Chapter 5

Intellectual Property and Plants

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Intellectual Property and Plants

INTRODUCTION

Intellectual property protection for living organisms is not a novel or recent phenomenon. Proprietary protection specifically for plant varieties has evolved in the United States over the last 60 years. **Plants are the sole life form for which the U.S. Congress has expressly permitted intellectual property protection.**

Two Federal statutes specifically confer ownership rights to new plant varieties: the Plant Patent Act of 1930 (PPA) (35 U.S.C. 161-164) and the Plant Variety Protection Act of 1970 (PVPA) (7 U.S.C. 2321 et seq.). The Supreme Court decision in *Diamond v. Chakrabarty (8),* coupled with *Ex parte Hibberd (16),* affords individuals the additional option of seeking a utility patent (35 U.S.C. 101) to protect a novel plant variety. Inventors have the opportunity to protect their plant discoveries through three different mechanisms based on three different, and not necessarily exclusive, statutes. Credentialed protection of plants encompasses three forms: plant patents, Plant Variety Protection Certificates (PVPCs), and utility patents. Together with trade secrets, they cover thousands of different plants and varieties.

Historically, what has been the economic impact of patent and patent-like protection of plants? Have biotechnological advances altered the situation? In addition to providing economic incentives to develop new plants and varieties, have there been other ramifications of proprietary protection of plants? Are there perspectives from the evolution of plant protection that are pertinent to the debate surrounding animal utility patents?

This chapter examines the history of intellectual property protection of plants and the relevant Federal statutes. Different mechanisms of protection are compared, to highlight advantages and limitations. The impact of intellectual property rights on both the U.S. seed industries and the public interest is also discussed.

Two forms of intellectual property protection of plants are not discussed in this chapter: trademarks and seed certification. Since 1956, trademarks are not allowed on seed and plant varieties under the Federal Seed Act (7 U.S.C. 1551 et seq.). Although trademarks on ornamental crops, which are not specifically excluded under the Federal Seed Act, could be a looming issue (31). And, while Federal and State regulations for seed certification are important protection methods for some crops, such as potatoes (45), this chapter focuses on the legal and economic issues of the three principal means for inventors to protect plants-plant patents, PVPCs, and utility patents.

DEFINITIONS

Asexually reproduced plants are usually reproduced commercially by cuttings, grafting, and budding, but not by seeds. Asexual reproduction assures the production of plants that are exactly the same. A sexually reproduced plants include flowering plants, such as roses, chrysanthemums, African violets, and lilies; fruits, such as peaches, apples, oranges, grapes, and strawberries; nuts, such as pecans and walnuts; shrubs, such as azaleas, hollies, and lilacs; conifers; and broadleaf trees.

Sexually reproduced plants reproduce by seed. These plants include varieties (often called inbreds) such as corn, sorghum, and sunflowers. Inbreds are used to produce hybrids, which are the commercial product. Hybrids can neither be used to derive the original parent inbreds nor be used to produce commercial seed. Sexually reproduced plants also include nonhybrid varieties, such as wheat and soybean, which are the commercial product. Their progeny can be used for commercial seed.

Plant patents, authorized by PPA, protect plant varieties that have been asexually reproduced, including cultivated sports,[1] mutants, hybrids, and newly found seedlings. They cannot be obtained for plants reproduced from seeds, tubers (e.g., Irish potatoes or Jerusalem artichokes), and wild varieties found in nature that are not asexually reproduced. Bulbs, corms, stolons, and rhizomes are not considered to be within the tuber exception. For a period of

[1] A sport is an individual exhibiting a sudden deviation from type beyond the normal limits of variation, usually as a result Of mutation.

Photo credit: Artmaster Book Co.

17 years, a plant patent holder can exclude others from asexually reproducing, selling, or using the plant so produced. The Patent and Trademark Office (PTO) issues plant patents.

Plant Variety Protection Certificates, authorized by PVPA, provide a form of protection for new, distinct, uniform, and stable varieties of sexually reproducing plants, except fungi, bacteria, tuber-propagated or uncultivated plants, and first-generation hybrids. PVPA is administered by the Plant Variety Protection Office (PVPO) within the U.S. Department of Agriculture (USDA). Under PVPA, the breeder can exclude others from selling, offering for sale, reproducing (sexually or asexually), producing a hybrid from the variety, and importing or exporting the protected variety. Two exemptions limit the certificate holder's protection: farmers may save seed for crop production, and breeders may use the protected variety to produce new varieties-the so-called research exception. Furthermore, the Secretary of Agriculture can require the certificate owner to grant licenses to third parties if it is in the public interest. The period of exclusion is 18 years (7 U.S.C. 2483(b)).

Utility patents, issued under general patent law by the PTO, can be granted for plant inventions (35 U.S.C. 101) (8,16). Patents issued can claim plants, seeds, plant varieties, plant parts (e.g., fruit and flowers), processes of producing plants, plant genes, and hybrids. Utility patents for plants and varieties provide 17 years of protection for the owner. Chapter 3 discusses the requirements that inventions, including plants, must meet to be patentable.

This chapter reserves the term "plant patent" only for applications protected under PPA, and uses "utility patent" for plants covered by general patent protection (35 U.S.C. 101).

HISTORICAL PERSPECTIVE OF PROPRIETARY PROTECTION OF PLANTS

Granting inventors an exclusive right to their creations for a limited time is authorized in the Constitution, and patents have been available since 1790 pursuant to statute. Until the late 1920s,

Photo credit: U.S. Patent and Trademark Office

Design, plant patent 641, rose plant.

however, three factors **were** thought **to weigh** against patenting plants and plant varieties:

- first, the sentiment that plant varieties were products of nature and thus not patentable under the general patent statute (33);
- second, the view that a new plant variety could not be adequately described to comply with the description requirements of the general patent statutes (35); and
- third, the legislature's conclusion that plant breeding was not sufficiently reproducible to allow for stable, uniform, and true-to-type material suitable for patent protection (29).

In resolving these and other issues, Congress, the courts, and PTO have developed a history of deliberation s that span nearly six decades of debate about proprietary protection of plants.

The Plant Patent Act of 1930

Prior to 1930, plant breeding and research depended, for the most part, on federally funded agricultural experiment stations or limited endeavors of amateur breeders to develop new disease-resistant, cold-tolerant, drought-tolerant, or medicinal varieties. Yet while such goals loomed important to agricultural development, financial incentives for the U.S. private sector to develop new varieties were inadequate to recover research and development costs and earn a sufficient profit. Once a new variety left a breeder's hands, it could be reproduced in unlimited quantity by anyone. The breeder's sole opportunity for financial reimbursement was through high sales prices of comparatively few reproductions during the first 2 or 3 years after the variety's initial availability. Private industry sought greater returns through plant protection legislation to offset increased investments of capital and encourage plant development (39).

In 1930, Congress enacted PPA into law. PPA allows protection for new and distinct asexually propagated varieties other than tuber-propagated plants. It did not extend to a right to exclude others from propagating the patented plant by seeds. At the time, it was thought that seeds lacked capability to reproduce true-to-type.

Two additional requirements for issuance of plant patents were of concern: whether all plants were products of nature (33) and whether a complete, written disclosure of the invention was possible (35). In enacting PPA, Congress concluded that the work of the breeder was an aid to nature and thus a patentable invention (39). Addressing the second point of contention, Congress recognized the inherent difficulty in describing a new plant variety and relaxed the written description requirement (35 U.S.C. 162) by permitting it to be in accordance with traditional botanical descriptions (39).

Photo credit: U.S. *Patent and Trademark Office*

Design, plant patent 2,566, ash tree.

PPA was designed to encourage new variety development and to afford agriculture the benefits of the patent system. At the time, American agriculture recently had suffered from "phony peach disease" which had threatened the peach supply upon which the State of Georgia was so dependent, and "chestnut blight*' which had virtually destroyed an entire timber source. It was believed that plant breeders could produce new disease-resistant, drought-resistant, and cold-resistant varieties of plants to extend the range of fruit crops and blunt the effect of extremes in weather patterns.

Protection under PPA is for only a single variety (e.g., the rose "Peace") and not a group of varieties having a common trait (e.g., a rose having white flowers). It is an open question as to whether plant patent protection extends to plant parts, such as flowers, fruit, and cuttings, which may be the actual commercial embodiment of the variety, yet may be incapable of asexually reproducing the plant (17,46). Deposit of the plant is not required under PPA. Box 5-A describes some judicial interpretation pertinent to PPA.

Since 1930, over 6,000 plant patents have been issued by PTO (see table 5-1) (41). Among plant patents that have been issued include those for ornamental flowering plants, ornamental trees, fruit trees, nut trees, and grapes,

The Plant Variety Protection Act of 1970

As with pre-PPA plant breeding work, between 1930 and 1970 developing new sexually reproduced varieties (i.e., nonhybrid cultivars that are pure strains and breed true) was primarily undertaken by

Box S-A—The Plant Patent Act of 1930: Judicial Interpretation

The mere existence of a variety that had been asexually reproduced is not sufficient to prohibit a plant patent, if the distinctive characteristics of the variety and its value were not appreciated by anyone prior to the discovery by the inventor or no one had known of the existence of the variety.

This finding was clarified in a case involving a chrysanthemum, Yoder *Brothers, Inc. v. California-Florida Plant Corp. et al.* In *Yoder Brothers, the court* said, "the whole key to the invention of a new plant is the discovery of new traits plus the foresight and appreciation to take the step of asexual reproduction." The court also determined that the requirement of distinctness for plants essentially replaced the requirements of utility and nonobviousness for utility patents. In *Yoder Brothers, the* court also concluded that infringement under PPA was either the asexual reproduction of a patented plant or selling or using a plant so reproduced. The court held that it was not necessary to show production of the whole plant and that the taking of plant material or cuttings was sufficient to find infringement,

In *Pan-American Plant Company v. Matsui,* again involving a chrysanthemum, the court set forth the list of characteristics that distinguishes two varieties. (This list was originally set forth in the legislative history of PPA.) In this case, the plant patent owner destroyed a chrysanthemum, which was not disease-resistant, for which a plant patent was later issued. The inventor substituted a disease-resistant chrysanthemum variety developed by a third party by a mutational event similar to the original patented plant. This disease-resistant variety was marked with the number of the patented plant. The court concluded that the replacement chrysanthemum was not the patented plant, based on the disease-resistance characteristic not being specified in the plant patent.

In determining infringement, the court considers the characteristics of the alleged infringing variety and the description in the plant patent. If there is no match, infringement is not found. In *Kim Brothers v. Hagler,* for example, the court concluded the size and color of the allegedly infringing nectarines were not the same as the size and color of the patented nectarines described and shown in the plant patent.

In addition, the court requires proof of an asexual reproduction of the patented plant (i.e., a physical appropriation from one of the patented plants). When asexual reproduction has been established, a finding of infringement will result. In *Armstrong Nurseries, Inc. v. Smith, et al.,* the court found infringement as a result of the asexual reproduction of the patented roses and the sale of the asexually reproduced plants. The court also held that providing material for asexual reproduction was an active inducement to infringe and that assisting in the sale of the roses was a contributory infringement.

SOURCES: Office of Technology Assessment, 1989; *Armstrong Nurseries, Inc v.* Smith et *al.*, 170 F. Supp. 519 (ED. Tex. 1958); Cole Nursery *Co. v. Youdath Perennial Gardens, Inc., 17* F. Supp. 159 (N.D. Ohio 1936); *Kim Brothers v. Hagler. 276* F.2d 259 (9th Cir. 1960); Langrock, P., *Journal of the Patent Office Society* 41:787, *1959; Nicholson v. Bailey, 182* F. Supp. 509 (SC. Fla., Orlando Div., 1960); *Pan-American Plant Company v. Matsui, 433* F. Supp. *693* (N.D. Cal. 1977); U.S. Congress, Senate Committee on Agriculture, Nutrition, and Forestry. *Plant Variety Protection Act,* hearings before the Subcommittee on Agricultural Research and General Legislation, June 17-18, 1980 (Washington, DC: U.S. Government pruning Office, 1980); *Yoder Brothers, Inc v. California-Florida Plant Corp. et al., 537* F.2d *1347 (5th Cu. 1976).*

Table 5-l—Plant Patents Issued

Crop[a]	Number granted between					
	1931-62	1963-68	1969-73	1974-78	1979-83	1984-87
African violet	9	0	12	45	54	49
Almond	6	15	9	11	15	7
Apple	55	22	17	36	33	17
Azalea	49	40	34	27	7	4
Begonia	4	0	7	28	7	11
Camellia	38	5	4	1	0	1
Carnation	50	6	11	33	10	83
Chrysanthemum	133	38	68	155	99	128
Fuchsia	27	3	0	0	0	1
Gladiolus	30	53	8	6	0	0
Grape	10	8	5	9	16	14
Kalanchoe	0	0	5	33	14	30
Nectarine	59	14	25	29	17	23
Peach	151	29	29	30	34	30
Plum	25	18	6	16	14	31
Poinsettia	13	14	17	22	0	15
Rose	1,061	232	141	239	232	201
Strawberry	30	8	13	18	21	14
Annual average	53	108	111	189	162	227
Total	2,207	647	556	946	808	907

[a]Partial listing of most common plants, representing from 70 to 79 percent of plant patents for the time period.

SOURCES: American Association of Nurserymen, Plant Patents with Common Names, 1931-1862; 19631968; 1969-1973; 1974.1978 (Washington, DC: American Association of Nurserymen, 1963; 1969, 1974; 1981)

plant breeders at State agricultural experiment stations. With the acceptance that sexually reproducing plants can replicate "true-to-type," private industry sought increased financial incentives to invest in research and development of new nonhybrid cultivars. At the time, breeders in private industry worked primarily with corn and sorghum, of which the commercial product is hybrids, with some breeding efforts for alfalfa, cotton, sugar beets, and certain other vegetables.

In addition to stimulating private investment in developing sexually reproduced varieties, international events influenced U.S. deliberations to protect sexually reproduced plants (34). In 1961, a number of European countries formed the International Union for the Protection of New Varieties of Plants (UPOV) to provide national breeders' rights. Most European countries had laws offering legal protection to plant breeders, but U.S. breeders had no law protecting their innovations, except for asexually reproduced plants covered by PPA. Concern that U.S. agriculture and domestic breeders would beat a competitive disadvantage in international markets for seed (and for food, feed,and fiber crops produced from them), weighed in favor of actions to provide protection for sexually reproduced plants.

Following an unsuccessful 1968 attempt to amend PPA to include sexually reproduced plants, PVPA became law in 1970, Again, PVPA was enacted to encourage the development of novel, sexually reproduced plants by providing an economic incentive for companies to undertake the costs and risks inherent in producing new varieties and hybrids. The protection extends only to a single variety and not to a group of varieties having a common trait. In 1980, amendments to the original act added protection for six vegetable crops, and protection for woody varieties was extended from 17 to 18 years. Congress extended coverage to 18 years so that PVPA would be consistent with UPOV, which stipulated 18 years as the minimum term for the protection of woody plants (see ch. 10).

Two important exclusions to a certificate holder's protection under PVPA are specifically stated. First, a breeder cannot exclude others from using the protected variety to develop new varieties (research exemption), and second, a right to save seed/crop (farmer's exemption) is provided. According to this exemption, it is not an infringement for individuals whose primary farming occupation is growing crops for sale for other than reproductive purposes to save protected seed and use that seed in the production of

CHAPTER 57—PLANT VARIETY PROTECTION

SUBCHAPTER I—PLANT VARIETY PROTECTION OFFICE

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PART B-LEGAL PROVISIONS AS TO THE PLANT VARIETY PROTECTION OFFICE

PART C—PLANT VARIETY PROTECTION FEES

SUBCHAPTER II—PROTECTABILITY OF PLANT VARIETIES AND CERTIFICATES OF PROTECTION

PART D-PROTECTABILITY OF PLANT VARIETIES

PART E-APPLICATIONS; FORM; WHO MAY FILE; RELATING BACK: CONFIDENTIALITY

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PART L-REMEDIES FOR INFRINGEMENT OF PLANT VARIETY PROTECTION, AND OTHER ACTIONS

Contents, plant variety protection statute.

a crop on their farm. Additionally, these farmers can sell the protected seed to people whose primary occupation also is growing crops. The farmer's exemption has been subjected to judicial interpretation (see box 5-B).

From 1970 through 1988, 2,783 applications for plant variety protection certificates were filed at USDA for some 100 different crops. By December 31, 1988,2,133 certificates had been issued and 274 applications were pending. Another 376 applications have been abandoned, withdrawn, declared ineligible, or denied (see table 5-2).

Utility Patents

Although *Diamond v. Chakrabarty* held that living things, namely micro-organisms, were patentable (8) (see ch. 4), the specific issue of whether utility patents could be issued for plants was not expressly addressed by the Supreme Court. Subsequently, in 1985, PTO's Board of Patent Appeals and Interferences (BPAI) ruled in *Ex parte Hibberd*

Box 5-B—The Plant Variety Protection Act of 1970: Judicial Interpretation

One provision of PVPA subjected to judicial interpretation is the farmer's exemption. In *Delta and Pine Land Co. v. Peoples Gin Co., the court* concluded that the farmer's exemption did not apply to either a nonprofit agricultural cooperative that arranged sales of a protected variety or to a company dispensing the protected variety without giving notice that it was protected, The court felt that the intervention of a third party to act as a broker or sales agent would frustrate the basic purpose of PVPA because the third party was larger in size than a single farmer and would be more aggressive. After concluding the farmer's exemption did not apply, the court concluded there was infringement because the variety had been sold, delivered (7 U.S.C. 2541(1)), and dispensed without notice of it being protected (7 U.S.C. 2541(6)); and these actions were instigated or actively induced (7 U.S.C. 2541(8)).

A second case, *Asgrow Seed Co. v. Kunkle Seed Co., Inc. et al.,* also involved the farmer's exemption. The issue was whether the primary farming occupation of the defendant is growing crops for sale for other than reproductive purposes. The district court refused to grant a preliminary injunction preventing the sale of seed of a protected variety of soybeans. The district court based its decision on the fact that less than half the total volume of seed produced by the defendant was sold for reproductive purposes. The plaintiff alleged that the defendant's primary occupation was to sell seed, as evidenced by its sale of 1.42 million pounds of the specific protected seed (not including additional public varieties which were sold), increasing the acreage to grow such seed, and intent to sell as much seed as possible, even though less than half of the farm income came from the sale of the specific protected seed. The Court of Appeals for the Federal Circuit affirmed the district court's decision.

SOURCES: Office of Technology Assessment, 19S9; *Asgrow Seed Co. v. Kunkle Seed Company, Inc et al.*, Appeal No. S7-1402 (Court of Appeals for the Federal Circuit), appeal from W.D. LA, Alexandria Division; *Delta and Pine Lund Co v. Peoples Gin Co.*, 694 F.2d 1012 (5th Cir. 1983).

that corn plants, seeds, and plant tissue culture containing an increased level of tryptophan, an amino acid, were patentable subject matter under 35 U.S.C. 101 even though such plants could be protected under PVPA (16).

The *Hibberd* application contained claims directed to plants, seeds, tissue cultures, hybrid plants, and hybrid seeds. The PTO examiner rejected the claims, asserting that although human-made life forms, including plants, were patentable under 35 U.S.C. 101 as a result of *Chakrabarty,* plants were excluded from utility patent protection by the prior enactment of PPA and PVPA. The examiner maintained that both laws set forth how and under what conditions plant life should be protected. In other words, the examiner maintained that PPA and PVPA were the exclusive forms of protection for plants specified in each law.

After considering the many aspects of the case, the BPAI disagreed with the examiner and held that plants. varieties, seeds, and plant tissue cultures could be protected by utility patent. The BPAI noted that the availability of one form of statutory protection does not preclude the availability of protection under another form.

Since the 1985 *Hibberd* ruling (16), plants have been considered to constitute patentable subject matter under the patent laws governing utility patents. There are statutory exemptions from infringing a plant utility patent—in contrast to PVPA, the holder of a plant utility patent can exclude others from using the patented variety to develop new varieties. Table 5-3 lists the number of utility patents issued by crop type.

COMPARISON OF DIFFERENT FORMS OF PLANT INTELLECTUAL PROPERTY PROTECTION

As described earlier, Federal proprietary protection of plants encompasses three forms: plant patents, PVPCs, and utility patents. Trade secrets, governed by State law, represent a fourth mechanism of protection. Although each method of protection differs in some respect, not all methods are mutually exclusive. This section compares the different forms of protection available to plant inventors.

Table 5-2-Plant Variety protection Certificates Granted

Crop	Number granted between 1971-1985	1971 -1987a
Soybeans	244 (37)[b]	430 (59)
Peas	113 (o)	187 (0)
Beans	110 (2)	169 (4)
Wheat	127 (36)	159 (44)
Cotton	102 (13)	151 (21)
Corn	12 (2)	78 (0)
Lettuce	44 (o)	69 (0)
Ryegrass	23(1)	64(2)
Fescue	22(1)	61(9)
Alfalfa	25(6)	49(10)
Barley	14(2)	36(3)
Marigold	25(0)	34(o)
Bluegrass	19(3)	33(3)
Tomato	9(o)	28(4)
Onion	14(0)	25(4)
Watermelon	lo(l)	24(6)
Tobacco	14(0)	22(o)
Cauliflower		19(0)
Oats	16(8)	21 (12)
Rice	12(0)	14(0)
China aster	lo(o)	11 (o)

● ToDac. 1. 1967.
[b]Figure in parentheses indicates the number of public varieties.

SOURCES: R.E. Evenson, "Intellectual Property Rights and Agribusiness Research and Development: Implications for the Public Agricultural Research System," *American Journal of Agricultural Economics* 65:967-975, 1963. K.H. Evans, Piant Variety Protection Office, US. Department of Agriculture, Beltsville, MD, personal communications, October and December 1967.

Table 5-3-Number of Utility Patents Issued for Plants by Crop

Crop	Number
Corn	11
Sunflowers	6
soybeans	5
Wheat	5
Other	17
Total	42[a]

● For two patents the claims include both corn and wheat, therefore the total number of patents is 42.

SOURCE: Office of Technology Assessment, 1988.

Plant Patents v. Plant Variety Protection Certificates

PPA provides rights, through plant patents, to plant breeders and horticulturists who discover or develop new and distinct plant varieties and propagate them by asexual reproduction. In contrast, PVPC holders under PVPA are granted protection for discovering or developing new, uniform, stable, and distinctive plant varieties that are propagated by sexual reproduction. Protection **under PPA and PVPA complement each other in providing protection for new varieties of plants-asexually reproduced by plant patents and sexually reproduced by PVPCs.**

Plant Patents v. Utility Patents

Utility patents provide protection for plants, including asexually reproduced plants such as those included within PPA, as well as plant parts (e.g., flowers, fruits, and nuts) and hybrids, which are excluded from PPA. Also seeds and plants with defined physical traits can be protected through utility patents. **Utility patents for plants, when the requirements can be satisfied, offer broader coverage than would be available for the same plant under PPA.**

Advantages of obtaining a utility patent for an asexually reproduced plant are many. A plant patent is limited to a single claim; a utility patent need not be so limited. Perhaps the most significant advantage of the utility patent is that it provides broad protection for inventions that can affect more than a single variety and can cover plant parts including flowers, nuts, fruits, and cuttings that do not asexually produce a plant. Further, no requirement exists for utility patents that an infringing plant be produced asexually from the patented plant, hence sexual reproduction of the protected variety is also covered. Finally, in theory, a utility patent can protect any plant having an inserted gene, rather than a single variety containing that gene. Also, protection is not dependent on whether the plant is sexually or asexually reproduced.

One disadvantage of utility patents is that the description requirement is more stringent than that required for a plant patent. In order to satisfy this requirement for utility patents, placing the plant or seed on deposit may be necessary (depending on whether or not the production of the plant can be enabled by words alone).

Plant Variety Protection Certificates v. Utility Patents

As is the case with plant patents, utility patents offer broader protection for the same plant than would be offered through PVPCs.

Photo credit: National Agricultural Library

Compared to PVPCs, several aspects of utility patent coverage for sexually reproduced plants appear advantageous to plant breeders. A utility patent is not limited to the specific variety described; it can protect the specific variety, as well as other varieties having the same traits and functional properties, Hybrids are specifically excluded from plant variety protection but are fully protectable by utility patents. Extensive scope of coverage is another significant advantage of utility patents over PVPCs. Utility patents can protect the plant, seed, plant parts, genes, plants having a specific physical trait, and processes for developing new varieties and hybrids.

Another key difference is that utility patent statutes do not provide for a farmer's exemption. Consequently, if anyone other than the patent owner makes, uses, or sells the seed for reproductive purposes, it is an infringement of the utility patent, subject to judicial enforcement. Another advantage of protecting plants with utility patents is that there is no research exemption (i.e., it is an infringement of the utility patent to use the patented plant or variety in developing a new variety or hybrid). Finally, compulsory licensing cannot be mandated by any Federal agency for a utility patent. In compulsory licensing under PVPA, the Secretary of Agriculture directs the PVPC holder to grant a license to a third party if the Secretary determines such a license is in the public interest. The owner receives a reasonable royalty but has no option and must grant the license.

An advantage of PVPCs over utility patents is that the latter have stringent description requirements that may necessitate the deposit of the plant or seed, which is publicly available when the utility patent issues. Although PVPA requires a seed deposit, the present PVPO policy is that the majority of deposited seed is not available to the general public. One other advantage of PVPCs is that protection is afforded to the new variety before the issuance of the certificate. With proper notice, coverage initiates when the seed is dispensed.

There is a perception that certainty in obtaining a PVPC is greater than for a utility patent (31), although some reviewers believe there is no difference (2).

Trade Secret Law

Trade secrets, in addition to plant patents, PVPCs, and utility patents, are also an important form of plant protection. Trade secrets are the subject of State law (see ch. 3). Trade secret rights can be protected in laboratories and factories where the movement of outsiders is confined and security is maintained. Academic researchers probably view trade secrets less favorably, since they hinder

publication efforts (36). If a trade secret is disclosed in a nonconfidential manner, it is lost forever. With secrecy a legal prerequisite to a trade secret, it can be difficult to use trade secrecy as a form of protection: some secrets may be known, for example, to many employees (l).

In some respects, plants are, by their nature, ill-suited to trade secret protection since they often cannot be easily confined to an enclosed space, thus making them susceptible to theft by outsiders. Some plants are easily grown from only a portion of the parent or, if the plant is an inbred, from a seed—if someone obtains inbred seeds, plants from those seeds can be easily reproduced. Theft of secret plant varieties jeopardizes producers potential compensation for their investment of creative effort, time, and dollars. Nevertheless, some inventors within the agricultural and horticultural industries successfully employ trade secret protection by not releasing the parents of hybrids that they sell.

Plant patent, PVPC, and utility patent applications are kept in confidence by PTO, and nondisclosure rules apply while an application is pending. The owner of the application controls public access to the file. Abandoned applications also generally are not available to the public, except under particular circumstances. However, once a plant patent, utility patent, or PVPC is granted, the information it contains is publicly available. Accordingly, these statutory modes of patent protection encourage the disclosure of new plants allowing the public to benefit from their use (12).

INTELLECTUAL PROPERTY AND THE U.S. SEED AND PLANT INDUSTRIES

Saving and bartering seed by farmers, once the norm, have evolved into corporate enterprises that depend on developing and selling seeds and plants. Agriculture is the principal client, however, ornamental and nursery products are also important. Expenditures for seeds, bulbs, plants, and trees accounted for 5-7 percent of a typical farmer's total 1985 operating cost and totaled $3.37 billion, nationwide (40). This is a relatively low portion of the operating cost, but is of prime importance to the success of the farming operation (12).

Photo *credit: Artmaster Book Co*

Profitability and innovation in the U.S. seed and plant industries rely on their ability to legally protect their products. This section analyzes the general criteria companies consider when making decisions about protecting plant inventions. Selected plant and seed industries are also discussed to identify important issues related to different sectors,

Choosing and Managing Plant Protection

The different forms of intellectual property are not equivalent in value or utility for all segments of the seed and plant industries. An OTA survey of universities, nurseries, seed companies, and biotechnology firms found an array of opinions on intellectual property protection of plants especially on plant utility patents (see box 5-C).

Opportunities for proprietary protection vary not only with the biology of different plants but on legal grounds as well. It may be possible to obtain different forms of protection on the same plant invention. If the invention, for example, related to the treatment of apple trees so that all the fruit ripened for harvest on the same day, a utility patent could be granted on apple trees so treated, and a plant patent granted on one or more specific varieties of

apple tree so treated. Any concern about double protection or a time extension of the exclusionary rights could be addressed by a terminal disclaimer (i.e., an instrument whereby the patent owner disclaims a portion of the term of a patent so that it expires on the same day as another patent) and covenants that both patents will be enforceable so long as they are commonly owned (42).

With respect to double protection for sexually reproduced plants, an overlap in the statutory subject matter of PVPA and 35 U.S.C. 101 exists and was acknowledged by BPAI in *Hibberd.* However, the mere presence of an overlap does not preclude obtaining more than one type of protection (21). At present, one company has obtained both PVPCs and utility patents for two inbred corn lines (20).

Although no one approach to protecting **plant intellectual property appears to be the most productive, the choice is generally clear for a specific plant.** Present strategies therefore involve multiple approaches based on several factors. Some key components to consider in reaching decisions about plant protections are crop type, farmer's exemption under PVPA, litigation, licenses, research exemption under PVPA, and deposit.

Crop Type

Proprietary protection varies fundamentally from crop to crop. Although crops can be classified by their natural reproductive processes, some crops can be propagated either sexually or asexually. Thus, it is the practical method by which a crop propagule is made that determines the intellectual property protection available for that crop. Further, in addition to utility patents for crops, new processes to produce propagules are also potentially patentable.

Farmer's Exemption Under PVPA

The farmer's exemption provision of PVPA reflects farming practices dating back to the Nation agricultural beginnings; practices that include retaining seed for upcoming planting cycles, as well as using seed for barter. Strictly unique to PVPA, the provision allows farmers to retain protected seed for planting and for sale to others whose principal occupation is also farming. It is the only provision of PVPA that has been subject to judicial interpretation (box 5-B).

In effect, farmers can compete, to a limited degree, directly with the seed industry that developed the variety, as long as the primary occupation of the farmer is production agriculture. Farmer-saved seed is a common practice for several crops, including wheat, cotton, and soybeans (25). Based on a USDA survey of 1986 plantings, only 54 percent of the soybean seed planted was purchased and only 60 percent of wheat seed planted was purchased (26). As a result, from an industry perspective, property rights under PVPA are considered inferior to utility patents and plant patents (24), and the net effect of the exemption is that PVPC holders will seldom profit as extensively as their variety is grown. Ironically, the more successful a new variety, the lesser the percentage of the seed that will be sold by the originator (12).

To circumvent the difficulties seed companies perceive about the farmer% exemption, increased protection through utility patents could be sought. At present, anecdotal evidence indicates that industries are considering this option, but proceeding cautiously since utility patents also are not without problems (31). Because more complaints about the farmer's exemption than any other are received by PVPO, and owing to concern that utility patents could undermine PVPA, the PVPO Advisory Board appointed a committee to examine this provision (15). The committee has recommended that USDA promulgate a rule clarifying the limits of a farmer's entitlement to sell the protected variety produced (43).

Litigation

Litigation is intrinsic to all types of intellectual property protection of plants. However, this involves substantial cost to assert or defend claims. A company should expect to spend a minimum of $500,000 for litigating important utility patents (17). Not all patents on plant-related claims can commercially support such costs. An average variety of corn, soybean, or wheat may remain profitable for only 5-10 years, although the occasional extraordinary variety, such as Pioneer Hi-Bred 3780, has been sold for more than 20 years (31). Although experience with utility patents of plants is minimal at present, it

Box 5-C--Survey of Universities, Seed Companies, Nurseries, and Biotechnology Companies

OTA obtained the views of 39 biotechnology companies, seed companies, nurseries, and universities about intellectual property protection for plants and varieties in general, and utility patents in particular.

There-was strong agreement that PVPCs, plant patents, utility patents, and trade secrets have been or will be beneficial, and that all four types of protection will provide an incentive to develop new varieties. A majority wanted both PVPC and plant utility patent protection, and expected that intellectual property protection of plants would not interfere with the development of new varieties or inbreds. A majority did not want compulsory licensing for new varieties or inbreds and desired worldwide standardization of plant protection.

Both industry and universities support all types of intellectual property protection of plants. Although most sectors favorably view plant utility patents, seed companies-on average—adopt a more neutral position. The overall neutral position by seed companies on many of the questions reflected differences in opinion between unaffiliated seed companies (less favorably inclined toward utility patents) and seed companies affiliated with the chemical or pharmaceutical industry (more approving of utility patents of plants).

Overall, biotechnology companies favored the protection provided by utility patents because they protect plant parts, processes, and genes. A majority of the universities favor all types of intellectual property protection for plant life, although trade secrets are more skeptically viewed by universities than other sectors. Nurseries strongly support plant patents and protection for asexually reproduced plants. Nurseries also favor utility patents, probably because they protect plant parts.

Reaction to utility patents for plants was equivocal. Many viewed utility patents as beneficial and necessary to provide adequate protection for new varieties, while at the same time not interfering with new varietal development. Unaffiliated seed companies, however, expressed concern about utility patents. These concerns included: restriction of germplasm, industry concentration, and domination of the industry by large conglomerates. Some of the concerns expressed by these seed companies are the same as those expressed during congressional hearings on the 1980 amendments to the Plant Variety Protection Act.

Concern by seed companies about broad protection of plants also is reflected in views on compulsory licensing. Unaffiliated seed companies prefer compulsory licensing for utility patents, but they are not as concerned about compulsory licensing of PVPCs. It appears these seed companies have less concern with restriction of access to germplasm if it is on a variety-by-variety basis, as opposed to a physical trait basis.

The perspective of unaffiliated seed companies on compulsory licensing is opposite to that of the biotechnology companies. This difference could result, in part, from the knowledge and perception concerning utility patents by the two sectors. Seed companies that favor compulsory licensing for plant utility patents have been operating profitably under the current seed business environment. These generally established companies could be concerned that any changes resulting from plant utility patents could lead to possible negative effects on their businesses. For the most part, these seed companies are less familiar with the utility patent system than are biotechnology companies and are concerned about having access to a major development that is patented—access that could be denied by the patentee unless there is compulsory licensing. Some developments that could be of interest include yield, herbicide resistance, disease resistance, and seed content (e.g., oil, starch, or protein). Since many of these developments will probably result from using new technologies (e.g., cell culture or genetic engineering) rather than from classical breeding, the unaffiliated seed companies may view utility patents as interfering in new varietal development.

In contrast, biotechnology companies have grown up with the utility patent system and recognize its value to them, Biotechnology companies fund research with the expectation of future financial return and consider utility patents essential to insure adequate return on the initial investment. They may feel that compulsory licensing of patents could significantly affect financial returns from their research and, consequently, oppose compulsory licensing.

There is a strong preference among companies primarily involved with biotechnology for utility patent protection for their plant inventions. Compulsory licensing is strongly disapproved. Some companies also expressed the belief that utility patents for plants are important and yield significant benefits for everyone and desire no change in the patentability of plants.

Seed companies indicate that all four mechanisms for plant protection have provided an incentive to develop new varieties and have been beneficial for their organizations. Compared to the other sectors, many seed companies express concern that utility patents of plants could interfere in the development of new varieties and inbreds. And, in contrast to biotechnology companies, seed companies further demonstrate this concern by having a preference for compulsory licensing with plant utility patents. Some seed companies state that a company having plant utility patents could refuse to license a new biotechnology or other plant development to competing companies. On the other hand, the majority of the seed industry companies generally view plant utility patents as having a beneficial effect on their business and as providing art incentive to develop new varieties.

Other views expressed by seed companies include: the undesirability of restriction of access to germplasm by plant utility patents, the belief that plant variety protection would be sufficient if it were strengthened, the necessity of a good database for PTO, and a concern that large conglomerates with ready capital could dominate the industry.

Universities expressed less concern than seed companies that plant utility patents would interfere with new varietal development. University respondents generally perceived PVPCs, utility patents, and plant patents as effective types of protection for universities. But, trade secret protection was viewed as a less favorable form of protection.

Nurseries strongly support PPA, which allows plant patents for asexually reproduced plants. Nurseries also favor the other forms of plant protection and advocate standardizing plant protection worldwide. Of the four sectors surveyed, nurseries most strongly opposed compulsory licensing. Other concerns and comments expressed by nurseries principally focus on strengthening plant patent protection to include plant parts.

SURVEY RESPONDENTS: *Biotechnology companies*—Agracetus; Biosource Genetics Corp.; Calgene; EniChem Americas, Inc.; Molecular Genetics, Inc.; Monsanto Co.; NPI; Plant Genetics, Inc.; Sungene Technologies Corp. *Seed companies*—Agricultural Alumni Seed Improvement Association; Agrigenetics, Corp., Cal/West Seeds; Cargill, Inc.; Dekalb-Pfizer Genetics; Edw. J. Funk & Sons, Inc.; Garst Seed Co.; Holden's Foundation Seeds, Inc.; Hoegemeyer Hybrids; Illinois Foundation Seeds, Inc.; J.G. Limited, Inc.; Mike Brayton Seeds, Inc.; Nickerson American Plant; Northrup King Co.; Peto Seed Co., Inc.; Pioneer Hi-Bred International, Inc.; United Agriseed, Inc , The Upjohn Co.; W. Atlee Burpee; Wyffels Hybrida, Inc. *Universities---iowa* State University, Ohio State University; Purdue University; Rutgers University; University of Illinois; University of Minnesota; University of Wisconsin. *Nurseries*—The Conard-Pyle Co.; Jackson & Perkins Co.; Mikkelsens, Inc.

SOURCES: Office of Technology Assessment, 1989; J.L. Ihnen, R.T. Gallegos, and R.J. Jondle, "Intellectual property Protection for Plants and Varieties," contract document prepared for the Office of Technology Assessment, U.S. Congress, November 1987.

is reasonable to speculate that for crops where the profit margins are small, or for varieties for which the total market is small, litigation costs could weigh in proprietary protection decisionmaking. And, as mentioned earlier, while the farmer's exemption has presented litigation problems for PVPC protection (see box 5-B), the perception exists that there is more certainty in obtaining a **PVPC than** a utility patent. Some, however, believe there is no difference (2).

Licenses

In general, licensing agreements can resolve patent litigation and enhance profitability; they are central to intellectual property management, including protection of plants. One aspect of licensing is unique to plants: compulsory licensing by the Secretary of Agriculture under PVPA when in the public interest. In principle, decisions to seek a PVPC versus a utility patent may factor in the mandatory licensing provision of PVPA, which is absent in general patent law. Since PVPA was enacted in 1970, however, no Secretary of Agriculture has exercised this authority. Compulsory licensing was supported by seed companies and opposed by biotechnology firms surveyed by OTA (see box 5-c).

Research Exemption Under PVPA

Neither 35 U.S.C. 101 nor PPA provide for unencumbered research uses of protected plants. In

sharp contrast, and again as part of the public interest focus of PVPA, varieties covered by PVPCs can expressly be used for research purposes. Companies with plant breeding research programs must evaluate concerns that improvements in their PVPC-protected plants can be directly used, without compensation, in breeding programs by their competitors. Despite such concerns, a company that bases its research program on commercial varieties of competitors will probably be a consistent follower in a marketplace that rewards innovation (7). Some argue, however, that there exists a plethora of followers who need not invest in breeding research because of the exemption, indicating a major disincentive keeping the level of investment, and hence innovation, in plant research lower than for human and veterinary biologics (27).

Deposit

Deposit considerations are important aspects of a company's management of plant intellectual property because of the risk taken when a biological deposit (e.g., seed) is made. Under PVPA, statutory deposit requirements exist, but access to the deposited material requires permission from the PVPC holder. In contrast, deposit for utility patents issued by PTO requires unrestricted access to deposited seed after a patent has issued. This type of deposit is considered substantially more risky than deposit under PVPA and provides a more accessible mechanism through which a patent can be pirated. Proof of pirating shifts from documenting access (under PVPA) to the pursuit of litigation to prove actual pirating.

Hybrid Corn

Hybrid corn seed is the largest seed industry in the country, with domestic sales of approximately $1.4 billion in 1985 (40). Examining proprietary protection of corn is interesting since the method used to produce hybrid corn varieties gives the company substantial control over the varieties without proprietary protection. Inbred parental lines are crossbred to produce high-yielding hybrid seed with "hybrid vigor." Commonly, a hybrid yields more than twice as much grain as its seed parents (13). But, unlike seed for nonhybrid crops, seed from a harvest from a planting of hybrid seed cannot be saved and used for additional high-yield planting cycles. Since hybrid vigor from subsequent progeny declines, the producer must return to the source for new seed to maintain the highest yields. Thus, hybrid seeds have "internal genetic protection," and *de facto* force the user back to the supplier.

PVPA specifically excludes protection of first-generation hybrid varieties, and therefore only inbred parental lines can be protected under PVPA. Protecting the parental lines under PVPA requires disclosure of the genetic nature of the plants, and protection is limited to 18 years. However, by protecting the parental plants as trade secrets, breeders can use the successful inbreds indefinitely to develop new inbred lines and hybrids. Historically, the hybrid corn industry has depended heavily on trade secret protection of parental lines (18). Through November 1987, only 78 PVPCs for corn, about 2 percent of all PVPCs, had been issued (table 5-2) (15).

The *Hibberd* ruling specifically involved corn seed (16) and clearly opened the possibility of a new avenue of proprietary protection for this and other crops. Of the 42 utility patents of plants granted by PTO, 11 are for corn (table 5-3). Coupled with the higher issuance rate of PVPCs for corn (table 5-2), indications are that both of these protection mechanisms will be used increasingly by the hybrid corn industry.

Several crops are grown as hybrid varieties, such as onions and sorghum. Many characteristics of the corn industry apply to the sorghum industry. However, the onion industry is more similar to the tomato seed case study discussed in a following section.

Soybeans

The value of the U.S. soybean seed industry was approximately $630 million in 1985 (31). This value represents both sales plus the value of seed planted by the farmer from soybeans stored from the previous year's harvest. Farmer-retained seed represents a significant portion of soybean seed planted annually in the United States. As mentioned earlier, a USDA survey indicates that in 1986,46 percent of soybean seed planted was from grower storage, ranging from 20-68 percent among different growing areas (26). Private soybean varieties have increased steadily since the mid-1970s, when public

variety use dominated by a 3-1 margin. The number of acres planted with private varieties is estimated to have tripled between 1976 and 1982.

The soybean sector might be an indicator of industry perceptions of PVPA. Since PVPA was enacted, 427 PVPCs, almost 23 percent of the total, have been issued for this crop. Although soybeans appear to be a favored crop for this mechanism of plant protection, concern about farmer-retained seed remains serious (31), and utility patents could become increasingly important (see table 5-4). Industry concerns about the research and farmer's exemptions under PVPA could drive them to seek broader coverage on soybean innovations.

Tomato Seeds

The tomato seed industry is two distinct industries--tomato varieties grown for processing and tomato varieties grown for fresh market. This examination focuses on seed producers for tomato processing, since plant protection features of this sector reflect issues similar to those for other crops (e.g., onion).

California is the principal locale for the processing tomato seed industry, growing 217,000 acres in 1985 (82 percent of the industry's total acreage). Two types of processing tomatoes are grown: open-pollinated and hybrid varieties. Approximately 65 to 70 percent of processing tomato acreage is in open-pollinated varieties (32). Seed costs per acre

Photo credit: U.S. Department of Agriculture

Soybean cells in dish at left have grown roots after a soil organism, *Agrobacterium tumefaciens,* inserted root-producing genes into them. Without added genes, soybean cells grow into unorganized clumps (right).

Table 5-4--U.S. Soybean Breeding Research By Private Industry Before and After the Plant Variety Protection Act of 1970

Year	Companies	Breeders
1966	2	2
1971	6	6
1964	30	63

SOURCE: C.A. Brim, 'Plant Breeding, Development From an Art to a High-Technology Industrial Activity," Symposium on the Protection of Biotechnological Inventions, Juna 4-5, 19S7 (Ithaca, NY: in press).

for farmers is approximately $25 to $45 per pound for open-pollinated varieties and $200 per pound for hybrids. The retail market for open-pollinated varieties is approximately $4 million and for hybrid varieties about $12 million (45).

Although the ratio in cost per pound to the farmer between the two types of seed is not reflected in the market differences, some farmers continue to plant expensive hybrid seed because of contracts with processors to deliver specified goods. Most important, hybrids also perform better in terms of overall quality and yield. The planting rate is about 1 lb per acre for open-pollinated seed; about 0.5 to 0.6 lb per acre for hybrid seed (45).

Since 1980, open-pollinated varieties and inbred tomato parental lines can be covered under PVPA, and PVPO has granted 28 PVPCs for tomatoes. However, skepticism similar to that for corn exists about the usefulness of protecting inbred parental tomato lines (31). Reservations exist about the desirability of protecting hybrid tomatoes with utility patents, since a single hybrid tomato variety might not justify the expense of enforcement (32). Unlike corn or soybean seed, the average tomato variety's lifetime is only 4-5 years. Furthermore, annual sales from a single variety are far lower. Thus, although corporate strategies to protect pollinating tomatoes will probably continue to rely on PVPCs, the useful role of utility patents in the hybrid variety sector is unclear due to market life of the product.

Plant Biotechnology

Commercial application of plant biotechnology is a developing industry. A 1987 OTA survey of nearly 300 dedicated biotechnology companies revealed that 12.5 percent focus (primarily and secondarily) on plant agriculture (37). In 1985, industrial research expenditures for biotechnological applications to crops were estimated at $90 million (30). With high expectations that the marriage of biotechnology and traditional agricultural research will be a critical factor in the near future, the patent strategies of companies involved in this partnership could be significant.

Two factors play an important role in influencing intellectual property strategies by the plant biotechnology industry: the technologies used and the experiences of the researched with proprietary protection. In the first instance, utility patent statutes are primarily applicable to discoveries resulting from recombinant DNA-related research. Although few patents have issued, case law precedent established for recombinant DNA applications in the biomedical sector could influence corporate approaches in plant biotechnology protection. Secondly, experience with intellectual property by most companies involved in plant biotechnology generally means experience with utility patents. In fact, biotechnology companies report they are favorably inclined toward utility patent protection of their inventions (see box 5-C).

As new developments in plant biotechnology move to the forefront and companies involved in these efforts become familiar with nonutility proprietary protection, PVPA and PPA could receive increased attention. At present, however, this sector appears to favor utility patent protection for plants in order to adequately recover the high costs of research and development.

IMPACTS OF PLANT PROTECTION ON U.S. AGRICULTURE

Intellectual property protection of plants has influenced and continues to influence the direction of seed and plant research and development. On one hand, intellectual property rights stimulated and are critical to maintaining investment in plant variety development. Innovation must be protected and rewarded to realize a continuing flow of dollars to agricultural research and development (14,43). On the other hand, some individuals are concerned that increased patent activity results in the privatization of agriculture and has adverse consequences for

Photo credit: Monsanto Corp.

Larvae were allowed to feed on a transgenic tomato plant (right) and a normal plant (left). After 7 days, the plant that was genetically engineered for tolerance to the insect is relatively intact, whereas the normal plant has been destroyed.

small farmers (5,9,23). Furthermore, in enacting PVPA, Congress recognized the essential role plants and seeds occupy in U.S. society, and specifically addressed concerns beyond the economics of increasing plant innovation. This section analyzes both economic and social impacts of intellectual property protection of plants,

Economic Impacts of Plant Protection

Since the enactment of PVPA and the *Chakrabarty* and *Hibberd* decisions, private sector interest has blossomed (38). Beginning with the passage of PPA in 1930, the primary development of new, asexually reproduced varieties moved from government experiment stations to private industry. The number of issued plant patents and the size of the present-day nursery industry may reflect the positive economic effects of PPA (20). The increased private investment in plant breeding resulting from PPA was widely discussed during deliberations on PVPA.

Some view the option of seeking plant utility patents as pivotal to sparking progress and increasing dollar flow in the industry by providing both the scope of protection needed to encourage new research investment and the rapid dissemination of information describing the new technology resulting from plant research (44). This is especially true for emerging applications of plant biotechnology (see box 5-C). And, although the availability of utility patent protection provides economic stimulus to the seed and plant industries, one analysis indicates that because utility patents do not provide a farmer's

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(4), although the same analysis concluded that those increases were not unremovable or unjustified.

Germplasm and Plant Protection

Greater awareness of potential profits to be accrued from patenting genes (and products) has led to a rush to file under the existing patent laws (14). To many in both the public and corporate sectors, increased patent activity is tying up (or has the potential to tie up) germplasm (10,11,14,19). Some argue that a noticeable slowing in the free exchange of germplasm that existed prior to patenting has occurred (10,1 1,1 9). In effect, they argue that the biological domain was once public domain but has shifted to a private property right (10). One analysis found that after enactment, PVPA had probably reduced the flow and exchange of information and germplasm from private companies to universities but had increased the flow from universities to private plant breeders (4). In the case of utility patents, others argue that they do not stifle free exchange (44). The grant of protection, by its very nature, promotes disclosure of new and useful plant materials, so all benefit (12).

One commentator has proposed creating a National Library of Germplasm Resources to hold mandatory biological deposits of all patented and PVPA-protected living forms. The intent of such an entity is to make germplasm readily available for research purposes and to offset trends toward privatization of germplasm (1).

To date. **any information regarding the impact of intellectual property protection of plants on germplasm is largely anecdotal.** In any case, advances in plant breeding and agri-biotechnology require a free-moving, international exchange of germplasm. A comprehensive analysis examining trends in plant protection and germplasm exchange could reveal whether a problem exists or direct attention to potential problems.

SUMMARY

Although in the United States an exclusive right to an invention is as old as the Constitution, until the late 1920s the sentiment was largely held that plant varieties were not patentable under the general patent statute. In deciding to expressly provide intellectual property protection for asexually reproduced plants, Congress concluded that the work of the breeder was an aid to nature and thus the resulting plant was a patentable invention. In the intervening six decades, U.S. proprietary protection for plants and varieties has further evolved. Today, two Federal statutes specifically confer ownership rights to plant innovations: the Plant Patent Act of 1930 and the Plant Variety Protection Act of 1970. The rulings in *Diamond v. Chakrabarty* and *Ex parte Hibberd* clarify the option of utility patent coverage for plants and seeds. Thousands of plants are now protected by four major mechanisms: plant patents, Plant Variety Protection Certificates, utility patents, and trade secrets.

The Plant Patent Act of 1930 was designed to encourage new variety development and afford agriculture the benefits of the utility patent system. Protection under PPA is patent-like and encompasses asexually propagated varieties other than tuber-propagated plants (at that time, sexually reproducing plants were not thought to breed "true-to-type"). Plant patents are issued by PTO. Since enactment, over 6,000 plant patents for a wide range of varieties have been issued, including ornamental flowering plants, ornamental trees, fruit and nut trees, and grapes.

With the realization that sexually reproducing plants can replicate "true-to-type," Congress passed the Plant Variety Protection Act of 1970 to provide proprietary protection for this class of plants. With this act, Congress specifically granted two exclusions to a certificate holder's protection under PVPA: the research exemption and the farmer's exemption. Under the former, a PVPC holder cannot exclude others from using the protected variety to develop new varieties. In the second instance, individuals whose primary farming occupation is growing crops for sale, other than for reproductive purposes, can save protected seed for subsequent crop production on their farm, without being considered infringing upon the certificate holder. These farmers also can sell the protected seed to people whose primary occupation is growing crops. To date, the farmer's exemption is the only provision of PVPA subject to judicial interpretation. Fungi, bacteria, tuber-propagated or uncultivated plants, and first-generation hybrids are not protected by PVPA. PVPCs are issued by USDA and, through

Photo *credit: U.S. Department of Agriculture*

Scientist holds ajar containing two small peach tree shoots capable of resisting leaf spot.

1987, over 1,800 PVPCs for approximately 100 different crops had been issued.

The different forms of plant protection each have unique advantages and disadvantages. **Overall,** utility patents appear **more advantageous than plant patents and PVPCs because they offer broader coverage, including protection of plant parts and seeds.** On the other hand, although litigation expenses are involved with each type of protection, costs associated with protecting utility patents can be especially substantial. From a practical perspective, no single approach to protecting plant intellectual property exists. Present strategy involves multiple approaches based on factors such as crop type, farmer's exemption under PVPA, litigation, licenses, research exemption under PVPA, and deposit.

The history of intellectual property protection of plants could be particularly germane to the present debate surrounding patenting animals. Plants are the sole life form for which the U.S. Congress has expressly permitted intellectual property protection. In particular, congressional provisions to protect research and farming interests seem pertinent, although both are not without controversy. Results from an OTA survey of indus-

try and university attitudes toward intellectual property protection of plants were equivocal-especially attitudes about utility patents. Access to plants for research to develop new varieties was the issue for which consensus was most lacking. Seed companies in particular are concerned about access to germplasm protected by utility patents and fear new plant variety development will be impeded. The survey did not address the farmer's exemption of PVPA, although evidence indicates widespread discontent within industry about the provision. On the other hand, a complete prohibition of farmer-saved seeds could cost farmers $500 million annually.

Profitability and innovation of U.S. nurseries, seed companies, and plant biotechnology firms depend on their ability to legally protect their products. Innovation must be rewarded with sufficient protection to ensure a continuing flow of investment in plant research and development. Yet, in its most recent deliberations on plant protection—PVPA—Congress recognized the essential role plants and seeds occupy in U.S. society and specifically addressed concerns beyond the economics of increasing plant innovation. Maintaining a continued balance of both societal and economic goals resulting from U.S. proprietary protection of plants is essential.

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