the patent holder has sold the patented item, the patent holder's right to limit use or sale of that item has ended. This means that a purchaser of a patented widget may use and dispose of that particular widget as he sees fit without infringing the patent.[444] However, if the widget is purchased and used as a template to mechanically reproduce the widget for sale, or reproduced for the use of the purchaser of the original widget, then the patent would be infringed.

Plants pose a problem that is different from mechanical widgets. In plants, the patented invention is reproduced as the plant grows and matures. However, mechanical widgets cannot, yet, reproduce themselves. Also, in mechanical widgets, common sense indicates that the "make" and "use" function are separable, while in plants the same common sense indicates that the "make" and "use" functions are not necessarily separable. The sole purpose of purchased plant seed is to plant them to produce a progeny crop. Both the seed manufacturer and the farmer are fully aware of this purpose. It is easy to argue that in the case of patented plants, the "make" function and the "use" function are inseparable, both of which the patentee has the right to exclude others from performing.[445] The issue

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441. *See* Peter J. Goss, *Guiding the Hand That Feeds: Toward Socially Optimal Appropriability in Agricultural Biotechnology Innovation*, 84 CAL. L. REV. 1395, 1400 (1996).

442. This conclusion may be reached only if the existence of the mighty beanstalk on Jack's land constitutes infringement of the patent. This is the view employed by Judge W. Andrew MacKay in the case of *Monsanto v. Schmeiser*. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256, at ¶ 119 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html. It is likely to be a common belief that possession of a genetically modified plant constitutes infringement. Therefore, that is the perspective that will be followed in the analysis of this issue.

443. *See* Adams v. Burke, 84 U.S. 453, 456-57 (1873).

444. A complete discussion on the doctrine of first use, or the doctrine of exhaustion, is given by Scott A. Chambers, *Exhaustion Doctrine in Biotechnology*, 35 IDEA:J. L. & TECH. 289 (1995).

445. The argument is as follows: The farmer purchases the seed with the clear intention of reproducing that seed to a very large number of progeny, harvest the progeny seed, and sell the harvested progeny seed (presumably) for a profit. The farmer plants the seed that he purchased, and a plant and progeny seed are produced. Because the farmer planted the seed, then he is using the invention patented (the seed); and because the farmer fertilized, cultivated, and possibly watered the field where the plant was growing then the

is whether the first sale doctrine should apply in the case of patented plants.[446] If the doctrine does apply, then Jack may purchase the protected seeds and dispose of them as he sees fit. If the doctrine does not apply, then Jack may purchase the seed, but his right to dispose of them is limited.

The Supreme Court has stated that "[a]n incident to the purchase of any article, whether patented or unpatented, is the right to use and sell it," and that when the patentee, or his licensee, sells "an article which is capable of use only in practicing the patent [then there] is a relinquishment of the patent monopoly with respect to the article sold."[447] Either the court must treat all articles that are offered for sale the same under the exhaustion doctrine or plants must be treated as a unique class of articles because the "use" and "make" functions cannot be separated. Under the first alternative, once the seed manufacturer sold the seeds to the farmer then it would lose all control over the seeds. Under the second alternative the seed manufacturer would retain all rights to the seed and the farmer would purchase worthless seed because he could not plant it to produce a crop.

It is worthwhile to note at this point that the sale of hybrid seeds by the seed manufacturer causes this problem to be solved in a natural manner. When Jack plants his beans, raises the mighty beanstalk, and reaps the harvest of the progeny beans from the beanstalk, he is engaged in biological reproduction rather than mechanical reproduction. The policy of protecting the interests of the seed manufacturer indicates that both cases of reproduction should be held equal under the light of patent law, and both should constitute infringement. This means that the doctrine of exhaustion would not apply to biological reproduction. Jack, then, may purchase the seed from the seed manufacturer and put the seed into the ground. From there, infringement of the patent depends upon the nature of the legal estate. If, indeed, the legal estate owned by the seed manufacturer is the transgene, or at most only the composition of the plant genome and the transgene, then as soon as the seed germinates, the patent is infringed. This is because each cell of the plant will have a copy of the subject matter of the legal estate that the patentee may exclude others from making. If the legal estate is the seed of the plant, then the patent is infringed as soon as the seed starts to grow. However, it is not entirely clear whether the doctrine of exhaustion applies to biological reproduction when that function is the

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farmer is making the invention patented. Therefore, the farmer is both making and using the invention patented. Under this argument, it is impossible to use the seed and not make the invention patented because as soon as the seed germinates the invention patented is reproduced, and hence "made". Thus, it might be concluded that the use and make functions are inseparable in the case of plants.

446. This question has not yet been directly addressed by the Supreme Court. In *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Intern. Inc.*, 122 S. Ct. 593 (2001), the Supreme Court decided the issue of whether a utility patent, under 35 U.S.C. § 101 (1994), may be obtained for a genetically modified seed or plant. Because the decision that was taken on certiorari by the Supreme Court was the denial of summary judgment for the defendant, the underlying issue in the case remains unresolved. The central issue to be decided at trial is whether the first sale doctrine applies to genetically modified seeds. *See* Pioneer Hi-Bred International Inc. v. J.E.M. Ag Supply, Inc., 49 U.S.P.Q.2d (BNA) 1813 (N.D. Iowa 1998). Since the issue will not reach the Supreme Court until several years after the publication of this article, we must speculate as to the disposition of the issue by the Court. The author predicts that the Supreme Court, in a majority opinion authored by Justice Thomas, will hold that legal title in the legal estate will remain with the seed manufacturer independent of the number of times that the genetically modified seed is sold. This is because should legal title pass to the purchaser of the genetically modified seed then the seed manufacturer will no longer have a basis for asserting his interest in the genetically modified seeds against the farmer.

447. United States v. Univis Lens Co., Inc., 316 U.S. 241, 249 (1942).

only use to which the seeds may be put.[448]

Turn now to Jack's second option for disposing of his progeny beans. Consider the case of Jack selling the crop of beans from his magic beanstalk for reproductive purposes. If the doctrine of exhaustion were applied to biological reproduction, then the seed manufacturer would not have the right to exclude Jack from selling the seeds for any purpose and Jack would be permitted to engage in biological reproduction of the invention patented where he would not be allowed to engage in mechanical reproduction of the patented widget. If the doctrine of exhaustion were not applied to biological reproduction, Jack would be infringing the patent upon selling the progeny seeds for reproductive purpose because, as discussed, there should be no difference under utility patent law between mechanical and biological reproduction, and Jack would have made the patented invention by growing the plant on his land. It would be unjust to the patent holder of a genetically modified seed to apply the doctrine of exhaustion and hence allow Jack to reproduce the seed for any purpose he sees fit, whereas the holder of the patent on the mechanical widget would be protected from such activity.

Mechanical and biological reproduction must be treated the same under patent law, therefore, the doctrine of exhaustion does not apply to biological reproduction and Jack, upon buying patented seed, does not acquire the right of production of the beans for sale, either for non-reproductive or for reproductive purposes. Jack only acquires the property right transfer, use, and waste of the beans that he originally purchased. A cause of action for equity and damages would exist for mechanical reproduction of a widget, so the same should lie for biological reproduction of beans. In order for Jack to produce progeny seeds, either for his own use or for sale for non-reproductive purposes, he must obtain a license from the seed manufacturers.

3. Property Rights Under Licensing Agreements

The seed manufacturers have increasingly turned to licensing agreements to provide protection for their intellectual property in genetically modified plants. The standard practice in the seed industry is to require the farmer to sign a license agreement[449] with the seed company before purchasing genetically modified seeds for planting on his farm.[450] In the case where the genetically modified plant is protected by a utility patent, the license allows the farmer to plant the seed and sell the progeny seed for non-reproductive purposes.[451] If the plant is also protected by a certificate issued pursuant to the Plant Variety Protection Act,[452] then the license agreement adds a redundant layer of protection

448. *See* Chambers, *supra* note 444, at 321-29.

449. *See* Rick Weiss, *Seeds of Discord; Monsanto's Gene Police Raise Alarm on Farmers' Rights, Rural Tradition*, WASH. POST, Feb. 3, 1999, at A1.

450. *See* Lewontin, *supra* note 127.

451. *See* HAMILTON, *supra* note 304.

452. The Plant Variety Protection Act, as interpreted in *Asgrow*, limits the sale of seed for reproductive purposes to only that quantity sufficient to replant the farmer's fields. The amendment to the Plant Variety Protection Act, § 2543, prohibits the farmer from selling any of his seed for reproductive purposes. Therefore, the provision in the license agreement, which prohibits the farmer from selling genetically modified seeds certified under the Plant Variety Protection Act for reproductive purposes, is redundant.

for the seed manufacturers by prohibiting the farmer from transferring, or alienating, any of the seed he produces for any purpose other than non-reproductive purposes.[453]

The license agreement prohibits the farmer from using the seed produced on his land for planting in the next growing cycle. However, the license does not prohibit the farmer from purchasing and using "brown-bag" seed as long as the technology-use license agreement is in force, and as long as the farmer observes the restrictions on using the seeds for a single growing cycle.[454] In addition, the farmer is prohibited from harvesting any volunteer seed. This prohibition is perplexing: first, if the volunteer plants occur in a field of non-modified seeds of the same species (say glyphosate-resistant canola in a field of glyphosate-susceptible canola) then how are these plants to be identified? And if they could be identified, how is the farmer expected to either remove the genetically modified plants or

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453. A copy of the Technology-Use License Agreement used by Monsanto in Canada for glyphosate-resistant canola was kindly provided by Mr. Schmeiser. It states:

> Technology Use Agreement terms and conditions
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> [1.]The Grower shall use any purchased Roundup Ready® canola seed for planting one and only one crop for resale for consumption. The Grower agrees not to save seed produced from Roundup Ready® canola seed for the purpose of replanting nor to sell, give, transfer or otherwise convey any such seed for the purpose of replanting. The Grower also agrees not to harvest any volunteer Roundup Ready® canola seed crops.
> [2.]The Grower shall purchase and use only Roundup® branded herbicide labeled for use on all Roundup Ready® canola seed purchased. The Grower shall purchase both the Roundup® branded herbicide and the Technology Use Agreement as a package from his retailer of choice. The Seed Purchase Fee shall be non refundable after the date of reconciliation of actual acres planted as set forth in the Monsanto Roundup Ready® canola service policy.
> [3.]Monsanto warrants the tolerance of plants from Roundup Ready® canola seed to Roundup herbicide when used at specified label rates and as per label instruction.
> [4.]The Grower grants Monsanto the right to inspect, take samples and test all of the Grower's owned and/or leased fields planted with canola, or any other land farmed by the Grower, and to monitor the Grower's canola fields and storage bins for the following three years for compliance with the terms of this Agreement. All such inspections shall be performed at a reasonable time, and if possible, in the presence of the Grower. The Grower also agrees to supply upon request the locations of all fields planted with canola in the following three years. Grower has or shall obtain all permissions required for Monsanto to exercise this right to inspect, take samples and test.
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> [5.]If the Grower violates any of the Terms and Conditions of this Agreement, the Grower shall forfeit any right to obtain any Agreement in the future and this Agreement may, at Monsanto's option, be terminated immediately. In the event of any use of Roundup Ready® canola seed which is not specifically authorized in this Agreement, the Grower agrees that Monsanto will incur a substantial risk of losing control of Roundup Ready® canola seed and that it may not be possible to accurately determine the amount of Monsanto's damages. ***
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> [6.]The Terms and Conditions of this Agreement are personal to the Grower and shall be binding and have full force and effect on the heirs, personal representatives, successors and permitted assigns of the Grower, but the Grower's rights hereunder shall not otherwise be transferable or assignable without the express written consent of Monsanto.

Monsanto Technology-Use Agreement provided by Mr. Percy Schmeiser, Farmer, Saskatchewan, Canada (July 6, 2001) [hereinafter Monsanto Technology-Use Agreement]. A copy of the Monsanto Technology-Use Agreement is on file with the author.

454. *See id.* at [1.].

avoid harvesting seeds from these plants? Second, if the genetically modified seeds are growing in a field of a different species of crop, then who should be liable for the cost of removal?[455] Volunteer plants arrive on the farmer's fields through a number of routes, including by the wind, animals, and farm equipment; and by latent germination of dormant seeds left from a previous harvest.[456] Identifying the volunteer genetically modified plants in fields of the same species of plants, or eradicating volunteer plants in a field of a different species of plants may be extremely expensive and difficult. Thus, the requirement that the farmer not harvest volunteer genetically modified plants places an unreasonable burden on the farmer's resources and an unreasonable restraint on his use of his land.

The license in the case of Roundup-resistant genetically modified plants also requires the farmer to purchase Roundup as a bundled package with the technology-use license.[457] The provision[458] grants Monsanto the exclusive right to sell herbicide to the farmer. The motivation behind this provision might be that Monsanto warrants the tolerance of the glyphosate resistant field crop plants, or that Monsanto wishes to prohibit the farmer from using glyphosate from another source and hence extend its monopoly in Roundup beyond the expiration of the patent. However, the warranty could easily be written to exclude situations in which the farmer used a glyphosate herbicide other than Roundup without limiting the farmer's right to purchase the herbicide from vendors other than Monsanto.

The most onerous provisions in the license grant Monsanto the right to inspect any and all fields and storage bins, which the farmer planted, or used, with the genetically modified seed. In addition, Monsanto assumes the right to inspect the farmer's fields and bins the following three years for the purpose of monitoring compliance with the terms of the agreement. This is independent of whether the farmer has chosen to use the genetically modified seeds in subsequent growing cycles or continue to grow that particular species of plant. Recall the provision that prohibits the farmer from harvesting volunteer seeds. If the volunteer seeds grew to a sufficiently dense population, and the farmer could not detect them, then the test for the transgene would indicate that the farmer was in violation of the technology-use license even if, in fact, he had planted non-genetically modified plants. In order to avoid the possibility of a false positive test for violation of the technology-use license, the farmer must give up his right to decide what seed varieties of a particular plant species to plant on his fields. Also, the farmer must give up the right to decide what species of plant to grown on his fields. Monsanto, by license, acquires the right to inspect both the farmer's fields and his bins. The license does not require the farmer's presence when Monsanto enters the farmer's land to inspect the crop.

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455. If the genetically modified seeds are Roundup-resistant then they must be removed by hand because spraying with Roundup would be ineffective and spraying with any effective herbicide in general would destroy the entire crop.

456. For instance, maize left behind from a previous growing cycle will grow as "volunteer" plants in a field of soybeans. Furthermore, canola will lie dormant for up to 10 years before germinating. *See* Interview: Schmeiser {July 6, 2001}, *supra* note 270.

457. While this may raise antitrust issues analogous to those where Microsoft required bundling of its web browser with its operating system, discussion of such issues are too far removed from this paper's thesis.

458. *See* Monsanto Technology-Use Agreement, *supra* note 453, at [2.].

Monsanto's assumed right to enter and inspect the farmer's fields is independent of whether the farmer is currently growing genetically modified plants on those particular fields.

The license agreement binds not only the farmer, but also the "heirs, personal representatives, successors and permitted assigns" of the farmer.[459] This provision leads to very curious results. First, Monsanto retains the right to enter and inspect the land upon which genetically modified plants were grown even after the farmer has died, and his estate has been distributed to his heirs who may not be farming the land at all. In fact, it is entirely conceivable that owners of the field parcels after the fields have been subdivided and houses built upon them, would not be able to exclude Monsanto from entering their land. Second, is the case where the farmer dies, his estate is distributed, and his heirs lease the land to other farmers. In that situation, the farmer's estate (where the farmer signed the technology-use agreement) could be liable for damages if the lessees unknowingly harvest genetically modified seeds. Evidently, the farmer lessees may not be liable for damages because the license specifies that the farmer who signed the license would be liable.[460] Third, consider the case where a farmer leases land from a disinterested landowner and plants genetically modified seed covered by the technology-use license in year one. At the end of year one, the first farmer is displaced and replaced by a second farmer who has not signed the license and who does not wish to grow genetically modified plants. If farmer two harvests volunteer genetically modified plants, either knowingly or unknowingly, then it appears that the first farmer would be liable for damages to Monsanto, because the second farmer would be a successor to the land. It is unjust and against the policy of contract law that a license signed by and agreed to by the first person should be binding upon the second person who was ignorant of the license and did not agree to the terms of the license. Also, by its language, the license is binding upon the signing farmer and is not an encumbrance upon the land. If the agreement were to be an encumbrance upon the land, then it must specifically so state and would be an easement, not a license. An easement must be registered with an authority of the state; the license agreement is, evidently, not so required. Therefore, only the grower is bound by the agreement and liable should the provisions be violated by an heir, assign, or successor.[461]

The above analysis is for Roundup-resistant canola. Yet, reports of similar conditions have been made for other Roundup-resistant plants in the United States. Typically, the license agreement will restrict the use of the progeny seed beyond that extent mandated by statute. The license agreement usually prohibits the farmer from using the seed produced on his land for replanting in the next growing cycle.[462] Therefore, the license agreement restricts the farmer to a single crop from a single

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459. *See id.* at [6.].

460. *See id.* at [5.].

461. In the case of Percy Schmeiser, the person (we shall call him R) who reported Mr. Schmeiser to Monsanto as possibly growing Roundup-resistant canola had rented a parcel of land upon which he had planted Roundup-resistant canola. The landowner declined to rent the land again to person R the next year and rented the land to Mr. Schmeiser instead. Because canola "volunteers" from one growing cycle to the next, the canola that Mr. Schmeiser harvested during the subsequent growing cycle was certainly contaminated with the transgene. Because Mr. Schmeiser would have retained some seed from these fields, as was his customary practice and right, then the following years his entire crop of canola would have been contaminated with the transgene. Since Mr. Schmeiser was a successor to the land and because Mr. Schmeiser did not sign the license agreement it is unjust to hold him to the terms of the agreement; rather person R must be held liable to Monsanto. Such an outcome would be ironic indeed. *See supra* note 456.

462. *See* Lewontin, *supra* note 127, at 72.

purchased seed. In essence, the farmer gives up the property right to use the purchased seed as he sees fit,[463] and must give up substantial property rights in his own land.

Ownership of land includes the right to use that land as the owner sees fit. To enter into the license agreement the farmer is forced to give up this right. The license agreement does so by requiring that the farmer return to the same seed company and purchase the same variety of seed for the next growing cycle if the farmer desires to continue production of the same type of crop.[464] Such a license provision protects the market share that the seed manufacturer has established, by prohibiting the farmer from: saving seed and replanting his own fields; transferring possession of the seed, whether the progenitor seed or progeny seed, to others; and using a competitor's seed in those growing cycles in which protection against either insect or herb pests is not necessary.[465] It is clear then that the seed manufacturers who use license agreements to protect their genetically modified seeds may have better control over the disposition of the seed crop by the farmer than they may have under the Plant Variety Protection Act or under Title 35 of the United States Code.[466]

Control by the seed manufacturer comes at a high cost to the farmer. The farmer no longer has the right of alienation of his property in the seed, either the progenitor seed or the progeny seed. He loses the right to use his lands as he sees fit: he may not plant a particular crop type with the genome of his choice and he may not be able to leave his fields lie fallow because the license stipulates that the farmer purchase the particular seed variety each year. Because the seed manufacturer has written the license agreement such that the company investigators may enter the farmers lands and test the crop for compliance with the license agreement, the farmer must give up the right to exclude others from his lands. The farmer can, however, choose to not plant the genetically modified plant and to not sign the technology-use license. This will not guarantee that the farmer will be immune to

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463. *See id.*

464. The licensing agreement from Monsanto for use of its Roundup Ready seeds requires that the farmer use them for only a single planting. The license agreement also includes a provision which states that Monsanto has the right for three years after the purchase of the seed to enter the farmer's lands and test the seeds to determine whether a Roundup Ready seed has been planted. *See* Monsanto Technology-Use Agreement, *supra* note 453. *See also* Weiss, *supra* note 449. Not only is this requirement an invasion of the farmer's property rights in his own land to exclude, it is unnecessarily costly because the farmer is required to purchase Roundup Ready seeds each year. Evidence is being accumulated which indicates that noxious plants adapt to environmental stress such as periodic glyphosate, the active ingredient in Roundup, exposure at a surprising rate. It is unclear whether the successful adaptation is the result of stress induced genetic modification by the plant species or by some other coping mechanism. *See* Gregg Hillyer, PROGRESSIVE FARMER 36 (Oct. 2000). The recommendations are that Roundup not be used for each growing cycle, and that several years intervene between its use. *See id.* at 37. Because glyphosate has a very short lifetime in the environment, it is unnecessary for the farmer to use Roundup Ready seeds during the growing cycles in which Roundup is not used for noxious plant control. Therefore, the license agreement permits an unnecessary invasion of the farmer's property rights by requiring the farmer to submit to random inspections during those planting cycles when he need not use Roundup Ready seeds.

465. In order to reduce the possibility of the development of herbicide resistance in noxious plants or bio-insecticide resistance in insects, it is necessary to alternate growing cycles in which either herbicides are applied for control of noxious plants or bio-insecticides are applied for control of insects with growing cycles in which the control is not applied. In those growing seasons in which the control is not applied, it is not necessary for the farmer to incur the additional costs associated with the genetically modified seed.

466. *See* Lewontin, *supra* note 127, at 72.

liability when the transgene is translocated onto his lands.

Without the genetically modified crops, the farmer must use pesticides to control insect pests, and herbicides and cultivation of the fields to control noxious weeds. The genetically modified crop is claimed to be beneficial to the farmer because of the reduced pesticide and herbicide costs and the reduced costs associated with the cultivation of the fields. In fact, the genetically modified crops are delivering high transaction costs and may not be living up to their expectations. The high transaction costs come when the farmer attempts to market the progeny seeds from genetically modified plants. The progeny seeds must be tested for the existence of the modified genome, and must be kept separate from the stream of crops destined for human consumption unless the crop is specifically licensed for consumption by humans. The failure to live up to expectations is seen in the development of glyphosate resistance in noxious plants and with the development of bio-insecticide resistance in insect pests. In summary, the farmer, by agreeing to the license agreement, becomes locked into the use of a variety of genetically modified plant marketed from a particular seed manufacturer which carries with it high input costs to his operation without the guarantee that the seed will yield the results expected.[467] As part of the bargain, the farmer must give up property rights in not

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467. It also appears that if the reasoning of the Federal District Court in Canada is followed then all farmers in the vicinity of the licensed farmer, who has the genetically manipulated plants on his farm, must also sign the Technology-Use License Agreement and pay the licensing fee, even though they may not wish to have the genetically manipulated plant on their fields. To see this, consider the case of *Monsanto Can., Inc. v. Schmeiser Enter., Ltd.*, 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html, in which Monsanto sued Mr. Schmeiser for patent infringement. In paragraph 28 of the court's decision in *Monsanto v. Schmeiser*, Judge MacKay discussed the rights retained by Monsanto under contract. Specifically, Judge MacKay stated that:

> [a]ll of the plaintiffs' licensing arrangements in Canada are made by or on behalf of Monsanto Canada. It licenses commercial seed growers to grow Roundup Ready canola for seed purposes. Farmers are required to attend a Grower Enrollment Meeting conducted by Monsanto representatives who describe the gene technology and the licensing terms for its use. A grower must be certified to use the gene technology by signing a Roundup Ready grower agreement. This entitles a farmer to purchase Roundup Ready canola seed from an authorized Monsanto agent, but to acquire seed the farmer must also sign a Technology-Use Agreement provided by the retail seed agent acting for Monsanto Canada. Under the latter agreement, the farmer can use the seed for planting only one crop, to be sold for consumption to a commercial purchaser authorized by Monsanto. The farmer undertakes not to sell or give seed to any other third party and not to save seed for his own replanting or inventory. Under the TUA Monsanto has the right to inspect the fields of the contracting farmer and to take samples to verify compliance with the agreement.

Id. The court indicated that the farmer must sign the Technology-Use License as a prerequisite for acquiring the genetically modified seed. This does not address the situation in which the farmer does not "acquire" the transgene through a vendor but rather the transgene contaminates his fields through natural forces. However, the tenor of the court's decision in paragraphs 94 through 97 indicates that even if the farmer does not "acquire" the transgene through normal retail channels, he must have signed a Technology-Use License Agreement in order to avoid infringement of the patent.

Three important items in paragraph 28 need to be recognized. First, the court is stating that Monsanto, by means of the Technology-Use License Agreement, claims the right to determine the retail channels through which the genetically modified seeds may be conveyed to the farmer (by stating that the farmer is entitled "to purchase Roundup Ready canola seed from an authorized Monsanto agent," paragraph 28). Second, Monsanto claims the right to dictate the channels through which the farmer may dispose of his crop (by stating that the farmer's crop may "be sold for consumption to a commercial purchaser authorized by Monsanto," paragraph 28). The court is, then, recognizing that Monsanto, by contract, may create a vertical monopoly which eliminates competition amongst retail level seed suppliers and which eliminates competition amongst commercial purchasers of the farmer's crop. The third important item in paragraph 28 is the court's statement

that: "Monsanto has the right to inspect the fields of the contracting farmer and to take samples to verify compliance with the agreement." Thus, by contract the farmer relinquishes the right to exclude Monsanto from his fields. However, the contractual right, claimed by Monsanto, to control the vertical structure of the market for genetically modified crops and the contractual right of access to the fields and crops of the licensee, s*ee* Monsanto Technology-Use Agreement, *supra* note 453, does not extend to the control of the vertical market structure for non-licensed farmers and does not extend to the right of access to the fields and crops of those non-licensed farmers. Further, Monsanto cannot claim such rights under the patent law.

However, Judge MacKay seems to have missed the distinction between contractual rights and interest protected by the grant of letters patent. In paragraph 37, Judge MacKay recognized that:

> [i]n the summer of 1997, the plaintiffs, through Robinson Investigations, a private agency in Saskatoon, undertook random audits of canola crops growing in Saskatchewan. The farms were identified by Monsanto from among their licensed farmers, or from leads or tips suggesting that Roundup Ready seed might be growing on property of an unlicensed farmer, or from random inspections undertaken to audit a farming area. The defendants' farm was included in this audit process after an anonymous tip was received indicating that Roundup Ready canola was being grown in Schmeiser's fields, where it was not licensed.

Id. Indeed, while the Technology-Use License Agreement allows Monsanto to inspect the fields of the licensee, it certainly does not grant Monsanto the right to enter and inspect the fields of a farmer who is not a licensee. Neither the technology-use license nor the patent grants Monsanto the right of entry onto the fields of non-licensed farmers or to take plants from those fields. As early as 1997, Monsanto was identifying target farmers and target fields using either informants, or more worrisome, through illegal inspections of the fields of farmers who did not sign the license. This strategy of conduct becomes particularly egregious when the farmer's land is contaminated by the transgene without the knowledge of the farmer. Further, neither the Technology-Use License Agreement nor the grant of a patent gives neither Monsanto nor any other person the right to take and convert the property of a farmer who has chosen to not become a licensee. Judge MacKay recognizes, in paragraph 46 of the decision, that:

> [l]ater in the spring of 1998, Monsanto representatives learned that the defendants had seed treated at the HFM and that HFM had retained samples of his seed for its own purposes. They requested a sample of the seed withheld from Mr. Schmeiser by HFM. Mr. Schmeiser had not previously used HFM for seed-treating purposes, and he was not aware that samples were regularly taken from the seed provided by farmers. As was done for all others whose seed was treated, HFM did take samples of the seed brought in by the defendants and of the seed after treatment and before delivery to Schmeiser. HFM provided a portion of both samples to Monsanto without informing Mr. Schmeiser that this had been done.

Id. Without criticism of Humboldt Flour Mills (HFM) or of Monsanto, Judge MacKay apparently approved of the practice engaged in by Humboldt Flour Mills of retaining seed from a customer without permission of that customer, and making that retained seed freely available to Monsanto without prior permission of the customer and without compensation to the customer. Humboldt Flour Mills is not contractually bound to the customer to retain the seed, is not contractually bound to the licensee farmer to retain the seed, and certainly is not contractually bound by Monsanto to either retain or assign possessory interest in the retained seed to Monsanto.

Of course, it could be argued that this is a *de minimis* situation where the remedy for the customer is in tort. However, if a representative of Humboldt Flour Mills were to enter a grocery and take an equivalent amount of candy from the store without obtaining permission to do so by paying, then that representative would be guilty of shoplifting and subject to a stiff criminal penalty. Furthermore, if that representative then assigned possessory interest in that stolen candy to a representative of Monsanto, then the Monsanto representative would be liable under criminal law as well. The situation of Humboldt Flour Mills taking from its customer and assigning that seed to a representative of Monsanto is analogous and similar criminal sanctions must be applied. Independent of how and from where Monsanto obtained its evidence, the court finds the evidence admissible at trial. Judge MacKay gives a clear stamp of approval to Monsanto overstepping the bounds of both the contractual rights and interest protected by the letters patent in paragraph 72 of the decision when he states that the evidence obtained from Mr. Schmeiser's fields by Monsanto "was not obtained illegally" and that "its admission would not bring the administration of justice into disrepute." Paragraph 72. To say that trespass, theft, and conversion is

not illegal is an insult to the face of an orderly society and it sends a clear message to each seed manufacturer that it may act with such impunity as to have no bounds that the law will proscribe. Neither contract nor patent law should be stretched to the point that it was in the decision by Judge MacKay in allowing plaintiff's evidence into court.

One may, of course, argue that Mr. Schmeiser has a cause of action in tort against Humboldt Flour Mills for theft and conversion. Further, it might be argued that Mr. Schmeiser has superior title over Monsanto to the sample of seed taken by Humboldt Flour Mills and conveyed to Monsanto. In both cases, it might be argued that the remedy is in tort and since the injury is *de minimis*, no damages will lie. Such an argument is without merit and is clearly meant to vest rights in Monsanto and Humboldt Flour Mills that should not be vested and completely ignores the rights both denied and passed with the sample.

Like the piece of candy in the grocery store, the small sample of Mr. Schmeiser's canola seeds represent far more than the fair market value of the item in question (be it the piece of candy or the sample of canola seeds). When Mr. Schmeiser took the canola seeds to Humboldt Flour Mills to be prepared for planting, he conveyed to Humboldt Flour Mills an immediate possessory interest in the canola seeds, but not the right to alienate the canola seeds to another. Further, because Mr. Schmeiser expected to have all of canola seeds returned, he did not convey a permanent possessory interest in the seeds. Certainly, Humboldt Flour Mills could alienate the seeds but it could not retain the value of the seeds because it would be unjustly enriched if it did so.

Mr. Schmeiser also had an expectation of privacy in the plant genome of the canola seeds. Indeed this expectation of privacy is not vitiated simply because of the conveyance of a temporary possessory interest. The conveyance was an essential aspect of the course of normal business conducted by Mr. Schmeiser. He expected that the plant genome would be disclosed to no other party, and he expected that Humboldt Flour Mills would neither discover the plant genome nor attempt to have it reproduced for itself. Furthermore, there was an underlying trust between Mr. Schmeiser and Humboldt Flour Mills that both the canola seed would be returned in proper course and that Humboldt Flour Mills would not convey the seeds to another. By retaining the sample of canola seeds and conveying it to Monsanto, Humboldt Flour Mills violated that trust. Such a violation might very well cost Humboldt Flour Mills dearly in the future because of lost business. Also, the violation cost Mr. Schmeiser because of the lost ability to have his seeds processed for planting in a readily available facility.
More importantly is the inability, because of the actions on the part of Humboldt Flour Mills, and ultimately Monsanto, of Mr. Schmeiser to use the canola plant genome that he had so meticulously developed over the span of half a century. Because the variety of canola that Mr. Schmeiser developed was superior to other available varieties, he would not have abandoned it in favor of an inferior variety, but for the actions of Humboldt Flour Mills and Monsanto. This means that his measurable loss is far greater than the value of the small sample of seeds conveyed from Humboldt Flour Mills to Monsanto (we shall leave to the side the question of chain of custody of the sample from Mr. Schmeiser's fields to the scientists who tested the samples at Monsanto's research facilities). The loss to Mr. Schmeiser is a function of the lost availability of the canola plant genome that he had developed.

Without specifying the nature of the function, we may assert that the loss is easily computed as follows. Let N represent the number of future planting cycles that Mr. Schmeiser would have had available to him. Let $p_S(i)$ be the profit to be realized from the crop containing the plant genome developed by Mr. Schmeiser in year (i) (in the future), and $p_C(i)$ be the profit to be realized from the crop grown from commercially available plant genome (that is, commercially available seeds containing a genome different from that developed by Mr. Schmeiser). Further, let $q_j(i)$ be the profit realized by Mr. Schmeiser due to the conveyance, either by license or transfer of title, by Mr. Schmeiser to farmer j in year i. Finally, define $Q(N+1)$ as the profit realized by Mr. Schmeiser for conveying title to his plant genome in the year $N+1$, the planting cycle immediately following the last year that Mr. Schmeiser plants canola (perhaps he finally retires and goes fishing with his grandson). Using some simple arithmetic, it is easily deduced that the total lost profit, P_L, to Mr. Schmeiser due to the actions of Humboldt Flour Mills and Monsanto resulting from the conveyance of the sample of canola is:

$$P_L = \sum_{i=1}^{N} (p_S(i) - p_C(i)) + \sum_{i=1}^{N} \sum_{j} q_j(i) + Q(N+1).$$

This number is certain to be quite large in comparison to the fair market value of the sample conveyed by Humboldt Flour Mills. In a cause of action by Mr. Schmeiser against Humboldt Flour Mills, this is the amount of damage that must be awarded.

only his crop but also his land without recourse for failure of the seed manufacturer to perform by delivering a seed that is resistant to pests.

Because the seed manufacturers have invested a considerable amount of resources in developing the genetically modified seed, there is an interest in protecting that investment so that revenue streams will compensate for the initial investment. The seed manufacturers should exercise every reasonable effort to protect their intellectual property. The farmer is motivated to reduce the costs of producing a crop of progeny seeds and therefore should exercise every reasonable effort to obtain his seed at the lowest possible cost. In the usual market place, the consumer (the farmer) and the producer (the seed manufacturer) negotiate the price of a commodity as roughly equals. If the consumer cannot obtain a favorable price from one producer, he is free to go to another producer. Unfortunately, the market in genetically modified plants is dominated by monopolies in the modified plants, possessed by a producer who is economically much stronger than the farmer. The farmer is not in a position to negotiate better terms in the license agreement, either because he is not sophisticated enough, because he cannot afford legal representation, or because the seed manufacturer is the only supplier of the seeds and the farmer has no choice but to accept the terms of the agreement. In essence, the political and capital strengths of the seed manufacturer simply overwhelms those of the farmer. Also, the farmer is constrained in the methods by which he may farm which require him to use modern technology to stay competitive in the marketplace. It is not clear, then, that the farmer is in a position to either negotiate better terms of the license agreement with the seed manufacturers or to refuse to plant the genetically modified seed variety altogether. Once the farmer has used the genetically modified seed, he is bound, essentially permanently, by the terms of the license agreement. The result is that the farmer must trade his property rights in his land and crop in exchange for a license to use the intellectual property rights owned by the seed manufacturers.

4. Property Rights in Light of the Terminator Gene

Three mechanisms have been examined by which the seed manufacturers may protect their investment in the development of genetically modified seeds. All three mechanisms modify, reduce, or eliminate the property rights of the farmer in favor of the property rights held by the seed manufacturers. However strong the protections may be, the seed manufacturers still face a heavy caseload of violators of these protections. The ability of the farmers to violate the protections is due to deficiencies in the law providing the protections. This result was the motivation for several companies to develop "terminator technology,"[468] a biological, and non-statutory method for protecting the seed manufacturer investment in genetically modified seed. The terminator technology involves inserting a gene into a plant that enables the seed to grow to maturity but which renders progeny seed sterile.[469] Thus, if the farmer saves seed for reproductive purposes it would not produce a progeny plant.

In summary, then, the total value of the sample of seeds far exceeds the fair market value of the canola seeds. The court is, indeed, committing a grand insult to justice if it awards an amount less than P_L to Mr. Schmeiser.

468. *See* Yves Savidan, *Terminator Genes: Fertility Rights*, 353 THE ECONOMIST 104 (Oct. 9, 1999).

469. *See* Danielle Knight, *Science-Rights: New Seed Technology Threatens Farmers*, INTER PRESS SERVICE, Mar. 31, 1998, *available at* 1998 WL 5986450.

The terminator gene[470] was originally developed by the USDA,[471] using approximately $229,000 of taxpayer money,[472] in collaboration with Delta and Pine Land Company, the nation's largest producer of cotton seeds with a seventy-three percent market share. The terminator technology comes in several flavors. One company has developed a seed sterilization technology called the "verminator" technology.[473] Terminator technology and verminator technology are similar in that both would render a second-generation seed sterile.[474] The two technologies are different in the particular genes that are altered.[475] In the verminator technology a rat gene is incorporated into a plant seed to render seeds infertile.[476] The patent covers all seeds, both transgenic and non-transgenic conventional varieties.[477] The technology has been tested only on cotton and tobacco; however, the inventors believe it could work on all major crops. Traditionally, seed manufacturers have been reluctant to invest in the wheat, oat, and rice seed markets, because these plant species are self-pollinating, meaning that their reproduction cannot be controlled. With these field crops farmers can save the seeds from one crop cycle for use in the next crop cycle with only having to return to the commercial market to replenish every five years or so.[478] With the "terminator technology," the

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470. *See* Oliver, *supra* note 139. In abstract, the patent states that:

> A method for making a genetically modified plant comprising regenerating a whole plant from a plant cell that has been transfected with DNA sequences comprising a first gene whose expression results in an altered plant phenotype linked to a transiently active promoter, the gene and promoter being separated by a blocking sequence flanked on either side by specific excision sequences, a second gene that encodes a recombinase specific for the specific excision sequences linked to a repressible promoter, and a third gene that encodes the repressor specific for the repressible promoter. Also a method for making a genetically modified hybrid plant by hybridizing a first plant regenerated from a plant cell that has been transfected with DNA sequences comprising a first gene whose expression results in an altered plant phenotype linked to a transiently active promoter, the gene and promoter being separated by a blocking sequence flanked on either side by specific excision sequences to a second plant regenerated from a second plant cell that has been transfected with DNA sequences comprising a second gene that encodes a recombinase specific for the specific excision sequences linked to a promoter that is active during seed germination, and growing a hybrid plant from the hybrid seed. Plant cells, plant tissues, plant seed and whole plants containing the above DNA sequences are also claimed.

Id. at 1.

471. *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) *available at* http://www.motherjones.com/news_wire/broydo.html.

472. *See* Keith Aoki, *Neocolonialism, Anticommons Property, and Biopiracy In The (Not-So-Brave) New World Order of International Intellectual Property Protection*, 6 IND. J. GLOBAL LEGAL STUD. 11, 54 (1998).

473. *See* Zeneca Pits, *Verminator Against Terminator*, ECON. TIMES, Aug. 27, 1998, *available at* 1998 WL 16762266.

474. *See id.*

475. *See id.*

476. *See id.*

477. *See* Oliver, *supra* note 139.

478. *See* Broydo, *supra* note 471.

farmers will be forced to purchase new seeds for each planting cycle.[479]

While the USDA and Delta and Pine Land created the "terminator technology," Monsanto, upon deciding to purchase Delta and Pine Land, stated that it disfavors the terminator technology.[480] The terminator technology is of grave concern to farmers in this country and abroad.[481] Since a vast majority of the world's farmers still collect their best seeds each year and replant them the following year, fears about the terminator technology were especially prevalent in developing countries. When the public became aware that Monsanto was set to acquire Delta and Pine Land, a worldwide protest was ignited against Monsanto. In spite of the fact that Monsanto had neither developed the technology nor held the patent for it, Monsanto was, consequently, inundated with protests against the terminator technology. Stimulated by the protests, Monsanto's Chief Executive Officer explained that

"[t]hough we do not own any sterile seed technology, we think it is important to respond . . . by making clear our commitment not to commercialize gene protection systems that render seed sterile."[482]

5. "Legal" Versus Intellectual Property Interest

A central question of considerable import to the defendant in a patent infringement case is whether the legal estate of the seed manufacturer also includes the right to dispose of the progeny plants and seed. If it does, then the seed manufacturer has the right to determine how and to whom the farmer may transfer his crop. This question was addressed in *Monsanto v. Schmeiser*.[483] In paragraph 91 of *Monsanto v. Schmeiser*, the Court considered defendant's argument that "Monsanto has no property interest in its gene, only intellectual property rights" because Monsanto allowed the uncontrolled release of the invention patented into the environment. The Court acknowledge[d] that the seed or plant containing the plaintiffs' patented gene and cell may be owned in a legal sense by the farmer who has acquired the seed or plant, that "owner's" interest in the seed or plant is subject to the plaintiffs' patent rights, including the exclusive right to use or sell its gene or cell, and they alone may license others to use the invention.[484] The Court continued in paragraph 92:

> [t]hus a farmer whose field contains seed or plants originating from seed spilled into them, or blown as seed, in swaths from a neighbor's land or even growing from germination by pollen carried into his field from elsewhere by insects, birds, or by the wind, may own the seed or plants on his land even if he did not set about to plant them. He does not, however, own the

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479. *See* Bill Lambrecht, *Critics Vilify New Seed Technology that Monsanto May Soon Control-"Terminator" Would Prevent Saving Seeds by Making them Sterile*, ST. LOUIS POST-DISPATCH, Nov. 1, 1998, at A1.

480. *See* Knight, *supra* note 469.

481. *See* John Vidal, *World Embraced For Terminator 2*, THE GUARDIAN, Oct. 6, 1999, *available at* 1999 WL 25735652; *The Transgenic Scare*, TIMES (India), Oct. 13, 1999, *available at* 1999 WL 28425544.

482. Savidan, *supra* note 468, at 104.

483. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html.

484. *Id.* ¶ 91.

right to the use of the patented gene, or of the seed or plant containing the patented gene or cell.[485]

Although the case was decided in a Canadian Federal Court, the underlying property principles are as applicable in the United States as in Canada. While no cases have come before United States Federal Courts concerning the exact same issue as the Canadian Federal Court addressed, it might be anticipated that the Federal Courts in the United States would resolve the underlying ownership issue very much as the Federal Court did in Canada. When a transgene exists on the field of a farmer, the Canadian Federal Court articulated that a "farmer who has acquired the seed or plant" owns the "patented gene and cell . . . in a legal sense,"[486] and that that farmer "may own the seed or plants on his land even if he did not set about to plant them."[487] However, "that 'owner's interest in the seed or plant is subject to the plaintiffs' patent rights,"[488] and the farmer "does not, however, own the right to the use of the patented gene, or of the seed or plant containing the patented gene or cell."[489]

Two concerns are immediately apparent in the Canadian Federal Court decision in *Monsanto v. Schmeiser.* First, the court did not clarify the interest of each party in the seed or plant cell that contains the transgene. Second, the court is apparently precluding recovery for genetic pollution of the crop of the farmer who does not wish for the presence of the transgene on his fields.

The court failed to clearly articulate the property rights of the farmer in the plant cells and seeds found on his fields, and fails to define the property rights of the seed manufacturer in the transgene found in those plant cells and seeds. When the court stated, in light of the conclusion articulated in paragraph 127, that by growing "seed known to be Roundup tolerant and selling the harvested seeds,"[490] Mr. Schmeiser had infringed Monsanto's patent, that the farmer has a "legal interest" in the plant seed or cell, which contains the transgene, but that that interest is subject to the patentee's patent rights, it, in effect, stated that a farmer has no viable interest in the plant seed and cells found on his fields. This is because if the transgene does exist in the plant seeds and cells found on the fields of the farmer, the farmer cannot harvest those seeds or cells and cannot either sell those same harvested seeds or cells for consumption or retain those seeds or cells for his own use. Also, because the court stated that the patentee "has the exclusive use of the invention"[491] the farmer may not even have the transgene in seeds or plant cells on his fields without infringing the patent (because in deciding the case in favor of Monsanto, the court is, in effect, equating possession with "use"). The

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485. *Id.* ¶ 92.

486. *Id.* ¶ 91.

487. *Id.*

488. *Id.* ¶ 91.

489. *Id.* ¶ 92.

490. *Id.* ¶ 127.

491. *Id.* ¶ 93.

court stated that how the transgene comes to exist on the land of Mr. Schmeiser is irrelevant to the question of patent infringement.[492] The court also stated that it is not relevant whether Mr. Schmeiser knew that the transgene was present on his land. The court is equating possession of the transgene, whether knowingly or ignorantly, with use of the transgene and hence Mr. Schmeiser is guilty of patent infringement.

While the court stated that the canola seeds are "owned in a legal sense by" Mr. Schmeiser,[493] he cannot alienate the transgene. If Mr. Schmeiser were a licensee of Monsanto then he could alienate the crop for non-reproductive purposes, but only through channels dictated by Monsanto. Because the court stated that the evidence submitted by Monsanto "was not obtained illegally,"[494] then Mr. Schmeiser does not have an expectation to the right of privacy in his crop. Since Mr. Schmeiser has no viable rights at all in his canola crop then the assertion of the court that the seeds are "owned in a legal sense" by Mr. Schmeiser is in direct opposition to reality.

The mirror of the situation in which Mr. Schmeiser is placed by the court is reflective of Monsanto's position. Because Monsanto has a legal estate containing the transgene, it appears that it possesses the right to use and the right to alienate the canola crop and the right to invade the property of Mr. Schmeiser. This exceeds reasonable bounds, and must certainly not be what the court intended. Thus, the decision of the court necessarily leads to the conclusion that no matter how the transgene arrived onto the fields of the farmer,[495] the farmer is liable for infringement when the transgene is found on his fields. Because the court denies the farmer any practicable interest in the crop grown on his own fields, then the court is, in effect, stating that to avoid the possibility of infringement the farmer must purchase and use genetically modified seeds from the seed manufacturer under license from the seed manufacturer.

Furthermore, the court is apparently precluding recovery for genetic pollution of the crop of the farmer who does not wish the transgene on his fields. Because the farmer owns both his own time and the land upon which the crop is grown, and the farmer bears the risk of the market value of his crop and the failure of his crop due to natural causes, then the farmer must, necessarily, also have the right of autonomy in deciding what species and variety of plant shall exist on his land. The autonomy of the farmer in decision making and choosing to have his crop free of the transgene is critical when the farmer is selling into the premium international commodity market. To see why this is so, consider that European countries and Japan are resistant to the introduction of genetically modified crops into their food stream, and that these countries are important destinations for American and Canadian grains. Because these countries are selective about the varieties of grain that will be allowed in their food streams, a premium price may be charged to the consumer. Conversely, animal food streams may contain genetically modified grains and therefore are neither selective nor premium. The highest premium is levied on organically grown grains that must be free of the transgene. Thus, if the farmer

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492. *See supra* note 271.

493. *Id.* ¶ 91.

494. *Id.* ¶ 72.

495. In paragraph 119, the court stated that "the source of the Roundup resistant canola in the defendants' 1997 crop is really not significant" for determining infringement of the patent.

wishes to obtain a premium price by selling into either the international market or the organic foods market, then he must chose those grains that are free of the transgene.

The farmer's right of choice and of autonomy is in peril when the courts follow the position articulated by the Federal Court in Canada. Because the Canadian Federal Court decided to strictly adhere to the position that "Monsanto does have ownership in its patented gene and cell" and therefore "has the exclusive use of its invention,"[496] it is denying the farmer the right of autonomy in decision making and the choice to have his crop be free of the transgene.

By stating that the farmer "does not, however, own the right to the use . . . of the seed or plant containing the patented gene or cell,"[497] the court is stating that even if the seed manufacturer negligently pollutes the farmer's field with the transgene, then the farmer has no right to either use the contaminated crop for feeding to his own livestock or for selling it into the market for consumption, premium or otherwise. Apparently, the court's stated position considers the farmer's knowledge of the presence of the transgene on his fields as being irrelevant. Further, the court stated that it did not agree that the situation is comparable to the "stray bull" cases that recognize that the progeny of stray bulls impregnating cows of another belong to that other, and that the owner of the straying bull may be liable in damages that may be caused to the owner of the cows. Further, the circumstances here are not akin to those cases that the defendants urge are part of the larger law of admixture, where property of A introduced by A without B's intervention to similar property of B from which it is indistinguishable, becomes the property of B. Monsanto does have ownership in its patented gene and cell and pursuant to the *Act* it has the exclusive use of its invention. That is an important factor which distinguishes this case from the others on which the defendants rely.[498]

The court makes a distinction when no difference exists.

It is exactly the fact that Monsanto has an interest (the term ownership, as used here by the court, is ambiguous to the point of being vitiated) in the transgene that makes the "stray bull" analogy apposite. The owner of the cow may wish it to not be impregnated by the sperm containing the genetic code of the stray bull; hence the owner of the stray bull must be liable in tort. The court, however, states that interest of Monsanto in the genetic code contained in the transgene, as granted by letters patent, puts it in a position different from the owner of the stray bull. The court is clearly precluding the farmer from being able to recover damages for the value of his contaminated crop once it has been polluted by the transgene. Also, the law of admixture is entirely apposite. Monsanto released its transgene to the environment without the ability to control the destination of that transgene. Because Monsanto did not and cannot control the destination of its transgene, then when that transgene becomes mixed with a plant genome, then Monsanto must not be allowed to assert its interest in that transgene without also bearing the risk of liability for genetic pollution. The court clearly takes the position that Monsanto may assert its interest in the transgene and avoids liability for genetic pollution.

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496. *Id.* ¶ 93.

497. *Id.* ¶ 92.

498. *Id.* ¶ 93.

The court provided ample support for this last statement in paragraphs 95 through 97. Mr. Schmeiser argued on the basis of photographic evidence that Monsanto both released the transgene into the environment and failed to exercise control over the destination of the transgene. The court summarized:

On the basis of the evidence of pictures adduced by Mr. Schmeiser, of stray plants and of plants in fields, in Bruno and its environs, it is urged that unconfined release and lack of control of Monsanto over the replication of the plants containing their patented gene clearly demonstrates extensive uncontrolled release of the plaintiffs' invention. Indeed it is urged this is so extensive that the spread of the invention cannot be controlled and Monsanto cannot claim the exclusive right to possess and use the invention. It is further urged that it was the plaintiffs' obligation to control its technology to ensure it did not spread and that Monsanto has not attempted to do so.[499]

In dismissing the evidence presented by the defendants, the court stated that:

> [t]hat assessment places much weight on photographs of stray plants in Bruno, said to have survived spraying with Roundup, in addition to photographs of canola in fields which is said to be of canola, some with the potential gene incorporated. With respect, the conclusion the defendants urge would ignore the evidence of the licensing arrangements developed by Monsanto in a thorough and determined manner to limit the spread of the gene. Those arrangements require agreement of growers not to sell the product derived from seed provided under a TUA except to authorized dealers, not to give it away and not to keep it for their own use even for reseeding. It ignores evidence of the plaintiffs' efforts to monitor the authorized growers and any that might be considered to be growing the product without authorization. It ignores the determined efforts to sample and test the crops of the defendants who were believed to be growing Roundup Ready canola without authorization.
>
> It ignores also the evidence of Monsanto's efforts to remove plants from fields of other farmers who complained of undesired spread of Roundup Ready canola to their fields.[500]

The statement that "the conclusion the defendants urge would ignore the evidence of the licensing arrangements developed by Monsanto in a thorough and determined manner to limit the spread of the gene" is clearly equating the use by Monsanto of the Technology-Use License to control dissemination of the transgene between farmers with control of dissemination of the transgene in the open environment by natural forces[501] Further, in its statement that "[i]t ignores the determined efforts to sample and test the crops of the defendants who were believed to be growing Roundup Ready canola without authorization," the court implicitly recognized a right for Monsanto to trespass upon the fields of a non-licensee and take plant material from those fields without permission of the farmer for

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499. *Id.* ¶ 95.

500. *Id.* ¶ 96.

501. The court specifically identifies the need to control the dissemination between farmers as the reason for the Technology-Use License in paragraph 27 of the decision as: "Monsanto developed a licensing arrangement to protect its patent, and its market, by limiting the opportunity of a grower, under license, to sell or give seed to another or to retain it for his own use."

testing simply because Monsanto has licensee farmers in the neighborhood. An analogous situation occurs when the representative goes into a grocery store and takes, without authorization by payment of value, genetically modified plant material from the produce section. Under shoplifting laws, that representative would be guilty of theft. However, the court takes the position that the patent grants immunity to representatives of Monsanto for the very same act when that act occurs on the field of a non-licensed farmer. Careful reading of both the United States patent statute and Canadian patent statute fails to yield an obvious and reasonable basis for the position of the court.

The final blow to the defendant's position concerning the waiver of interest in the transgene by Monsanto due to uncontrolled release into the environment came when the court stated, "[i]ndeed the weight of evidence in this case supports the conclusion that the plaintiffs undertook a variety of measures designed to control the unwanted spread of canola containing their patented gene and cell."[502] The fallacy underlying the court's position in favor of Monsanto cannot be clearer. The court took the position that the efforts of Monsanto to control the dissemination of the transgene from farmer to farmer by use of the Technology-Use License is equivalent to control of the pollen and seed once it is released into the environment. The Technology-Use License only controls the disposition of the genetically modified crop and plant cells by the licensee. The Technology-Use License does not require the licensee to prevent dissemination of the transgene by the wind, birds, bees, or careless truck drivers. Because the court equates control of dissemination between farmers with control in the environment, the court, presumably, expects the wind, the birds, the pollen and seed that contain the transgene, as well as careless truck drivers who fail to cover the beds of their trucks with tarpaulin, to be bound by the Technology-Use License of Monsanto. In fact, because Monsanto must have regulatory approval for unconfined release of the transgene into the open environment, then both the government and Monsanto must realize that once released into the environment, the final destination of the transgene cannot be controlled (whether by license or any other means). Further, the court stated in paragraph 96 that Monsanto cannot control the dispersion of the transgene by natural forces in its statement that: "[i]t ignores also the evidence of Monsanto's efforts to remove plants from fields of other farmers who complained of undesired spread of Roundup Ready canola to their fields." It evidently did not recognize the importance of this statement to the validity of the defendant's argument. More important than the fallacy of the court's position, articulated in paragraphs 95 through 97 of *Monsanto v. Schmeiser*, is that the court views the Technology-Use License as a legally sufficient means of controlling the dispersion of the transgene in the open environment. Therefore, Monsanto needs to license only a single farmer in a large region to have a legally sufficient basis for suing every other neighboring farmer whose fields are contaminated with the transgene by genetic pollution.

In summary, a farmer cannot transfer seed produced from patented genetically modified seed. Further, the crop exemption of the PVPA should be eliminated so that the farmer is prohibited from saving seed for replanting on his own farm. Also, although the farmer loses property rights in his own land under licensing agreements, these agreements may be the only way that the seed manufacturers can enforce their property rights in genetically modified seeds protected under either Title 35 of the United States Code or the Plant Variety Protection Act. Given this position, it is necessary to give something back to the farmer.

502. *Id.* ¶ 97.

B. The Giving Back To The Farmer

Because the seed manufacturers are concerned with making a profit from investment in agricultural biotechnology, and because the ability exists for the farmer to grow and sell, for reproductive purposes, seeds that are developed by the seed manufacturers, protection of intellectual property is of overriding concern for the seed manufacturers. In fact, the seed manufacturers view "[p]atenting germplasm and biotechnology inventions [a]s critical to [their] ability to deliver useful products and get paid for those products."[503] Driven by the need to show a profit, the seed manufacturers are motivated to take all steps necessary to protect their investment, even if such steps involve taking property rights from the farmers.

Farmers are also driven by the need to show a profit. They also have rights in their property, the right to continue to develop a germplasm base suitable to their locale, and the right to have a choice of whether to reproduce the transgene developed by the seed manufacturers. Where the balance point between these two groups should be located is not clear. What is clear is that it should not be so far in favor of the seed manufacturers that the farmer becomes a serf to the seed manufacturers, and it should not be so far in favor of the farmer that the seed manufacturer loses the profit motive to develop new and useful varieties through agricultural biotechnology.

1. Introduction

It has been stated that: "[p]lant breeding and discovery. . .is fundamentally connected with the Nation's food supply, and will, if encouraged and developed, be of incalculable value in maintaining public health and prosperity, and in promoting public safety and the national defense."[504] The accuracy and insightfulness of these words are as relevant today as they were in 1930. Since the beginning of agriculture, establishing a secure food supply has been a driving force of society.[505] Hence, current domestic plant varieties have been almost exclusively influenced by human intervention.[506] Since the United States lacked a broad spectrum of crop plants in the early days of the country, agriculture in the United States depended on importation of crops from other countries.[507] These imported plant varieties formed the foundation of modern American agriculture.[508] An important player in the process of developing the crop varieties in use today was the farmer, because the farmer was able to select seeds from plants which gave the best performance in his locale and

503. NATIONAL RESEARCH COUNCIL, INTELLECTUAL PROPERTY RIGHTS AND PLANT BIOTECHNOLOGY, at 13 (1997) (quoting Robert Fincher of Pioneer Hi-Bred International).

504. COMMITTEE ON PATENTS, PLANT PATENTS, H. R. REP. NO. 1129, at 2 (2d Sess., 1930) [hereinafter COMMITTEE ON PATENTS: 1930].

505. *See* Karen Lehman & Al Krebs, *Control of the World's Food Supply*, *in* THE CASE AGAINST THE GLOBAL ECONOMY AND FOR A TURN TOWARD THE LOCAL 122, 123 (Jerry Mander & Edward Goldsmith eds., 1996).

506. *See* CAMPBELL, *supra* note 13, at 407.

507. *See* Blair, *supra* note 22, at 299.

508. *See id.*

use those seeds for replanting his fields.[509]

To briefly summarize our extensive discussion in the Background section: plant development became the responsibility of the government with the establishment of the USDA in the mid 1800's.[510] The USDA guided the development of new plant varieties and with the cooperation of land grant universities and local agricultural organizations produced seed which was distributed free of charge to the farmers.[511] Thus, the practice of saving and transferring seed became a commonly used part of the method of new seed variety development.[512] With encouragement of Congress, the responsibility for producing and marketing the seeds shifted to the private seed manufacturers. The Congressional action included: in 1924 Congress enacted legislation that terminated free distribution of seeds by the government to farmers which forced farmers to rely on private seed companies;[513] intellectual property right protection was afforded to the seed manufacturers through the Plant Patent Act of 1930 and the Plant Variety Protection Act of 1970;[514] legislation passed in the 1980s encouraged co-operation between the seed manufacturers and federal agencies.[515]

Research by both private industry and government scientists has lead to advancing the understanding of the genetics of plants important to agriculture, and has lead to developments in exploiting genetic modification technology to improve the quality and productivity of agricultural crops.[516] A revolution in the agricultural industry has resulted from these changes in the law and science.[517] The agricultural revolution had the effect of significantly reducing the number of farms in the United States.[518] It can be anticipated that the number of farms and, most probably, the number of acres dedicated to crop production will continue to decline.

This movement coupled with the continued aggression of the seed manufacturers in the agribusiness arena will cause the farmer to become nothing more than a propertied laborer employed, under contract, by the seed manufacturer. The packaging of intellectual property, in the form of agricultural biotechnology, with pest management systems, and with information systems for use by the farmer, under contract, will strengthen the hold of the seed manufacturer over agricultural

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509. *See* Lewontin, *supra* note 127.

510. *See* Frederick H. Buttel & Jill Belsky, *Biotechnology, Plant Breeding, and Intellectual Property: Social and Ethical Dimensions*, *in* OWNING SCIENTIFIC AND TECHNICAL INFORMATION, VALUE AND ETHICAL ISSUES 110, 113 (Vivian Weil & John W. Snapper eds., 1989).

511. *See* Weiss, *supra* note 449.

512. *See id.*

513. *See* Buttel & Belsky, *supra* note 510, at 113.

514. *See id.* at 115-16.

515. *See* Weiss, *supra* note 449, at A1.

516. *See* CAMPBELL, *supra* note 13, at 390.

517. *See* Ehrenfeld, *supra* note 166.

518. *See* KLOPPENBURG, *supra* note 18, at 118-21.

productivity. Such a result is, however, not necessary. The farmer has legal interests in his land, labor, and crop. There is no need for the farmer to surrender his interests to the seed manufacturer in order to continue to engage in agribusiness. Within the law and historical precedent there exists tools through which the farmer, in cooperation with certain organizations, can become an equal to the seed manufacturer. Before reaching that analysis, there are a few points that need to be clarified.

2. Whether Growing Is "Making" or "Using"

In 1977 the question of the patentability of microorganisms, and life itself, was being litigated in the courts.[519] While the question of patenting life forms was being directly addressed by the courts, the prevailing belief was that the types of life forms which could be patented were limited. Specifically, the court stated that "[a]s for the . . . fears that our holding will of necessity, or 'logically,' make all new, useful, and nonobvious species of plants, animals, and insects created by man patentable, we think the fear is far-fetched."[520] The court was clearly wrong in believing it far-fetched that all things created by man will be patentable. Now that seed manufacturers are being granted rights in genetically modified plants, it is essential to look more closely at the patent statute to determine when use by the farmers will infringe the rights of the seed manufacturers.[521]

The patentee gains the interest in the legal estate of excluding others from making, using, selling, or offering to sell the patented invention. There are clear distinctions among the rights to make, to use, and to sell or offer to sell the invention patented.[522] When the patentee transfers the right to exclude others from making or selling the invention patented, the purchaser obtains a portion of the interests in the legal estate.[523] However, the purchaser of the patented invention for use "in the ordinary pursuits of life stands on different ground."[524] When sold under such a condition, the patented invention "is no longer under the protection of the act of Congress."[525] Instead, the purchaser acquires complete title to the patented invention because of the purchase.[526] The purchase

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519. *See Application of* Bergy 563 F.2d 1031, 1038 (C.C.P.A. 1977), *cert. granted, vacated by* Parker v. Bergy, 98 S. Ct. 3119 (Mem) (1978).

520. *Id.*

521. The following discussion moves beyond the standard legal dogma commonly used to analyze issues of rights in genetically modified plants and seeds, and enters fields rich in concepts and ideas for discussion and analysis. Unfortunately, limitations on time and space prohibit the full discussion of any of the new ideas or only a partial discussion of a few of them.

522. *See* Bloomer v. McQuewan, 14 How. 539 (1852). The court stated that "the distinction is there taken between the grant of the right to make and vend the machine, and the grant of the right to use it. The distinction is a plain one." *Id.* at 549.

523. *See id.*

524. *Id.*

525. *Id.*

526. *See* Mitchell v. Hawley, 83 U.S. 544, 548 (1872) (stating that "[c]omplete title to the implement or machine purchased becomes vested in the vendee by the sale and purchase, but he acquires no portion of the franchise, as the machine, when it rightfully passes from the patentee to the purchaser, ceases to be within the

of the patented invention for use in the ordinary pursuit of life converts that invention into the "private individual property of the purchasers."[527] Further, the Supreme Court has stated that "[a]n incident to the purchase of any article, whether patented or unpatented, is the right to use and sell it" and that when the patentee, or his licensee, sells "an article which is capable of use only in practicing the patent [then there] is a relinquishment of the patent monopoly with respect to the article sold."[528] In *Bloomer v. McQuewan*, Chief Justice Taney viewed the transfer of the right to make and to sell the patented invention as distinct and different from the transfer of the right to use, as long as such use was for "the ordinary pursuits of life." Section 271 of Title 35 states that infringement of the patent occurs by "whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States during the term of the patent therefor."[529] In most cases, the acts of making, using, or selling are distinct and separate, and when at least one is committed then the patent is infringed.

A patent may be granted for a new device such as a type of cooling device for a computer central processor unit and a claim may be made for any computer containing such cooling device.[530] When a computer is made, used, or sold with the patented cooling unit installed without a license to do so, then the person who made, used, or sold the computer system is liable for infringement. By analogy, patents for genetically modified plants are written to claim both the transgene and the plant.[531] Because infringement occurs in our mechanical example, then infringement must occur in the plant situation as well.

This conclusion does not, however, necessarily follow from the logic used for mechanical devices when applied to plants. Infringement occurs when a person, not the patentee, makes, uses, offers to sell or sells the invention patented. The words "make," "use," and "sell" are not defined within Title 35

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limits of the monopoly").

527. *Id.*

528. United States v. Univis Lens Co., Inc., 316 U.S. 241, 249 (1942).

529. 35 U.S.C. § 271 (1994 & Supp. III 1997).

530. *See* Bradley W. Bartilson, *Large Area, Multi-Device Heat Pipe for Stacked MCM-Based Systems*, U.S. PAT. NO. 6,055,157 (issued Apr 6, 2000) (claiming a "computing module for a computer, said module comprising: a first heat pipe assembly having a first evaporator plate" in Claim 1 and a "computer system comprising: a housing; a scalable computing module positioned within the housing, . . . said scalable computing module further comprising . . . a first heat pipe assembly having a first evaporator plate" in Claim 14); U.S. Patent No. 5,781,411 (issued July 14, 1998) (claiming a "heat sink for cooling an electronic component which generates heat, the heat sink comprising. . ." in Claim 1 and a "computer system which incorporates a heat sink, the computer system comprising . . ." in Claim 10).

531. *See* Nicolai Strizhov et al., *Synthetic* Bacillus thuringiensis *CryIC Gene Encoding Insect Toxin*, U.S. PAT. NO. 6,043,415 (issued Mar. 28, 2000) (claiming an "isolated DNA sequence coding for *Bacillus thuringiensis*CryIC protein comprising the nucleotide sequence shown in SEQ ID No:1," in claim 1 and a "transgenic plant comprising the isolated DNA Sequence of claim 1" in claim 5); Shah, *supra* note 414 (claiming a "chimeric plant gene which comprises. . ." in claim 1 and a "glyphosate-resistant dicotyledonous plant. . ." in claim 29); Deluca-Flaherty, *supra* note 414 (claiming a "[r]ecombinant DNA molecule comprising a nucleic acid sequence encoding the peptide" in claim 4 and "[a] transgenic plant comprising a foreign gene which encodes a peptide according to claim 1" in claim 9).

and therefore the meaning of these words must necessarily be left to the courts. Whether the court should find infringement in the case of agricultural biotechnology should turn on the definition of these words, and not necessarily on whether the alleged infringer was aware that the invention was patented. The plant genome is a unique entity to the law. It has contained within it the complete set of instructions to reproduce itself with only elemental raw materials as inputs. To date, man has been unable to construct any mechanical or biological device which simulates the ability of the plant genome to both reproduce itself and carry all the information necessary to generate a useful product. Even in the case of plants, the best that man can do is to insert a miniscule part into a very large entity. The plant genome not only contains the instructions necessary to reproduce itself, but it is also capable of creating, with the aid of cellular machinery, a variation of itself having very different characteristics. The closest patentable thing that man can create is a computer program capable of replicating itself onto other computers, and those copies will replicate to still other computers. While the program itself may be patentable, it is doubtful that any court will uphold a claim of infringement if one of the target computers started replicating that program onto itself or onto other computers with or without the knowledge of the target computer owner.

In the case of a transgenic plant, what was actually created was a transgene that was inserted into the plant genome by genetic manipulation of that genome such that the transgene is expressed. To claim property rights in the entire plant is to claim too much. The cellular machinery required to reproduce the inserted transgene and to effect its function was not "created by man"[532] and was not fully characterized by the inventor. The cellular machinery, instructed by the plant genome (discounting the presence of the transgene), has been evolving for longer than humans have existed. While man has developed an understanding of some of the processes occurring in the plant cell, our understanding of all the processes occurring is woefully inadequate. In fact, the entire genome of any plant has not been fully characterized, let alone the genome of all plants.[533] Therefore, it is impossible that any inventor could have so fully characterized the entire genome of the target plant or could have constructed that genome (without the use of the cellular machinery) as to be entitled to a patent on it. And, even if the inventor had fully characterized the genome, it is impossible that he could have characterized all of the functions of the plant genome to entitle him to a patent on the plant. The mechanical analogy is simple to construct. An inventor invents a widget which is made in a manufacturing plant (which has been in existence for longer than the inventor); the processes involved in the manufacturing of the widget are either poorly understood or completely unknown to the inventor. Would a patent issue for the manufacturing plant as well as for the widget? For the widget, probably yes; for the manufacturing plant, probably not. Rejection of an attempt to patent the plant would fail for a number of reasons, not the least of which, except the plant genome, being lack of enablement by the inventor. Therefore, to claim property interest in the biological processes involved in replication of the transgene should not stand.

Because the inventor has characterized the transgene and because the "creation by man" is a transgene inserted into the genome by genetic manipulation techniques and which is expressed, all of which may be adequately characterized, the inventor may only claim the expressed transgene

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532. *See* Diamond v. Chakrabarty, 447 U.S. 303, 309-10 (1980).

533. *See generally* NATIONAL RESEARCH COUNCIL, DESIGNING AN AGRICULTURAL GENOME PROGRAM (1998). (containing proceedings, published by the National Academy Press, of the forum on "Designing an Agricultural Genome Project" held on April 26, 1997 as a collaborative effort between the Board on Biology and the Board on Agricultural of the National Academy)

inserted into the genome by genetic manipulation techniques. The legal estate in what is claimed is protected by statute that grants the patentee the right to exclude others from making, using, selling, or offering to sell the claimed invention.

Simply stated, a transgenic plant simply is not patentable at all. Justice Story stated with his usual perspicacity that:

> [w]here a specific machine already exists, producing certain effects, if a mere addition is made to such machine, to produce the same effects in a better manner, a patent cannot be taken for the whole machine, but for the improvement only. The case of a watch is a familiar instance. The inventor of the patent lever, without doubt, added a very useful improvement to it; but his right to a patent could not be more extensive than his invention. The patent could not cover the whole machine as improved, but barely the actual improvement.[534]

The cell of a plant is a machine that operates according to the instructions in the plant genome. The multiplicity of the cellular machines constitutes the plant, which is a machine that produces a consumable crop. The addition of a single transgene, or even a set of transgenes, creates neither a new cellular machine nor a new plant, but only allows the existing machine, be it cellular or the whole plant, to produce the same effects (the consumable crop) in a better manner. It might be argued that the composition of matter, constituting the plant genome and the transgene, is patentable. Indeed, the combination of the plant genome and the transgene is a composition of matter, much like an alloy constituted of several different types of metal. However, the combination of the plant genome and the transgene, separate from the cellular or plant machinery cannot produce an effect, much like the alloy cannot produce an effect; rather, it may only be used in construction to produce an effect. The cellular and plant machinery produce an effect, the consumable crop. They are, therefore, not simply compositions of matter, but rather highly complex, intimately interconnected machines. The addition of a transgene to a plant genome is completely analogous to adding a patented lever to a watch. The plant still produces a consumable crop, and like the watch with the patented lever, merely does it better with the added transgene. Because the entire watch could not be patented, the entire transgenic plant cannot be patented. By cloaking the cellular machinery and the plant as compositions of matter will not change the nature of the cellular machinery and the plant. The transgenic plant, according to the rule articulated by Justice Story, is no more patentable as so-called compositions of matter than they are as machines. To hold such a patent valid would be to reward dexterity with language of form over discernment of differences in substance. A detailed analysis of this assertion will be left for a later date.

The central issue is whether the activity engaged in by the farmer is “making” the invention patented. The Supreme Court in *Deepsouth Packing*[535] makes no attempt to define the word “make,”

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534. Whittemore v. Cutter, 29 F. Cas. 1123, 1124 (C.C.D. Mass. 1813) (No. 17,601). There is no known case history specifically reversing the holding and arguments of this case, and there is no known legislative history specifically overruling the same.

535. *See* Deepsouth Packing Co. v. Laitram Corp., 406 U.S. 518, 529 (1972) (affirming the conclusion reached by Judge Swan in *Radio Corp. of America v. Andrea*, 79 F.2d 626, 628 (2d Cir. 1935), that “unassembled export of the elements of an invention d[oes] not infringe the patent”).

but rather defers to the construction Justice Day outlined in *Bauer v. O'Donnell*.[536] While such deference moves only incrementally closer to the meaning of "make," certainly the Court does not believe the word should be accorded the meaning that the Fifth Circuit Court of Appeals used, namely that make "means what it ordinarily connotes–the substantial manufacture of the constituent parts of the machine."[537] Further, the Court refused to answer the question of whether the definition used by the Fifth Circuit more closely corresponds to the ordinary meaning than the meaning constructed by Judge Swan in *Andrea*[538] that provided that a non-living object is made only when it has "reach[ed] the state of final 'operable' assembly."[539] While it is not possible to know with precision what the Court meant by "make," it is more than likely that the word should be given its ordinary meaning and that the accused device is made only when it has reached a state of construction exactly equal to the patented invention.

The ordinary meaning can be obtained from an English language dictionary.[540] That is, "make" is "to bring into being; specifically, (a) to form by shaping or putting parts or ingredients together, physically or mentally; to build, construct, fabricate, fashion, create, compose. . ."[541] The common meaning of the word "make" requires some action and volition to bring a thing into being by "shaping or putting parts or ingredients together."[542] It is not practically possible that a thing could construct itself without some action on the part of a person.[543] Having constructed an interpretation of the meaning of the word "make," developing an interpretation of the infringement provision of the patent

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536. 229 U.S. 1, 10 (1912) (stating that the "right to make can scarcely be made plainer by definition, and embraces the construction of the thing invented").

537. Laitram Corp. v. Deepsouth Packing Co., 443 F.2d 928, 939 (5th Cir. 1971). The Fifth Circuit held against Deepsouth Packing Co. because it believed that "substantial" construction of the deveining equipment amounted to "making" the patented invention in the United States. *See id.* The author recognizes that the line of cases up to *Deepsouth Packing* are concerned with "combination inventions" constituted of mechanical or electrical components. For the present purposes, the issue is determining the meaning of the word "make" and the word "use" which adequately describes the state in which a thing exists.

538. *See* Radio Corp. of America v. Andrea, 79 F.2d 626, 628 (2d Cir. 1935).

539. Deepsouth Packing Co. v. Laitram Corp, 406 U.S. 518, 527-28 (1972).

540. *See* WEBSTER'S NEW UNIVERSAL UNABRIDGED DICTIONARY (2d ed. 1983).

541. *Id.* at 1088. To gain a fuller understanding of the meaning of the word, consider the meaning of the synonyms of make: to build is "to construct or erect . . . to unite into a structure," *id*. at 238; to construct is "to put together the parts in their proper place and order," *id*. at 392; to fabricate is "to make or build as a whole, by connecting its parts," *id*. at 654; to create is "to produce; to cause; to bring about," *id*. at 427; and to compose is "to form by uniting two or more things," *id*. at 372. The word "to" is used before a verb as a sign of the infinitive. *Id.* at 1619. An infinitive is the "simple, uninflected form of the verb, expressing existence or action without reference to person, number, or tense. *Id.* at 939.

542. *Id.* at 1088.

543. A conclusion of the second law of thermodynamics is that every enumerable state of a system will exist with a finite probability. However, without an input of work the system will be observed in some state of disorder far more often than in the perfectly ordered state (which will be observed with probability near zero). A very penetrable discussion of the second law of thermodynamics is given by HANS CHRISTIAN VON BAEYER, MAXWELL'S DEMON: WHY WARMTH DISPERSES AND TIME PASSES (1998).

statute is now necessary.

Because the legislative history of the 1952 Patent Act[544] indicated that it was meant to codify the patent law of that date, and "make" is to be given its ordinary meaning in section 271 of Title 35 of the United States Code, then there must be some volitive action on the part of the accused infringer to bring the patented thing into being by "shaping or putting parts or ingredients together."[545] Indeed, there must be some intent on the part of the accused infringer to construct a thing, even if by accident it becomes equal to the patented invention. Of course, section 271 is devoid of any mention of intent on the part of the accused infringer. This is because the right to exclude others from making, using, or selling is independent of the mental state of accused infringer. While this is an accurate statement of the right to exclude granted by statute it is an incomplete statement of the requirements for infringement. This is because the statute requires that the accused infringer must "make" the patented device,[546] it is insufficient for a cause of action that the accused infringer merely possess, as property, the patented device.[547]

Plants present a situation different from mechanical or electrical devices. Where some volition and manipulation is required to form or assemble the items necessary to yield the mechanical device, no such volition or manipulation is required to produce a plant. Of course, the farmer digs a small hole in the ground, places a seed in the hole, and covers it with soil. Is this action sufficient to make a plant? No more than replacing the seed with a pile of electronic chips would be sufficient for making a digital computer. While the farmer may be initiating a process that eventually yields a plant, this initiation is no more making a plant than placing a transistor on to the assembly room bench would be making a radio. As stated in *Deepsouth Packing Co.* the word "make" cannot be constructed to mean "substantial manufacture."[548] It means that to "make" the patented invention, embodied in the plant, the farmer would have to construct the complete genome with the expressed, inserted transgene.

The farmer cannot completely manufacture a plant, only nature can do that. In fact, if the soil containing the seed is not moistened occasionally by rain, and if the seedling lacks sunshine, then no plant will be produced. The initiating act of the farmer falls far short of making the patented invention or even a substantial manufacture. Once the seed is in the soil, the plant will either grow or not grow independent of any reasonable actions by the farmer. The farmer, therefore, does not make the plant. The plant is a product purely of natural forces. A powerful corollary is that the farmer, even if deemed

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544. *See* Revision of Title 35, United States Code, H. R. REP. NO. 1923, 82D CONG. 2D SESS. Committee on Judiciary, at 1 (1952).

545. WEBSTER'S, *supra* note 540 at 1088.

546. It is recognized that "makes, uses, sells, or offers to sell," 35 U.S.C. § 271 (1994), are exclusive actions, but for present purposes we require focus upon the word "make."

547. *See* WILLIAM C. ROBINSON, 3 THE LAW OF PATENTS FOR USEFUL INVENTIONS § 898 (1890).

548. Deepsouth Packing Co. v. Laitram Corp., 406 U.S. 518, 528 (1972). The Court stated that it will not "endorse the view that the 'substantial manufacture of the constituent parts of [a] machine' constitutes direct infringement when [it has] so often held that a combination patent protects only against the operable assembly of the whole and not the manufacture of its parts." *Id.* at 528 (quoting Laitram Corp. v. Deepsouth Packing Co., 443 F.2d 928, 939 (5th Cir. 1971)).

to have "made" the plant, cannot by his own actions cause the transgene to be either replicated or expressed. Replication and expression of the transgene are controlled strictly by the cellular machinery, machinery over which the farmer can exert no force or influence.

Infringement of the exclusive right of the patentee can occur by making the patented invention. Making requires the volition to "bring into being" a patented thing. The accused infringer must be aware that the thing is being created or brought into being. It is irrelevant for purposes of section 271 of Title 35 that the person knew that the thing was patented for there to be infringement, only that it was made. The patentee must prove infringement; and to show infringement the patentee must show that the accused infringer made the patented thing. Merely having the patented thing in his possession does not make him an infringer. This is because there are a number of routes that the accused infringer could have come into possession of the patented thing other than having made it. The doctrine of exhaustion states that these alternative routes protect the accused infringer from liability for infringing the patent. With regard to plants in particular, merely having patented plants on his farm does not automatically subject the farmer to liability for infringement.

To examine the basis for why liability does not automatically lie simply because the farmer possesses the patented plants, consider two *Zea mays* plants growing in a field belonging to the farmer. Presume that one plant is genetically modified, hence patented, and the other is of conventional *Zea mays* variety. Without testing the two plants, it is difficult, if not impossible, to say which one is genetically modified.[549] Consider two cases. In the first case, the farmer intentionally planted seeds for both plants. As discussed above, this initiation of the process of growing the plant does not constitute infringement because it is only a very small step in the process by which the final plant comes into being. It is not even a "substantial manufacture," which the Supreme Court rejected as defining the word making in *Deepsouth Packing Co.* Because "substantial manufacture" cannot rise to the level of "making" for purposes of infringement analysis, certainly the step of planting the seed is such a small step in the process that it cannot amount to "making."

In the second case, in which the genetically modified plant came into being in the farmer's fields, involves translocation of the seed (which already contained the transgene) into the farmer's field from a route other than through the farmer (the analysis of this particular case is as applicable to cross-pollination with a remote plant containing the transgene as it is to the translocation of the genetically modified seed). The plant is growing in the field of the farmer through no volitive act of the farmer. The farmer is completely unaware that the plant seeds contain the patented transgene; the farmer did not plant the seed (or cause the cross-pollination of a non-modified plant with a genetically modified plant through a volitive act) to initiate the process of bringing the plant into being and the farmer could not distinguish, without testing, the non-modified and genetically modified plants. The farmer cannot, through any action of his own, assemble the nucleotides to bring the patented DNA into being. The farmer, through volitive acts of his own, cannot cause the germination of the seed; rather, he can only take the very small step of initiating the process by which the germination occurs, but the germination will occur only if other, far more substantial, forces act upon the seed. Since the seed or pollen came to be located on the farmer's land through no action of the farmer, then this second case constitutes

549. Mr. Schmeiser was completely unaware that his land was contaminated with a variety of canola different than his own conventional canola until he sprayed canola plants which were growing by the roadside with Roundup. *See* Interview: Schmeiser{July 6, 2001}, *supra* note 270. When these plants failed to die, he began to suspect that they might have developed a resistance to glyphosate. *See id*.

an even less significant step in bringing the plant into being than planting the seed does in the first case. Therefore the farmer is not "making" the patented transgene or plant. The natural conclusion is that the farmer cannot be guilty of infringement merely for possessing the patented plant on his own land.

Following the analyses above, demonstrating that the farmer cannot make the patented genome or plant, the farmer may not "use" the patented genome or plant even if it is growing upon his own lands. The purchase of a patented invention from the patentee for use in the ordinary pursuit of life grants to the purchaser the right to use that invention as long as the invention is capable of use, and use to the full extent to which that invention is capable of use when title transfers to the purchaser.[550] The right of use of the patented invention means "the right to put into service [the] given invention."[551] Working from the ordinary meaning of the word use we may deduce that a volitive action is required on the part of the actor. Specifically, the dictionary meaning of use is "to put or bring into action or service; to employ for or apply to a given purpose."[552] Therefore, if a patented invention must be used, then the invention is to be brought into service and applied to its given purpose to the fullest extent possible.

In the case of a genetically modified plant, "use" means that the expressed transgene is brought into service and applied to its given purpose to the fullest extent possible. Consider a plant that contains a transgene encoding 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) polypeptide.[553] This transgene contains a chloroplast transit peptide, which allows either the EPSPS polypeptide, or an enzymatically active fraction of the polypeptide, to be transported into the chloroplast of the plant cell. When this transgene is expressed in the plant cell and the EPSPS polypeptide is transported into the chloroplast, the cell exhibits a substantial degree of glyphosate resistance.[554] As illustrated earlier, even if the claims of the patent claim contain language regarding claiming "a glyphosate-resistant plant cell,"[555] or a "plant comprising transformed plant cells"[556] the claim would be too broad if the language were to be read as being an element; rather, the language is

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550. *See* Adams v. Burke, 84 U.S. 453, 455 (1873) (stating that the purchase of an invention patented "carri[es] with it the right to the use of that machine so long as it was capable of use" and that the basis for this holding is that "the sale by a person who has the full right to make, sell, and use such a machine carries with it the right to the use of that machine to the full extent to which it can be used").

551. Bauer v. O'Donnell, 229 U.S. 1, 11 (1913) The Court stated that: "[the] right to use is a comprehensive term and embraces within its meaning the right to put into service any given invention." *Id*. at 10-11.

552. WEBSTER'S TWENTIETH CENTURY DICTIONARY 2012 (2d ed. 1983).

553. *See* Dilip M. Shah, Stephen G. Rogers, Robert Horsch & Robert T. Fraley, *Glyphosate-Resistant Plants*, U.S. PAT. NO. 4,940,835 (issued July 10, 1990). This patent issued from a continuation-in-part application filed July 7, 1986, which claimed the earlier filing date of a continuation-in-part application filed on October 29, 1985, which in turned was filed as a continuation-in-part application based on the original application filed August 7, 1985.

554. *See id.*

555. *Id.* at Claim 22.

556. Ganesh M. Kishore & Dilip M. Shah, *Glyphosate-Tolerant 5-endolpyruvyl-3-phosphoshikimate Synthase*, U.S. PAT. NO. 5,145,783, Claim 16 (issued Sept. 8, 1992).

to be interpreted as merely the preamble to the claim. Such a position takes on significance in determining the "use" of the patented invention.

Consider a claim that reads, "[a] glyphosate-resistant dicotyledonous plant seed, said seed comprising a chimeric plant gene."[557] Say the farmer plants such a seed and a plant grows from the seed. While the farmer has used the purchased seed for the purposes of planting, and the process of planting yields a plant on his land, he has not used the invention patented. The language "[a] glyphosate-resistant dicotyledonous plant seed" is not an element of the claim, but rather the preamble. Therefore, the claimed invention is the expressed transgene that is inserted into the genome of the plant by genetic engineering techniques. The claim identifies that this claimed invention may be embodied within a seed. The farmer may have either purchased the seed from some source, including the seed manufacturer, or may have saved the seed from a previous crop cycle for planting in the current planting cycle. Either way, by planting the seed he is bringing the seed into service and applying it to its given purpose to the fullest extent possible; that is, he is planting the seed to initiate the process by which a plant comes into being on his lands. The only way that the farmer can bring the invention patented into service and apply the invention to its given purpose to the fullest extent possible is to apply glyphosate to the plant or seed.

There are two volitional acts which involve "use": first is the use of the seed for planting, which does not constitute infringement because it is not bringing into service the patented invention; second is the use of the expressed gene to protect the plant from the action of glyphosate, which may constitute infringement because it is bringing into service the patented invention.[558] The patented invention may consist of the plant genome, the transgene, and any promotors inserted into the plant genome to cause the plant to express the gene. The plant genome, under given necessary forces, causes the plant to come into being from the seed. The transgene is not necessary for the process of bringing the plant into being. The transgene is only necessary to confer some type of protection upon the plant. This means that the transgene may be "switched off" such that it is not expressed and the plant will still be produced. Since the patented invention may be the composition consisting of the plant genome and the transgene with its promotors, then the use of the plant gene in the process of growing the plant is employing only an element of the invention, not the entire invention. Indeed, a process is initiated by planting the seed in which the plant genome, which is an element of the patented invention, is brought into service and applied to its given purpose of producing a plant to the fullest extent possible, and hence is "used." However, the use of a component element of an invention is not infringement, only the use of the entire invention constitutes infringement. Whether mere possession of the patented invention implies use has not been clearly articulated in any reported cases.[559] However, to use a thing and to possess a thing are distinct and separate concepts; the language of the statute is clear in that it is the "use" that constitutes infringement, not "possession."

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557. *See* Dilip M. Shah, Stephen G. Rogers, Robert Horsch & Robert T. Fraley, *Glyphosate-Resistant Plants*, U.S. PAT. NO. 5,188,642, Claim 8 (issued Feb. 23, 1993).

558. Of course a doctrine exists in patent law in which the use of a patented invention for a completely different purpose constitutes "use" and hence infringement of the patent. However, in this case, the patented invention is not being used for some completely different purpose; rather, the patented invention is not being used at all.

559. *See* ROBINSON, *supra* note 547, § 898.

Mr. Schmeiser argued, as part of his defense, that he did not "use" the patented glyphosate-resistant canola found growing on his farm because he did not apply Roundup to his canola.[560] While Federal Judge W. Andrew MacKay took note of Mr. Schmeiser's argument, he found it irrelevant for determining infringement because he interpreted the language of the patent statute to mean that if the transgenic plant is growing on Mr. Schmeiser's farm then Mr. Schmeiser is infringing the patent rights of Monsanto. It is impossible to know precisely why Judge MacKay drew such an erroneous interpretation from the patent statute. It is completely contrary to the clear meaning of the patent statute that mere possession of the patented invention on the lands of the farmer constitutes infringement. To find infringement, it must be proven that the farmer either made, used, or sold the patented invention. Since economic aspects are not at issue for the time being, the selling of the crop is not relevant to the question of whether possession of the patented invention on the lands of the farmer constitutes infringement. To make or use the patented invention requires a volitional action on the part of the farmer. As discussed above, no volitional action on the part of the farmer can cause the "making" of the patented invention. Therefore, there can be no infringement due to making the plant simply by initiating the process by which the plant eventually comes into being. Unless the farmer actually uses the patented invention for its intended purposes,[561] then there is no infringement. Mr. Schmeiser never sprayed Roundup on his fields because such an action would be counterproductive to his efforts. Therefore, Mr. Schmeiser never used the patented invention. According to the decision by Judge MacKay, Monsanto never proved that Mr. Schmeiser either made or used the patented invention. Their claim was that he merely possessed the patented invention on his lands and hence he must be guilty of patent infringement.

3. The Farmer as Plant Breeder

The advancement of law and science has left the farmer at the side of the road. The farmer has first hand knowledge of crops in his field. He also would be in the position to detect and characterize, on a superficial level, any plants that appear anamolously through routine inspection and maintenance of his fields. The farmer may then assume the role of plant breeder. If the farmer is classified as a plant breeder, then he may be allowed to use protected plants without infringing the rights of the original developer of the plants; it may strengthen his hand in negotiating with the seed manufacturers as well as in legal disputes with the seed manufacturers. The farmer as a plant breeder may also have available to him statutory protection from infringement claims by the seed manufacturers. Appropriate places to start in defining the farmer as a researcher and plant breeder are the dictionary and case law.

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560. *See supra* note 442.

561. In the case of plant agricultural biotechnology, it is difficult, if not impossible, to use the patented invention for any purpose other than for which it is originally intended. The patented invention was not intended to be planted and produce a plant. It was intended to confer some type of protection upon the plant. Indeed, the plant genome produces a plant, but that is only an element of the entire patented invention. Even if the farmer could "make" a plant by employing its genome, he still would not be employing the patented invention simply by allowing the plant to grow on his lands.

A breeder is a person who breeds either animals or plants. To breed plants means to "produce (plants) by selective pollination."[562] A plant breeder is typically thought to be a corporation[563] or a worker for an agricultural station[564] or university.[565] However, it does not appear that the courts require that "selective pollination" be the sole criteria distinguishing a plant breeder from an ordinary grower of plants.[566] In *Yoder Bros. v. California-Florida Plant Corp.*, the Fifth Circuit stated, "the breeder must possess the skill and discrimination to spot potential new varieties and recognize whether they possess desirable traits."[567] While corporations have typically been viewed as "plant breeders" common-sense indicates that such fictional legal entities are incapable of being plant breeders; rather, the people employed by these corporations are the actual plant breeders.

No particular set of criteria establishes an individual as a plant breeder. For example, in the early twentieth century, an individual could be registered as a "cotton seed breeder" in Texas upon application and compliance with statutory requirements.[568] While the individual plant breeder may require that "facilities for elaborate testing and development must be available,"[569] such requirements need not always be satisfied. Indeed, plant breeders were not required to have elaborate facilities, only to have the ability to discern desired traits in individual or small groups of plants. In fact, the status of the individual as a plant breeder was recognized by Congress in passing the Plant Patent

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562. WEBSTER'S NEW WORLD DICTIONARY 173 (3d ed. 1988).

563. *See* Pan-American Plant Co. v. Matsui, 433 F. Supp. 693, 695 (N.D. Cal. 1977) (stating that "[p]laintiff breeds" new chrysanthemum plant varieties); *see also* Pioneer Hi-Bred v. Holden, 35 F.3d 1226, 1234 n.34 (8th Cir. 1994) (stating that "McConnell is a plant breeder employed by Pioneer"); Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1352 (5th Cir. 1976) (identifying Mr. Duffett as Yoder's head breeder).

564. *See* TRUE, *supra* note 29, at 221, 255, 274.

565. *See* Mumm v. Illinois, 10 Ill. Ct. Cl. 652, 652-53 (1939) (recognizing that plaintiff was "an associate in plant breeding in the Agronomy Department of the College of Agriculture of the University of Illinois").

566. For instance, the court in *Pan-American Plant Co. v. Matsui* stated that the term "breeder" of chrysanthemums "also includes a person or firm who uses mutation inducing techniques such as radiation." 433 F. Supp. 693, 695 n.3 (N.D. Cal. 1977).

567. Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1352 (5th Cir. 1976). In describing the process for identifying and propagating new chrysanthemum varieties, the court stated that "a skilled breeder will select for further development those that display such desirable characteristics as fast response time, temperature tolerance, durability, size, and vigor" and after the new variety has been isolated, "the only way he can preserve his creation is by means of asexual reproduction." *Id.*

568. *See* Terrell v. Kasch, 10 S.W.2d 208, 209 (Tex. Civ. App. 1928). The court upheld an injunction by the trial court restraining appellants from:

> (a) . . . registering or certifying any cotton seed produced or owned by the plaintiff, Ed Kasch, without his application therefor or his express consent. (b) From in the future certifying any cottonseed that is produced from and is the 1st-year progeny of Ed Kasch's unregistered commercial seed that he offers and sells to the public as Kasch's improved pedigreed cottonseed. (c) From in the future issuing and delivering to any person, firm or corporation certification tags for cottonseed that is the first-year progeny of Ed Kasch's unregistered commercial cottonseed.

Id. at 209.

569. Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1352 (5th Cir. 1976).

Act of 1930.[570] The report of the House of Representatives states that the Plant Patent Act is intended to correct the (then existing) discrimination between rewarding genius of mechanical invention and the failure to reward the genius of inventing new varieties of plants. Specifically, the report states that by correcting such discrimination it was "hoped the genius of young agriculturist of America will be enlisted in a profitable work of invention and discovery of new plants that will revolutionize agriculture."[571] The author has been unable to find any case law in which the status of a farmer as a plant breeder has been explicitly addressed. While the farmer may not be typically viewed as a scientist or engineer,[572] he may certainly be considered a plant breeder.[573]

While the farmer may not possess sophisticated equipment, he can still engage in the practice of observing which crop varieties work best for his local environment and employ those same varieties. In some cases, the farmer will conduct this practice with his own crops. Such is the case with Percy Schmeiser who has grown conventional canola on his farm in Canada since 1947 and is known as a seed developer and seed saver.[574] Mr. Percy Schmeiser has engaged in a multi-decade long program of retaining select seed from one crop cycle for use in the next planting cycle. He uses canola seeds grown on a field allowed to "summer fallow" the previous year for the subsequent growing cycle because those seeds are the "cleanest." In doing so, he is able to plant seeds that are the least contaminated with weed seeds and the least likely to transmit diseases. Through his rational farming practice, Mr. Schmeiser has developed a variety of conventional canola that is relatively free of blackleg and sclerotinia with higher than average yield for the Saskatchewan area.[575] In his practice of farming he displays all the characteristics of a plant breeder defined above. That he lacks formal training as a scientist does not make him less a plant breeder than the trained scientist who

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570. *See* COMMITTEE ON PATENTS: 1930, *supra* note 504, at 2. The committee recognized that "plant breeding and research is dependent, in large part, upon Government funds to Government experiment stations, or the limited endeavors of the amateur breeder." *Id*. The statutory language was cited in *In re Arzberger*, 112 F.2d 834, 838 (C.C.P.A. 1940) (holding that the word "plant" as used in the Plant Patent Act did not include bacteria), *distinguished by* Application of Bergy, 563 F.2d 1031, 1039 (C.C.P.A. 1977) (stating that "[w]e are not here concerned with interpretation of the Plant Patent Act as this court was in *In re Arzberger*, . . . which simply held that that act did not encompass bacteria").

571. COMMITTEE ON PATENTS: 1930, *supra* note 504, at 2.

572. When the term "scientist" is used, it is easy to conjure up an image of a bearded, slightly unkempt, pipe-smoking man in a laboratory working with petri dishes and test tubes in deep contemplation of serious questions of science. But, it is possible to recognize the farmer as a scientist if he engages in the scientific method while improving the productivity of his crops. By scientific method, it is meant that through the process of hypothesis development and testing, a clearer understanding is obtained of the system under investigation. The engineer is a person who understands the scientific principles involved and is able to apply or manipulate those principles to construct a system or device capable of converting a raw material input into a desirable product. Such activity is the essence of farming.

573. *See* Kim Bros. v. Hagler, 276 F.2d 259, 260-61 (9th Cir. 1960) (identifying Mr. F. W. Anderson as "a plant breeder of some considerable standing, [who] produced and sold to appellant partnership a new variety of nectarine").

574. *See* Interview: Schmeiser {July 6, 2001}, *supra* note 270.

575. *See generally* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html. *See also* Interview: Schmeiser{July 6, 2001}, *supra* note 270.

works for a seed manufacturer. It is the nature of his work that makes him a plant breeder. In fact, any farmer that meets the criteria of a plant breeder discussed above is, by definition, a plant breeder. However, not all farmers are necessarily plant breeders.

Another farmer is Mr. Dallas Thomason, who owns a cotton ginning facility in Louisiana that is used by many neighboring cotton farmers for ginning their cotton. It has been a practice of Mr. Thomason to retain the cotton seeds from the farmers who have their cotton ginned at Mr. Thomason's facility as partial consideration for the use of his cotton gin.[576] A portion of these seeds is used by Mr. Thomason to plant his own fields, and the balance is sold for processing into animal feed.[577] Mr. Thomason was successfully sued by Monsanto and Delta and Pine Land for planting "brown-bag" genetically modified cotton seed[578] without a technology use license.[579] However, even his long-standing practice of using part of the seeds retained from ginning other farmer's cotton would have given Monsanto and Delta and Pine Land a cause of action against Mr. Thomason for patent infringement and infringement of the PVPA. Because Mr. Thomason is not engaged in the process of creating a new variety of cotton, then one would be hard pressed to give him the status of a plant breeder. However, a serious question in the current status of the law remains where Mr. Thomason is liable to Monsanto when he does indeed engage in his conventional practice of using a portion of the seed retained from the cotton ginning process for reproductive purposes.

After many years of artificial selection the growers of Washington Red Delicious apples managed to produce the visibly "model" apple which does not have an appealing taste to the consumer.[580] The

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576. *See* Interview: Thomason, *supra* note 7.

577. Mr. Thomason has stated that he never resold any portion of these seeds to farmers for reproductive purposes. *See id.*

578. Mr. Thomason planted "brown-bag" cotton seed during the 1996 crop cycle on only 50 acres of the normal 4000 acres that he plants. Typically, Mr. Thomason has cotton seeds, that he saved from his own fields, cleaned and delinted by Sinkers Seed Corp., Kennett Mo., for planting during the next crop cycle. In 1996, Mr. Thomason did not have a sufficient amount of his own "saved" seed to complete the planting of the 4000 acres. He insists that he did not know that the seed he purchased from Mr. Pete Mulhern, then employed by Tri-State Chemical, in 1996 was genetically modified to contain the *Bacillus thuringiensis* δ-endotoxin gene. *See id.* Furthermore, he insists that Mr. Mulhern, who sold the seed to him, neither told him that the cotton seed was genetically modified nor required him to sign the technology-use license. *See id.* It is known that in the first year of general use of *Bacillus thuringiensis* cotton, the cotton seed was first placed on the open market in 1996, the farmers were sold far more seed than they would have used had they been planting conventional cotton, and that the farmers planted the new genetically modified seeds more densely than they typically planted conventional seeds. In many cases, farmers would return the excess seed to the seed dealer, who would rebag it in unlabeled brown bags and resell the seed without a technology-use license. Under such circumstances, it is plausible that Mr. Thomason genuinely did not know, or could not have known, that the "brown-bag" seed was genetically modified but, the seed dealer certainly must have know and for his own reasons did not want to bother with requiring the farmers who were purchasing the seed to sign the technology-use agreement. *See id.* Mr. Thomason stated that it was Mr. Mulhern who reported him to Monsanto as using *Bacillus thuringiensis* genetically modified seed without a technology-use license. *See id*.

579. A technology-use license utilized by Monsanto in Canada to regulate canola farmers is given *supra*, note 453.

580. *See* Timothy Egan, *'Perfect' Apple Pushed Growers Into Debt*, N. Y. TIMES, November 4, 2000, at A1.

Washington Red Delicious apple was "bred for color and size and not for taste."[581] Because of a change in the taste of consumers, and the lack of appeal of the Washington Red Delicious apple, the Red Delicious apple growers of the United States are facing a rapid decline in their industry.[582] Recently, one astute apple farmer in the state of Washington observed an anomalous apple growing in his orchard of Red Delicious apples. The new apple, called the Cameo apple, is distinct from the Red Delicious apple in color, skin texture, shape, and flavor. This case raises two interrelated questions: first, whether the apple grower is a "plant breeder;" second, whether the apple represents a new variety of apples. If each of these two issues is resolved in the affirmative, then the owner of the intellectual property in the ancestral plant variety may not have a cause of action for infringement. The apple growers in general, and the grower of the Cameo apple in particular, satisfy all the requirements discussed above for giving a farmer the status of a plant breeder. The apple growers are continuously refining a variety of apples to make it more appealing to the consumer and awareness and development of new varieties of apples is the core definition of being a plant breeder. Therefore, the farmer who discovered the Cameo apple is a plant breeder, as are all the farmers who continue to refine the particular variety of crop that they are growing.

4. Breeding a New "Variety"

The second issue related to the Cameo apple considers whether it constitutes a new variety of apples separate from the Red Delicious Apple. The answer to this question depends upon whether the new plant is reproduced sexually[583] or asexually.[584] If the newly observed plant or plant product was the result of asexual reproduction, including a sport, then it might be a new "variety" and hence patentable under Title 35 of the United States Code. If the plant or plant product was produced by sexual reproduction then it might be a new "variety" under the Plant Variety Protection Act and hence

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581. *Id*. (quoting Doyle Fleming, lifelong apple farmer).

582. *See id.*

583. *See* Asgrow Seed Co. v. Winterboer, 513 U.S. 179, 181 (1995). If the variety is sexually reproduced, then it may be protected under the Plant Variety Protection Act. As indicated earlier, sexual reproduction means that plants grow from seeds, which in turn produce seeds. Sexually reproduced plants are afforded protection under the Plant Variety Protection Act of 1970. Specifically, the Act affords "patent-like protection to novel varieties of sexually reproduced plants (that is, grown from seed) which parallels the protection afforded sexually reproduced plant varieties (that is, varieties reproduced by propagation or grafting) under Chapter 15 of the Patent Act." *Id.*

584. Asexually reproduced plants are those which are reproduced through cuttings, grafting, or otherwise cloning the source plant. These plants may be protected by the Townsend-Purnell Plant Patent Act. The provisions of the Plant Patent Act were included in Title 35 of the United States Code in 1952. Law of July 19, 1952, ch. 950, 66 Stat. 804 (1952) (current version at 35 U.S.C. §§ 161-64 (1994)). Subsequently, the plant patent grant was changed from the "exclusive right" to the "right to exclude" resulting from court decisions explaining the nature of rights granted by a patent. *See* 35 U.S.C. § 163 (1994); Crown Die & Tool Co. v. Nye Tool & Mach. Works, 261 U.S. 24, 34 (1923) (stating that: "[a]ll that the Government grants and protects is the power to exclude others from making, using, or vending during the grant"); P. J. Federico, *Commentary on the New Patent Act*, 35 U.S.C.A. 1, 40-41, reprinted in 75 J. PAT. OFF. SOC'Y. 161, 202 (1993). Only a single claim is allowed in a plant patent, *see* 37 C.F.R. § 1.164, and the specification of the plant patent must contain as complete a description of the characteristics of the plant as possible so as to distinguish it from related known varieties; also, the specification must contain language which points out with particularity the manner of asexual reproduction. The entire plant is patented; hence only a single claim is permitted in the plant patent. *See* Kim Bros. v. Hagler, 167 F. Supp. 665, 667 (S.D. Cal. 1958).

subject to protection. While the discovering farmer may be able to claim a patent or certification on the new plant or plant product, will the farmer still be liable for infringement of the original patent or Plant Variety Protection Act certification? The answer depends upon whether the farmer has the status of a plant breeder, and upon the definition of a new "variety."[585] The definition of variety depends upon whether the ancestral plant variety was protected under the Plant Variety Protection Act or the Plant Patent Act.

a. Protection Under Plant Variety Protection Act

The progenitor plant may be certified under either the Plant Variety Protection Act[586] or[587] under the Plant Patent Act.[588] The right to certification under the Plant Variety Protection Act depends on whether the variety[589] is new, distinct, stable, and uniform. Because the scope of the Plant Patent Act[590] is different from the scope of the Plant Variety Protection Act,[591] "the meaning of variety in the Plant Patent Act and the PVPA" must not necessarily be the same.[592] If the new plant was obtained by harvesting cells from a plant protected by the Plant Variety Protection Act, satisfies the requirements of 7 U.S.C. §2402(a), and its progeny are sexually reproduced, then the progeny may

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585. As is usually the case when dealing with language, we must struggle with ambiguities inherent in the use and meaning of particular words. In the case at hand, our problem is adequately by the following: "[i]t is very difficult to tell just what is meant by the word variety; in fact, it means different things to different people." Carleton R. Ball, *Varieties of Hard Spring Wheat*, 680 U.S.D.A. FARMERS' BUL. 1, 2 (1915). Mr. Ball gave a somewhat useful definition as "it means a collection of plants in which all the individuals are alike in appearance, including form, size, color, and other visible characters." *Id.*

586. *See* 7 U.S.C. § 2543 (1994).

587. Because the Plant Variety Protection Act applies only to plants that are sexually reproduced and the Plant Patent Act applies only to plants that are asexually reproduced, then it is not possible to obtain protection under both acts.

588. *See* 35 U.S.C. § 161 (1994).

589. Under the PVPA, the term "variety" is defined as follows:
[t]he term "variety" means a plant grouping within a single botanical taxon of the lowest known rank, that, without regard to whether the conditions for plant variety protection are fully met, can be defined by the expression of the characteristics resulting from a given genotype or combination of genotypes, distinguished from any other plant grouping by the expression of at least one characteristic and considered as a unit with regard to the suitability of the plant grouping for being propagated unchanged. A variety may be represented by seed, transplants, plants, tubers, tissue culture plantlets, and other matter.
7 U.S.C. § 2401(a)(9) (1994). The 1994 amendments to the Plant Variety Protection Act were made to conform the statutory language with the International Convention for the Protection of New Varieties of Plants of March 1991. *See* H. R. REP. NO. 103-2927 (1994).

590. The Plant Patent Act grants a patent to anyone who "invents or discovers and asexually reproduces any distinct and new variety of plant." 35 U.S.C. § 161 (1994).

591. The Plant Variety Protection Act permits certification of a plant that has been sexually reproduced and has met the requirements of 7 U.S.C. § 2402(a)(1-4).

592. *See* Imazio Nursery, Inc. v. Dania Greenhouses, 69 F.3d 1560, 1568 (Fed. Cir. 1995) (Imazio Nursery brought a cause of action for infringement of its plant patent for a variety of winter blooming heather. Resolution of the case depended upon the definition of "variety.").

also be protected under the Plant Variety Protection Act. If, however, the new plant exhibits at least one characteristic which is clearly distinguishable from the progenitor plant and from other publicly known variety then the new plant is the originator of a new variety of plant.

Since the Plant Variety Protection Act grants patent-like protection for certified plants, then the owner of the certificate may exclude others from the use of the plant for breeding purposes,[593] but only to the extent that the progenitor and progeny plants are of the same variety. If the research farmer[594] uses the Plant Variety Protection Act certificated plant variety to develop a "hybrid or different variety therefrom"[595] then the owner of the certificate may not exclude him from doing so. For instance, Delta and Pine Land held a Plant Variety Protection Act certificate on the *Bacillus thuringiensis* transgenic cotton planted by Mr. Dallas Thomason, and was awarded damages equal to $100 per acre of cotton planted by Mr. Thomason. If Mr. Thomason had been using the *Bacillus thuringiensis* transgenic cotton to *develop* a new variety of cotton (say with a superior fiber length) then Delta and Pine Land would not have a cause of action for infringement of the Plant Variety Protection Act certificate because Delta and Pine Land would not have the right to exclude Mr. Thomason from doing so.

Because *Zea Mays* L. is open pollinated the argument for using the certificated plant variety in developing a new variety may be easier to make. For example, in the case of maize, it would only be necessary to intercalate a number of rows of *Bacillus thuringiensis* transgenic *Zea Mays* L., which was Plant Variety Protection Act Protected, with another variety of maize for the purposes of developing a new variety of maize.[596] Again, in such a case, the owner of the certificate would not have a cause of action against the research farmer because the research farmer is using the certificated variety to develop a new variety.

There is no language in the Plant Variety Protection Act specifying that the existence of the transgene in the certificated plant variety precludes the use of that variety in the development of a new variety. This observation has considerable import in the case that the field of the research farmer is contaminated with the transgene from a field of genetically modified plants. Because the presence of the transgene in the field containing originally non-modified plants creates a new variety, the holder of the certificate has no cause of action when the farmer, whose plants were contaminated, saves seed from that field for use in the next crop cycle.

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593. *See* Kim Bros. v. Hagler, 276 F.2d 259 (9th Cir. 1960).

594. The farmer who engages in the practice of developing a variety of plant is a plant breeder. Also, since the farmer is also engaged in the practice of developing hypotheses about which plants will yield the highest return on investment, then the farmer is also a researcher. *See generally* Ball, *supra* note 585. For simplicity, the term "research farmer" will identify any farmer who engages in the practice of rationally refining a variety of plant.

595. 7 U.S.C. § 2483(a)(1) (1994).

596. Such an intercalation of *Bacillus thuringiensis* transgenic *Zea mays* L. with non-modified maize is actually required by the refuge plan to reduce the possibility of creating δ-endotoxin resistant European corn borers.

The Plant Variety Protection Act contains a research exemption.[597] Research is beneficial to society and must be encouraged rather than discouraged by the threat of liability for either patent or Plant Variety Protection Act infringement. Because of the overriding benefit to the public, Congress exempted experimentalist from infringement under the Plant Variety Protection Act.[598] The overarching purpose is, of course, to encourage further developments of the useful arts and continue to add to the human understanding. It is not necessary that research be conducted only by the seed manufacturers. Any person in the field who is working daily with the plants and land have just as much, if not more, experience and knowledge of plant husbandry as the person in the lab who works with petri dishes. In fact, the person in the field is more likely to understand the economic, environmental, and social impact of his or her work because he is the closest to those effects. Because the research farmer is, indeed, engaged in a bona fide research program to develop his own plant variety, as is Mr. Percy Schmeiser, then the research exemption must apply to the research farmer equally with its application to the laboratory investigator.

b. Protection Under Plant Patent Act

35 U.S.C. § 161 provides that "[w]hoever invents or discovers and asexually reproduces any distinct and new variety of plant . . . may obtain a patent therefor."[599] Once granted, the patent allows the patent holder to "exclude others from asexually reproducing the plant or selling or using the plant so reproduced."[600] Two issues need to be resolved in order to identify the level of protection and liability of the farmer under Title 35: first, whether the newly discovered and reproduced plant is a new variety; second, whether the discoverer of the Cameo apple, or the research farmer who develops a new variety, is liable for infringement of the Plant Patent Act (the mirror issue is whether the holder of the plant patent has exclusive rights in the Cameo apple). The import of the first issue is that if the newly discovered and reproduced plant is a new variety, then the plant breeder or research farmer that asexually reproduced the plant cannot be guilty of infringement of the exclusive rights of the patentee. The second issue is important because the plant breeder and research farmer must have available to him as many legal protections as possible for their important contributions to the general public. The resolution of the first issue was examined by the United States Court of Appeals, Federal Circuit in 1995.[601] In *Imazio Nursery*, the decision turned on the definition of variety and what steps by the plant breeder give rise to a new variety. The Federal Circuit provides a starting point in analyzing the issue of whether the Cameo apple constitutes a new variety of apples.

Presume that a plant is obtained[602] which has a Plant Patent protected progenitor plant, but which

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597. The "research exemption" under the Plant Variety Protection Act provides that "[t]he use and reproduction of a protected variety for plant breeding or other bona fide research shall not constitute an infringement of the protection provided under this chapter." 7 U.S.C. § 2544 (1999).

598. *See* Robert P. Merges, *Intellectual Property in Higher Life Forms: The Patent System and Controversial Technologies*, 47 MD. L. REV. 1051, 1073 (1988).

599. 35 U.S.C. § 161 (1994).

600. 35 U.S.C. § 163 (1994).

601. *See* Imazio Nursery, Inc. v. Dania Greenhouses, 69 F.3d 1560, 1568 (Fed. Cir. 1995).

602. It is irrelevant for this part of the discussion whether the plant is obtained as a sport, mutant, hybrid, or a

does not contain an exact copy of the progenitor plant genome.[603] To be precise, consider a progeny plant that was produced by the protocol required for asexual reproduction but which differs from that protocol[604] sufficiently to produce a plant that does not possess an exact copy of the ancestral plant genome.[605] While the construction of the situation under consideration is quite broad, the analysis of this situation will be applicable to the much narrow situation in which a Plant Patent protected plant containing a transgene is produced by a modification of the protocol for asexual reproduction. Such modifications could be accomplished by radiation or toxins directed at the plant's DNA. The case at hand differs from *Pan-American* because in *Pan-American* the sport from the ancestral plant was asexually reproduced without modification.[606]

Under Title 35 of the United States Code, the progeny plant is of the same variety as the ancestral plant only if it is produced as the result of asexual reproduction.[607] To determine whether our progeny plant is an asexual reproduction of the ancestor plant requires review of the meaning of asexual reproduction.[608] The importance of asexual reproduction to the plant act was clarified in

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newly found seedling observed in the cultivated state. While the Plant Patent Act does not define "variety," the legislative history of the statute illuminates the inquiry as follows:

> new and distinct variety results from bud variation and not seed variation. A plant or portion of a plant may suddenly assume an appearance or character distinct from that which normally characterizes the variety or species. In the second class of cases, the mutants, the new and distinct variety results from seedling variation by self-pollination of species. In the third class of cases, the hybrids, the new and distinct variety results form seedlings of cross pollination of two species, two varieties, or a species and a variety.

S. REP. NO. 71-315, at 3 (1930). Congress added another class of plants in 1954, newly found seedlings, with the exception that seedlings found in the uncultivated state cannot be patented. Act of Sept. 3, 1954, Pub. L. No. 83-775, 68 Stat. 1190; *Ex parte* Moore, 115 U.S.P.Q. (BNA) 145, 146 (Pat. Off. Bd. App. 1957) (section 161, as amended was intended to include "cultivated sports, mutants, hybrids, and *newly found* seedlings").

603. The only way of knowing for sure that the relevant gene in the newly obtained plant is not an exact copy of the ancestral gene is by gene mapping. Currently, technology exists to do gene mapping but it is costly.

604. For instance, the protocol might be varied by exposing the ancestral plant cells to conditions that are known to modify the genetic code. *See* Pan-American Plant Co. v. Matsui, 433 F. Supp. 693, 695 (N.D. Cal. 1977).

605. *See* Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347 (5th Cir. 1976). In recognizing that frequently occurring, but rarely observed mutations would still be patentable, the court stated that:

> [a]lthough we are willing to assume for purposes of this argument that some mutations may appear that would have been genetically impossible before i. e. that a fundamental change in the biochemical structure of the chromosome may take place by far the majority of mutations and sports of chrysanthemums are predictable to some extent for those skilled in the field . . . . Indeed, part of the skill required of a [] breeder is to know what to look for and to take steps immediately to preserve it by asexual reproduction if the desired trait appears. Given that fact we think that the purpose of the Plant Patent Act would be frustrated by a requirement that only those rare, never-before-seen, if not genetically impossible sports or mutations would be patentable.

Id. at 1382.

606. *See* Pan-American Plant Co. v. Matsui, 433 F. Supp. 693 (N.D. Cal. 1977).

607. *See* 35 U.S.C. § 161 (1994 & Supp. III 1997).

608. Asexual reproduction has been described as being "not only a pre-requisite but of the very essence of the patent itself." Peter F. Langrock, *Plant Patents-Biological Necessities in Infringement Suits*, 41 J. PAT. OFF. SOC'Y. 787 (1959).

Yoder Bros.: "[a]sexual reproduction is literally the only way that a breeder can be sure he has reproduced a plant identical in every respect to the ancestral plant."[609] The court went on to state that infringement of the patent would occur "only if stock obtained from one of the patented plants is used"[610] and that "[i]f the alleged infringer could somehow prove that he had developed the plant in question independently, then he would not be liable in damages or subject to an injunction."[611]

The test then for asexual reproduction requires that some form of appropriation[612] occur from the patented ancestral plant.[613] The district court in *Yoder Bros.* determined the point at which appropriation occurs when it ruled "that the act of asexual reproduction was complete at the time the cutting [physical appropriation] was taken."[614] It would seem then that at first glance asexual reproduction has occurred in our case despite the progeny having a different genetic construct than of the ancestral plant.

In 1948, Magnuson set out a test of infringement of the plant patent protection by asexual reproduction that asked "whether there was a *reproduction* of substantially the same plant as covered by the patent by any means *other than by seed*."[615] The Magnuson test would seem to indicate that the new plant would certainly be asexually reproduced because it was "substantially the same plant."[616] However, the Magnuson test "misses the narrow confinement of the protection afforded to plant patents."[617] Title 35, section 161 does not allow the granting of a patent for substantially the same plant[618] but "one particular plant that has one particular chromosome structure and when reproduced asexually will produce plants that have an absolute genetic identity"[619] with the ancestral plant.[620] To discriminate, our grower has not "reproduced a plant identical in every respect to the

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609. Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1380 (5th Cir. 1976).

610. *Id.*

611. *Id.*

612. An adult plant can be reproduced from a single cell grown in tissue culture. *See* CAMPBELL, *supra* note 13, at 410. Some commercially important plants that have been grown from single cells include alfalfa, asparagus, cabbage, carrots, citrus fruits, potatoes, sunflowers, tobacco and tomatoes. *See id.* at 390.

613. *See* Langrock, *supra* note 608, at 788.

614. Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1383 (5th Cir. 1976).

615. Raymond A. Magnuson, *A Short Discussion on Various Aspects of Plant Patents*, 30 J. PAT. OFF. SOC'Y. 493, 508 (1948).

616. *Id.*

617. *See* Langrock, *supra* note 608, at 789.

618. *See* 35 U.S.C. § 161 (1994); Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1380 (5th Cir. 1976); Langrock, *supra* note 608, at 789.

619. Langrock, *supra* note 608, at 789.

620. The court in *Yoder Bros.* appears to follow this reasoning. *See* Yoder Bros. v. California-Florida Plant

parent"[621] but has produced a plant that is "substantially the same plant"[622] as the ancestral plant.

Is the "substantially the same plant" of interest still "identical in every respect to the parent"[623] just because "asexual reproduction was complete at the time the cutting was taken"?[624] The answer to this question should be no.[625] Modern gene mapping methods have advanced to the point that it is nearly trivial to show whether an allegedly infringing plant is genetically the same as the patented plant. Therefore, Langrock's basic premise, that genetically identical plants can manifest different superficial characteristics because of environmental factors,[626] fails in light of modern science. It is now possible to determine whether two plants allegedly genetically identical but manifesting different characteristics are indeed genetically different.[627] Since the patent was granted on one particular plant with one unique genetic structure and the new plant has a different chromosome structure, then the patent cannot be valid for the new plant.[628] The fact that there was physical appropriation from the patented ancestral plant is problematic.[629] The resolution of our quandary appears to be in how the plant cells were obtained for the new plant.

If the cells for the progeny plant are harvested from a Plant Patent protected plant which has already undergone the genetic mutations due to environmental forces, then there is physical appropriation of the cells from a plant which are the same as the one protected by the Plant Patent Act. In this case, the appropriation would constitute asexual reproduction of the patented plant, and

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Corp., 537 F.2d 1347, 1380 (5th Cir. 1976) (stating that "[a]sexual reproduction is literally the only way that a breeder can be sure he has reproduced a plant identical in every respect to the parent").

621. *Id.*

622. Magnuson, *supra* note 615, at 508.

623. Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1380 (5th Cir. 1976).

624. *Id.* at 1383.

625. The position argued here is contrary to that taken by Langrock. Langrock articulated his position as being that the law must create a "presumption that an infringement has occurred upon the showing by the patentee that the defendant's allegedly infringing plants are substantially the same as the patented plant and that the defendant has had at least a minimum opportunity to make actual physical appropriations." *See* Langrock, *supra* note 608, at 789-90.

626. *See id.* at 789.

627. Of course, environmental factors may cause two genetically identical plants to exhibit very different characteristics. This is because the gene, or genes, underlying the relevant characteristic, or characteristics, may be either expressed at different levels or not expressed at all. This situation adds a level of complexity which will serve only to obscure the point presently being pursued.

628. How similar the genetic structure must be and still express distinguishable characteristics is unclear. Quite possibly, a difference of one DNA base-pair may be sufficient to assert that the two varieties are indistinguishable.

629. The court in *Yoder Bros.* cited Langrock with approval that there must be physical appropriation in order to have asexual reproduction. *See* Yoder Bros. v. California-Florida Plant Corp., 537 F.2d 1347, 1380 (5th Cir. 1976).

hence the new plant would be of a variety indistinguishable from the plant that is protected.[630] If the cells themselves had undergone genetic mutation and then were harvested from the Plant Patent protected plant then there would be no appropriation because the appropriated cells are not an identical copy of the ancestor plant results. However, if the cells were harvested from the protected plant and genetically modified then, according to the doctrine articulated in *Yoder Bros.*, there would be physical appropriation and asexual reproduction. Thus, there would be infringement. In summary, any cells that contain genetic mutations and are harvested from a plant allegedly protected by Plant Patent are not physically appropriated and hence cannot constitute an asexual reproduction of the ancestral plant. The rationale is that the harvested cells cannot be the progeny of the ancestral plant because the progeny can only be identical replicas of the ancestral plant. On the other hand, if the cells are harvested and then modified there would be physical appropriation.

This nonsensical result need not occur in light of recent developments in science. With genetic identification techniques now available, although expensive, it is possible to determine if two plant genomes are from the same source. Therefore, the Patent Act should be amended to provide that the gene or genes corresponding to the distinctive characteristic of the plant, to be patented, be clearly identified in the patent.[631] This will put the alleged infringer on notice as to what property is protected by the Plant Patent. Further, the Patent Act should include additional requirements to show infringement: first, that the gene or genes corresponding to the putative distinctive characteristic of the alleged infringing plant be identified and shown to be the same as the gene or genes in the Patent Act protected plant; second, that the gene or genes corresponding to the distinctive characteristics of the Plant Patent protected plant be identified and shown to be the same as the corresponding gene or genes in the allegedly infringing plant. Under this construction of the Plant Patent Act, the entire question of physical appropriation becomes irrelevant. If the allegedly infringing plant cannot be shown to have a gene or set of genes that makes it distinctive from the Plant Patent protected plant, then infringement is demonstrated.

The answer to the first issue surrounding the Cameo apple is that it constitutes a new variety and infringement does not exist because the cells leading to the Cameo apple were mutated before being removed from the Plant Protected apple tree. To resolve the second issue surrounding the Cameo apple, whether the discoverer of the Cameo apple, or the research farmer who develops a new variety, is liable for infringement of the Plant Patent Act (the mirror issue is whether the holder of the plant patent has exclusive rights in the Cameo apple), requires a review of the experimental use exception.

i. Experimental Use Exception

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630. Congress defined the characteristics that may be used to distinguish a new variety. These include: among others those of habit; immunity from disease; resistance to cold, drought, heat, wind, or soil conditions; color of flower, leaf, fruit, or stems; flavor; productivity, including everbearing qualities in case of fruits; storage qualities; perfume; form; and ease of asexual reproduction. Within any one of the above or other classes of characteristics the differences which would suffice to make the variety a distinct variety, will necessarily be differences of degree.
S. REP. NO. 71-315, at 4 (1930).

631. In the case that the patent is granted for a transgenic plant, both the transgene and the location in the plant genome where the transgene is inserted must be clearly identified. Further, the transgene must be inserted using genetic engineering techniques and must be expressed.

The experimental use exception to the Patent Act appears to have been created by Supreme Court Justice Story in 1813.[632] In defining "infringement" the trial judge had included the requirement that there must have been an intent to use the invention for profit.[633] Justice Story both approved of the jury instruction and added that "it could never have been the intention of the legislature to punish a man, who constructed such a machine merely for philosophical experiments, or for the purpose of ascertaining the sufficiency of the machine to produce its described effects."[634] Justice Story found that the defendant's complaint regarding the jury instruction was without merit because the instruction given by the trial judge to the jury was in the favor of the defendant.[635] Justice Story gave neither authority nor evidence of legislative intent supporting the cited proposition. Furthermore, the statement was not necessary to decide the case. Therefore, Justice Story created the experimental use exception to the Patent Act in *dictum*. The Patent Act remains devoid of language concerning the common law experimental use exception. Congress, in the 188 years since Justice Story's decision in *Whittemore v. Cutter*, has not explicitly overruled the experimental use exception despite sufficient opportunity to do so.

In a separate case involving the sale of the plaintiff's patent protected machinery by a sheriff under a writ of execution, Justice Story was called upon to decide whether the sale constituted patent infringement. In *dictum*, Justice Story stated that

> it has [been] held that the making of a patented machine to be an offence within the purview of it, must be the making with an intent to use for profit, and not for the mere purpose of philosophical experiment, or to ascertain the verity and exactness of the specification.[636]

Continuing, Justice Story stated that "the making must be with an intent to infringe the patent right, and deprive the owner of the lawful rewards of his discovery."[637] In *Sawin v. Guild*, Justice Story formalized the element required for infringement as being an intent to profit from the act.

Several theories have been advanced to explain the creation of the experimental exception by Justice Story.[638] By revisiting the circumstances under which Justice Story first established the

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632. *See* Whittemore v. Cutter, 29 F. Cas. 1120 (C.C.D. Mass. 1813) (No. 17,600). On appeal defendant Cutter objected to an instruction which the trial judge gave to the jury in a patent case which was that "the making of a machine fit for use, and with a design to use it for profit, was an infringement of the patent right." *Id.* at 1121.

633. *Id.* at 1121.

634. *Id.* at 1121.

635. *Id.* at 1122-23.

636. Sawin v. Guild, 21 F. Cas. 554, 555 (C.C.D. Mass. 1813) (NO. 12,391).

637. *Id.*

638. *See* Richard E. Bee, *Experimental Use as an Act of Patent Infringement*, 39 J. PAT. OFF. SOC'Y. 357 (1957).

experimental use exception it may be determined that while the exclusive rights of the patentee were established by statute, such rights were the codification of long established common law.

One possible basis for the establishment of the experimental use exception is that it arises from the scienter requirement of common law tort actions. Both *Whittemore v. Cutter* and *Sawin v. Guild* were decided under the Patent Act of 1793[639] since the Patent Act of 1793 was not repealed and replaced until 1832.[640] The Patent Act of 1793 specified that a patent granted to the patentee "the full and exclusive right and liberty of making, constructing, using, and vending to others to be used, the said invention or discovery."[641] Section 5 of the Patent Act of 1793 states that "if any person shall make, devise and use, or sell the thing so invented" then that person is an infringer of the exclusive rights of the patentee.[642] It is true that the Patent Act did not require an intent to infringe,[643] did not require an intent to use for profit, and established that lack of knowledge of the existence of the patent is irrelevant in determining infringement.[644]

Presume that indeed Justice Story based his analysis upon the common-law tort action of trespass on the case to conclude that it required an intent to use for profit before infringement could be found. Then to conclude that Justice Story was incorrect[645] is to require both an ignoration of essential language in the Patent Act of 1793 (that is, infringement occurs when the accused infringer makes, uses, or vends) and a misinterpretation of the scope in relevant Supreme Court cases. As discussed above, volitive acts are essential to "make" or "use," and by logical extension to "sell" the invention patented. Therefore, scienter must be an essential element in a cause of action for infringement. Justice Brewer, in *United States v. Berdan Fire-Arms*,[646] and Justice Woodbury, in *Hogg v. Emerson*,[647] were both referring to the use of ignorance of the patent as a complete defense

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639. *See* Act of February 21, 1793, ch. 111, 1 Stat. 318-23 (1793) (the act was also published as: An Act to promote the progress of Useful Arts, and to repeal the Act heretofore made for that purpose, ANNALS OF CONG. 1431-35 (1793) (2d Cong. Sess. 2)).

640. *See* Act of July 4, 1836, ch. 162, 5 Stat. 117-25 (1836) (the act is entitled: An Act to promote the progress of useful arts, and to repeal all acts and parts of acts heretofore made for that purpose).

641. Act of February 21, 1793, *supra* note 639, at 321.

642. *See id.* at 322.

643. Bee argues that because the exclusive right in an invention is a statutory grant, the scienter requirement that is appropriate in common-law tort cases is inappropriate in determining whether infringement occurred. *See* Bee, *supra* note 638, at 365.

644. *See* United States v. Berdan Fire-Arms Mfg. Co., 156 U.S. 552, 566 (1895) (stating that it would not be a defense to an infringement action that the accused infringer "had, subsequent to [the] invention, and without knowledge thereof, devised the contrivance which he was using").

645. *See generally* Bee, *supra* note 638.

646. *See Berdan Fire-Arms*, 156 U.S. 552.

647. *See* Hogg v. Emerson, 52 U.S. 587, 607 (1850) (stating that ignorance "of the existence of the patent right" and lack of intent to infringe may be a defense when making the machine was "merely for a model, or for fancy, or philosophical illustration" but not when the machine is made "to be used").

to infringement. In both cases, ignorance of the existence of the patent was held to be irrelevant in determining whether there was infringement. The facts of *United States v. Berdan Fire Arms* do not support an analysis of the intent to use the invention patented for profit, and in *Hogg v. Emerson* analysis of the use for profit was unnecessary to reach the decision in the case.

Justice Story correctly decided *Whittemore v. Cutter* and *Sawin v. Guild* under the common-law doctrine of trespass on the case. Evidence that a patent grants property rights is obtained from the Patent Act of 1793, section 1, which states that any person who "shall desire of obtaining an exclusive property" in an invention may be granted letters patent for the invention.[648] In *Sawin v. Guild*, Justice Story stated that to prohibit the seizure and sale by authorities of the state of the patented machines would create a "great public mischief" because the patentee could "lock up his whole property, however, great, from the grasp of creditors, by investing it in profitable patented machines."[649] Such a possibility available to the patentee would be "against the whole policy of the law, as to the levy of *personal property* in execution."[650] Therefore, the exclusive interest granted by the patent was property, and Justice Story clearly viewed it as personal property, which could be seized in execution of a judgment.[651] The cause of action for infringement of the exclusive rights in an invention "is only a tort"[652] and the issue to be considered is whether the defendant "ever trespassed on any intangible right created by the patent."[653] The plaintiff, then, in 1813 must plead trespass on the case[654] because trespass *vi et armis* required an injury resulting from the "direct and immediate force or violence against the plaintiff or his property,"[655] and most forms of action were not abolished until 1832 to 1833.[656] The cause of action of trespass on the case would be brought for consequential injuries to the plaintiff resulting from the negligent activity of the defendant.[657] Negligence is the failure to exercise care and such failure is subject to liability only if the law imposes the duty of care. Section 5

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648. *See* Act of February 21, 1793, *supra* note 639, at 320.

649. Sawin v. Guild, 21 F. Cas. 554, 555 (C.C.D. Mass. 1813) (NO. 12,391).

650. *Id.* (emphasis added)

651. At common law, the inventor possessed interest in his invention but not an exclusive interest. Exclusive interest in the invention "did not exist at common law, and the rights, therefore, which may be exercised under it cannot be regulated by the rules of the common law." Gayler v. Wilder, 51 U.S. (10 How.) 477, 494 (1850). Further, "no rights can be acquired in [the invention] unless authorized by statute, and in the manner the statute prescribes." *Id.* Thus, the exclusive interests in the invention are defined by statute and the exercise of those rights must conform to the language of the statute. However, where the statute is silent, such as in the meaning of make, use, sell, the courts must turn to either common law or impose their own interpretation.

652. United States v. Berdan Fire-Arms Mfg. Co., 156 U.S. 552, 566 (1895).

653. *Id.* at 565.

654. *See* Byam v. Bullard, 4 F. Cas. 934 (C.C.D. Mass. 1852) (NO. 2,262) (stating that the "patentees and their assignees . . . bring actions on the case, to recover damages for making, using, or selling the thing").

655. BLACKS LAW DICTIONARY 1504 (6th ed. 1990).

656. *See* 2 J. H. BAKER, AN INTRODUCTION TO ENGLISH LEGAL HISTORY 60 (1979).

657. *See id.* at 345.

of the Patent Act of 1793 imposed the duty of care in defining the damages for infringement as: "if any person shall make, devise and use, or sell the thing so invented . . . without the consent of the patentee" then the offender shall pay an amount no less than "three times the price, for which the patentee has usually sold" the patented invention.[658] Thus, the alleged infringer is under a positive duty to seek a license from the patentee before he may "make, devise and use, or sell" the invention. Failure to determine whether a patent existed for an invention constituted negligence sufficient to find for the plaintiff in a cause of action for trespass on the case.

The language of the statute gave Justice Story considerable latitude in determining if indeed infringement had occurred. Section 6 of the Patent Statute of 1793 states that "the defendant in such action shall be permitted to plead the general issue"[659] which allows the defendant to "explain the circumstances in evidence to the jury."[660] The evidence that may be presented must relate to the validity of the patent. Thus, while the statute does not impose a requirement to intend to infringe the patent, it does impose a duty to know whether the invention was already patented. The statement that "lack of knowledge by a party of the existence of the patent rights does not excuse his infringement"[661] is technically correct, but it is incorrect to conclude that patent infringement is a "creature of statute and should be governed by statute."[662] As a result, Justice Story was correct in availing himself of the interpretation of "make, use, sell" in determining whether the defendant should be liable for infringement.

To argue that infringement of the exclusive rights of the patentee and the cause of action to obtain a remedy are strictly creatures of statute, and not common law,[663] is simply wrong. In 1813 the cause of action for infringement of a patent was by way of trespass on the case, and was clearly stated as such in the Patent Act of 1793.[664] The cause of action for infringement remained the tort of trespass on the case[665] until 1952,[666] when the statute was changed to specify that the cause of action is to be brought before the Federal Court as a civil action. Nevertheless, the cause of action for

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658. Act of February 21, 1793, *supra* note 639, at 322.

659. *Id.*

660. BAKER, *supra* note 656, at 340.

661. Bee, *supra* note 638, at 365.

662. *Id.*

663. *See id.*

664. Specifically, the Patent Act of 1793 stated that damages "may be recovered in an action on the case founded on this act." *See* Act of February 21, 1793, *supra* note 639, at 322.

665. The Patent Act of 1870 stated that: "damages for the infringement of any patent may be recovered by action on the case in any circuit court of the United States." Act of July 8, 1870, ch. 230, 16 Stat. 198, 207 (1870) (the act is entitled: An Act to revise, consolidate, and amend the Statutes Relating to Patents and Copyrights).

666. The Patent Act of 1952 states that: "[a] patentee shall have remedy by civil action for infringement of his patent." The Patent Act of 1952, Pub. L. No. 82-593, § 281, 66 Stat. 792, 812 (H.R. 7794).

infringement of a patent is a tort,[667] which is a cause of action established in common law, not statute. This distinction was clearly recognized by Justice Story in *Whittemore v. Cutter* when he stated that "a party relying on an action given by a statute must bring himself within the provisions of the statute"[668] and "where, as in the present case, the law is remedial, it should receive a liberal construction, to effectuate the intentions of the legislature."[669] The patent statute was remedial; it did not specify the cause of action for infringement, but rather only defined what actions constituted infringement. These characteristics of the Patent Act remain unchanged to this day.

A second theory offered to explain Justice Story's development of the experimental use exception is that since no damages occur to the patent holder because of the experimental use, there can be no cause of action.[670] Specifically, this theory requires that for the patentee to support an action for infringement there must both injury and damage.[671] Justice Curtis recognized that this theory was "the principle proceeded upon by" Justice Story.[672] Thus, if there is no damage there can be no cause of action. The absence-of-damage theory developed by Justice Story was well-engrained into patent law by the late nineteenth century.[673]

In *Whittemore v. Cutter*, the defendant advanced the theory that the "making of a machine cannot be an offence, because no action lies, except for actual damage[s]" and no damages exist for an "infringement by making a machine."[674] Justice Story rejected this theory and stated, "where the law gives an action for a particular act, the doing of that act imports of itself a damage to the party."[675] The position assumed by Justice Story was that every infringement of a right causes some damage, even if that damage is nominal. In dictum, Justice Story in *Sawin v. Guild* reiterated his earlier position that the "making must be with an intent to infringe the patent-right, and deprive the owner of the lawful rewards of his discovery."[676] As to what the making of a patented machine for the purposes of "philosophical experiment" has to do with a cause of action for patent infringement due to the sale of protected machinery at a sheriff's sale remains unclear to this day. Evidently, Justice Story felt compelled to finish molding his newly created experimental use exception even if he had to do it in dictum. Bee erroneously concludes that the absence-of-damages theory was specifically rejected by

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667. *See* Honeywell Inc. v. Metz Apparatewerke, 509 F.2d 1137, 1141 (7th Cir. 1975) (stating that "[i]nfringement of a patent is a tort").

668. Whittemore v. Cutter, 29 F. Cas. 1120 (C.C.D. Mass. 1813) (No. 17,600).

669. *Id.*

670. Under the doctrine of *injuria absque damno*, even though the patent holder's right to exclude has been violated he has suffered no damage recognizable under the law. *See* Bee, *supra* note 638, at 365.

671. *See* Byam v. Bullard, 4 F. Cas. 934, 935 (C.C.D. Mass 1852) (No. 2,262).

672. *Id.*

673. *See* ROBINSON, *supra* note 547, § 898.

674. Whittemore v. Cutter, 29 F. Cas. 1120, 1121 (C.C.D. Mass. 1813) (No. 17,600).

675. *Id.*

676. Sawin v. Guild, 21 F. Cas. 554, 555 (C.C.D. Mass. 1813) (NO. 12,391).

Justice Story in all infringement cases because there would always be at least nominal damages.[677]

The criticism of the absence-of-damage justification is that it is unsound because it directly contravenes the statutory language and the holding in *Whittemore v. Cutter*.[678] If the infringer had licensed the invention from the patent holder, or had purchased the invention with the clear understanding that the infringer was going to use the machine in experiments then the patent holder would have a substantial pecuniary gain for which the infringer is liable.[679] In fact, the language of the Patent Act of 1793 provided a statutory counter to Justice Story's absence-of-damages theory because damages shall be "at least equal to three times the price, for which the patentee has usually sold or licensed" the invention,[680] indicating that the minimum damages must exceed nominal damages. Of course, it is easily recognized that more than nominal damages may occur as the result of patent infringement under the guise of experimental use.

The experimental use exception is readily harmonized with both the statutory language and with the absence-of-damages theory articulated by Justice Story and supported by Justice Curtis (if the underlying assumption is correct).[681] To determine if the assumption that there is no damage is correct, it is necessary to return to the cause of action for infringement. Infringement occurs where the person shall "make, devise and use, or sell the thing so invented"[682] and fails to determine whether the device is, indeed, patented. In *Whittemore v. Cutter* and *Sawin v. Guild*, Justice Story took the position that when there is infringement of the exclusive rights of the patentee, then there must be at least nominal damage. Before this point is reached, however, it must be demonstrated that infringement actually occurred. Here, Justice Story set the standard that the making must be with "an intent to infringe the patent-right, and deprive the owner of the lawful rewards of his discovery."[683]

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677. *See* Bee, *supra* note 638, at 366.

678. *See generally* Bee, *supra* note 638.

679. *See* Dowagiac Mfg. Co. v. Minnesota Moline Plow Co., 235 U.S. 641, 648 (1915) (stating that the "normal measure of damages was the value of what was taken"); Duplate Corp. v. Triplex Safety Glass Co., 298 U.S. 448, 457 (1936) (stating that the "wrongdoer must yield the gains begotten of his wrong").

680. Act of February 21, 1793, *supra* note 639, at 322. In the Patent Act of 1832, this language was changed to reflect the possibility of a de minimus actual damages: "it shall be in the power of the court to render judgment for any sum above the amount found by such verdict as the actual damages . . . not exceeding three times the amount thereof." Act of July 4, 1836, *supra* note 640, at 123. The language was changed to "the court *may* enter judgment thereon for any sum above the amount found by the verdict as the actual damages . . . not exceeding three times the amount of such verdict" in the Patent Act of 1870. See Act of July 8, 1870, ch. 230, 16 Stat. 198, 207 (1870) (emphasis added) (the act is entitled: An Act to revise, consolidate, and amend the Statutes relating to Patents and Copyright*s*). By 1952, the language specifying the level of damages read: "in no event less than a reasonable royalty for the use made of the invention by the infringer." The Patent Act of 1952, Pub. L. No. 82-593, § 284, 66 Stat. 792, 813. The damage specification of the Patent Act has remained essentially the same since 1952. *See* 35 U.S.C. § 284 (1994 & Supp. IV 1999)).

681. In *Byam v. Bullard*, Justice Curtis stated that he doubted "whether the assumption is correct, that in such cases there is no damage; yet if the assumption be correct, I think the inference is sound that no action lies." Byam v. Bullard, 4 F. Cas. 934, 935 (C.C.D. Mass 1852) (No. 2,262).

682. Act of February 21, 1793, *supra* note 639, at 322.

683. Sawin v. Guild, 21 F. Cas. 554, 555 (C.C.D. Mass. 1813) (NO. 12,391).

Thus, even if the person was fully aware that the invention was patented, he may make and use it unless there is an intent to "deprive the owner of the lawful rewards of his discovery."[684]

It has been argued that Justice Story believed that inaction of Congress to create an experimental use exception in the Patent Act was simply no reason for there not being one.[685] This position ignores the need of the courts to render justice, and not just blindly follow narrow interpretations of the statutory language. It is quite likely that Justice Story simply realized that the clear language of the Patent Statute of 1793 forced the courts to decide patent infringement cases unjustly.

Consider the following cases: the patentee does not exploit his invention patented for profit; the accused infringer makes a single copy of the invention patented for exhibition without using or selling the copy;[686] the accused infringer makes the invention patented strictly for experimental purposes; or the patentee admits that there "is no evidence of actual damage" but requests "damages either to the full value of the expense of making the machine, or of the price, at which such a machine might be sold."[687] Where the injury to the patentee is nominal or nonexistent, it would be unjust to force the accused infringer to "pay to the patentee, a sum, that shall be at *least* equal to three times the price, for which the patentee has usually sold"[688] the invention. While the language of the statute is clear in defining the damages for infringement and the clarity with which the statute speaks on the irrelevance of knowledge of the existence of a patent to determination of infringement affords no mistake, Justice Story found great latitude in the language defining what actions constituted infringement. To avoid the embarrassment to his court of having to award no less than triple the price of the invention patented to a plaintiff who clearly admitted that he was not injured or suffered damage, Justice Story created the exception that if there is no damage, then there is no cause of action. This is the correct result. It is evidence of the considerable legal genius of Justice Story that he so clearly saw such an opening in the otherwise impenetrable wall, created by the Patent Act, around the rights of the patentee. By utilizing that opening, Justice Story did not allow the Patent Act to force the courts to render unjust decisions in a narrowly defined set of patent infringement cases.

To illuminate the application of the experimental use exception to the Patent Act, a number of cases have been analyzed[689] and carefully characterized.[690] To clarify the exception for our purposes,

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684. *Id.*

685. *See* Bee, *supra* note 638.

686. Standard Measuring Mach. Co. v. Teague, 15 F. 390, 393 (C.C.D. Mass 1883) (stating that in such a case "the evidence of infringement of th[e] patent [is] insufficient to require us to compare the inventions with each other").

687. Whittemore v. Cutter, 29 F. Cas. 1123, 1125 (C.C.D. Mass 1813) (No. 17,601).

688. Act of February 21, 1793, *supra* note 639, at 322 (emphasis added).

689. *See* Bee, *supra* note 638.

690. *See* Ronald D. Hantman, *Experimental Use as an Exception to Patent Infringement*, 67 J. PAT. & TRADEMARK OFF. SOC'Y 617 (1985).

it seems profitable to catalogue these cases and review their common threads.[691]

ii. Experimental Use Exception Accepted as Defense

In the following cases, the court accepted the experimental use exemption as a defense to infringement. In the first case, the defendant experimented with patented dyes in the course of developing the manufacturing techniques for metal harness trimmings coated with celluloid.[692] The experiments with the dies were unsuccessful, and were shortly abandoned. The court stated that "[i]t is a technical infringement, and is sufficient to authorize an injunction restraining their future use; but no reference will be ordered, as no damage or profits have been shown or suggested."[693] Thus, liability for infringing the patent appears to have been excused because no profit was accrued to the infringer whilst using the infringed invention.

In the second case the defendant experimented with a number of marble making machines before going into production.[694] The Plaintiff held a patent on one of the machines, designed for making children's marbles, which was tested by the defendant. This machine was abandoned in favor of a machine that was not covered by the plaintiff's patent. The court held that there was no infringement because the defendants tested the offset rolls, required for making the marbles, "for a brief period before going into commercial production" while they decide upon which offset rolls to use in production and the "marbles were not commercially sold."[695] In both *Albright* and *Akro Agate,* the court clearly ignored the fact that the experimentation was conducted in the course of business. Also, in both cases, the experimentation was clearly not "for the sole purpose of gratifying a philosophical taste, or curiosity, or for mere amusement."[696] Therefore, the decisions in these cases cannot be squared with, what was at that time, considered established law.[697]

In the third case, the defendant had built a radio direction-finding and position-indicating device based upon technology that was covered by a patent held by the plaintiff.[698] One of the devices was

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691. The courts have employed the experimental use exception in only a small number of cases since it was first articulated in 1813. A brief review of some of the pertinent cases permits a determination of the scope of the exemption and how courts will likely apply it in the case of assessing property rights in genetically modified plants. The author acknowledges that the following brief review depends largely upon the framework developed by both Ronald Hantman and Richard Bee.

692. *See* Albright v. Celluloid Harness-Trimming Co., 1 F. Cas. 320 (C.C.D.N.J. 1877) (No. 147).

693. *Id.* at 323.

694. *See* Akro Agate Co. v. Master Marble Co., 18 F. Supp. 305 (D.C.N.D.W.Va. 1937).

695. *Id.* at 333.

696. Poppenhusen v. Falke, 19 F. Cas. 1048, 1049 (C.C.S.D.N.Y. 1861) (No. 11,279). The precise articulation of the experimental use exception doctrine by Judge Shipman was that: "[i]t has been held, and no doubt is now well settled, that an experiment with a patented article for the sole purpose of gratifying a philosophical taste, or curiosity, or for mere amusement, is not an infringement of the rights of the patentee." *Id*.

697. *See id.*

698. *See* Dugan v. Lear Avia, Inc., 55 F. Supp. 223 (D.C.S.D.N.Y. 1944).

eliminated from consideration in the case[699] because it appeared that the "defendant built that device only experimentally and that it has neither manufactured it for sale nor sold any."[700]

iii. Experimental Use Exception Not Accepted as Defense

In the following cases the court refused to accept the experimental use exemption as a defense to infringement. In the first case the defendant used a patented process for creating shaped articles of vulcanized rubber.[701] Previous attempts to analyze this case either misstated or ignored the process that was protected by patent (in this case understanding the patented process is essential to understanding how the court handled the experimental use exception). The court rejected the experimental use defense because the defendant had infringed the patented invention "as a matter of business, [and] where the product of that experiment has been thrown into the market, to compete with the products of the plaintiff."[702] In its analysis, the court stated that when "use [is] merely for experiment, and not with a view to profit; and when there has been no profit and no sale, it will not make a party liable, because the patentee would not be injured by it."[703]

The second case in which the court rejected the experimental use defense involved the infringement of a patent held by Otto P. Meyer for creating shaped articles of vulcanized rubber.[704] Apparently, defendants were once employed by the plaintiff and later left Poppenhusen to form their own manufacturing company, the New York Gutta Percha and India Rubber Vulcanite Company. The court rejected the experimental use defense because the defendants were rivals of the plaintiff "in the very business to which his patents relate;"[705] and they "[were] perfectly familiar with his patents and processes, having formerly been in his employ in manufacturing articles under his patents."[706] The court stated that "it can hardly be necessary for the [defendants] to experiment with the [plaintiff's] inventions in order to perfect their own."[707]

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699. It is interesting to note that even without the experimental use exception to exclude one of the devices, the court states that since the claims of the plaintiff's patent are invalid, it must render judgment for the defendant. *See id.* at 230.

700. *Id.* at 229.

701. *See* Poppenhusen v. New York Gutta Percha Comb Co., 19 F. Cas. 1059 (C.C.S.D.N.Y. 1858) (No. 11,283).

702. *Id.* at 1063.

703. *Id.*

704. *See* Poppenhusen v. Falke, 19 F. Cas. 1048 (C.C.S.D.N.Y. 1861) (No. 11,279).

705. *Id.* at 1049.

706. *Id.*

707. *Id.*

In the third case in which the court rejected the experimental use exception defense, the defendants claimed that they experimented with a patented process for tanning skins in excess of nine months to determine the desirability or utility of the process.[708] Given the extensive time frame over which the defendants "experimented" with the process, it was safe to assume that the use of the protected process was in the course of ordinary business with the intent to profit from the use of the invention and in competition with the patentee.[709]

In the next three cases, the court rejected the experimental use exception defense because the infringement clearly took place in the course of ordinary business. In the first of these, the defendant used a patented process for three years,[710] but claimed he was only experimenting with the machines to identify possible improvements. In the second, defendant used a patented process for three to four months[711] and attempted to defend the action as merely experimental. In the third case, the defendant assembled six disk water meters[712] according to a patent owned by the plaintiff, and one of the meters was sold by the defendant to the plaintiff.[713] The court rejected the experimental use defense because the evidence demonstrated an intention to infringe the patent.[714] In an additional case, the defendant claimed the experimental use exception because the use of the protected process was only incidental to their search for a new agent and, therefore, was not a commercial operation.[715] Because some of the pearl essence resulting from the experiments was sold, the court rejected the defense.[716]

In another case, the defendant built the circuit absent the tubes that were packaged with the circuit for sale but were not plugged into their sockets in an attempt to circumvent the patent protection on an electronic oscillator circuit.[717] Immediately before the packaging, the vacuum tubes were plugged into their appropriate sockets to determine if the circuits would function properly.[718] The

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708. *See* Clerk v. Tannage Patent Co., 84 F. 643 (3d Cir. 1898) (holding that in the absence of actual permission from the patent holder the expression of a willingness to sell a license under the patent did not confer the privilege to use the process of the patent to experimentally test its desirability or utility).

709. *See* Poppenhusen v. New York Gutta Percha Comb Co., 19 F. Cas. 1059, 1063 (C.C.S.D.N.Y. 1858) (No. 11,283).

710. *See* Cimiotti Unhairing Co. v. Derboklow, 87 F. 997, 999 (C.C.E.D.N.Y. 1898).

711. *See* United States Mitis Co. v. Carnegie Steel Co., 89 F. 343, 346 (C.C.W.D. Pa. 1898).

712. *See* Thomson Meter Co. v. National Meter Co., 106 F. 519, 526 (C.C.S.D.N.Y. 1900).

713. *See id.* at 541.

714. *See id.* at 542.

715. *See* Pairpearl Prod., Inc. v. Joseph H. Meyer Bros., 58 F.2d 802, 804 (D.Me 1932).

716. *See id.*

717. *See* Radio Corp. of America v. Andrea, 15 F. Supp. 685, 686 (E.D.N.Y. 1936).

718. *See id.*

defendant claimed that this was merely experimental, and hence the patent was not infringed. In rejecting this argument the court observed: "one can well understand that the law, not concerning itself with trifles, would ignore a mere casual appropriation for amusement or even scientific purpose."[719] Upon modifying on other grounds,[720] the Court of Appeals said, with respect to the question of experimental use, "[t]he tests were made to see if they were marketable—a commercial and hence an infringing use."[721]

The next case in which the experimental use defense, that the patented anchors were used for experimental purposes, was rejected the court said that the defendant's "experiments were evidently not made for philosophical or amusement purposes but were made in connection with his business as a manufacturer and salesman of anchors."[722] In the last relevant case, the defendant argued that he experimented with a patented method for freezing fish on board a fishing vessel at sea to determine the desirability of the method.[723] The defense was rejected because the defendant used the patented process while the vessel was engaged in commercial fishing operations.[724]

By analyzing the cases in which the experimental use exception defense has been raised it can be concluded that the exception is not applicable when there has been a business purpose or profit motive associated with the experimental use. If the experimental use is for personal convenience then the exception is not a valid defense to patent infringement.

The previously reviewed cases left open the question of whether the interest of the patent holder must always take the form of money in assessing damages. In 1982, this question was resolved in a case in which the defendant made and distributed, without remuneration, substantial quantities of a drug that infringed the plaintiff's invention.[725] The court stated that in order to qualify for the experimental use exemption there must be no intended commercial use of the invention[726] and that monetary remuneration by sale of the invention within the United States was not a necessary condition to finding infringement.[727] The cases indicate that if the research is motivated by a

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719. *Id.* at 687.

720. *See* Radio Corp. of America v. Andrea, 90 F.2d 612, 614 (2d Cir. 1937) (holding that even though the tubes were not plugged in to make the complete circuit, which was patented, the sale of the circuit constituted infringement).

721. *Id.*

722. Northill Co. v. Danforth, 51 F. Supp. 928, 929 (N.D. Cal. 1942), *modified on other grounds*, 142 F.2d 51 (9th Cir. 1944).

723. *See* Spray Refrigeration Co. v. Sea Spray Fishing, Inc., 322 F.2d 34, 36 (9th Cir. 1963).

724. *See id.*

725. *See* Pfizer, Inc. v. International Rectifier Corp., 217 U.S.P.Q. (BNA) 157, 160 (C.D. Cal. 1982) (rejecting the defendant's argument that because none of the drug was ever sold in the United States his actions were exempted by the experimental use doctrine).

726. *See id.* at 161.

727. *See id.* at 158-60.

commercial purpose, then the experimental use exception defense is not available.[728]

The experimental use exception to the Patent Act was developed from judicial dictum. The experimental use exception as it now stands could be overruled in favor of obtaining the same results directly from the statutory language, and from the rules relating to patent law. Specifically, the extenuating circumstances of experimental use would be weighed when deciding the amount of damages to be awarded. Alternatively, the judicially constructed experimental use exception could be codified within the Patent Act itself.

The patent laws of the United States[729] grant a monopoly to inventors for a period of twenty years from the date of filing the application.[730] The purposes of granting the monopoly are to promote economic activity by encouraging the quest for new ideas and to encourage full public disclosure of the new ideas. When an infringement of the patent monopoly occurs is defined by statute: "whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent."[731] The patent holder "shall have remedy by civil action for infringement of his patent."[732]

The rights of the patent holder are clear and unambiguous in that he has "the right to exclude others from using, offering for sale or selling throughout the United States."[733] However, the experimental use exception, while being very narrow, limits these rights. The statutory rights of the patent holder may necessarily be limited in order to effect the purpose of the Patent Act itself.

Section 101 of Title 35 provides that "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any *new and useful improvement thereof*, may obtain a patent therefore."[734] Also, Title 35 provides that the term process "includes a new use of a known process, machine, manufacture, composition of matter, or material."[735] Therefore, Title 35 contains within its statutory language the basis for formulating the experimental use exception. This is

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728. *See* Roche Prod., Inc. v. Bolar Pharm. Co., 733 F.2d 858 (Fed. Cir. 1984), *cert. denied*, 469 U.S. 856 (1984). The Court of Appeals for the Federal Circuit rejected the defendants experimental use exception defense because experimentation in the guise of scientific inquiry is not covered "when that inquiry has definite, cognizable, and not insubstantial commercial purposes." 733 F.2d at 863.

729. *See* 35 U.S.C. §§ 1-376 (1994).

730. *See* 35 U.S.C. § 154(a)(1)-(2) (1994 & Supp. IV 1999).

731. 35 U.S.C. § 271(a) (1994).

732. 35 U.S.C. § 281 (1994).

733. 35 U.S.C. § 154(a)(1) (1994 & Supp. III 1997).

734. 35 U.S.C. § 101 (1994) (emphasis added).

735. 35 U.S.C. § 100(b) (1994).

so because section 283 provides that the court may "grant injunctions in accordance with the principles of equity to prevent the violation of any right secured by patent,"[736] and that the statute also provides damages for the violation.[737] If the experimental use exception were precluded by the statutory language of Title 35, then new and useful improvement patents would be prevented by section 283, which would frustrate section 101 of Title 35 that explicitly provides for new use and useful improvement. The only way to have a new use and useful improvement is to allow experimentation with an existing invention (which is presumably protected by patent). If the experimental use exception were anticipated by Title 35, then the "right to exclude" language found in section 154(a)(1) cannot be interpreted to mean the "exclusive right" but must be interpreted to be the "right to exclude" limited by the privilege of others to the experimental use of the invention.[738] Experimental use of the patented invention is the only way by which new and useful improvements may be made.[739]

It might be argued that if the statutory language of Title 35 were to be interpreted to mean that an experimental exception must exist, then a scientific researcher could openly infringe a patented invention to develop improvements. The researcher would then replace the patented invention in the marketplace and redirect the infringed patent holders profits to himself. This response is exactly that contemplated by the patent system. The open, public disclosure of the invention is the price that the inventor must pay in exchange for the "right to exclude," and it opens the inventor to the very real risk that his invention may be made obsolete.

Given the importance of experimental work to the developments in biotechnology,[740] and in particular agricultural biotechnology,[741] an experimental use exception to Title 35 protection is a necessity for the continued growth of our economy. Of course, reasonable royalties might be awarded to the patent holder.[742] The provisions of the exemptions would include: (1) permitting the

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736. 35 U.S.C. § 283 (1994). It is of interest for the current discussion to note that section 283 also contains the language "on such terms as the court deems reasonable."

737. *See* 35 U.S.C. § 284 (1994).

738. It is recognized that the stated purpose of changing the statutory language from "the exclusive right" to "the right to exclude" was to make the meaning of the rights granted by the patent clearer by conforming the statutory language to that used in case law. The language "the exclusive right" is ambiguous when applied in certain situations. *See* Bee, *supra* note 638, at 360-61. It was argued then that the ambiguity was resolved by judicial decision and codified in the Patent Act of 1952, 35 U.S.C. §§ 1-293 (1952). Stefan A. Riesenfeld, *The New United States Patent Act in the Light of Comparative Law I*, 102 U. PA. L. REV. 291 (1954). The argument continues that the Patent Act of 1952 cannot have contemplated the experimental use exception because the granting clause of the Patent Act of 1952 "reaffirms the older decisions which governed while the experimental use exception was being developed." *See* Bee, *supra* note 638, at 361.

739. *See* Irving N. Feit, *Biotechnology Research and the Experimental Use Exception to Patent Infringement*, 71 J. PAT. OFF. SOC'Y. 819, 836 (1989).

740. *See* Merges, *supra* note 598, at 1053.

741. Monsanto estimates that it takes a period of ten years and approximately $300 million to create a commercially viable product of genetically modified seeds. *See* Weiss, *supra* note 449, at A1.

742. *See* Feit, *supra* note 739, at 258.

testing of a protected invention to determine the veracity of the claim; (2) permitting experimentation for the purposes of designing around the invention or improving the invention;[743] and (3) permitting testing of the invention in preparation for entering into a license agreement with the seed manufacturer.[744] An unfettered experimental use exception doctrine would invite abuse. Therefore, the ordinary customer of the protected invention should not be exempted.[745] In addition, a researcher who used the protected invention in other experiments must not be exempted[746] because he would be the intended user of the invention.

With regard to the second issue surrounding the Cameo apple, the experimental use exception also applies. The experimental use exception was developed for inventions patented under what is now section 101 of Title 35 (of the United States Code). Since the Plant Patent Act of 1930 is now part of Title 35, and since plants may be patented under section 101, then it is reasonable that the experimental use exception applies to plants, whether a patent was granted under section 101 or under section 161.

If plant cells of a patented plant (the analysis is independent of whether the patent was granted under section 101 or section 161) spontaneously mutate to express a characteristic different than those exhibited by the patented plant, and if those cells are then harvested, a new variety of plant comes into being. In the propagation of the new variety there is no intent to profit from the use of the invention patented, rather it is the characteristics of the new variety that are seen to be of value. There is neither injury nor damage to the patentee because the patentee could not have anticipated the new variety, and could not have gained a financial reward for the new variety. The patentee has already profited from the sale of the ancestral plant; there was no intended commercial use of the invention because the new variety arose spontaneously. Even if there was human intervention that eventually led to the spontaneous mutation, there can be no intent to make that particular mutation commercially viable because it cannot be known *a priori* whether the characteristics of the new variety are of commercial interest. While any one of these reasons is sufficient to invoke the experimental use exception, the strongest reason to invoke the doctrine is simply that the research farmer or plant breeder cannot know if and when the cells of the ancestral plant will mutate to give rise to the new variety. That is, there can be no intent to use the invention patented for profit because of the lack of knowledge if and when the mutation will occur.

If the plants are of a variety long cultivated and developed by the research farmer, and if these plants become contaminated by a transgene, then the experimental use exception must be invoked. While the research farmer is developing his variety for the market, his intent is to develop a variety suitable for his local clime and soil conditions. It is not of interest to use the invention patented, the transgene, because if it was the research farmer would purchase the technology-use license and the transgenic seeds from the patentee. Indeed, following Justice Story's lead, it would be a manifest injustice to allow the patentee to contaminate the plants of the research farmer and then try to claim

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743. *See* Eisenberg, *supra* note 375, at 1078.

744. *See* HOUSE COMM. ON THE JUDICIARY, TRANSGENIC ANIMAL PATENT REFORM ACT, H. R. REP. NO. 888, 100th Cong., 2d Sess. 40, 51 (1988).

745. *See* Eisenberg, *supra* note 375, at 1085.

746. *See id.*

that the sale of a crop containing the transgene was an injury to the patentee. Further, the cases reviewed above involve the active procurement of the invention patented by the accused infringer. In this case, the research farmer is not actively engaged in procuring and experiment with the transgene, rather the transgene literally "fell from the sky." Therefore, the experimental use exception must be available to the research farmer whose land is contaminated with the transgene.

5. Use of Farm Cooperatives as Research Institutions

Under the current structure of the seed market and statutory protection mechanisms, the farmer's only choice, save for a limited number of cases, is to purchase seed from commercial seed manufacturers. The farmer must return to the commercial seed manufacturer each year because either the plant variety is a hybrid, which loses vigor upon planting the progeny seed, or is a genetically modified variety, requiring a yearly renewal of the technology-use license. The seed manufacturer in turn dictates the nature of the rights which the farmer has in his own property to the extent that the farmer must effectively license the use of his own land and crop from the seed manufacturer in exchange for the privilege of planting the protected seed. The current market and legal structure need not be the only structures available to the farmer. An alternative structure can be built within existing cooperative marketing associations.

Farm marketing associations were first created in the early years of the twentieth century to provide a vehicle by which individual farmers could lower their risk to fluctuations in the commodities market. By pooling within the farm marketing association, the individual farmer could avail himself of the results, which accrue from the efforts of a large organization that would not be available to him if he acted alone.[747] In the absence of the marketing association, the individual farmer is unable to act effectively in the market. This occurs for a number of reasons: he is unable to effectively bargain for a fair price or a reduction in his risk exposure; he is exposed to a high transaction cost, as is the purchaser because the purchaser must negotiate a large number of small contracts (therefore, the purchaser must pay a lower price for the commodity to recoup the transaction costs when he sells that commodity on an exchange or into the final product market); he is required to bear the risk of fluctuations in market price and demands; and he must sell his crop when and where the local market requires him to sell.[748]

By pooling operating and marketing expenses, contract negotiations, and management of risks associated with market fluctuations, the individual farmer is able to increase his profit margin and increase the financial stability of his farm enterprise.[749] The most important role of the marketing

747. *See* Chris L. Christensen, *Pooling as Practiced by Cooperative Marketing Associations*, 14 U.S.D.A. MISC. PUBL. 1, 2 (1929).

748. *See id.*

749. For an economic analysis of a wheat pool, a type of farm marketing association, see Won W. Koo, William Nganje, D. Demcey Johnson, Joon Park & Richard Taylor, *Economic Analysis of The Proposed North Dakota Wheat Pool-Summary*, AG. ECON. REPORT NO. 410, (25 January 1999) (the report is available from the Department of Agricultural Economics, P.O. Box 5636, North Dakota State University, Fargo, N.D.). Also, a summary of Report 410 is available online. *See* Won W. Koo, William Nganje, D. Demcey Johnson, Joon Park & Richard Taylor, *Economic Analysis of The Proposed North Dakota Wheat Pool-Summary*, AG. ECON. REPORT NO. 410, (25 January 1999) *at* http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=1172.

association is to act to reduce the financial risks associated with market fluctuations and expansion of the market area and type of products.[750] The individual farmer has neither the financial resources nor the time and skill to expand his market through exploitation of a new market product and policy. However, the market association can do so and can minimize market risks by pooling the resources of a large number of individuals.

The agricultural marketing associations may effectively expand their control of the market by using the pooled resources to develop plant varieties, including transgenic varieties, suitable for their locale, or export to regions of comparable clime and soil conditions.[751] Such investment in plant variety development can occur through two distinct mechanisms. The association may invest the pooled resources to support the efforts of a group of farmers who continue to develop varieties for their locale, or the pooled resources may be used as consideration for contracting the efforts of university schools of agriculture.[752]

a. Support of Farmers as Researchers

Under the first model the association would either contract for the services of a small group of farmers or would coordinate the services of a large number of farmers who would pool select seeds from each year's crop for planting in the next crop cycle. Under the model of contracting for the services of a small group of farmers, the association would assume the risk of fluctuations in the success of a particular crop in exchange for using the results of that crop for future planting cycles. The individual farmer who has and continues to develop a particular variety of plant would promise to sell his entire crop, or that portion required by the association, as consideration for a contract under which the association would provide operating costs for the production of the crop and a premium for any portion of his crop used for seed in the next growing cycle.

Farmers who engage in the practice of selecting plants for continued propagation in subsequent growing cycles are bona fide researchers. The individual research farmer engaged in the program would promise that his entire crop, or that fraction sufficient to satisfy the needs of the association, will be made available to the association at the time of harvest for a fixed price. The price would represent a premium above market value of seeds sold for non-reproductive purposes to reflect the fact that seeds used for reproductive purpose command a higher price on the commercial market than

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750. *See id.* at 4.

751. The cooperative marketing associations have assisted their members beyond coordinating marketing efforts in other cases. Prominent amongst such efforts is the agricultural credit corporations established in the 1920's. *See* William H. Rowe, *Agricultural Credit Corporations Affiliated with Cotton Cooperative Marketing Associations*, 322 U.S.D.A. TECH. BUL. 1, 2 (1932).

752. The functioning and long term stability of farm marketing associations depends upon the level of cooperation between the members of the association. *See* Nicole Witwicki, Naomi T. Krogman & Harvey Brooks, *Theoretical Guidance on the Determinants of Success in Agricultural Marketing and Production Clubs*, RURAL ECONOMY STAFF PAPER 98-10 (1998), available at http://lipsey.re.ualberta.ca/STAFF-PAPERS/sp-98-10.pdf (the staff paper is published by the Department of Rural Economy, University of Alberta, Edmonton, Canada); John M. Staatz, *The Cooperative as a Coalition: A Game-Theoretic Approach*, 65 AGRICULTURAL ECONOMICS 1084-89 (1983); John M. Staatz, *A Game-Theoretic Analysis of Decisionmaking in Farmer Cooperatives*, *at* http://www.rurdev.usda.gov/rbs/pub/sr18/agame.pdf; Thomas W. Hertel, *Applied General Equilibrium Analysis of Agricultural and Resource Policies*, STAFF PAPER 99-2 (March 1999) *available at* http://ae761-e.agecon.purdue.edu/gtap/resources/ download/11.pdf.

the crop for non-reproductive purposes. That fraction of his crop that would not be required by the association would be purchased at a premium above the market price for a non-reproductive crop, but at a price below the price paid for that portion to be used for reproductive purposes.

This scheme would insulate the research farmer against the risk of a decline in demand while properly compensating him for the efforts expended in producing the seeds. Such an arrangement would shift most of the burden of the risk associated with production of seed for reproductive purposes from the research farmer to the association. Since the association has a large number of members, it has ready access to the information required to determine the amount of seed necessary for the following planting cycle. The research farmer would be motivated to produce seed for reproductive purposes for the association because of the premium above market value he would obtain for his crop. The members of the association would be motivated to purchase and use the seed produced by the research farmer for two primary reasons: first, the seed would presumably be available to the non-research farmer at a price substantially lower than the price commanded from the seed manufacturers; second, the seed would be of a variety which is optimized for the local clime and soil conditions.

Under this model, there would be no mechanism constraining either the research farmer or non-research member from saving seed for use in the next planting cycle. It is possible that such a result could be avoided by making continued membership in the seed pool contingent upon returning to the pool each year and purchasing seed. This restraint would still be to the benefit of the non-research farmer for the reasons just cited, and would benefit the association in the long term. Continued membership of the farmers would result in continued support of the research farmers and hence the plant genome would be continuously improved for the particular locale. Counterbalancing this is the possibility that the research farmer fails to be sufficiently vigilant to recognize and nurture new varieties or there is a cataclysmic failure of the research farmer's crop. Both of these risks are reduced or eliminated by using the services of multiple research farmers well distributed over the geographical area served by the cooperative marketing association. Continued vigilance on the part of the research farmer could be assured by requiring a showing of a superior crop for the location.

The restriction that non-research farmer return to the pool each year for his seeds could work to the detriment of the association in the long run. To recapture its market share in the geographical area controlled by the association, the seed manufacturers would be motivated to compete directly with the seed pool of the association. This could be done in one of two ways. First, the seed company could show that its seed was far superior to that produced by the association by contracting with non-research farmers who were members of the association to grow a competing variety on their farm. If the seed manufacturer's variety produced a crop sufficiently superior to that of the association such that the profit margin of the non-reproductive crop was favorable to the farmer, then the seed pool of the association would be broken by defection of members seeking superior product and a favorable profit margin. Second, the seed manufacturer could undercut the price for which the co-operative marketing association would sell its competing variety of seed. Because the association could not compete, then the seed pool could no longer afford to exist. In its efforts to eliminate the seed pool the seed manufacturer would have a strong motivation to engage in unfair competition and pricing.

It may be beneficial to the association if individual farmers saved seed for planting in the next crop cycle. The advantage exists in the increased probability of observing and propagating a superior

variety when there are a multiplicity of observers than if there was a minimum number of observers. Once a new superior variety was identified the machinery of the seed pool would lead to its rapid dissemination over the geographical area served by the association. The primary shortcoming of the seed pool based upon the selection efforts of research farmers is that neither hybrid nor transgenic varieties may be introduced into the seed pool of the association.

b. Coordination of Research Farmers

By coordinating the efforts of two or more research farmers, the association can introduce hybrid varieties into the available seed pool. Because these hybrid varieties are already adapted to the local clime and soil conditions, and because the costs of producing the hybrid variety is distributed between the members of the association, the hybrid variety would be genetically superior to varieties imported into the locale by the seed manufacturers and would be available at a price less than or competitive with varieties available from seed manufacturers.

Under this model, individual research farmers would be contracted to grow either elite or first generation hybrid varieties for cross-breeding and other research farmers would be contracted to conduct the steps required to produce the final hybrid variety. The association would be in the position to hire the expertise in plant genetics required to assist in the production of the hybrid varieties. While individual farmers may lack both the sophistication and resources required to produce hybrid varieties, the collective efforts coordinated by the association would almost certainly be sufficient to produce superior quality hybrid varieties. The non-research farmers would be motivated to return each year to the seed pool for two reasons: first, the hybrid vigor is not sustained past the first generation; second, the variety would be superior in quality and value to imported hybrid seed varieties. The research farmer would be encouraged to participate in the hybrid seed pool by the premium that his seed crop would command. Because the hybrid variety produced by the association would be well suited to the locale it would be superior to that available from the seed manufacturer. Therefore, the seed manufacturer may be disinclined to enter the geographical market area served by the cooperative marketing association.

Because there would be directed human intervention in producing the hybrid then the variety may be protected by Plant Variety Protection Act certification, a utility patent, or both. The association would be the patentee, and the patent or Plant Variety Protection Act[753] certificate would give the marketing association leverage to enter cross-licensing agreements or research contracts with commercial seed manufacturers. In addition, the association would be in the position to enter a patent pool with other agricultural marketing associations.[754] An overriding benefit of this particular construct would be that the association would directly control the intellectual property and the farmer has a voice in the policies underlying the control because of his ability to vote as a member of the association.

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753. *See, e.g.*, Julian M. Alston & Raymond J. Venner, The Effects of the U.S. Plant Variety Protection Act on Wheat Genetic Improvement, EPTD DISCUSSION PAPER NO. 62 (May 2000) *available at* http://216.15.202.3/docs/eptdp62.pdf. (The EPTD discussion paper is published by the International Food Policy Research Institute, Washington, D.C.).

754. The instance of ownership of intellectual property by an agricultural marketing association will be discussed below.

c. Cooperation Between the Cooperative Marketing Association and the Land-Grant University

The ultimate strength of the cooperative marketing association would be obtained when it has interests in intellectual property associated with genetically-modified plants. Clearly, individual farmers do not possess the resources to make genetically-modified plants. However, land-grant universities certainly possess the required technological expertise within their colleges of agriculture. The second model available to the cooperative marketing association for expanding its control over the production of seed is to establish a cooperative effort with the college of agriculture within the state land-grant university. Under this model, the marketing association would provide funding for research and development of genetically modified plants, and individual farmers could be contracted by the cooperative marketing association to provide land for planting the test varieties. In exchange for financial support from the cooperative marketing association, the university would provide the intellectual capital required to make the genetically-modified plants.

The revenue to fund the university research would initially be generated by levying each member of the cooperative marketing association an amount based on a function of the total acreage he has traditionally planted in the crop species and upon the deviation between his own average yield and the average yield from the maximum yield producer. When the new variety is actually produced, the initial price of the seed to each member will depend upon the difference between the average yield of the maximum producer and the average yield from the new variety. This assessment structure will shift the greater burden of the cost of the new variety onto those members who will profit the most from the new variety.

The cooperative marketing association bears a great deal of risk in funding research at a land-grant university. University research laboratories typically follow a common model: a single professor is at the head of the laboratory and the laboratory is staffed by a mix of postdoctoral research fellows and graduate students. Generally the graduate students far outnumber the postdoctoral fellows, and the graduate students work essentially independent of the postdoctoral fellows and the professor of the laboratory. Typically, the graduate students and postdoctoral fellows will report their progress from time-to-time to the other members of the laboratory by means of a semi-formal presentation. The university laboratory is typically organized such that an individual staff member will work on a single aspect of a particular topic and multiple topics may exist simultaneously within the laboratory.

While such organization of research is certainly conducive to development of an individual's work within an area of his or her primary interest, it is a recipe for disaster when an outside group wishes to fund work directed toward production of a specific product in an economically feasible manner. Several reasons exist for this observation. First, it is common for a given graduate student to start work on a particular research project only to either abandon or substantially modify the goals after a considerable amount of time has elapsed. Second, the head of the laboratory may be quite unaware of the details of the research project and even may be unaware of the possibly high risk of failure of a particular course of research. In fact, it is nearly impossible to start on a particular trajectory of research with knowledge of whether that particular trajectory will be successful and whether that particular trajectory will lead to the desired result in an economically reasonable amount of time. Third, the head professor, and most associate professors within the laboratory, do not actually engage in the practice of laboratory investigation. Also, new ideas for pushing the research forward will typically come from interactions between the postdoctoral fellows and graduate students rather than from the head of the laboratory. This means that control of the direction of research may not lie with

the head of the laboratory. Fourth, in order for all members of the laboratory to advance their careers, it is essential that their results, which are many times preliminary in nature, be presented in the forum of professional meetings and published either in the press or on the Internet. Further, informal discussions between members of separate laboratories may be, in many cases, essential to the progress of a research project because the discussions facilitate the transmission of knowledge and expertise between the parties to the discussions. These forms of information transmission within the academic research community facilitate progress and inhibiting such transmission of information hampers or completely halts progress in research. Conversely, such transmission of information may eliminate the proprietary interests in the results of the research. Worse, is the very real possibility that the information may be inadvertently transmitted to a competitor who may be able to lay proprietary claim to the results generated from that information.

To retain proprietary interests in the results of cooperative marketing association funded research at land-grant universities, the association must have a voice in the selection of both the faculty who conduct the research and the research staff of the laboratories that receive funds from the association.[755] Both the land-grant university and the laboratory receiving the funds would be motivated to accept these terms for several reasons. First, such cooperation would supply much needed funds to the university. Second, it would allow the university to hold interest in property to which it would not otherwise have access. Third, such arrangements would help the university fulfill its land-grant mission. Finally, it would allow the university to remain at the forefront of a rapidly developing technology. The cooperative marketing association would be motivated to insist upon such conditions by the need to protect its interests in the results of the research.

Because the cooperative marketing association would provide resources for the development of the genetically-modified plant, as would the university, both would be able to claim ownership interests in the results of the research. If the university retained exclusive interest in the intellectual property generated by the cooperative effort, then it would be free to either license or sell it to any organization. Further all royalties from the sale of the seed and the technology-use fee would belong to the university. Most important is that the cooperative marketing association would lose all control over and access to the results of research that it funded. If the cooperative marketing association retained all interests, then the university would not have two of its primary motivations for entering into an effort with the cooperative marketing association, access to the technology and access to the income streams generated by sale of seeds and technology-use licenses.

The balance point can be determined by considering several factors. The marketing association does not want the university to alienate any interest in or license the technology to competitors of the cooperative marketing association. Such alienation would immediately defeat the primary reason for the association to fund the research. The cooperative marketing association must profit from the risk that it took in funding the research. The university took no risk in entering into the cooperative effort

755. It is immediately recognized that the optimal solution to the distribution of rights between the farm marketing association and the university is determined as an equilibrium point in a two-person cooperative game, while the distribution of duties and benefits within the farm marketing association is determined as an equilibrium point in an n-person cooperative game. *See, e.g.*, John F. Nash, *Equilibrium Points in N-Person Games*, 36 PROC. NAT'L ACAD. SCI. 48-49 (1949); John F. Nash, *The Bargaining Problem*, 18 ECONOMETRICA 155-62 (1950); John F. Nash, *Non-Cooperative Games*, 54 ANN. MATH. 286-95 (1951); John F. Nash, *Two-Person Cooperative Games*, 21 ECONOMETRICA 128-140 (1953); John F. Nash, *Non-Cooperative Games*, 54 ANN. MATH. 286-95 (1951); J. P. Mayberry, John F. Nash & M. Shubik, *A Comparison of Treatments of a Duopoly Situation*, 21 ECONOMETRICA 141-54 (1953).

because the university can either raise the required funds, if necessary, from other sources or not enter into the relevant area of investigation. The balance point is then obtained when the cooperative marketing association retains all interests in the legal estate of the resulting research while the university is granted a revocable license to make and use, but not to alienate, the property. Such an arrangement rewards the cooperative marketing association for bearing the risks involved with the subject matter of the relationship while allowing scientific investigations to move forward because of access to otherwise proprietary property. All members of the marketing association could purchase for planting the seed for reproductive purposes without having to pay the technology-use fee because they are already part owners of the technology.

The association may chose not to obtain patent protection for the genetically modified seed, but rather to restrict sale to persons outside of the association by levying the member transferring the seed outside the association an amount equal to that amount the purchaser would have had to pay if the purchaser had been an initial investor in the research project. This option may be advantageous to the cooperative marketing association because it will eliminate the transaction costs associated with obtaining and defending exclusive rights under a utility patent. The members of the association may individually purchase the seed from growers within the association at a premium above the price of the crop used for non-reproductive purposes (to adequately compensate the growers of the seed) or they may reproduce seed for planting the next cycle. Either way, the association is not harmed. This is because the cooperative marketing association functions to maximize profit from sale of the crop for non-reproductive purposes by reducing risks associated with fluctuations in market price and reducing transaction costs.

The association, which consists of farmers as members, has exclusive control over the seed and each member has already paid according to the formulae described above. Since there is no competition between the members of the association to gain a profit by selecting between several different transgenic varieties of seed for planting, then there is no loss of market share because of availability of a superior seed from within the association. There may be competition between cooperative marketing associations for availability of seed, but because the particular variety of seed is optimized for the local clime and soil conditions, such competition is unlikely to contribute much to the profit margin of individual farmers within the association. In fact, it might be better for the association to allow farmers to save seed for use in the next planting cycle because this will continue to improve the varieties through local artificial selection. The members are not competition against each other for the market for their crops, but rather are acting in concert to obtain the highest price possible for the collective. Thus, the association can avoid the transaction costs associated with obtaining and enforcing the exclusive interests in the legal estate in the transgenic plant while obtaining its goal of maximizing the profit for its members by not obtaining patent protection for its intellectual property. That the competition in the seed manufacturing industry may have access to the intellectual property is not problematic for obvious reasons.

6. Genetic Pollution

Cross-breeding between varieties (within the same species) occurs in the open environment and cannot be controlled by the seed manufacturers.[756] Consider then two adjacent fields: the one owned

756. For instance, *Zea mays* L. pollen can travel distances up to 600-800 feet, and canola pollen can travel at least one-half mile (sufficiently far to completely engulf the one-quarter section field discussed above in the case

by Farmer Jack is planted with a genetically modified variety of plant; the other field owned by Jack's neighbor Farmer Adams is planted with a non-modified variety of the same species. The crop from the non-modified field is intended to be sold into a market requiring that the crop does not contain a transgene, or some other premium market. Because the dispersion of the gene in the open environment cannot be controlled, the crop in the field containing the non-modified variety of plants will become contaminated with the transgene.[757] Even though the transgene translocated through no effort of Farmer Adams, his crop will be polluted by the transgene. Under one interpretation of the law, Farmer Adams is infringing the exclusive interest of the seed manufacturer when his crop becomes contaminated. To determine whether this is the correct outcome, it must be determined to whom responsibility must be assigned for the genetic pollution and whether that party has a right to pollute and to sue Farmer Adams.

To avoid infringement liability, Farmer Adams must either destroy his crop or have the seed manufacturer deal with the problem. The first alternative, though suggested in some forums, is unrealistic. The second is equally unrealistic for other reasons. If the seed manufacturer were called to eliminate all possibly infringing plants, then each plant would have to be tested for the transgene and removed by hand. Presuming that the transgene conferred herbicide resistance, spraying with a herbicide would allow ready identification of infringing plants. However, such destructive testing would cause a complete loss of the crop. If the transgene conferred some other characteristic upon the plant, then other forms of testing would be necessary. In either case, other techniques of identification, such as genetic testing or growing up progeny seeds and testing them in the laboratory, would be equally expensive, cumbersome, and impractical. Aside from the impracticality and costs of identifying and destroying infringing plants, any strategy requiring that the farmer identify the supposedly infringing plants shifts the burden associated with the (putative) benefits of the transgene from the seed manufacturer onto the farmer who chose to grow a non-modified variety. Determining to whom responsibility for causing the pollution is assigned determines to whom the burden associated with the genetic pollution must be assigned.

The farmer who grows genetically modified plant varieties, Farmer Jack, and the farmer who grows non-modified plant varieties, Farmer Adams, have equal rights of choice. Both farmers have the property right to use their land to yield a crop that they each believe will maximize their profit. Farmer Jack chooses to use a genetically modified variety because he believes that by doing so his input costs will be minimized and thereby maximize his profit even if he cannot sell his crop into the premium market. Farmer Adams chooses to plant a non-modified variety because he believes that by doing so he will be able to sell into the premium market and hence maximize his profit even if he cannot minimize all of his input costs. Both farmers are using their respective lands in a manner which each believes will maximize his profit. Neither farmer is infringing the right of the other farmer in any way. Farmer Jack is not interfering with the rights of Farmer Adams to plant non-modified varieties, and Farmer Adams is not interfering with the rights of Farmer Jack to plant genetically modified varieties. Recognize, of course, that the transgene will be translocated from the field of

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of Mr. Percy Schmeiser). *See* Interview with Dean Charles Muscoplat, Dean, Univ. of Mn. Coll. of Agric. (July 31, 2001) [hereinafter Interview: Muscoplat].

757. If the transgene is translated through pollen, then only the crop (containing the progeny seeds) from the plants will be contaminated. However, if seeds from the first crop are used in the next planting cycle, then most, if not all, of the plants and their progeny seeds in the second planting cycle will be contaminated with the transgene.

Farmer Jack onto the field of Farmer Adams. Farmer Adams may not desire that the transgene be reproduced in the plant cells of the plants growing on his land. Farmer Adams does not benefit from the presence of the transgene on his land. He is, however, harmed by the presence of the transgene if the premium market is no longer available to him because of the transgene's presence.

Farmer Jack, who planted the genetically modified seed, initiated the process by which the transgene is reproduced in the cells of the plant on his field. Farmer Jack has no (legal) interest in the transgene; rather the seed manufacturer possesses the exclusive interests in the legal estate of the transgene. As discussed above, the legal estate in which the seed manufacturer has exclusive interest is the expressed transgene that was inserted into the plant genome using genetic manipulation techniques. At most, the legal estate is the combination of the plant genome and the expressed transgene. Farmer Jack has no interest in this legal estate, he merely has a license to use the protein, or other compound generated when the transgene is expressed, for its intended purpose. The license allows Farmer Jack to sell the resulting crop for non-reproductive purposes. Since Farmer Jack has no interest in the legal estate, and since the seed manufacturer possesses the exclusive interest in the transgene, it is the property of the seed manufacturer that is translocated to the fields of Farmer Adams. Since the property of the seed manufacturer is contaminating the fields of Farmer Adams, it is unreasonable to hold Farmer Jack liable for the genetic pollution.

When the transgene is translocated from the field of Farmer Jack onto the field of Farmer Adams then under the current legal structure, Farmer Adams may be subject to liability for infringing the exclusive interests of the seed manufacturer. Farmer Adams may also incur a substantial loss in the value of his crop because he may no longer have access to the premium market. Furthermore, he may have suffered a permanent loss of his own variety which he developed through either artificial selection or cross breeding.[758] Since these outcomes are the result of translocation of property in which the seed manufacturer has exclusive interests, then the seed manufacturer must be liable for the damages to Farmer Adams. The seed manufacturer enjoys the benefit that runs with the legal estate in which it has exclusive interest. The seed manufacturer must also bear the risk associated with the benefit; the risk must not be shifted onto either Farmer Jack or Farmer Adams. Justice is not served by allowing the seed manufacturer to enforce its exclusive interest in the genetically modified plants against the farmer upon whose property the transgene is located and simultaneously avoid liability when the transgene was translocated onto the land of that same farmer either against the will of that farmer or unbeknownst to that farmer.[759]

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758. It might be argued that the farmer has no interest in his own plant variety unless it is patented. Such a position is not only erroneous, but ignores a centuries old common-law doctrine that states that proprietary interests in all inventions are protected by common law. What is not protected under common law is the right to exclude others from making, using, or selling when the other person created the invention independent of and without knowledge of the original inventor. Justice Clark clearly stated that "[i]t has long been settled that the patentee receives nothing from the law which he did not have *before*, and that the only effect of his patent is to restrain others from manufacturing, using or selling that which he has invented." Motion Picture Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 510 (1917) (emphasis added). Thus, under common law the farmer that developed his own variety through his own genius does indeed have enforceable interests in the estate comprising the plant variety.

759. The liability for damage to Farmer Adams must be born by the seed manufacturer even if Farmer Adams knew or should have known that the transgene was translocated onto his land. As discussed earlier, requiring the farmer to be continuously vigilant for the transgene, identifying contaminated plants and eradicating those plants is an unreasonable position. Likewise, requiring the seed manufacturer to identify and remove contaminated plants is equally unreasonable. To place upon the farmer the liability associated with the

Several theories are available under which the seed manufacturer may be held liable for the genetic pollution, and these theories have been thoroughly investigated elsewhere and hence need not be detailed here. Recent proposals include: imposition of both negligence law and strict liability for abnormally dangerous activity may be available for an injured party to recover damages in the United States;[760] utilization of public and private nuisance actions when the transgene from genetically modified plants is translocated onto fields which contain non-modified plants;[761] examination of the potential liabilities associated with genetic pollution under the tort liability theories of trespass, nuisance, negligence and strict liability;[762] and examination of the legal remedies available to organic farmers for genetic pollution of their crops.[763] While these theories of liability may be available to the farmer, the probability of success in any single case is very small (considering the disparity between the legal counsel available to the seed manufacturer and legal counsel available to the farmer) and the cost to the farmer is prohibitive.

A far more powerful tool is available to the defendant-farmer to prevent the lawsuit from ever getting into the courthouse door in the first place. This tool is the long established doctrine of unclean hands. Utilizing this doctrine, when the plants on the land of Farmer Adams are contaminated by the transgene the seed manufacturer should lose his exclusive interest in the legal estate of the contaminating transgene, and hence lose his right to seek damages in a court of justice. Simply put, it is unjust and inequitable that the seed manufacturer markets a product for planting in a field knowing that that product will pollute surrounding fields and then sue the owners of the surrounding fields because that product is found on those surrounding fields. The doctrine of unclean hands clearly states that the court of justice will not grant the plaintiff a remedy in such circumstances.

Recall that Farmer Jack initiated a process by which a plant was produced that reproduces the transgene in its cellular machinery. Farmer Adams initiated a process by which a plant was produced that lacks the transgene. If the transgene is translocated from the fields of Farmer Jack onto the fields of Farmer Adams, then the fields of Farmer Adams have been contaminated through genetic pollution. Before turning to the discussion of why the seed manufacturers should not be able to obtain a remedy when genetic pollution has occurred, the issue to be considered is whether the seed manufacturers knew or should have known that the transgene would translocate from one field to another.

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translocation of the transgene onto his property forces the farmer to either purchase a technology-use license for every transgene that might contaminate his plants or quit farming altogether. Neither of these possibilities is reasonable.

760. *See* Stephen Kelly Lewis, *"Attack of the Killer Tomatoes?" Corporate Liability for the International Propagation of Genetically Altered Agricultural Products*, 10 TRANSNAT'L LAW. 153 (1997).

761. *See* Thomas P. Redick & Christina G. Bernstein, *Nuisance Law and the Prevention of "Genetic Pollution": Declining a Dinner Date with Damocles*, 30 ENVTL. L. REP. 10328, 10333 (2000).

762. *See* Richard A. Repp, *Biotech Pollution: Assessing Liability for Genetically Modified Crop Production and Genetic Drift*, 36 IDAHO L. REV. 585 (2000).

763. *See* Joshua M. Stone, *Restraints on Competition Through the Alteration of the Environment at the Genetic Level*, 8 N. Y. U. ENVTL. L. J. 704, 716-19 (2000).

a. Transgene Translocation Happens in the Open Environment

There can be no question that the seed manufacturers were aware by 1998, and quite possibly earlier, that a transgene could be moved from one variety to another variety, within a species, by traditional plant breeding techniques.[764] In fact, evidence indicates that seed manufacturers were commonly using traditional breeding techniques for moving a transgene between varieties before 1993. In 1993, Koziel published the first report on a genetically manipulated cereal plant with an elevated resistance to insects.[765] To be specific, after inserting the synthetic gene for the Cry1A(b) δ-endotoxin into a maize plant cell, a mature maize plant was produced. The resulting elite transgenic maize plant was produced using traditional cross-breeding techniques to create a stable, genetically modified variety of maize.[766] Allowing approximately one year for analyzing the experimental results, writing the manuscript for publication, and publication of the manuscript, and between five and seven years for field experiments, Monsanto was most likely engaged in moving the transgene between varieties of maize as early as 1985 to 1987. Indeed, by 1985 it was known that genetically modified progeny would be reproduced in "simple Mendelian fashion."[767] Moreover, by 1986 it was openly contemplated that the methods of genetic manipulation would "compliment those used in classical plant breeding" to produce varieties of transgenic plants.[768] Because information about moving transgenes between varieties, within a species by traditional breeding programs existed from at least 1987, the seed manufacturers either knew or should have known that the transgene would be translocated from the genetically manipulated plant to a non-modified plant of the same species when the transgene was released to the environment. The transgene is present in the pollen, which is readily transported by the wind and insects.[769] The transgene is also present in seeds that may be transported by the wind, humans, or animals. None of these methods of transport may be controlled by the seed manufacturers. The seed manufacturer is, therefore, incapable of controlling the movement of the transgene between plant varieties.

Monsanto's position is, and was, that genetically modified seed or pollen would be carried into a non-modified field of crops by no more than a few feet.[770] Further, Roger Hughes, representing

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764. *See generally* Koziel, *supra* note 434 (explaining that once the new gene is introduced into a crop variety, the new characteristic exhibited due to the expression of that gene can be moved into other sexually compatible varieties of that plant specie using traditional breeding techniques).

765. *See* Michael G. Koziel et al., *Field Performance of Elite Transgenic Maize Plants Expressing an Insecticidal Protein Derived from* Bacillus thuringiensis, 11 BIO/TECHNOLOGY 194-200 (February 1993).

766. *See generally* Koziel, *supra* note 434.

767. Horsch, *supra* note 176, at 1230.

768. Patricia Powell Abel, Richard S. Nelson, Barun De, Nancy Hoffmann, Stephen G. Rogers, Robert T. Fraley & Roger N. Beachy, *Delay of Disease Development in Transgenic Plants that Express the Tobacco Mosiac Virus Coat Protein Gene*, 232 SCIENCE 738, 743 (1986).

769. *See* Interview: Muscoplat, supra note 756.

770. *See* Karl A. Thiel, *Seeds In the Wind: For Monsanto, Patent Protection Stirs Controversy*, *available at* http://www.biospace.com/ articles/120699.cfm. In countering Percy Schmeiser's arguments that the Roundup-ready gene could be carried by seeds or pollen blown into the fields, "Monsanto's Evans claims that company studies show it is unlikely that Roundup Ready seed from one field would penetrate an adjacent field by more than a few feet, and that it would take hurricane force winds to spread pollen over the large distances described

Monsanto, stated, "[f]orces of nature such as wind and bees are clearly insufficient to produce a ninety percent crop of Roundup-ready canola."[771] The conclusion that the seed manufacturers want to draw is that if the transgene is located on the land of the farmer, then the transgene must have gotten there by nefarious action on the part of the farmer.[772] In fact, that transgenes may travel great distances was recently demonstrated in a documented case from northern Alberta Canada.[773] In this case, three varieties of canola were planted by the same farmer on different parts of his farm in 1997. The first field was planted with Roundup Ready canola, a twenty-acre field across the road was planted with Innovator (a variety of canola modified to resist Liberty[774] herbicide), and a field four hundred meters away was planted with canola that was resistant to Cyanamid's Pursuit and Odessey[775] herbicides. In 1998 it was discovered that a variety of canola that was resistant to two commonly used herbicides was growing on the farmer's fields, and by 2000, gene stacking had produced a variety of canola resistant to Roundup, Liberty and Pursuit. It is a reasonable deduction then that the transgene traveled a great distance, by transgene standards, to create a transgene-stacked variety of plant. The distances between the different fields of canola varieties and the creation, without human intervention, of a canola variety with "stacked" transgenes indicate that Monsanto's argument against extensive genetic pollution by natural causes is vacuous at best.

An article was published on November 29, 2001 in Nature that demonstrated that the transgene not only translocates in the environment, but that it can do so over considerable distances.[776] An

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by Schmeiser." *Id*. (internal quotes omitted).

771. Murray Lyons, *Farmer's Reapings No Fluke, Court Told: Schmeiser Planted Roundup Ready Canola Knowingly*, THE SASKATOON STARPHOENIX at A1 (06 June 2000), *available at* http://www.biotech-info.net/no_fluke.html.

772. Roger Hughes, the attorney for Monsanto, stated that "Percy Schmeiser deliberately segregated seed that he knew was Roundup Ready from his 1997 canola crop" without first obtaining permission from Monsanto and in violation of the patent on Roundup Ready canola. LYONS, *supra* note 771 (internal quotation marks omitted). Further, Hughes argued that the genetically modified canola could not have been translocated onto the land of Percy Schmeiser's through either cross-pollination or being blown by the wind. *See id.* Also, in Monsanto's complaint against Mr. Schmeiser it was claimed that Mr. Schmeiser "obtained canola seeds which are resistant to glyphosate from one or more persons licensed" by Monsanto and planted them on his lands. Monsanto Canada, Inc, and Monsanto Company -and- Percy Schmeiser Statement of Claim, COURT FILE NO. T-1593-98, Claim 15 (06 August 1998) *available at* http://www.tv.cbc.ca/national/pgminfo/canola/doc1.html *et. seq.*. Monsanto also claimed that Mr. Schmeiser knowingly saved seed from his 1997 crop and planted those seeds in his 1998 crop. *See id.* Having dismissed the possibility that the seeds containing the transgene arrived on Percy Schmeiser's farm by any means other than his intentionally purchasing them and planting them without a license, Monsanto apparently presumed that the transgene could only have existed on the land of Mr. Schmeiser through actions by Mr. Schmeiser that were in violation of the law.

773. *See* Gillian Steward, *Genetically Engineered Superweeds Emerge in Canada*, THE GLOBE AND MAIL (CANADA) at A1, (June 15, 2000), *available at* www.purefood.org/ge/superweed.cfm.

774. Liberty® is a trademark name of a product produced and marketed by Aventis. For simplicity, this trademark name will be used throughout the text, unless a specific quotation is identified, without the symbol ®.

775. Pursuit® and Odessey® are trademark names of products produced and marketed by Cyanamid. For simplicity, these trademark names will be used throughout the text, unless a specific quotation is identified, without the symbol ®.

776. *See* David Quist and Ignacio H. Chapela, *Transgenic DNA Introgressed into Traditional Maize Landraces in Oaxaca, Mexico*, 414 NATURE 541-43, (Nov. 29 2001) *available at* http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v414/n6863/full/414541a0_fs.htm&content_filetype=PDF. In the study by

opinion was subsequently published in Nature in January 2002,[777] in which it was emphatically stated that the occurrence of the transgenes, found by Quist and Chapella in criollo landrace maize in

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Quist and Chapela, native, or "criollo," landraces of maize were sampled from four fields of standing maize, two each from two separate locations in the state of Sierra Norte de Oaxaca, Southern Mexico. *See id.* at 541. The fields were located in a remote part of Mexico, in excess of "20 km from the main mountain-crossing road that connects the cities of Oaxaca and Tuxtepec in the Municipality of Ixtlán." *Id.* Significantly, the fields were located at least sixty miles from the location where the last known genetically modified maize plants were grown in 1998, s*ee* John Vidal, *Mexico's GM Corn Shocks Scientists*, THE GUARDIAN, (Friday November 30, 2002) *available at* http://www.guardian.co.uk/international/story/ 0,3604,609293,00.html), three full years before the discovery of the fields in the Municipality of Ixtlán. In five of seven samples of criollo landrace maize, the element used most commonly in transgenic constructs, the 35S promoter (p-35S) from cauliflower mosaic virus, was detected. *See* QUIST AND CHAPELA, *supra* note 776. In four of the samples, 98% homology was found between the p-35S promoter found in the criollo landrace maize and the cauliflower mosaic virus 35S promoter used in the commercially available vectors such as pMON273 (GenBank accession number X04879.1) and the K1 sample (GenBank accession number AF434746). Also, the *Agrobacterium tumefasciens* nopaline synthase terminator sequence (T-NOS) was detected in two of the six criollo samples (respectively, GenBank accession number AF434752 and A434751). *See id.* Further, in one of the criollo landrace maize sample, the *Bacillus thuringiensis* cryIA(b) gene, which, when expressed, causes the plant cell to produce the *Bacillus thuringiensis* CryIA(b) δ-endotoxin, was detected. These results "demonstrate that there is a high level of gene flow from industrially produced maize towards populations of progenitor landraces." *Id.* at 542. The results observed by Quist and Chapela were confirmed in a study conducted by the Mexican environment ministry. *See* Rex Dalton, *Transgenic Corn Found Growing in Mexico*, 413 NATURE 337 (Sept. 27, 2001). The findings by Quist and Chapela and by the Mexican environment ministry are particularly troubling to those who oppose the production and consumption of genetically modified plants. See, for example, VIDAL, *supra* note 776; NEWS RELEASES, *Genetic Contamination Found In Mexican: Center of Diversity for Corn Threatened by Gene-Altered Corn From U.S.* (Sept. 27, 2001) *available at* http://www.greenpeaceusa.org/media/press_releases/ 01_09_27text.htm. However, as anticipated, the finding, which was published in the journal Nature, is not free of controversy and criticism. Specifically, studies conducted under the direction of David Hoisington, director of the Applied Biotechnology Center at the International Maize and Wheat Improvement Center (CIMMYT) in El Batan, Mexico, and Tim Reeves, director-general of CIMMYT, showed that there is no evidence of either the commercially used cauliflower mosaic virus 35S promoter or of the *Bacillus thuringiensis* cryIA(b) transgene in any of the twenty-eight maize genomes in its seed bank. *See* John Hodgson, *Doubts Linger Over Mexican Corn Analysis*, 20 NATURE BIOTECHNOLOGY 3-4 (January 2002) at http://biotech.nature.com. Further studies are being conducted at CIMMYT on samples collected from fields in Oaxaca, Mexico. Hodgson argues that the studies conducted at CIMMYT "conflict with some unreported work by the Berkeley group." *Id.* However, as of December 14, 2001, CIMMYT had only completed screening of fifteen additional native landrace maize varieties from its own genebank. *See* David Hoisington, *Further Tests at CIMMYT Find No Presence of Promoter Associated with Transgenes in Mexican Landracces in Gene Bank or From Recent Field Collections*, (Dec. 14, 2001) *at* http://www.cimmyt.org/whatiscimmyt/furthertest.pdf. Hoisington reported that the varieties tested from the CIMMYT genebank were free of the cauliflower mosaic virus promoter 35S that is commonly associated with a transgene. Additionally, seeds from forty-two native landrace varieites from Oaxaca were tested and found to be negative for the transgene (at least for the year 2000 maize crop). *See id*.

The fact that the studies conducted at CIMMYT found no indication of a transgene contaminating the native landrace maize genome pool, while the study conducted by Quist and Chapela did find evidence of a transgene, indicates that the possibility exists that a transgene has become introgressed into the criollo landrace maize. The most sensible way to move forward is for CIMMYT and the Berkeley investigators to exchange seed samples and test again for evidence of transgene translocation. Hodgson may have overstated the difference between the results obtained by the investigators at CIMMYT and by the investigators at Berkeley. The two sets of studies do indicate that introgression of transgene into native landrace maize varieties is a very real possibility and care must be taken in assessing the effect of such introgresson on biodiversity. But of equal or greater significance than the effect on biodiversity is the legal consequences attendant to the translocation of transgenes into native landrace maize varieties.

777. *See* Juan Pablo Ricardo Martínez-Soriano, Ana María Bailey, and Joel Lara-Reyna, *Transgenes in Mexican Maize*, 20 NATURE BIOTECHNOLOGY 19 (Jan. 2002).

Oaxaca, Mexico, is not genetic contamination. Specifically, Martínez-Soriano, et al. stated that: "[c]ontamination means unexpected, undesirable, and uncontrollable spread" of the transgene, and "that is not happening."[778] Further, Martínez-Soriano, et al. opined that "if someone wants to remove the transgene from these plants, the procedure would be simple: select and multiply those susceptible maizes and do not harvest and multiply the insect-resistant ones."[779] Finally, Martínez-Soriano, et al. state that "there is no need for concern."[780]

This position parallels that articulated by Vivian Moss, chairperson of the CropGen Panel, Val Giddings of BIO (an U.S. industry organization in Washington, D.C.), and Tim Reeves, director-general of CIMMYT,[781] and reported by Hodgson.[782] Specifically, Tim Reves is quoted as stating that: "the real question is whether it makes any difference if one of the genes that has" translocated is a transgene.[783] Further, Hodgson reported that Luis Herrera Estrella (Director of CINVESTAV-IPN, Mexico's premier center for plant biotechnology) "pointed out that the Nature paper provides no experimental evidence of negative effects on biodiversity."[784] Finally, Hodgson has reported that Val Giddings argued "that given its demonstrable influence in improving yields, improving agronomic performance and decreasing agricultural footprints, . . . biotechnology is combating the threat to

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778. *Id.* Of course the validity of the quoted statement is open to serious debate.

779. *Id.* The fact that a maize is susceptible, to either insect pests or herbicides depending upon the transgene present, is not dispositive as to the question of whether the transgene is present. Thus, it is entirely possible that the simple protocol suggested by Martínez-Soriano may not be effective in removing the transgene from the landrace maize variety. Further, if the transgene is dominant and highly promiscuous, the suggested protocol may not even be applicable.

780. *Id.*

781. CIMMYT has a partnership with IRD (France), Novartis, Limagrain and Pioneer Hi-Bred Co. that has the objective of developing, evaluating, and distributing apomictic hybrid maize to subsistence farmers. The agreement is for five years extending from 1999 to 2004 and CIMMYT receives "[a]ccess to scientific expertise and proprietary technologies; a paid-up, royalty-free, worldwide, non-exclusive license (with the right to sub-license to non-profit institutions) to provide research products to subsistence farmers." CIMMYT, *Transparency Is Important* (Oct., 2000), *available at* http://www.cimmyt.org/whatiscimmyt/AR99_2000/transparency/transparency.htm. Further, CIMMYT receives "financial support for CIMMYT scientists involved" from the industrial partners. *See id.* In return, CIMMYT provides to its partners, "[s]taff and laboratory resources; access to CIMMYT and IRD's apomixis technology; a paid-up, royalty-free, worldwide, co-exclusive license for research products." *Id.* Also, CIMMYT received a grant from Monsanto (to develop a hybrid wheat) in the amount of $154,000 in 1999 (last year for which statistics are available) and a grant from World Bank for $3,623,000 in 1999. *See* CIMMYT, Resourcing the Research: CIMMYT Financing, 1999-2000, (Oct., 2000) *available at* http://www.cimmyt.org/whatiscimmyt/AR992000/resourcing/resourcing.htm.

782. *See* John Hodgson, *Doubts Linger Over Mexican Corn Analysis*, 20 NATURE BIOTECHNOLOGY 3-4 (Jan., 2002) at http://biotech.nature.com.

783. *Id.* at 3.

784. *Id.* While the statement by Mr. Estrella is true, the point of the Quist and Chapela paper was to demonstrate the presence of the cauliflower mosaic virus promoter 35S in the criollo landrace varieties. Quist and Chapela were entirely entitled to speculate that if the transgene has indeed introgressed into criollo landrace maize varieties then it could have an adverse affect on biodiversity. Quist and Chapela were careful to state that further experimental studies were necessary in order to identify the long-term effect of transgenes upon biodiversity. *See* Quist & Chapela, supra note 776.

biodiversity."[785] Thus, the proponents of the development and deployment of agricultural biotechnology appear to take the position that it is not particularly surprising that "genes move around in nature" but that the fact that they do so "is hardly new."[786] Further, observing that "[g]ene flow is constant"[787] in the open environment is as "shock[ing as] to discover gambling in a casino."[788] Finally, the proponents appear to focus not on the destruction of biodiversity but upon "whether it makes any difference if one of the genes that has flowed in is a transgene."[789] Evidently, the preferred answer is that not only diversity not be affected,[790] but that it can be "predict[ed] that this useful transgene will be found in increasing numbers and types of native maizes."[791] The conclusory statements of the proponents of agricultural biodiversity may not have as solid a basis as the proponents might think. Also, they focus only on one single aspect of the issue associated with transgene translocation in the open environment.

Given that "[e]xotic libraries can make a wide array of previously unexplored genetic variation rapidly available to plant breeders and geneticists,"[792] and that these libraries of exotic plants are available in existing seedbanks[793] and wild species,[794] then the presence of transgenes in native landraces may be quite problematic indeed. Consider a very real scenario: A *Bacillus thuringiensis* cryIA(b) gene, which, when expressed, causes the plant cell to produce the *Bacillus thuringiensis* CryIA(b) δ-endotoxin, translocates to a variety of criollo landrace maize in Oaxaca. The consequences of this apparently natural and "useful"[795] translocation may have significant legal ramifications to the farmer upon whose field the transgene was translocated as well as throughout the plant breeding world. Consider the farmer upon whose field the transgene was translocated. If the Federal Courts in Mexico follow the decision in *Monsanto v. Schmeiser*,[796] then by simply having the

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785. *Id.*

786. Hodgson, *supra* note 782 (quoting Professor Vivian Moses, Chair of the GropGen Panel).

787. *Id.* (quoting Val Giddings).

788. *Id.* (quoting Val Giddings).

789. *Id.* (quoting Tim Reeves).

790. *See* Martínez-Soriano, *supra* note 777.

791. *Id.*

792. Dani Zamir, *Improving Plant Breeding With Exotic Genetic Libraries*, 2 NATURE REVIEWS GENETICS 983, 989 (December, 2001).

793. *See id.* at 985 (stating that "[t]he observation that wild genetic resources can contribute to crop improvement, combined with the alarming rate at which locally adapted landraces are being lost and at which natural habitats are being damaged, has led to the establishment of large germplasm collections in the form of seed banks").

794. *See id.* at 983 (stating that it is "time to return to the wild ancestors of crop plants to use them as a source of genetic variation that has been lost during domestication").

795. *See* Martínez-Soriano, *supra* note 777.

796. *See* Monsanto Can., Inc. v. Schmeiser Enters., Ltd., 2001 FCT 256 (Fed. Ct. Canada 2001), *available at* http://decisions.fct-cf.gc.ca/fct/2001/ 2001fct256.html.

transgene on his land, the farmer may be guilty of infringing the patent on the transgene. Further, if the farmer harvests the maize, then he can neither alienate that maize nor plant the seeds in the next crop cycle because, presuming that Mexican courts follow the lead of the Canadian Federal Courts, disposition of the transgene follows the disposition of the seeds, and disposition of the transgene is completely within the control of the holder of the patent on the transgene. Further, if the farmer attempts to market the maize containing the transgene into the United States, and if the transgene is patented in the United States, then the farmer will be guilty of infringing the United States patent. Also, suppose that the transgene is patented, and that that particular criollo landrace maize genome is considered part of the exotic library[797] sought to be used for genetic diversification of domesticated *Zea mays* species. Then not only can the criollo landrace maize not be harvested, but the harvested maize cannot be brought into the United States for experimental use without either infringing the United States patent or obtaining a license from the holder of the United States patent. The result, from the farmer's perspective, is that the criollo landrace maize that was contaminated with the transgene is no longer of any value to the farmer, and that same variety of criollo landrace maize is no longer available for its genome to diversify the domesticated *Zea mays* varieties. Should the transgene contaminate most, if not all, of the landrace maize varieties existing in Mexico, then that genome pool will no longer be available to any person or entity other than the holder of the patent on the transgene (at least for the term of the patent). Clearly, then, it does matter that "any . . . one of the genes that has flowed in is a transgene."[798]

In summary, it must be common knowledge among seed manufacturers that transgenes can, and do, translocate between varieties within the same species; it has been documented that gene stacking occurs in the open environment, even when the source of the transgenes are hundreds of meters apart. Any argument maintaining the position that the transgene cannot contaminate large portions of non-genetically modified field is simply without support. Even if, for the sake of a complete analysis, the travel distance of a transgene were several tens of meters to several hundreds of meters, then a field of 1/4 section[799] would still exhibit a considerable level of contamination.[800] In fact, the contamination may be sufficient to cause a crop harvested from the entire field to test positive for the transgene, even for a very modest infiltration of the transgene into the field. Therefore, the

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797. *See generally* Dani Zamir, *supra* note 792.

798. Hodgson, *supra* note 782 (quoting Tim Reeves).

799. One of the fields at issue in Percy Schmeiser's case was of 1/4 section in size. *See* Interview: Schmeiser{July 6, 2001}, *supra* note 270.

800. Given that, in a sample of seeds to be tested, a mixture of one part genetically modified seeds and five parts non-modified seeds will test positive for the transgene, only 1,161,600 square feet of the 1/4 section field need contain genetically modified plants. If the genetic contamination is uniformly infiltrating from all edges of the 1/4 section, then the distance to be traveled into the field to obtain the required level of contamination is 115 feet. This is calculated by recognizing that the square annulus is composed of four trapezoids with the long edge being b = 1/2 mile in length; the area of each trapezoid is 1,161,600/4 square feet; and the area of the trapezoid is $(b - b' \cos(45°)) \, b' \sin(45°)$, where the distance into the field is $b' \sin(45°)$. Solving for b allows ready computation of the required distance of infiltration into the field. It is a remarkable conclusion that a uniform infiltration to a distance of 115 feet by the transgene into a square field of 1/4 section may cause the crop harvested from the entire section to test "positive" for the transgene.

assumption that the transgene translocated to the land of the farmer only through nefarious deeds is simply not valid.

b. Why Seed Manufacturers Have "Unclean Hands"

The court of equity was historically a vehicle for positively enforcing the requirements of good faith and conscience. If the court granted relief to a party who "acted fraudulently, or who by deceit or any unfair means has gained an advantage"[801] then the court would be "the abettor [sic] of iniquity."[802] Whatever rights the plaintiff possesses, "[a] court of equity acts only when and as conscience commands, and if the conduct of the plaintiff be offensive to the dictates of natural justice," then he will not be granted relief.[803] The doctrine of equity states that "he who comes into equity must come with clean hands."[804] This does not mean that the doors to the courthouse are closed to the plaintiff because of misconduct unrelated to the case at issue; rather, plaintiffs can be denied relief "only for such violations of conscience as in some measure affect the equitable relations between the parties in respect of something brought before the court for adjudication."[805] The doctrine of equity, or "clean hands," is applied not to punish the plaintiff, but "upon considerations that make for the advancement of right and justice."[806] Thus, the court is not "bound by formula or restrained by any limitations that tends to trammel the free and just exercise of discretion."[807] This means that the doctrine of "clean hands" may be invoked by the court for "[a]ny willful act concerning the cause of action that rightfully can be said to transgress equitable standards of conduct."[808] Further, if the case involves a public interest[809] as well as the private interest of the parties to the suit, then the doctrine "not only prevents a wrongdoer from enjoying the fruits of his transgression but averts an injury to the public."[810] Because of the "social and economic consequences of a patent," the public has a "paramount interest in seeing that patent monopolies spring from backgrounds free from fraud or other inequitable conduct and that such monopolies are kept within their legitimate scope."[811] Of course, the doctrine of equity

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801. Bein v. Heath, U.S. (6 How.) 228, 247 (1848).

802. *Id.*

803. *See* Dweese v. Reinhard, 165 U.S. 386, 390 (1897).

804. Precision Instrument Mfg. Co. v. Auto. Maint. Mach. Co., 324 U.S. 806, 814 (1945).

805. Keystone Driller Co. v. General Excavator Co., 290 U.S. 240, 245 (1933) The court denied relief to plaintiff in a patent infringement case because plaintiff came into court with "unclean hands." *Id.* at 246-47.

806. *Id*.

807. *Id.* at 245-46.

808. *Precision Instrument Mfg. Co.*, 324 U.S. at 815.

809. Indeed, a patent by "its very nature is affected with a public interest," because "[t]here are issues of great moment to the public in a patent suit." *Id.* at 816; *see also* Hazel-Atlas Glass Co. v. Hartford-Empire Co., 322 U.S. 238, 246 (1944) *reversed* on other grounds in Standard Oil Co. v. United States, 429 U.S. 17, 18 (1976).

810. *Precision Instrument Mfg. Co.*, 324 U.S. at 815.

811. *Id*. at 816.

"should never be applied if its application results in injustice."[812]

Cases in which relief was denied because of improper actions on the part of the patentee include: attempted use of the patent grant to "secure a limited monopoly of unpatented material used in applying the invention,"[813] because the patentee derives a profit not from the invention patented but from "the unpatented supplies with which it is used and which are wholly without the scope of the patent monopoly,"[814] a strategy which effectively extends the power to fix the price for the unpatented supplies to the patentee;[815] the use of the patent as a mechanism for restraining commerce in violation of the Sherman Anti-Trust Act;[816] making leases containing clauses, terms, and conditions in violation of the Clayton Act;[817] committing fraud on the patent office;[818] entering into a contractual agreement where defendant waives his right to manufacture using patented devices after expiration of the patent;[819] using the patent to restrain competition and creating a limited monopoly in the marketing of unpatented articles;[820] obtaining a patent by fraudulent misrepresentation to the Patent and Trademark Office;[821] and committing fraud on the patent office in obtaining a design patent renders the patent unenforceable.[822]

Case law indicates that the court will deny enforcement of a patent by the patentee if the patentee has acted in such a manner as to "transgress equitable standards of conduct"[823] with regard to the issue brought before the court. The genetic pollution of the field of Farmer Adams is germane to the

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812. Leo Feist, Inc. v. Young, 138 F.2d 972, 975 (7th Cir. 1943).

813. Carbice Corp. v. Am. Patents Dev. Corp., 283 U.S. 27, 33-4 (1930).

814. Motion Picture Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 517 (1917). This strategy effectively extends the power to fix the price for the unpatented supplies to the patentee.

815. *See* Standard Sanitary Mfg. Co. v. United States, 226 U.S. 20, 49 (1912) (stating that "[the] [r]ights conferred by patents are indeed very definite and extensive, but they do not give any more than other rights an universal license against positive prohibitions").

816. *See id*.

817. *See* United Shoe Mach. Co. v. United States, 258 U.S. 451, 464 (1922) (stating that the "patent grant does not limit the right of Congress to enact legislation not interfering with the legitimate rights secured by the patent but prohibiting in the public interest the making of agreements which may lessen competition and build up monopoly").

818. *See* Precision Instrument Mfg. Co. v. Automotive Maintenance Mach. Co., 324 U.S. 806 (1945).

819. *See* Pope Mfg. Co. v. Gormully, 144 U.S. 224 (1892).

820. *See* Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 488 (1942).

821. *See* Monsanto Co. v. Rohm & Haas Co., 456 F.2d 592 (3d Cir. 1972).

822. *See* W. R. Grace & Co., Inc. v. W. U.S. Industries, Inc., 608 F.2d 1214 (9th Cir. 1979).

823. *Precision Instrument Mfg. Co.*, 324 U.S. at 815.

issue brought before the court by the plaintiff-seed manufacturer. This is because if the genetic pollution had not occurred, or if Farmer Adams had unknowingly planted seeds containing the transgene, the transgene would not have been on the land of Farmer Adams and the seed manufacturers would have not had a cause to sue. Also, allowing the suit to come forward would recognize the right of the seed manufacturer to expand its monopoly beyond the limitations set in the patent.

The plant genome is analogous to any naturally occurring molecule in any physical phase, including dry ice. Dry ice is an unpatented and unpatentable subject matter because the public has long known[824] that it is carbon dioxide, which is naturally occurring and is a product of nature. Because the plant genome is a product of nature and has been in public use since the beginning of the domestic use of the plant, it is unpatented and unpatentable.[825] The patentee cannot exert control over such unpatented material because the control is beyond the limited scope of the patentee's legal estate; "[E]very use of a patent as a means of obtaining a limited monopoly of unpatented material is prohibited."[826] Such a limitation is inherent in the patent grant and "is not dependent upon the peculiar function or character of the unpatented material or on the way in which it is used."[827] Relief in such a case must be denied because the patentee is using the patent to secure a "monopoly of unpatented material used in applying the invention."[828]

If the seed manufacturer were allowed to enforce its exclusive interest in the transgene, the genetic pollution would affect a monopoly over the unpatented plant genome that existed on the lands of Farmer Adams. The reasoning behind this assertion is as follows. Either Farmer Adams planted seeds devoid of the transgene, or, at the very least, he was ignorant of whether the seeds contained the transgene. The public possesses exclusive interest in the plant genome, which, as discussed above, is unpatentable. When the transgene is translocated onto the field of Farmer Adams, it contaminates the plant genome of the plants on that field. The incorporation of the transgene into the plant genome in the progeny seeds occurs by an entirely natural process, without the intervention of humans. The incorporation was not by genetic engineering techniques as used to develop the patented invention. The seed manufacturers know that such incorporation will occur in the open environment by natural processes. The plant genome, which is contaminated by the transgene, is not within the limitations of the patent grant (further, the plant genome cannot be within the patent grant). Once the transgene is translocated into the cells of the plants on the land of Farmer Adams, the seed manufacturer may claim infringement of its patent by Farmer Adams. If the seed manufacturer is successful in enforcing its exclusive interest, then the plant genome of the plants on Farmer Adams' field will be pulled within the limitations of the patent. At that point, Farmer Adams is completely divested of any interests he may have had in the plant genome that was on his land before the

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824. *See* Carbice Corp. of America v. American Patents Dev. Corp., 283 U.S. 27, 29 (1930).

825. *See* Leitch Mfg. Co. v. Barber Co., 302 U.S. 458, 461-62 (1938) (stating that the "sole business of the Dry Ice Corporation was to make and sell dry ice-which is unpatented material"). Once a product has been in public use for more than one year it becomes unpatentable.

826. *Id.* at 463.

827. *Carbice Corp.*, 283 U.S. at 33.

828. *Id.* at 34.

transgene was translocated to the cells in his plants. Also, by bringing the plant genome within the limits of the patent the public is divested of all interest in the plant genome. Therefore, Farmer Adams is prohibited from having the plant genome on his land unless he pays the seed manufacturer the technology-use license fee. Such an outcome would extend the monopoly of the seed manufacturer far beyond the limitations inherent in the patent grant.

By permitting the seed manufacturer to enforce its exclusive interest when genetic pollution occurs, the seed manufacturer would establish, with the approval of the court, a limited monopoly in the marketing of unpatented material and would be restraining competition.[829] By enforcing its exclusive interest, Farmer Adams would not be able to market his crop, in part because he would not be able to have the plants with the transgene reproduced in their cells on his land. Because multiple farmers in the same situation as Farmer Adams comprise the competition to the genetically modified plant industry, enforcement of the exclusive interest would completely eliminate the competition. Because any crop yielded by the plant on Farmer Adams land could not be sold, then assertion of the exclusive interest would cause the seed manufacturer to create a monopoly in the marketing of the consumable portion of the plant generated by the plant genome.

Because the seed manufacturer polluted the land of Farmer Adams and because the seed manufacturer is attempting to assert a monopoly beyond that limited by the patent grant, the seed manufacturer comes to the court with unclean hands.

c. Why Exclusive Interest is Not Enforceable

Before the seed manufacturer can assert its exclusive interest it must have a right to do so, and it must come to the courthouse door with clean hands. The right to assert its interests arises from either common law or Section 271 of Title 35, United States Code. Both of these avenues have been discussed elsewhere in this work. Common law doctrine affords very little protection for intellectual property, and successful assertion of an exclusive interest under 35 U. S. C. Section 271 is not as simple as demonstrating possession and implying that the possessor is infringing the patent as a result of strict liability. The reason behind this assertion is that while the patent statute requires strict liability with respect to the exclusive interest of the patentee (meaning that it is irrelevant whether the alleged infringer knew that the invention was patented) there must be scienter with regard to acts which cause legal liability. Thus, scienter with regard to the existence of the patent is not equivalent to scienter with regard to the infringing acts. An alternative route to assertion of the interests may exist if the seed manufacturer acquired the right to pollute the land of Farmer Adams. Under this alternative, Farmer Adams would necessarily have to obtain a technology-use license from the seed manufacturer as a part of the shifting of the right to control the use of his land to the seed manufacturer.

The patent statute[830] is silent on the right of a patent holder to pollute, and specifically Section 101 is silent on the right of a utility patent holder to pollute the property of others with the protected property. The statute grants only the right to exclude others from making, using, selling, or offering to

829. *See* Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 488 (1942).

830. Title 35 of the United States Code.

sell the invention patented.[831] There is no statutory grant of a right to make, use, offer to sell, or sell the invention patented.[832] The patentee may grant a license to Farmer Jack. The license is a waiver by the seed manufacturer of the right to sue Farmer Jack when he chooses to make, use, offer to sell, or sells the patented invention, which for simplicity is taken to be the transgene. While neither Farmer Jack nor the seed manufacturer have the statutorily granted right to make, use, offer to sell, or sell the invention patented, the seed manufacturer, through the vehicle of the license, is relinquishing its right to sue Farmer Jack should Farmer Jack decide to make, use, offer to sell, or sell the invention.[833] Since the seed manufacturer does not have the statutorily granted right to pollute, it cannot shift that right to Farmer Jack, either outright or through a license agreement. The license agreement also does not shift the risk, of the genetic pollution of the fields of Farmer Adams by the transgene, onto the licensee, Farmer Jack. Should Farmer Jack sign such a license to assume such a risk, he would certainly be a fool headed for financial destitution.

The property law concepts of nuisance and trespass are helpful in examining these issues. Nuisance theory arises from the right of the property owner to the use and enjoyment of his property without interference from others,[834] while trespass theory arises from the exclusive interest that the property owner has in the "exclusive possession of his land."[835] There are two competing interests in the case: first is the right of the manufacturer to use its property as it sees fit, which includes the manufacture of a thing that is beneficial to society; the second is the right of the individual property owner to the use and enjoyment of his property without interference. Independent of the outcome of a trial in a court of justice, the loser may simply pay the winner an amount sufficient to obtain an easement for the continued exercise of their uninhibited rights. If either Farmer Jack or the seed manufacturer has the right to exercise their respective property interests, they may simply pay Farmer Adams an amount sufficient to compensate Farmer Adams for his permanent losses and continue with business as usual. Before assigning the right to pollute, it is first necessary to determine the relative interests of Farmer Jack and Farmer Adams in the agricultural enterprise.

Farmer Jack has no statutorily granted right to either "make"[836] the transgene or have the

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831. *See* 35 U.S.C. § 271 (1997). *See also* Continental Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 424 (1908) (stating that the patentee "receives nothing from the law that he did not have before, and that the only effect of the patent is to restrain others from manufacturing and using that which he has invented").

832. Justice Clarke stated in *Motion Picture Patents Co. v. Universal Film Mfg. Co*, that "the only effect of his patent is to restrain others from manufacturing, using or selling that which he has invented." 243 U.S. 502, 510 (1912).

833. Interestingly enough, Farmer Jack cannot "make" the invention patented, as discussed above. The waiver by the seed manufacturer of its right to sue Farmer Jack can only relate to the use, offer to sell, or sell privileges exercised by Farmer Jack. Further, if the transgene expresses the characteristic in the plant of herbicide resistance and if Farmer Jack does not use the herbicide for which specific resistance is conferred on the plant, then Farmer Jack is also not "using" the transgene or its expressed compounds. While these points may seem to be fine, they do assist in clarifying the precise nature of the relationship between Farmer Jack and the seed manufacturer.

834. *See* PROSSER AND KEETON ON THE LAW OF TORTS 619 (W. Page Keeton et al. eds., 5th ed. 1984).

835. *Id.* at 622.

836. To clarify the distinction made here, to "make" the transgene is to produce, employing the techniques of molecular biology, the precise DNA sequence required for the transgene. Through commonly employed

transgene reproduced by the cellular machinery of the plants on his land. Since the public has exclusive interest in the plant genome, the public may grant Farmer Jack permission, in essence a license, to plant the seed and initiate the process whereby the consumable portion of the plant is generated or reproduced.[837] Such a license is granted equally between Farmer Jack and Farmer Adams. The license is not granted to the seed manufacturer, because it is not desirous of the license; rather the seed manufacturer is granted the exclusive interest in the transgene or to the combination of the plant genome and the transgene in exchange for public access to the resulting technology. The resulting technology advances society economically and it must be of benefit to the public.[838] The seed manufacturer can neither alienate nor license to Farmer Jack the right to make, use, sell, or offer to sell the plant genome because it does not possess the interest to do so. The rights of Farmer Jack and Farmer Adams are equal with respect to producing a consumable crop on their respective fields. As discussed earlier, neither farmer interferes with the right of the other to plant the seed. Because of the equality of the license, neither farmer can be favored over the other based on the right to use land for crop production. The seed manufacturer cannot be granted the right to pollute on this basis because it is not producing a consumable crop.

There are strongly competing public rights that exist within the right of choice. These are the right of the public to choose crops with the transgene and the right of the public to choose crops without the transgene.[839] The right of those members of the public to consume crops with the transgene is as strong as the right of those members of the public to consume crops without the transgene. That a majority of the public is either indifferent to consumption of the transgene or wishes to consume crops containing the transgene is irrelevant to whether the relative rights of these two subsets of the public must be given equal weight. There is no particular reason to favor one subset of the public over the other subset, and the exercise of the right of choice by each subset is reasonable. If Farmer Jack is granted the right to have the transgene translocated from his fields, then Farmer Adams will be denied

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agricultural production techniques, the farmer plants a seed, which may or may not contain the transgene, thereby initiating the process by which the consumable crop is produced and the transgene is reproduced by the cellular machinery of the plant. If the seed planted by the farmer does not contain the transgene then the farmer, by planting the seed, does not even initiate the process by which the transgene is reproduced in the cells of the plant or produced in the progeny seed. Indeed, Farmer Jack and the seed manufacturer initiate the process leading to the contamination of such plants.

837. Even though Farmer Jack purchased the seed from a vendor, he does not necessarily have a license from the public to have the consumable portion of the plant reproduced on his lands. The clearest example of the distinction is the marijuana seed. A person may purchase marijuana seeds from the local vendor, and therefore the person owns the seeds. However, it is a criminal offense to plant the seeds to initiate the process by which marijuana plants are produced.

838. That the resulting technology must be for the benefit of the public arises from Justice Story's statement that a "useful" invention is "one as may be applied to some beneficial use in society, in contradistinction to an invention, which is injurious to the morals, the health, or the good order of society." Bedford v. Hunt, 3 F. Cas. 37 (C.C.D. Mass. 1817) (No. 1217). Justice Story further stated that "[a]ll that the law requires is, that the invention should not be frivolous or injurious to the well-being, good policy, or sound morals of society." Lowell v. Lewis, 15 F. Cas. 1018, 1019 (C.C.D. Mass. 1817) (No. 8568). Inventions that are not patentable include "a new invention to poison people, or to promote debauchery, or to facilitate private assassination." *Id.*

839. The right of the public to have a choice will become a stronger issue when the consumable crop is from plants that produce plastics, *see, e.g.*, Maliyakal John, *Transgenic Cotton Plants Producing Heterologous Polyhydroxy(E) Butyrate Bioplastic*, U.S. PAT. NO. 5,602,321 (issued Feb. 11, 1997), anti-cancer drugs, antibiotics, antibodies, anti-psychotic drugs, and other pharmaceuticals.

his ability to produce a crop free of the transgene and the public that chooses to consume crops free of the transgene will not have such crops locally available. If Farmer Adams is granted the right to not have the transgene translocated onto his fields, then Farmer Jack will be denied his ability to produce a crop with the transgene and the subset of the public that chooses to consume crops containing the transgene will also not have such crops locally available. Either way, the respective choice of the members of the public will be denied. Also, the right to pollute cannot be shifted to the seed manufacturer because, as in the case of favoring Farmer Jack over Farmer Adams, the result would be discriminatory against that part of the public that chooses to not have the transgene or its products. Further, the seed manufacturer has no economic or commercial interest in planting the seeds or engaging in agricultural practices that would yield a crop for consumption by the public. Rather, the seed manufacturer has only the economic interest of selling the transgenic seeds and the technology-use license to Farmer Jack.

It might be argued that both the seed manufacturer and Farmer Jack are engaged in legitimate business enterprises, and hence immune to a cause of action for nuisance. It is unquestionable that Farmer Jack and the seed manufacturers are each engaged in a legitimate business enterprise.[840] However, the legitimacy of the business enterprise does not eliminate the clear right of the individual specially injured by the pollution to seek preventive relief.[841] Farmer Adams is, indeed, specially injured by the pollution of his lands by the transgene.

Farmer Adams has a license from the public to plant seeds containing the plant genome in which the public has exclusive interests. The public benefits from having access to the consumable portion of the plant resulting from the efforts of Farmer Adams. The seed manufacturer was granted a license to develop a combination of the plant genome and the transgene and was subsequently granted exclusive interest in the combination (but not in the plant genome). The public benefits from this arrangement over not having access to the patented technology only to the extent that a choice free from the transgene is locally available, and only to the extent that the risk of injury to the public and damage to the environment is no greater than that associated with the continued use of the non-modified variety of plant. The general rule of property is that the owner may exercise exclusive interests in his own property, and may "subject it to such uses as will best subserve his private interests."[842] While no other person may, in general, infringe on the right of the owner to exercise his exclusive interests in his own property, the owner may not, in general, infringe excessively upon the corresponding rights of those around him. This, of course, does not imply that the property owner must never use his "own property so as to do any injury to his neighbor or his property."[843] However,

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840. *See, e.g.*, United Verde Extension Mining Co. v. Ralston, 296 P. 262, 264 (Ariz. 1931) (stating that the operation of a "smelter is a perfectly lawful business and necessarily not a nuisance per se").

841. *See* Ariz. Copper Co., Ltd. v. Gillespie, 230 U.S. 46, 57 (1912). The Supreme Court held that contamination of waters in Arizona by a copper plant upstream of the lower appropriators constituted a nuisance and under the circumstances of the case an injunction was properly granted. The defendant might have the decree modified upon completion of remedial works to avoid future contamination. *See id.* at 58-59.

842. Campbell v. Seaman, 63 N.Y. 568 (C. App. N.Y. 1876). The plaintiff was awarded damages for injury by sulphuric acid gas to white and yellow pines and Norway spruce as well as destruction of from "100 to 150 valuable pine and spruce trees, and had injured their grape vines and plum trees." *Id.* at 576. The sulphuric acid gas was produced as the result of burning bricks with anthracite coal. *See id.*

843. *Id*. at 577.

the owner of the property is bound to cause no unnecessary injury or annoyance to those property owners that are his neighbors through unreasonable use of his own property. The basic rule of nuisance theory is that the property owner will be guilty of a nuisance if "he make[s] an unreasonable, unwarrantable or unlawful use of it, so as to produce material annoyance, inconvenience, discomfort or hurt to his neighbor."[844] The requirement for a successful cause of action for nuisance is that the property owner's use must "produce a tangible and appreciable injury to neighboring property, or such as to render its enjoyment specially uncomfortable or inconvenient."[845] As noted earlier, if the seed manufacturer is granted the right to pollute the fields of Farmer Adams with the transgene, Farmer Adams either must submit to the technology-use license[846] or will not be able to enjoy the use of his lands for agricultural production, and the public will be harmed. If the seed manufacturer is not granted the right to pollute the fields of Farmer Adams, then Farmer Jack either must plant a non-modified variety of seed or will not be able to enjoy the use of his lands for agricultural production, and the public will be harmed. The issue is then whether the seed manufacturer is granted the right to pollute the fields of Farmer Adams or whether Farmer Adams is granted the right to be free from the pollution.

The basis for the assignation of the right to pollute or to be free from pollution was clearly articulated by Judge Earl in 1876 when he stated that:

> One cannot erect a nuisance upon his land adjoining vacant lands owned by another and thus measurably control the uses to which his neighbor's land may in the future be subjected. He may make a reasonable and lawful use of his land and thus cause his neighbor some inconvenience, and probably some damage which the law would regard as damnum absque injuria. But he cannot place upon his land any thing which the law would pronounce a nuisance, and thus compel his neighbor to leave his land vacant, or to use it in such way only as the neighboring nuisance will allow.[847]

If the seed manufacturer is granted the right to pollute, then Farmer Adams will be forced to either discontinue agricultural production or produce a crop containing the transgene. Further, the public will lose its right to choose between consuming crops with the transgene and crops without the transgene. The assignation of the right to pollute also depends upon the relative injury to the two parties. If the injury to Farmer Adams is small or trifling, and the damage to the seed manufacturer is large in the event that the seed manufacturer is restrained from polluting the fields of Farmer Adams, the restraint may not be placed upon the seed manufacturer. The damage to Farmer Adams is considerable. He will loose access to his premium market, he will loose his own interests in his own plant variety, and his crop may have to be destroyed if the seed manufacturer is granted the right to pollute. The

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844. *Id*.

845. *Id.*

846. In this scenario, Farmer Adams may still plant the non-modified variety of seed but must still sign the technology-use license to avoid liability.

847. Campbell v. Seaman, 63 N.Y. 568, 584 (N.Y. App. Ct. 1876).

ancient maxim remains applicable: *Sic utere tuo ut alienum non laedas.*[848]

The only reasonable resolution is to assign to Farmer Adams the right to have his lands and plants free from genetic pollution. Should the transgene translocate onto the lands of Farmer Adams the person claiming exclusive interest in the legal estate consisting of the transgene must be held liable for the genetic pollution. Further, if the transgene proves injurious to the health of the subset of the public who chose to not consume crops containing the transgene, then the person claiming exclusive interest must also be held liable for the injury to that subset of the public.

One school of economic analysis in the law states that once the initial rights of interfering parties is delimited, market transactions will yield an optimum utilization of the rights of the parties.[849] Under this theory, the institution of private property interests in combination with the pricing system inherent in the market transactions will resolve the conflicts between the interfering parties. In the case of interference between radio operators at the same or adjacent frequencies, the operator who had the right to stop the interference with his transmission would forego his right "if he were paid more than the amount by which the value of his service was decreased by this interference or the costs which he would have to incur to offset it."[850] The interfering operator would pay an "amount up to the costs of suppressing the interference or the decrease in the value of the service he could provide if unable to use his transmitter in a way which resulted in interference" to be allowed to interfere.[851] In the alternative, if the interfering operator had the right to interfere, he would desist "if he were paid more than the costs of suppressing the interference or the decrease in the value of the service he could provide if interference were barred."[852] In addition, the operator whose signals were being interfered with could halt the interference by payment of "an amount up to the decrease in the value of his service that it causes or the costs he has to incur to offset the interference."[853]

A further refinement of this line of thought leads to the conclusion that the rights to perform certain activities constitute the factors of production. The loss, which is suffered by others because of the exercise of the totality of the factors of production, is the cost of exercising those factors.[854] It is a tempting extension of this theory to consider only the costs associated with the exercise of a right (that is the factor of production) in determining which of the interfering parties is assigned that right.

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848. *See id.* at 576. "To use your own so that you do not injure another." Andrews v. Andrews, 88 S. E.2d 88, 92 (N.C. 1955) (plaintiff was awarded damages for destruction of his crops by wild geese lured to a pond located on a neighbor's land).

849. *See* R. H. Coase, *The Federal Communications Commission*, 2 J. L. ECON. 1, 27 (1959).

850. *Id.* at 28.

851. *See id.*

852. *Id.*

853. *Id.*

854. *See* R. H. Coase, *The Problem of Social Cost*, 3, 44 J. L. ECON. 1 (1960) (stating that "[i]f factors of production are thought of as rights, it becomes easier to understand that the right to do something which has a harmful effect . . . is also a factor of production").

This clearly ignores the basic tenant of social cost theory, which is that it is "desirable that the choice between different social arrangements for the solution of economic problems should be carried out in broader terms than this and that the total effect of these arrangements in all spheres of life should be taken into account."[855] The reduction of the right to be free of harmful effects of another's actions to an economic factor of production allows the party with the greater economic, and hence legal, resources to place upon the right to engage in the harmful activity a very high value while placing upon the right to be free of the harmful effects of that activity a very low value. This result simply ignores "the total effect of these arrangements in all spheres of life."[856] That is, while the seed manufacturer may possess resources considerably in excess of Farmer Adams, social cost analysis will not necessarily render the conclusion that the optimal arrangement is for the seed manufacturer to possess the right to pollute the lands of Farmer Adams and to possess the right to sue Farmer Adams when the transgene is translocated to his lands.

The seed manufacturer possesses no right to pollute the land of Farmer Adams. No language exists in the patent statute that dictates that liabilities lie with Farmer Jack when the property of the seed manufacturer is translocated onto his lands. Neither Farmer Jack nor the seed manufacturer have a statutorily granted right to make, use, or sell the property of the seed manufacturer; hence there is no right to pollute associated with the right to manufacture or produce a consumable crop. Nuisance theory dictates that Farmer Adams has the right to make use of his lands for agricultural production free of genetic pollution, and the seed manufacturer cannot obtain the right to pollute the lands of Farmer Adams either through direct application of nuisance theory or through the machinery of social cost theory. Further, the public will be denied its right of choice if the seed manufacturer obtains the right to pollute. Under common law, the seed manufacturer cannot enforce its exclusive interest because the discovery and propagation of plants containing the transgene by Farmer Adams was done through no nefarious deeds on the part of Farmer Adams. Under the patent statute, the seed manufacturer cannot enforce its exclusive interests because it does not have the right to pollute the lands of Farmer Adams, it knows that the genetic pollution will occur in the open environment, and because it comes to the courthouse door with "unclean hands."

CONCLUSION

There is a tension between the rights of the seed manufacturers in the intellectual property underlying genetically modified plants and the rights of the farmers in their land and the crop produced on his land from his labors. The rights of the seed manufacturers include the right to exclude others from making, using, offering to sell or selling the protected plants. A utility patent affords the strongest form of protection for the intellectual property, and the farmer may only make, use, or sell the crop from genetically modified plants when he has signed a technology-use license. Because Jack purchased and planted the beans without a technology-use license, the seed manufacturers can successfully sue him for infringement of their property rights. Through the technology-use license, the seed manufacturers can force Jack to give up his property rights in the crop he produces and in the land upon which the beans are grown. The technology-use license also prohibits Jack from saving

855. *Id.* at 43.

856. *Id.*

seed from one crop for planting in the next crop cycle. The patent statute has typically been interpreted as meaning that if a farmer has a patented transgene on his property then he is guilty of infringement of the property rights of the seed manufacturer. While the intent of the farmer is inapposite to the right of the patentee to assert his exclusive rights, the strict liability interpretation is overly strict because it eliminates the scienter element required in the "making," "using," or "selling" of the invention patented. Furthermore, the strict liability interpretation of the patent statute ignores the fact that the seed manufacturer may come to the courthouse doors with unclean hands, in which case the seed manufacturer may not assert its case against the farmer.

The farmer need not remain the weak participant in agricultural biotechnology. Through farm marketing associations, a collective of farmers may develop its own intellectual property in both conventional hybrid and genetically modified plant varieties. In this case, farmers, through farm marketing associations, can come to the negotiating table with seed manufacturers as equals.[857]

857. In epilog, both Percy Schmeiser and Dallas Thomason have appealed the decision of the trial court. The appeals have not been decided at publishing of this article.

Appendix A

To gain some fundamental understanding of the economics underlying the introduction of hybrid maize varieties into the United States farm market, it is necessary to review the maize production and cost statistics between 1900 and 1950. In Figure 1, below, the annual yields of corn (for grain), in bushels per acre, are presented for the states of: Illinois, panel (a); Indiana, panel (b); Iowa, panel (c); Missouri, panel (d); and Ohio, panel (e). Also, in panel (f) the aggregate annual United States corn yield, in bushels per acre, is given with the average for the five indicated states. The yield data is readily available from the U.S.D.A. National Agricultural Statistical Service website. Specifically, the data presented in Figure 1 was obtained by querying the database for the relevant states and for the required years.[858] To insure reliability of the data collected from the website, the original U.S.D.A. Agricultural Statistics bulletins were consulted.[859]

It is difficult, if not impossible, to distinguish the maize yield levels between Illinois, Indiana, Iowa and Ohio. By inspection of Figure 1, and Table 1, it is readily seen that the maize yield levels did not change substantially between 1900 and 1920. In 1920 the expected "Four State"[860] yield was approximately 40 bushels per acre, see Table 1, the "Five State"[861] yield was approximately 35 bushels per acre, and the total U.S. aggregate expected yield was approximately 27 bushels per acre. While the states of Illinois, Indiana, Iowa, and Ohio had an expected yield increase of approximately 0.1 per centum, of the yield level in 1900, per year, and the United States aggregate expected yield declined by approximately 0.01 per centum, of the expected level in 1900, per year.[862] The expected annual yield for the "Four State" aggregate fell, on average, between the years of 1920 and 1936 by approximately 1.2 per centum per year; such that by 1936 the expected average corn yield was approximately 32 bushels per acre. The "Five State" annual average yield declined by approximately 1.5 per centum of the 1920 yield level between 1920 and 1936 while the overall U.S. total yield declined by 1.65 per centum of the average U.S. yield level in 1920. In the 13 years between 1937

858. See NASS, *State Level Data for Field Crops: Grains*, U.S.D.A. STATISTICAL SERVICE *at* http://www.nass.usda.gov:81/ipedp/.

859. Specifically, the U.S.D.A. Agricultural Statistics bulletins consulted were for the years 1924, 1930, 1932, 1933, 1936, 1946, 1952, 1972, 1998, and 1999.

860. The "Four State" annual aggregate yield is computed as the direct average of the annual yield of Illinois, Indiana, Iowa, and Ohio.

861. The "Five State" annual aggregate yield is computed as the direct average of the annual yield of Illinois, Indiana, Iowa, Missouri and Ohio.

862. The statistical results reported in this work are computed based directly upon the agricultural statistical data obtained from U.S.D.A. reports. The analysis is as follows: The U.S.D.A. agricultural statistics for the yield of corn, in bu./acre, were obtained from the U.S.D.A. National Agricultural Statistical Service website at http://www.nass.usda.gov:81/ipedp/. The corn yields for the years in any particular desired range of years were segregated and analyzed using basic data statistical techniques (computing mean, variance, etc.) and simple linear regression to determine trends in the yields over the relevant range of years. For any given range of years, the origin of the abscissa axis is taken as the beginning of the range of year, and the "y-intercept" is computed as the intersection of the linear regression graph and the vertical line situated at the origin of the abscissa axis. The per centum change in the yield is easily computed as the slope of the linear regression equation divided by the y-intercept value and multiplied by 100%. See Table 2 for the linear regression results of the average corn yields for the "Four States," the "Five States," and the U.S. Total for the years between 1920 and 1936.

and 1950, the expected yield changes were, in per centum of the 1937 expected yield for the category, 0.8 for the "Four State" aggregate, 1.3 for the "Five State" aggregate, 2.9 for the U.S. Total aggregate.

It is not surprising that farmers in those states were amenable to the educational and advertising campaigns conducted by both the U.S.D.A. and the seed manufacturers.[863] While the trend in the yields did change starting in 1938, it is not clear whether the modest increase was due to the introduction and acceptance of hybrid maize varieties, or whether the change was due to other factors (the yield, averaged over the principal four states in the corn belt is approximately 30% higher than the average for the two decades from 1900 to 1920, when the average varied little over these two decades). While the average yield for the corn belt increased between 1939 and 1956, the average in 1956 was only approximately 12% higher than the average yield in 1939. Further, the average yield in 1956 exceed the average yield for the first two decades of the century by only approximately 48% of the latter yield level. To examine more carefully the relation between yield and use of hybrid maize varieties by farmers, these two quantities are plotted, for the years from 1930 to 1950, in Figure 2 for: Illinois, panel (a); Indiana, panel (b); Iowa, panel (c); Missouri, panel (d); and Ohio, panel (e). The U.S. average corn production, for grain, is presented in panel (f) for the years from 1930 to 1950.

In Figure 2, both the annual yield per acre, for each state and the percentage of all acres of corn planted to hybrid maize varieties are given for each year between 1930 and 1950, inclusive.[864] The data for the yield of maize was collected as indicated in footnotes 858 through 862. It should be noticed that a substantial difference exists between the expected and actual yield levels for 1937. The expected yield value in 1937, based upon the yield levels between 1920 and 1936, were: for the "Four State" aggregate, the expected yield was 31.6 bushels per acre and the actual average production was 45.3 bushels per acre (a 43 per centum difference); for the "U.S. Total" aggregate, the expected yield was 20.6 bushels per acre while the actual average production was 28.9 bushels per acre (a 40 per centum difference). It is striking that while the average percent of corn acreage planted to hybrid corn varieties in the "Four State" aggregate was 18 per centum, the actual yield was 43 percent above the expected level based upon the 1920 through 1936 yield. Further, the corresponding numbers for the "U.S. Total" aggregate are 7.9 and 40 respectively. By inspection from Figure 2, panels (a) and (b), it is clear that between 1936 and 1937 the yield nearly doubled in both Illinois and Indiana even though the percent of all corn acreage planted to hybrid varieties were

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863. *See generally* Donald N. Duvick, *Biotechnology in the 1930s: The Development of Hybrid Maize*, 2 NATURE REVIEWS GENETICS 69-74 (Jan. 2001).

864. The data for the percentage of all corn acreage planted to hybrid maize varieties was collected from U.S.D.A. publications as follows: the data for all states, and the United States total aggregate, for the years 1933 through 1945 were obtained from 1945 U.S.D.A. AGRICULTURAL STATISTICS 42 (1945), and for 1946 the data was collected from 1946 U.S.D.A. AGRICULTURAL STATISTICS 41 (1946); the data for the years 1947 through 1950 is from 1951 U.S.D.A. Agricultural Statistics 45 (1951). The data for Missouri for the years 1945 through 1948 was obtained from 1948 U.S.D.A. AGRICULTURAL STATISTICS 48 (1948). The data for the United States total aggregate for the years 1945 through 1948 was collected from 1948 U.S.D.A. AGRICULTURAL STATISTICS 48 (1948) and the data for years 1949 through 1958 were obtained from 1959 U.S.D.A. AGRICULTURAL STATISTICS 32 (1959). The data for Indiana for the years 1946 through 1948 was obtained from 1948 U.S.D.A. AGRICULTURAL STATISTICS 48 (1948). The data for Illinois for the years 1947 and 1948 was obtained from 1948 U.S.D.A. AGRICULTURAL STATISTICS 48 (1948). The Ohio data for the years 1946 through 1948 was obtained from 1948 U.S.D.A. AGRICULTURAL STATISTICS 48 (1948).

approximately 25 and 11 per centum, respectively.[865] From a careful analysis of Figure 2 it is clear that the introduction of the hybrid varieties could not have caused the significant increase in corn yields observed between 1936 and 1937. To see this, consider that by 1938 the percent of all corn acreage planted with hybrid corn varieties was 47.5 per centum in Illinois and 51.9 per centum in Iowa; however, in neither state did the yield levels change significantly between 1937 and 1950.[866] Further, for all states studied, the yield levels changed only modestly between 1937 and 1950. Consider the results of the statistical analysis, of the agricultural statistics discussed in notes 858 through 862, presented in Table 3. For the years between 1937 and 1947, the yield levels changed as follows: for the "Four State" aggregate, the increase was less than 0.01 per centum of the expected 1937 value (of 47.5 bushels per acre) per year; for the "Five State" aggregate, the increase was 0.2 per centum of the expected 1937 value (of 43.8 bushels per acre); and for the "U.S. Total" aggregate, the increase was 1.7 per centum of the expected 1937 value (of 29 bushels per acre).

To gain a clearer picture of the influence of the deployment and use of hybrid seed varieties upon the corn yield levels between 1933 and 1946, it is necessary to consider the unexplained increase in the yield levels between 1936 and 1937. Presuming that the event that caused the increase was both not due to the use of hybrid maize varieties and was constant after 1937, then the yield levels between 1937 and 1946 may be adjusted by subtracting out excess 1937 increase from the yields of all years between 1937 and 1946. Appendix B below examines this relatively trivial calculation. Once the quantity $(Y_{act}(1937) - Y_{exp}(1937)$ (where y is the year of interest between 1937 and 1948, $Y_{act}(1937)$ is the actual corn yield for y 1937, and $Y_{exp}(1937)$ is the expected corn yield for 1937 based upon the corn yields between 1920 and 1936) is subtracted from the annual average yields for the years 1937 through 1946 then the statistical analysis may be executed in a relatively simple manner. The results, shown in Table 4 below, indicate that the yield levels changed as follows: for the "Four State" aggregate, the increase was approximately 1.7 per centum of the expected 1933 value (of 30.6 bushels per acre) per year; for the "Five State" aggregate, the increase was approximately 1.9 per centum of the expected 1933 value (of 27.4 bushels per acre); and for the "U.S. Total" aggregate, the increase was about 2.6 per centum of the expected 1933 value (of 19.5 bushels per acre).

The modest level of increase in productivity was not offset by a commensurate increase in profitability of maize production.[867] As demonstrated in Figure 3, the cost of producing a bushel of

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865. *See* 1945 U.S.D.A. AGRICULTURAL STATISTICS 42 (1945).

866. *See id*.; *infra*, Figure 2, panels (a) and (c).

867. Production costs were obtained from the following sources: for the years between 1937 and 1945, the production costs were obtained from 1947 AGRICULTURAL STATISTICS 47 (1948); for the years between 1933 and 1936, the production costs were obtained from 1943 AGRICULTURAL STATISTICS 44 (1943). *See also* U.S.D.A. *Cost of Producing Field Crops, 1925*, 3 CROPS AND MARKETS 170 (1926); U.S.D.A. *Cost of Producing Field Crops, 1926*, 4 CROPS AND MARKETS 202 (1927); U.S.D.A. *Cost of Producing Field Crops, 1927*, 5 CROPS AND MARKETS 196 (1928); U.S.D.A. *Cost of Producing Field Crops, 1928*, 6 CROPS AND MARKETS 202 (1929); U.S.D.A. *Cost of Producing Field Crops, 1929*, 7 CROPS AND MARKETS 220 (1930); U.S.D.A. *Cost of Producing Field Crops, 1930*, 8 CROPS AND MARKETS 232 (1931); U.S.D.A. *Cost of Producing Field Crops, 1931*, 9 CROPS AND MARKETS 222 (1932); U.S.D.A. *Cost of Producing Field Crops, 1932*, 10 CROPS AND MARKETS 226 (1933); U.S.D.A. *Cost of Producing Field Crops, 1933*, 11 CROPS AND MARKETS 66 (1935); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production, 1934*, 1936 AGRICULTURAL STATISTICS 342 (1936); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production, 1935*, 1937 AGRICULTURAL STATISTICS 396 (1937); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production, 1936*, 1938 AGRICULTURAL STATISTICS 440 (1938); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in 1937*, 1939 AGRICULTURAL STATISTICS 492 (1939); U.S.D.A. *Corn, Wheat, and Oats: Cost of*

corn increased by nearly 60 per centum, of the cost in 1936, between 1936 and 1945; however, the price of a bushel of corn did not increase significantly. In 1933, the season average price of corn was $0.52 per bushel, in 1936 the season average price of corn was $1.044 per bushel, while in 1945 the season average price was $1.14 per bushel.[868] Thus, in 1933 the average profit was 2¢ per bushel[869] and in 1936 the average profit was 2¢ per bushel[870] and in 1945 the profit was 8¢ per bushel;[871] however, the Consumer Price Index had increased nearly 48 per centum of its 1936 level by 1945.

In partial summary, the introduction of hybrid maize values between 1933 and 1948 corresponded with both a decline in average corn yield levels, between 1933 and 1936, and a modest increase in yield between 1937 and 1948 as well as a substantial increase in yield level between 1936 and 1937. Because hybrid varieties were not fully introduced between 1936 and 1937, it is difficult to argue that the use of hybrid maize varieties was a cause of that increase in yield. The use of hybrid maize varieties did not produce a substantial increase in yield between 1933 and 1946 when the yield levels are adjusted for the spike in 1937. Based upon the productivity levels discussed and the attendant economics of production, the deployment and use of the hybrid seed varieties did not leave the farmers financially better off during the two decades between 1930 and 1950.

The simple statement of the summary is that the introduction of hybrid maize varieties did not substantially alter the corn yield levels. However, even in light of modest, or no, increase in yield the immediate question is why did the farmers continue to purchase and use hybrid varieties? Under the theory of a purely competitive market, other cheaper but equally productive non-hybrid varieties would have entered the market and displace the hybrid varieties. The fact that the non-hybrid varieties effectively lost the entire market to hybrid varieties seems to indicate that the market was not purely

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Production in 1938, 1940 AGRICULTURAL STATISTICS 569 (1940); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in 1939*, 1941 AGRICULTURAL STATISTICS 576 (1941); U.S.D.A. *Cost of Producing Field Crops, 1940*, 18 CROPS AND MARKETS 308 (1941); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in 1941*, 1943 AGRICULTURAL STATISTICS 414 (1943); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in 1942*, 1944 AGRICULTURAL STATISTICS 434 (1944); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in Groups of States, 1943*, 1945 AGRICULTURAL STATISTICS 452 (1945); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production, 1945*, 1947 AGRICULTURAL STATISTICS 548 (1947); U.S.D.A. *Corn, Wheat, and Oats: Cost of Production in 1946*, 1948 AGRICULTURAL STATISTICS 604 (1948). The commodity index number for seed was obtained from 1946 U.S.D.A. AGRICULTURAL STATISTICS 551 (1946) and the consumer price index was obtained from 1946 U.S.D.A. AGRICULTURAL STATISTICS 559 (1946).

868. *See* U.S.D.A., *Corn: Acreage, Production, Value, and Foreign Trade, United States, 1929-1946*, 1946 U.S.D.A. AGRICULTURAL STATISTICS 39 (1946).

869. *See* U.S.D.A. *Cost of Producing Field Crops, 1933*, 11 CROPS AND MARKETS 66 (1935); U.S.D.A., *Corn: Acreage, Production, Value, and Foreign Trade, United States, 1929-1946*, 1946 U.S.D.A. AGRICULTURAL STATISTICS 39 (1946).

870. *Compare* U.S.D.A. *Cost of Producing Field Crops, 1933*, 11 CROPS AND MARKETS 66 (1935) and U.S.D.A., *Corn: Acreage, Production, Value, and Foreign Trade, United States, 1929-1946*, 1946 U.S.D.A. AGRICULTURAL STATISTICS 39 (1946).

871. *Compare* U.S.D.A. *Cost of Producing Field Crops, 1933*, 11 CROPS AND MARKETS 66 (1935) (the U.S. average price of producing corn was $1.06 per bushel) and U.S.D.A., *Corn: Acreage, Production, Value, and Foreign Trade, United States, 1929-1946*, 1946 U.S.D.A. AGRICULTURAL STATISTICS 39 (1946) (the season average price of corn in 1945 was $1.14 per bushel).

competitive.[872] In the nearly four and a half decades since 1956, the yield levels for maize have increased substantially so that by 2001 the yields were approximately 2.6 times the levels of 1956. Since hybrid maize varieties were completely integrated into American agriculture by 1956, the substantial rise in productivity must be due to factors other than the use of hybrid maize varieties (at least directly). A careful examination of these factors is outside the scope of this endeavor.

872. *See generally* Donald N. Duvick, *Biotechnology in the 1930s: The Development of Hybrid Maize*, 2 NATURE REVIEWS GENETICS 69-74 (January 2001) (indicating that both the U.S.D.A. and Pioneer Hi-Bred aggressively promoted the use of hybrid seed varieties).

Figure 1. Annual maize yields by state.

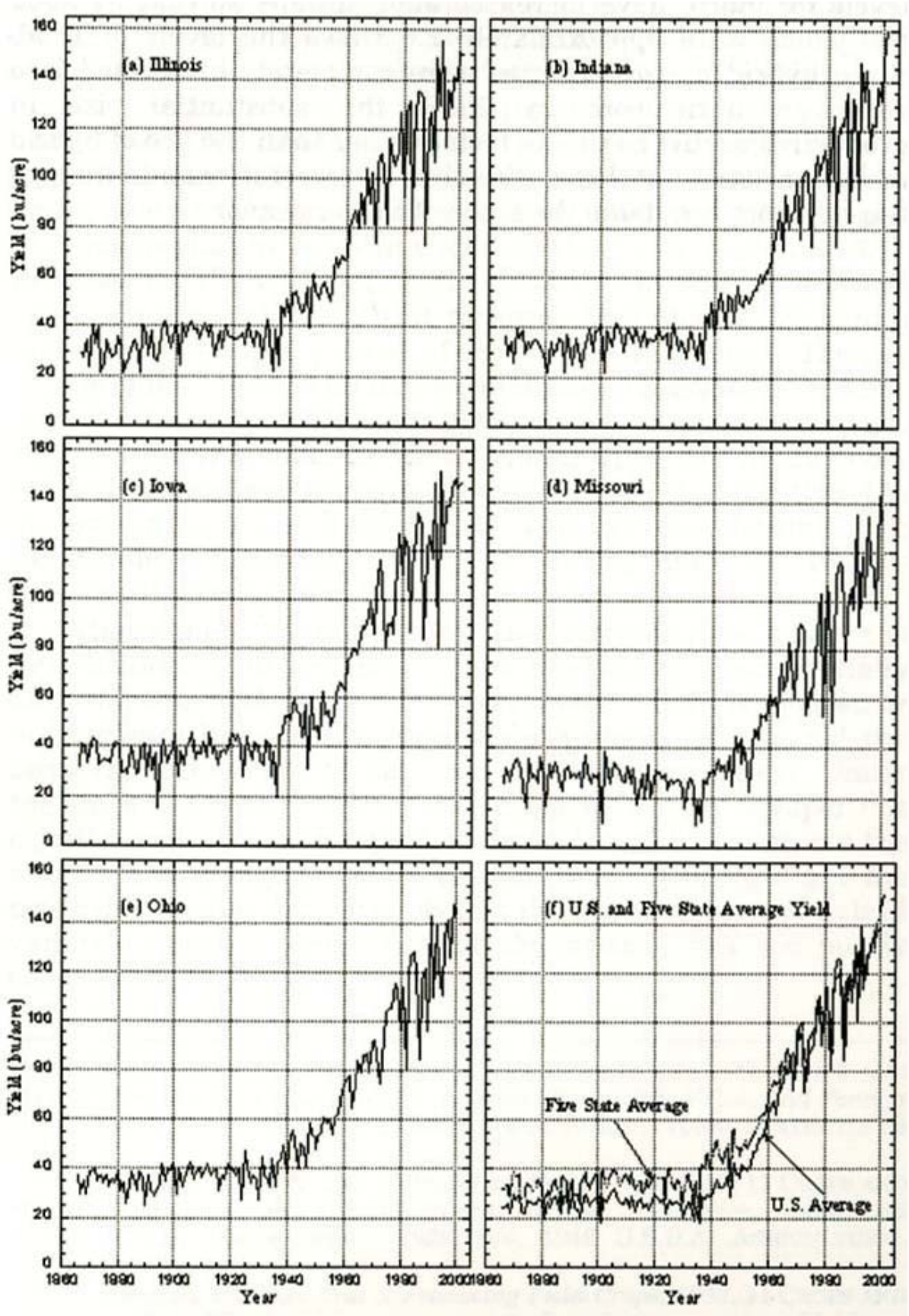


Figure 2. Maize yields and percent of corn acreage planted to hybrid varieties.

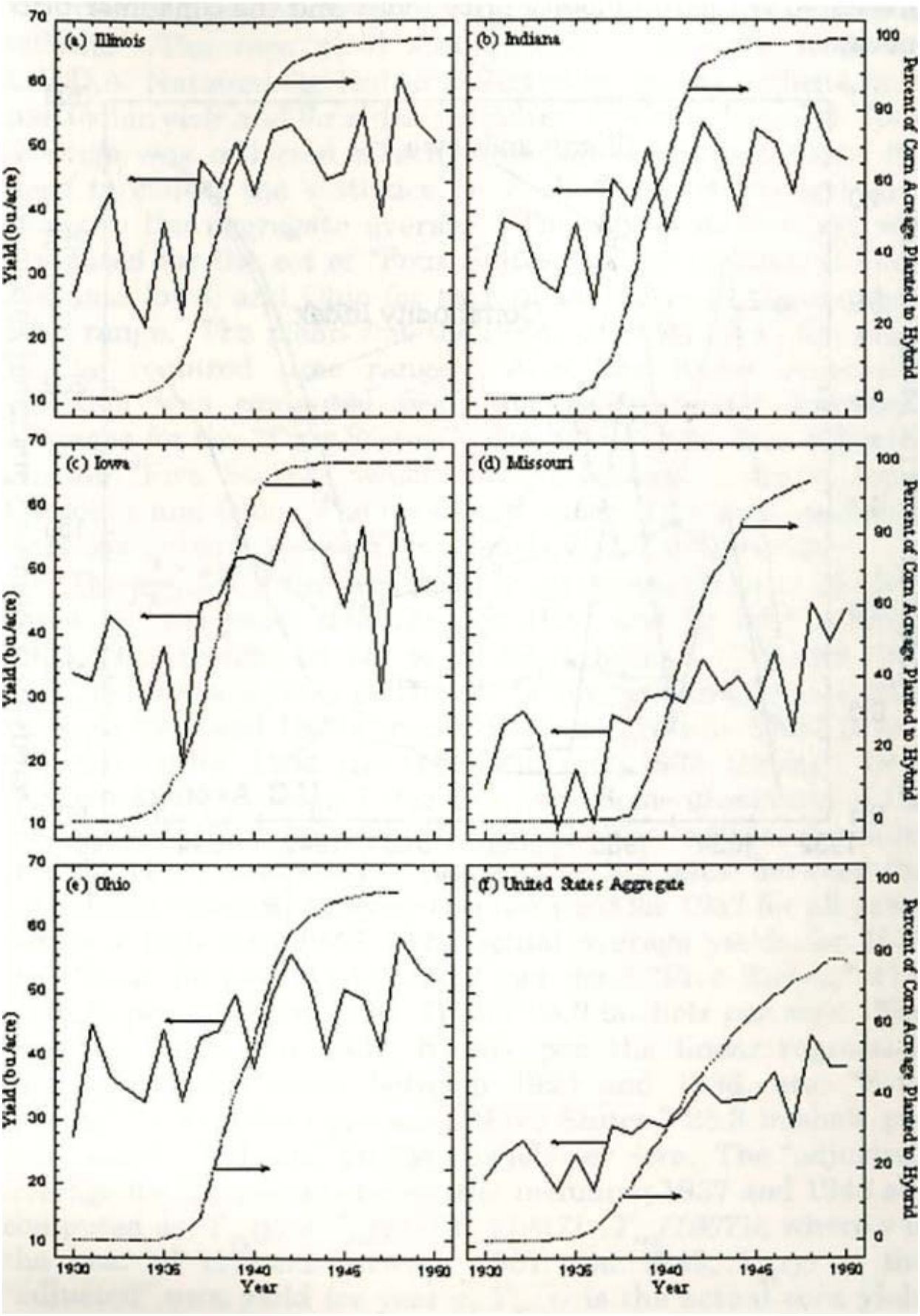
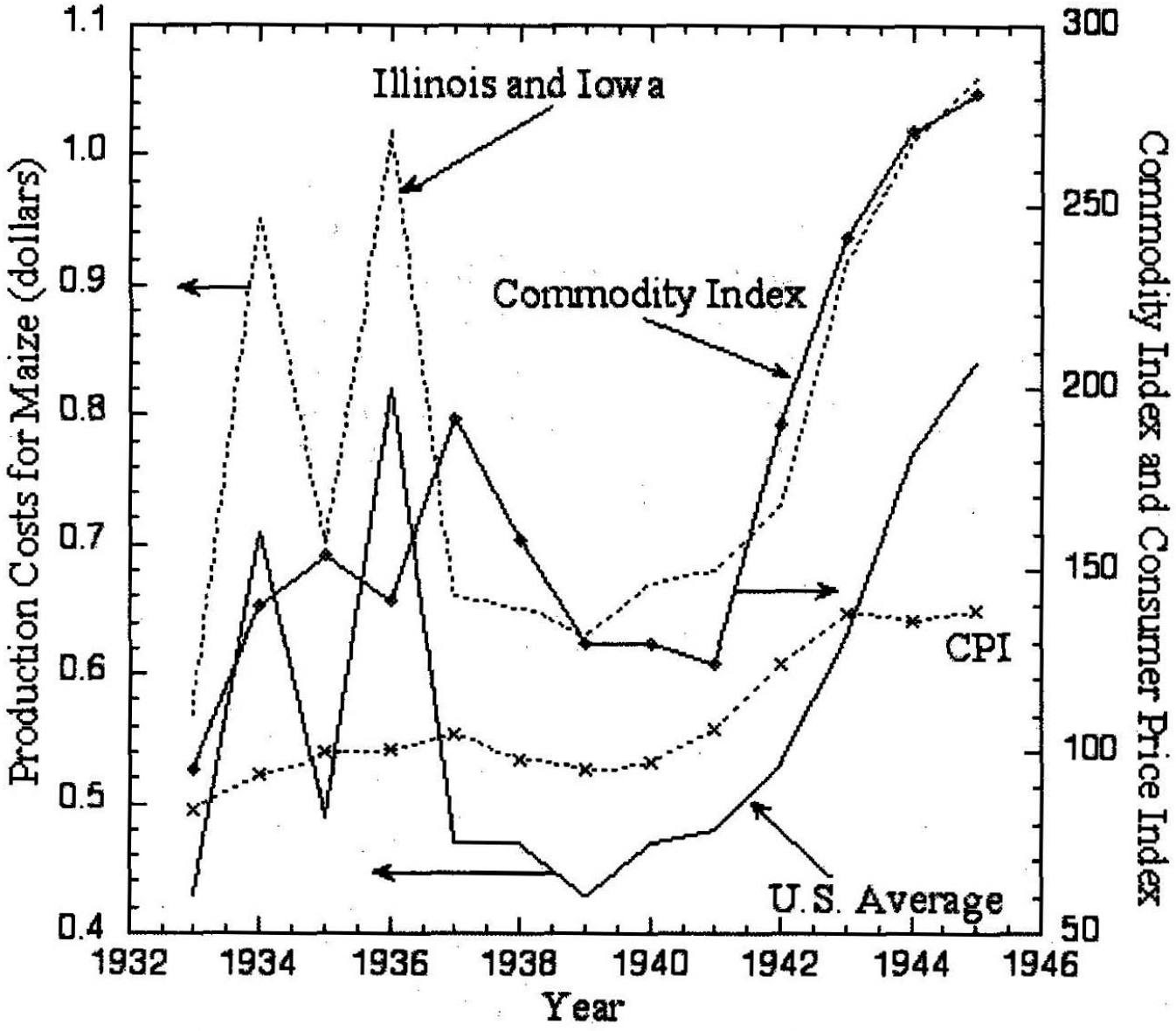


Figure 3. Maize production costs for Illinois and Iowa combined and for the United States in aggregate. Also presented is the commodity price index and the consumer price index.



Appendix B

The analysis of the corn yield statistics was performed as follows. The corn yield statistics were collected from the U.S.D.A. National Agricultural Statistics Service website for a particular year and for a desired range of years. The U.S. Total average was collected directly from the website without the need to collect the statistics for each of the states and then compute the aggregate average. The aggregate average was computed for the set of "Four States," which includes Illinois, Indiana, Iowa, and Ohio for each of the years in the required time range. The mean was then computed for all of the years in the required time range. Also, the linear regression equation was computed from the set of yearly aggregate averages for the "Four States." The process was then repeated for the "Five States," which include Illinois, Indiana, Iowa, Missouri, and Ohio. The mean and linear regression equations were computed based upon the yearly U.S. Total averages.

The results of the corn yield analysis are given in Table 1, below, for the years 1900 through 1920, and for 1920 through 1938. The results for the years 1920 through 1936 and 1937 through 1950 are given in Table 2, below; results for years 1937 through 1947 and 1933 through 1946 are given in Table 3; and the results for 1933 through 1946 and 1933 through 1946 (Adjusted) are given in Table 4, below. Some discussion of the results in

Table **4**, below, is warranted. The "adjusted" results in Table 4 are computed to remove the difference between the actual and expected difference in the yield for 1937 for all years between 1937 and 1946. The actual average yields for 1937 are: "Four States," 45.3 bushels per acre; "Five States," 41.7 bushels per acre; and "U.S. Total," 28.9 bushels per acre. The expected values for 1937, based upon the linear regression analysis for the years between 1920 and 1936, are: "Four States," 31.6 bushels per acre; "Five States," 28.3 bushels per acre; and "U.S. Total," 20.634 bushels per acre. The "adjusted" average for the years between and including 1937 and 1948 are computed as: $Y_{adj}(y) = Y_{act}(y) - (Y_{act}(1937) - Y_{exp}(1937))$; where y is the year of interest between 1937 and 1948, $Y_{adj}(y)$ is the "adjusted" corn yield for year y, $Y_{act}(y)$ is the actual corn yield for year y, and $Y_{exp}(1937)$ is the expected corn yield for 1937 based upon the corn yields between 1920 and 1936. The rational behind "adjusting" the corn yield data for the years between 1937 and 1948 is that the difference between the actual and expected (based upon the corn yields between 1920 and 1936) yields for 1937 are, arguably, not due to the introduction of hybrid maize varieties.[873] Therefore, to be able to assess the influence of the introduction upon the trend in corn yields over time due to the introduction of the hybrid maize varieties, it is necessary to remove the differences in the 1937 and subsequent year's data.

873. The difference between the actual and expected corn yield values for 1937 are: "Four States" equals 13.7 bushels per acre (30% based upon actual yield); "Five States" equals 13.4 bushels per acre (32% based upon actual yield); and "U.S. Total" equals 8.3 bushels per acre (29% based upon actual yield).

Table 1. Part A {1900-1920, 1920-1938}. Results of the statistical analysis of corn yield statistics for the range of years and for the states indicated. The mean value is the mean corn yield of all years indicated in the given range, and the linear regression equation is computed based upon the corn yields for the indicated years, where "y" is the year.

States	1900 - 1920		1920 - 1938	
Four States	Mean	37.348	Mean	36.632
	Linear	39.94 + 0.040 (y - 1900)	Linear	37.251 - 0.068 (y - 1920)
Five States	Mean	35.368	Mean	34.163
	Linear	35.28 - 0.008 (y - 1900)	Linear	35.789 - 0.1808 (y - 1920)
U.S. Total	Mean	26.743	Mean	25.154
	Linear	26.994 - 0.025 (y - 1900)	Linear	27.177 - 0.225 (y - 1920)

Table 2. Part B {1920-1936, 1937-1950}. Results of the statistical analysis of corn yield statistics for the range of years and for the states indicated. The mean value is the mean corn yield of all years indicated in the given range, and the linear regression equation is computed based upon the corn yields for the indicated years, where "y" is the year.

States	1920-1936		1937-1950	
Four States	Mean	35.706	Mean	49.912
	Linear	39.391 - 0.461 (y - 1920)	Linear	46.301 + 0.40 (y - 1937)
Five States	Mean	33.365	Mean	45.763
	Linear	37.897 - 0.57 (y - 1920)	Linear	42.34 + 0.53 (y - 1937)
U.S. Total	Mean	24.78	Mean	33.27
	Linear	28.47 - 0.46 (y - 1920)	Linear	27.93 + 0.82 (y - 1937)

Table 3. Part C {1937-1947, 1933-1946}. Results of the statistical analysis of corn yield statistics for the range of years and for the states indicated. The mean value is the mean corn yield of all years indicated in the given range, and the linear regression equation is computed based upon the corn yields for the indicated years, where "y" is the year.

States	1937-1947		1933-1946	
Four States	Mean	47.67	Mean	43.69
	Linear	47.5 + 0.04 (y-1937)	Linear	32.5 + 1.72 (y - 1933)
Five States	Mean	44.2	Mean	40.3
	Linear	43.77 + 0.095 (y - 1937)	Linear	29.3 + 1.69 (y - 1933)
U.S. Total	Mean	31.51	Mean	28.74
	Linear	29.0 + 0.502 (Y - 1937)	Linear	20.671 + 1.241 (Y - 1933)

Table 4. Part D {1933-1946, 1933-1946 (Adjusted)}. Results of the statistical analysis of corn yield statistics for the range of years and for the states indicated. The mean value is the mean corn yield of all years indicated in the given range, and the linear regression equation is computed based upon the corn yields for the indicated years, where "y" is the year.

States	1933-1946		1933-1946 (Adjusted)	
Four States	Mean	43.69	Mean	33.91
	Linear	32.5 + 1.72 (y - 1933)	Linear	30.579 + 0.513 (y - 1933)
Five States	Mean	40.3	Mean	30.7
	Linear	29.3 + 1.69 (y - 1933	Linear	27.4 + 0.51 (y - 1933)
U.S. Total	Mean	28.74	Mean	22.83
	Linear	20.671 + 1.241 (Y - 1933)	Linear	19.5 + 0.514 (y - 1933).