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THE EVOLVING LANDSCAPE OF IP RIGHTS FOR PLANT
VARIETIES IN THE UNITED STATES, 1930-2008

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ABSTRACT

The United States was the first country in the world to explicitly offer intellectual property protection for plant varieties. Beginning in 1930, asexually reproduced plants were afforded plant patent protection, in 1970 sexually propagated plants could be awarded plant variety protection certificates, and beginning in 1985, courts confirmed that varieties of all types of plants were eligible for utility patents. From 1930 to 2008, a total of 34,340 varietal rights applications were lodged. The number of rights being sought continues to grow, with 42 percent of all the varietal rights claimed since 2000. Contrary to popular perception, most of these rights are for horticultural crops (69 percent), with ornamentals accounting for the lion's share of the horticulture-related rights (73 percent, or 50 percent of all plant rights). Food and feed crops constitute only 24 percent of the rights sought, although just two crops (corn and soybean) made up 84 percent of the 3,719 varietal rights claimed via utility patents. The structure of these rights has changed dramatically over the years. During the 1930s when the only rights on offer were plant patents, 72 percent of the rights sought were for ornamental crops and individual innovators played a substantial role (50 percent of the rights). By 2004-2008, the annual applications for plant patents had increased in number but fallen to a 60 percent share of the total rights claimed. During this recent period, utility patents were as popular as plant variety protection certificates, and ornamentals made up a large but much reduced share of the total (52 percent). Individual innovators accounted for only 12 percent of the rights, whereas the corporate sector sought the dominant share of varietal rights (82 percent in 2004-2008). These intellectual property markets are complex, with corporations, universities and other agencies seeking different types of rights for different crops.

Keywords: plant patents, plant variety protection, utility patents,

JEL codes: Q16, Q18, O32, O34

1. Introduction

Intellectual property protection for plant varieties seems perpetually embroiled in policy controversy and professional debate. The United States provides an especially revealing study of the policies, institutions and practice of intellectual property pertaining to plant varieties. Almost all countries with intellectual property protection for plant varieties limit that legal coverage to just one form of protection. The United States is an exception, with three forms of legal protection presently available.¹ The United States is also a large source of varietal innovation, and the U.S. market for these innovations is large by world standards. Moreover, 29 percent of the estimated \$42 billion of global commercial seed sales in 2010 (ISF 2011) occurred in the United States, and the country spent \$9.6 billion on agricultural R&D: about 20 percent of the world's total spending on agricultural research (Pardey and Chan-Kang 2012; and Pardey and Alston 2011), which has substantive consequences for the rates of varietal innovation in the United States and elsewhere in the world.²

Thus a study of the evolution of varietal rights in the United States has important international implications, not only because of the significance of the United States in global intellectual property and innovation markets, but because varietal rights continue

¹ For now we set aside a consideration of trademarks that are increasingly used in marketing plant varieties (see, for example, Drew 2010) and trade secrets, plus technical forms of protection that confer some degree of intellectual property protection such as hybrid varieties and the yet-to-be commercially realized potential for genetic use restriction technologies. Smith (2008) describes how modern biotechnologies enable the protection conferred by hybrids to be breached.

² The U.S. agricultural (private and public) research total is a 2009 estimate, and the U.S share of global spending is a 2000 estimate, the latest year for which globally comparable figures are available. These estimates are taken here to be indicative of the corresponding 2010 figures.

to be controversial and subject to ongoing public policy scrutiny and debate worldwide.³ Unfortunately, a large share of the debate takes place absent evidence on the particulars and the practicalities of these intellectual property rights. For example, unknowns include what is protected (specifically, what is the extent of the rights granted for each crop, and how is that changing over time and among the rights on offer), and who are granted these rights (including the changing balance of rights held by public versus private or domestic versus foreign entities)? As well, are these rights affecting the pace and orientation of new entrants into innovation markets, and has the more recent option of protecting new varietal innovations by way of utility patents crowded out the other types of legal protection being sought? In this paper we use an entirely new set of intellectual property rights data spanning all three forms of U.S. varietal rights for the entire history of these rights to quantitatively assess some of these developments. Before turning to the empirical evidence, we briefly review the pertinent legal and legislative developments shaping plant varietal rights in the United States.

2. Legal and Legislative Landscapes⁴

Given the difficulties in sufficiently describing plant varieties, they were long deemed unpatentable until the United States became the first country in the world to offer legal protection for new plant varieties via passage of the Plant Patent Act that was signed into law by President Hoover on May 23rd, 1930.⁵ However, the passage of this legislation

³ The ETC Group (Action Group on Erosion, Technology and Concentration) has been an especially vigorous and consistent critic of varietal rights. Nottenburg (2009a and 2009b) offers an analysis of the veracity of the assessments and conclusions in ETC Group (2001 and 2008a).

⁴ See also Pardey et al. (2004). Here we summarize and update these developments, including a chronology of relevant legislative and legal rulings in Appendix Table 1.

⁵ As White (1975, p. 129) noted, in 1891 the famed horticulturalist L.B. Bailey remarked that "... it would be difficult to define what a variety was or what was new, and any jury of horticulturalists would be

was preceded by more than half a century of commercial and policy debate. U.S. discussions on patenting life forms date back to the 1860s, coinciding with the 1862 publication of Darwin's *The Variation of Animals and Plants under Domestication* (Fowler 1994, ch. 3; Barragan-Arce 2007; and Kevles 2008). Nurserymen and horticulturalists were among the most vocal in the public discussion, and while many were proponents of plant patent legislation that view was by no means universally held.⁶ For example, Newman (1931, p. 35) cites the position of Patrick Barry, who in 1869 wrote in the *Rural New Yorker*

As a horticulturalist I protest the movement and hope Congress pays no attention to the matter. The originators of valuable varieties have it in their power now to secure ample compensation: and it is their own fault if they do not....In my opinion, the influence of a patent law of this kind would be to retard the dissemination of new things and in this way be a positive damage to the country....For these and many other reasons I am in favor of letting this matter regulate itself, as it does at present...

With the renewed impetus from the rediscovery of Mendel's Laws of Heredity in 1900 and the concerted Congressional lobbying efforts of the American Association of Nurserymen (led by Paul Stark of Stark Brothers Nursery), the Plant Patent Act ushered

puzzled to make needed decisions." Others expressed reservations about patenting life forms of any description. Kevles (2008, p. 210) discussed one manifestation of these concerns, observing that "... in 1889, in *Ex parte Latimer* the U.S. commissioner of patents rejected an application for a patent to cover a fiber identified in the needles of a pine tree, declaring that it would be "unreasonable and impossible" to allow patents upon the trees of the forest and the plants of the earth. The commissioner's ruling formed the basis for what came to be known as the "product-of-nature" doctrine—that while processes devised to extract what is found in nature can be patented, objects discovered there or bred from there cannot be patented." Notwithstanding these concerns, soon after the passage of the U.S. Plant Patent Act, other countries followed suit, including Germany in 1933, Austria in 1938 and the Netherlands in 1941 (Fowler 1994, p. 99).

⁶ White (1975, p. 128) wrote that the American Association of Nurseryman first considered the "...protection of discoverers of new varieties of plants..." at their 1883 annual meeting in St Louis. He noted that "The subject was debated pro and con under two questions: "Is it feasible?" and "Is it desirable?" Some were in favor of patents for plants for protection of the originator or discoverer; others were opposed, and some said it could never be made to work. No conclusion was reached on either question..."

in legal protection for asexually reproduced plants.⁷ It took forty years before U.S. legal protection was expanded to encompass sexually reproduced plants with the passage of the Plant Variety Protection (PVP) Act in 1970. Fifteen years later, U.S. courts held that seeds, plants and tissue cultures were also subject to utility patent protection, and subsequent court decisions admitted the prospect of multiple forms of protection for a single plant variety by way of utility patents and either plant patents or plant variety protection certificates. The more recent U.S. legislation, including the 1970 PVP Act (and its subsequent amendments in 1980 and 1994), and the legal decisions that enabled utility patents for plant varieties, all took place against a backdrop of highly controversial and politically charged debates and decisions regarding requirements for the legal protection of plant varieties that were incorporated into international agreements.

Expanding the scope of intellectual property (IP) protection to encompass plant varieties was among the more contentious aspects of the Uruguay Round trade negotiations (see, for example, Odek 1994 and Verma 1995).⁸ Enshrined in Article 27.3(b) of the TRIPS (Trade Related Aspects of Intellectual Property Rights) agreement that came into force on January 1, 1995 for signatories (including the United States) to the Uruguay Round was the requirement to make plant varieties eligible for protection

⁷ White (1975) noted that Stark Brothers Nursery is the oldest nursery in America, and was the largest in the world at the turn of the twentieth century.

⁸ The TRIPS Agreement required that a review of Article 27.3(b) be undertaken in 1999. Although the review scheduled for 1999 never materialized at the Seattle meetings of the WTO held in November of that year, a review was tabled by the WTO Council in March 2006 (see WTO 2006). According to WTO (2011a) the review assessed "...the pros and cons of various types of protection (patents, UPOV, etc); how to handle moral and ethical issues (e.g., whether invented life forms should be eligible for protection); how to deal with traditional knowledge and the rights of the communities where genetic material originates; and whether there is a conflict between the TRIPS Agreement and the international Biodiversity Convention (CBD)." As noted by WTO (2010), countries have expressed a range of opinions on all these subjects. In particular, some developing countries wanted to ensure that the TRIPS Agreement allowed their farmers to continue to save and exchange harvested seeds, and prevent anti-competitive practices that threaten developing countries' "food sovereignty".

either through patent protection or a system created specifically for the purpose (i.e., so-called *sui generis* forms of protection), or a combination of the two.⁹

Legislation shapes the broad plant varietal rights on offer in the United States, but a substantial number of legal interpretations have important implications for the details and practice of these rights (see Appendix Table 1 for a chronological summary).

Although utility patents had been granted for methods of treating and breeding plants since the early 1970s in the United States (Seay 1989), the landmark *Diamond vs. Chakrabarty* case of 1980 opened the door for legal protection of living organisms themselves—be they sexually or asexually reproduced—by means of a utility patent (Kevles 1994).¹⁰ In a 5-4 ruling in favor of Ananda Chakrabarty, the U.S. Supreme Court held that “... anything under the sun that is made by man” is patentable subject matter.¹¹ The first legal case to explicitly apply the 1980 Supreme Court ruling to patentability of seeds, plants and tissue cultures by means of a utility patent was the

⁹ As WTO (2011) describes, “...when the WTO agreements took effect on 1 January 1995, developed countries were given one year to ensure their laws and practices conformed to the TRIPS agreement. Developing countries and (under certain conditions) transition economies were given five years, until 2000. Least-developed countries had 11 years, until 2006—now extended to 2013 in general, and to 2016 for pharmaceutical patents and undisclosed information. If a developing country did not provide product patent protection in a particular area of technology when the TRIPS Agreement became applicable to it (1 January 2000), it had up to five additional years to introduce the protection. But for pharmaceutical and agricultural chemical products, the country had to accept the filing of patent applications from the beginning of the transitional period (i.e., 1 January 1995), though the patent did not need to be granted until the end of this period. If the government allowed the relevant pharmaceutical or agricultural chemical to be marketed during the transition period, it had to—subject to certain conditions—provide an exclusive marketing right for the product for five years, or until a product patent was granted, whichever was shorter.”

¹⁰ Moreover, prior to the 1980 *Diamond vs. Chakrabarty* ruling, the USTPO “...had issued utility patents which contained product claims to plants and seeds. [and] At least two patents issued which claimed plants themselves (Seay 1989, p. 427).”

¹¹ In *Diamond vs. Chakrabarty* (206 USPQ 193, 1980) the Court also found that “... the patentee has produced a new bacterium with markedly different characteristics from any found in nature and one having the potential for significant utility. His discovery is not nature's handiwork, but his own; accordingly it is patentable subject matter under §101.”

September 1985 ruling in *Ex parte Hibberd* (227 USPQ 443, 1985).¹² Thus the *Diamond vs. Chakrabarty* case and subsequent legal rulings clarified that plant varieties, parts of plants, genetically engineered organisms, processes for transforming cells and expressing proteins, and gene products themselves were also eligible subject matter for a U.S. utility patent.¹³

The 1930 Plant Patent Act established intellectual property rights for a breeder who has invented or discovered new and distinct *asexually* reproduced varieties, other than a tuber propagated plant or a plant found in an uncultivated state (35 U.S.C. 161). Plant patents, like utility patents, are examined and granted by the United States Patent and Trademark Office (USPTO).¹⁴ Unlike utility patents, which require the payment of regular maintenance fees to retain the rights for the full life of a patent, no maintenance fees are required to maintain plant patent rights to their full term.¹⁵ Following the Plant Patents Amendment Act of 1998, patentees are now able to exclude others from importing a protected plant or any of its parts, actions that were allowed under the

¹² Here, the claimed invention was maize seeds, plants and tissue culture that either exhibited increased free tryptophan levels or was capable of producing plants or seeds having increased levels of free tryptophan. Subsequently, in *Ex parte Allen* (2 USPQ2d 1425, 1987), the court expressly provided that complex living organisms beyond the microscopic world of bacteria (in this case oysters), were not per se excluded from patent protection, thus opening the way for patent protection to encompass animals. The first patent on an animal was issued in 1998 to a genetically engineered mouse (called the “Harvard Mouse,” US Patent No. 4,736,866).

¹³ In addition to the United States, plant varieties are also subject to utility patents in Australia and (since October 2006) South Korea. Patentability also appears possible, but is not certain, in Japan (Lightbourne 2005).

¹⁴ In fiscal year 2010, the USPTO had an annual budget of \$2.1 billion with a total staff of 9,507, including 6,225 patent examiners and 378 trademark examining attorneys (USPTO 2010). As of April 2011, there were 5.5 examiners prosecuting plant patent applications and 19 examiners prosecuting utility patent applications directed to plants (USPTO 2011). A total of about 509,367 patents were lodged with the patent office in 2010, along with 368,939 applications for trademark protection.

¹⁵ Moreover, the fees required to maintain a utility patent increase over time: from \$1,130 at 3.5 years after the date of issue, to \$2,850 at 7.5 years, and \$4,730 at 11.5 years as of September 2011 (with these fees being halved in the case of a small business or non-profit organization or an independent inventor).

original Plant Patent Act.¹⁶

The 1970 Plant Variety Protection Act (PVPA) protects new varieties of *sexually* reproduced crops, with applications for PVP certificates being administered by the U.S. Department of Agriculture's Plant Variety Protection Office (which in 2011 had a total of seven examiners, PVPO 2011).¹⁷ The protection afforded by a PVP certificate is significantly weaker than a utility patent, largely because of two exemptions: a so-called "breeders' exemption" that allows competitors the use of protected varieties for breeding (but not commercialization) purposes (7 U.S.C. 2543), and a "farmers' exemption," which allows farmers to save seed for reproductive purposes, and even to sell seed to other farmers whose primary farming occupation is growing crops for consumption or feed (7 U.S.C. 2541).

The ability of farmers to sell seeds was narrowly interpreted in *Asgrow Seed Co. v. Winterboer* (115 USC 788, 1995). The case focused on whether selling seeds to other farmers for planting using a process known as "brown-bagging" was exempt from an infringement claim under the farmers' exemption clause that formed part of the 1970 version of the PVPA.¹⁸ In 1995 the Supreme Court found that a farmer could sell saved seed for reproductive purposes, but only up to the amount that would be necessary to replant the farmer's own acreage. By restricting the scope of the farmers' exemption, this

¹⁶ Now the law states that "... in the case of a plant patent, the grant shall include the right to exclude others from asexually reproducing the plant, and from using, offering for sale, or selling the plant so reproduced, or any of its parts, throughout the United States, or *from importing the plant so reproduced, or any parts thereof*, into the United States (35 U.S.C. 163)" [italics emphasized by authors].

¹⁷ Seed and tuber samples must be submitted to the PVPO for examination as part of the certification process. Upon issuance of a certificate the main sample is sent to the National Center for Genetic Resources Preservation in Fort Collins, Colorado where it is maintained but not available via this facility until the term of the protection expires (USDA, AMS 2011).

¹⁸ Brown-bagging is a process in which a farmer purchases seed from a developer, plants then harvests the seed, cleans it, and then places it in a non-descriptive brown bag for sale (Gustad 1995).

ruling effectively increased the strength of protection afforded by way of a PVP certificate. A 1994 amendment to the Plant Variety Protection Act enshrined this legal precedent into legislation, consistent with the 1991 revision of the International Union for the Protection of New Varieties of Plants (UPOV).

In contrast, the *Imazio* decision of 1995 narrowed the scope of plant patent protection by holding that independently created plants having identical characteristics do not infringe a plant patent. To establish infringement of a plant patent, it is necessary to prove that the plant in question is derived from, i.e., [constitutes] a copy of the *actual* plant.¹⁹ Thus the *Imazio* decision requires that a plant patent owner prove that an alleged infringing variety was derived asexually from plant material representing the patented variety (Gioia 1997).

Following the 1980 Supreme Court ruling concerning the patentability of living organisms and the subsequent granting of utility patents on plant varieties, there was legal uncertainty as to whether or not a variety protected by either a plant patent or a plant variety protection certificate can also be protected via a utility patent: the so-called “double protection” issue.²⁰ This issue was legally resolved in 2001 by means of the *J.E.M. Ag Supply v. Pioneer Hi-Bred Int’l* ruling, which affirmed the legality of dual protection for plants. In response to Pioneer’s patent infringement lawsuit, J.E.M. argued that plants ought to be excluded as eligible subject matter under a utility patent because

¹⁹ *Imazio Nursery Inc. v. Dania Greenhouse* (36 USPQ 2d 1673, 1995).

²⁰ Before the court resolved this matter the double protection issue was the subject of considerable legal debate. Seay (1989), for example, noted that on the one hand overlapping protection via different forms of intellectual property such as a trademark and a design patent was deemed permissible (in *Mogan David Wine Corp.* 328 F.2d 925, 140 U.S.P.Q. 575 CCPA 1964), while on the other hand the courts had rejected the possibility of double patenting where the scope of protection afforded by the two intellectual property instruments was deemed equivalent (see *Ropat Corp. v. McGraw Edison Co.*, 535 F.2d 378, 191 U.S.P.Q. 556 7th Cir. 1976 where the applicant had sought a design patent and a utility patent on the same article).

Congress had created other forms of protection (i.e., plant patents and plant variety protection certificates), designed specifically for protecting plants. The Supreme Court rejected this argument based on the *Chakrabarty* decision, thus opening up the prospects for protecting a plant by means of a utility patent and a plant variety protection certificate or a utility patent and plant patent (Janis and Kesan 2002b).

More recently, the use of licenses to control plant propagation has been challenged. Monsanto Co., in particular, contracts with farmers through a Technology Agreement that provides for a royalty payment by the farmer and an agreement that the farmer will not save seed for replanting. A farmer, Homer McFarling, sued by Monsanto for infringing its patents on Roundup Ready® soybeans by replanting seed and for violating terms of the Technology Agreement, raised as a defense that the contractual restriction violated the first sale doctrine.²¹ Under this doctrine, a patent owner's rights are exhausted upon the first sale. The court found no merit in this argument because the new seeds produced by McFarling were not sold by Monsanto. Furthermore, in addition to plants, seeds were covered by the patents held by Monsanto. In an appeal, McFarling unsuccessfully asserted that the Technology Agreement constituted patent misuse by tying together the seed and the genetic trait.²² Lastly, plant varieties subject to both a utility patent and a PVP certificate did not entitle farmers to infringe the patents by planting farmer-grown saved seed, which is allowed under the PVP Act.²³

The recently enacted Leahy-Smith America Invents Act of 2011 radically changes patent law. Although none of the changes are to the Plant Patent Act itself, all of the

²¹ *Monsanto Co. v. McFarling*, 302 F.3d 1291 (Fed. Cir. 2002), otherwise known as *McFarling I*.

²² *Monsanto Co. v. McFarling*, 363 F.3d 1336 (Fed. Cir. 2004)–*McFarling II*.

²³ *Monsanto Co. v. McFarling*, 488 F.3d 973 (Fed. Cir. 2007), cert. denied, 128 S.Ct. 871 (2008).

provisions in the act apply. Provisions of the law will be implemented over an 18 month timeframe, with some of the most far-reaching changes occurring in March 2013. At this time, the United States adopts a first inventor to file regime, expands the categories of prior art, and contracts the types of activities that qualify under the one-year grace period. Prior art will include on-sale and public-use activities anywhere in the world, instead of just in the United States, and, moreover, the inventor's own sale and public use activities do not appear to be exempted under a one-year grace period. A variety of new procedures, post post-grant and pre-grant will allow third parties to attack a patent.

3. Data Sources and Compilation Details

To quantitatively assess the changing amounts and forms of intellectual property rights for plant varieties in the United States, along with changes in the types of plants and the pool of applicants applying for those rights, we compiled a complete and novel set of count and attribute data for all three types of U.S. varietal rights. Unless otherwise specified, all the data in this study are reported by the year of application of the right.²⁴

Our primary focus on the pursuit of varietal rights is best served by compiling data on applications for varietal rights, distinct from the rights actually granted. This is not possible for some forms of rights for some periods of time. Prior to the American Inventors Protection Act of November 1999, all utility and plant patent applications in the United States remained confidential until the patent was granted.²⁵ Thus, if a patent

²⁴ The other option is to report data by the year the right was issued or granted. Like Hall (2005) we opted for the year of application, taking that to be a better indication of the year the innovation was made and the rights were sought. This gives a better indication of the innovative behavior of crop breeders, abstracting from the irregular administrative lags that are inherent in data reported by date of grant. See also Griliches (1990) for a comprehensive assessment of the use of patent statistics in economics.

²⁵ This Act was later amended as the Intellectual Property and High Technology Technical Amendments Act of 2002 (Public Law 107-273). This Act requires that patent applications be published promptly at the

failed to issue then the details of this patent application were never made public. Although in March 2001 the USPTO began publishing details of nearly all patent applications (granted or otherwise) 18 months after the earliest priority date of the application, for consistency our compilation includes only data for granted utility and plant patents, and excludes data for applications that were either rejected, withdrawn, or still under examination as of October 2010. The PVP data include all applications (and their subsequent disposition) for the entire data set.

Information on plant patents and utility patents pertaining to plant varieties was obtained from databases maintained by the United States Patent and Trademark Office (USPTO). We manually compiled information on plant patents granted before 1976 from image files accessed via the USPTO website (see www.uspto.gov/patft/index.html). Information on plant and utility patents granted since 1976 was taken from digitized purpose-built files purchased from the USPTO Office of Electronic Information Products in June 2009. To minimize missing observations arising from administrative lags in publishing patents, we conducted a final backfill of our data series in January 2011 using the proprietary Thompson Innovation compilation available from www.thomsoninnovation.com. Combining data from both digitized and on-line sources yielded a complete series of 20,982 plant patents for the period July 1930 (the date plant patents were first lodged) to December 2008.²⁶

end of 18 months after their earliest priority date, but provides for an opt-out of publication if the applicant declares that the application is not filed anywhere else in the world that publishes a patent application (35 U.S.C. §122(b)(2)(B)(i).

²⁶ The first non-image plant patent entry in our file is PP03987 issued in December 1976. For entries prior to that, there are 35 plant patent numbers missing from our compilation because either the image file was missing or unreadable on the USPTO site or the plant patent was never issued. In the text that follows we typically treat our patent grant series as a proxy measure of patent applications. Lemley and Sampat (2008, p. 184) noted that “The [US]PTO reports that the [grant] rate historically has been about 66% and ... now

Utility patent filings related to plant varieties begin showing up in our data set in 1982, hot on the heels of the 1980 *Diamond vs. Chakrabarty* ruling.²⁷ However, plant-related utility patents encompass much more than patents on new plant varieties per se. For example, a plant-related patent can claim exclusionary rights over inventions applied to groups of plants (e.g., a particular gene inserted into all dicotyledonous plants, all plants of the family *Brassicaceae*, or all plants of the genus *Brassica*), parts of plants, seeds, propagation methods, plant cells, and so on. To address this matter, we devised selection criteria to generate a set of utility patents whose claims afforded protection for a *specific* plant variety. Thus the utility patents in our compilation encompass plant varieties that were also amenable to protection by means of a plant variety protection certificate or a plant patent.

To compile the utility patent series we began by extracting more than 5,000 utility patents for the January 1980 to October 2010 period assigned a U.S. patent classification code 800 (i.e., Multicellular Living Organisms and Unmodified Parts Thereof and Related Processes). From this set we excluded all non-plant patents. We then scrutinized the claims of each patent in the subclasses 260 (pertaining to method of using a plant or

is only 54% ... Considering continuations, Quillen and Webster estimated the rate to be as high as ... 85%. Others, taking account of continuations with different assumptions, find the number to be lower, around 75%.” Tracking a sample of 9,960 patents applications consisting of every original utility patent application filed in the month of January 2001 that was published by April 2006, Lemely and Sampat (2008, p. 193) estimated “... that the grant range as of April 2008 runs from a lower bound of 71.8% to an upper bound of 75.9%. ... Even after accounting for continuations, the odds of an applicant getting a patent are pretty good, but it is an exaggeration to say that the PTO is a rubber stamp.”

²⁷ In our data set there are three granted utility patents for plant varieties whose applications were lodged prior to 1985, specifically, a 1982 application for a chrysanthemum variety, one in 1983 for a turf grass variety, and a 1984 application for a variety of mushroom. The 1982 application was granted in October 1986, 13 months after the *Ex parte Hibberd* ruling. Seay (1989) noted utility patent number 2,048,056 granted to Edgar Boehm of Arkansas in July 1936 that claimed a method *and product* of hybridizing plants (in this instance new varieties of fruits), as well as patent number 3,861,079 issued in 1975 to Earl Patterson of the University of Illinois on sterility procedures in the production of commercial hybrid maize and patent number 4,143,486 issued to Shivcharan Maan in 1979 on hybrid wheat, both of which claimed specific seed products. Thus a few patents with product claims to plants and seeds were issued by the USPTO prior to the 1985 *Ex parte Hibberd* ruling.

plant part in a breeding process which includes a step of sexual hybridization) and 295 (plant, seedling, plant seed, or plant part per se). We retained those patents claiming protection for a particular plant variety, and excluded those claiming protection for an invention that encompassed only parts of plants or for very broad categories of plants, such as “all dicots” or “all monocots.” To double check the validity of our selection, we randomly sampled 108 patents from the screened group and thoroughly re-read each claim. Two sampled patents were deemed to be mis-assigned, an error rate of just 1.8 percent. For the analysis that follows, our final compilation of utility patents claiming one or more plant varieties included 3,719 patent entries for the period July 1982 to December 2008.

We tapped the USDA’s on-line Plant Variety Protection Office Certificate Status Database made available by way of the Germplasm Resources Information Network (GRIN) to compile data on plant variety protection certificates (USDA-GRIN n.d.). Our series includes a total of 9,639 applications for plant variety protection certificates lodged between January 1971 (the date of first issue) and December 2008.

For plant and utility patents we recorded the USPTO’s classification code (class and sub class) for each entry in our database. For each of the PVP, utility patent and plant patent entries in our database we recorded information on the plant variety name, crop type, filing and issuance date (where available), and applicant name.²⁸ While PVPs report only the applicant name(s), plant and utility patents record both the inventor and the assignee name(s) at the date of grant, and the latter was used to designate “applicant”

²⁸ The databases we used ostensibly include an initial “filing date,” and, after allowance for continuances, a “filed date,” which is typically the latest filing date. Continuation practice is not common for plant-related patents, so most of the entries in our data series only report a “filed date.”

in our series. The on-line certificate status database provided by USDA, GRIN periodically revises the designated applicant name to reflect changes in the ownership of PVP rights via merger or acquisition activity. Thus the reported PVPO “applicant” at any point in time does not necessarily reflect the applicant at the time of grant (as is always the case with the available plant and utility patent records). At our request, PVPO staff queried their unpublished historical records to track the change in recorded “applicants” during each decade back to the 1970s.²⁹ We used this information to retrofit the publicly reported PVP applicant data so that the “applicant names” included in our PVP series were more comparable with the assignees at the time of grant that were used to designate applicants in our utility and plant patent series.

Using information where needed from a variety of sources we assigned U.S. state, country, and type (specifically, individual, corporation, or university) tags to all the applicants-cum-assignees listed for each right and also calculated the lag in days between application and issuance dates for each PVP entry. PVP records always report taxonomic, common, and varietal names, and each were duly recorded. Plant and utility patents irregularly report common (and sometimes taxonomic) names that we used in conjunction with other information to develop a complete and standardized set of plant names. Based on our understanding of its most likely intended product use, we then assigned each variety to a particular product class using the classification scheme designated by the FAO (2010) *World Program for the Census of Agriculture 2010* report

²⁹ Information on the original applicant for each PVP certificate can also be obtained from the PVPO’s Scanned Certificate Database available at <http://apps.ams.usda.gov/CMS/>.

and to a market category using a more detailed USDA classification scheme (see USDA-NASS 2000).³⁰

4. Plant-Related IP Landscapes

4.1. Overall Trends

Figure 1 reveals trends in the annual number of applications lodged in the United States for varietal-related utility patents, plant patents, and PVP certificates since their inception. To finesse unavoidable data truncation problems we terminated each of the series reported here in 2008. While applications for PVP certificates are published with little delay, there are typically substantial administrative delays in posting both plant patent and utility patent applications to the USPTO web site (at least 18 months after the earliest priority filing date), so that many applications lodged in the last year and a half are yet to be published.

[Figure 1: *U.S. varietal rights, 1930-2008*]

Through to December 2008 a total of 34,340 applications had been lodged for PVP, utility patent and plant patent protection, with 42 percent (14,431) of these applications lodged since 2000 (an average of 1,600 applications per year since 2000, compared with just 41 applications per year during the first decade, 1930-1939, of our time series). The overall pace of growth in applications for varietal rights has been uneven, particularly so when tracking developments according to the different types of

³⁰ The categories used in the FAO schema are: beverages and spices; cereals; fruits; grasses; industrial; medicinal; oilseeds; ornamentals; roots and tubers; sugar crops; trees; tree nuts; and vegetables. The USDA plant classification scheme reflects the plant categories defined in the U.S. Census of Agriculture and includes a more detailed classification of ornamental plants used as nursery and greenhouse crops. Assigning some plants to some subcategories (e.g., assigning certain ornamental plants to a greenhouse and nursery crops subcategory) is problematic because some plants have more than one likely product use. In these instances the protected varieties were designated to more than one market class. Thus, for example, a single rose variety may have uses as a cut flower, a potted plant, or a nursery plant, and was assigned to all three market categories.

rights on offer. Beginning in 1930, the number of plant patent (PP) applications steadily increased until the early 1980s (by 2.14 percent, or 95 applications, per year on average from 1930-1980). Thereafter the rate of PP applications accelerated, growing by 2.91 percent, or 575 applications, per year from 1981-2008.³¹

This mostly uninterrupted and comparatively rapid, long-run rate of increase in PP applications contrasts with the trends in plant variety protection (PVP) and utility patent (UP) applications. Initially, both PVP and UP applications (beginning in 1971 for PVPs, and 1986 for UPs) mirrored the initial upward trends evident in the PP data, with PVP applications growing at 1.36 percent per year from 1971 to 1999, and UP applications growing (from a very small base) by 12.06 percent per year from 1986 to 1999.³² Then, beginning in 1999, the annual number of applications for both forms of protection declined markedly. PVP applications fell by 33 percent (from 428 in 1999 to 288 in 2000), while UP applications declined by 12 percent (from 259 in 1999 to 228 in 2000). It took nine years, until 2007, before the annual number of PVP applications rebounded to match their 1999 total: it took seven years before the annual pace of UP applications recovered to match its 1999 level.

Plant patents are the most prevalent type applied for among the three types of varietal-related intellectual property rights. Of the 34,340 total rights sought since 1930, plant patents accounted for 61 percent (20,982) of these rights, PVPs constituted 28 percent (9,639) of the rights sought, while only 11 percent (3,719) of the rights claimed

³¹ Growth from 1981-1990 averaged 4.05 percent per year, 2.08 percent per year from 1991-2000, and 1.13 percent per year from 2001-2008. The evident, but transitory, dip in the number of applications in the early 1990s may have reflected a hesitation of the part of would-be applicants to lodging claims while the *Imazio* case (first filed in 1992 and not resolved until 1995) was pending in a federal court in California.

³² Given there are only three utility patent entries in our varietal rights database prior to 1986, to obtain meaningful period average growth rate estimates we opted to begin reporting our growth rates for this form of varietal rights in 1986.

were for utility patents. However, the composition of these varietal rights changed markedly over time (Table 1). From 1930 to 1971, plant patents were the only rights on offer. For the decade beginning in 1971, PVP grants accounted for 43 percent of the rights sought, with plant patents making up the remaining 57 percent. In response to the 1980 Supreme Court ruling and the 1985 clarification concerning the patentability of plants, utility patents claimed a growing share of plant varietal rights: accounting for 13 percent (1,223) of all varietal rights applications lodged in the period 1991-2000, and 18 percent in the period 2001-2008. During more recent years, the rate of utility patenting has generally outpaced the rate of PVP applications so that for most years after 2006 the number of applications for utility patents exceeded the number of PVPs being sought.

[Table 1: *Changing Structure of Plant Variety Rights, 1930-2008*]

As mentioned, beginning in the late 1990s the number of PVP applications dropped precipitously: from 458 in 1998 to 428 in 1999, and just 288 a year later (Figure 1). Application rates more-or-less flat lined for around 6 years, and in 2008 totaled only 425 applications, still less than the number of PVPs sought a decade earlier. Janis and Kesan (2002a) and Lesser and Mutschler (2002) suggested that as the demand for transgenic corn, soybean, and cotton crops began to accelerate, breeders increasingly opted for the marketing plus breeding restrictions afforded by utility patent protection in lieu of the marketing-only protection obtained via PVP certificates. While this argument may have some merit, especially in more recent years, the late 1990s drop in PVP applications was paralleled by a marked drop in utility patent applications for plant

varieties (from 259 applications in 1999 to just 164 applications in 2001).³³ Spot checks of the claims in these applications suggest that many of the applications were for transgenic corn and soybean varieties. Concerns over the international tradability of transgenic crops and their purported adverse environmental effects stalled the growth in demand for these crops at that time.³⁴ In 1999, in the United States, an estimated 26 percent of the U.S. corn acreage was sown to transgenic varieties, and that share did not change for the following two years (Alston et al. 2010, Figure 8.5). Growth in the demand for transgenic crops resumed thereafter, and by 2008, around 80 percent of the U.S. corn area was sown with transgenic seeds.

Lesser and Mutschler (2002, p. 107) also suggested that delays in processing applications made to the PVP office (see below) might be another possible reason for the late 1990s downturn in PVP applications. This explanation has prima facie merit, both in

³³ In contrast, the total number of applications for U.S. utility patents (encompassing all innovations) continued to grow unabated during this period, from 219,486 applications in 1997 to 331,580 applications in 2002 (an average rate of growth of 8.3 percent per year).

³⁴ For example, Federoff (n.d) wrote that “On August 10th, 1998, Arpad Pusztai of the Rowett Research Institute in Aberdeen, Scotland appeared on the British TV show ‘World in Action.’ In the course of the interview, he announced that his experiments showed that rats fed a diet of potatoes expressing a gene coding for a snowdrop sugar-binding protein showed stunted growth and reduced immune function [Enserink 1998]. He is further quoted as saying that he would not eat GM food and that he found it ‘very, very unfair to use our fellow citizens as guinea pigs’ (Lee and Tyler 1999).” A version of the study was later published in *The Lancet* (Ewen and Pusztai 1999), but this study and the original claims have been hotly contested and deemed by some as deeply flawed. In Federoff’s even-handed commentary she concluded that “Unfortunately, Pusztai’s analyses of the chemical composition of the transgenic lines were rather superficial. And his quick leap to the conclusion that the variation he observed was attributable to the fact that they were transgenic was simply unwarranted...” See also Enserink (1999) for additional details on this case. In 1999, a laboratory at Cornell University published results that appeared to indicate that pollen from genetically modified Bt corn presented a substantial threat to monarch caterpillars (Losey et al. 1999). This report also got widespread attention, but what was largely ignored by the popular press was a series of risk assessment studies published in the October 9, 2001 issue of the Proceedings of the National Academy of Sciences, that reached much less alarmist conclusions. For example, one of these studies stated that “This 2-year study suggests that the impact of Bt corn pollen from current commercial hybrids on monarch butterfly populations is negligible (Sears et al. 2011, p. 11937).” Pew Initiative on Food and Biotechnology (2002) provides a good overview of the evolution of this particular controversy. Other developments that may have contributed to this slowdown include the collapse of the R&D venture capital market in the wake of the dot-com bust, and the beginnings of a shift in business strategy by the large life science companies that had hitherto agglomerated health (pharmaceutical) and agricultural assets, but around this point in time began divesting themselves of their agricultural assets.

terms of explaining the timing of the onset and the duration of the downturn. Figure 2 provides evidence on the changing structure of the lags between applying for and being granted a PVP. Panel (a) plots PVPs according to their recorded number of applications and grants in each year. Panel (b) tracks the lag, in days, between the application and grant dates of each PVP that was eventually granted a certificate. Setting aside the initial start up years, grant lags averaged around 500 days during the 11 year period 1977–1987. Beginning in 1987, grant lags began to lengthen, markedly so after 1997, peaking at 1,449 days (almost 4 years) in 1999. Thereafter, the grant lag declined, but plateaued at around 1,019 days for the period 2001–2005, double the average lag of the earlier (post-startup) phase. The lag continued to shrink, to 786 days for the years 2006–2008.

[Figure 2: *PVP applications, grants, and grant lags, 1971–2008*]

The substantial increase in the lag between applying for and being granted a PVP that began in 1989 has two distinct phases. Setting aside 1992 (when the number of grants that year spiked at 340), most of the decade following 1989 saw a sharp downturn in the number of PVPs granted (Figure 2, Panel a), dropping to just 68 PVPs being issued in 1998. In contrast, over the same ten-year period, the number of applications continued climbing steadily (from 317 in 1989 to 458 in 1998). This evidence is inconsistent with the view that the demand for PVPs diminished during this decade. However, it does point to substantial and growing administrative delays in granting applications; lags that continue to be double the length during the 2000s compared with the decades of the 1970s and 1980s.

Using data on the comparative yield performance of wheat varieties subject to PVPs and those that were not, Alston and Venner (2002) questioned the productivity

premiums one might expect from the typically more expensive PVP varieties. Some sense of the prospective value (via enhanced productivity or other means) that applicants placed on plant varieties encumbered with PVP rights can be gleaned from an examination of the fate of applications once they are lodged. At any point in time, applications may be a) granted, b) abandoned or withdrawn by the applicant, c) deemed ineligible (likely because of an incomplete application), d) denied by the office, or e) still pending examination. Unlike utility patents which can be abandoned via nonpayment of renewal fees, all PVPs run to the full term of the rights issued upon a payment made at the time of issue.³⁵ As of December 2008, 7,316 (76 percent) of the total of 9,639 PVP applications lodged during 1971-2008 were granted, 895 (9 percent) of the applications were still being examined, while the remaining 1,315 (14 percent) of the applications were either abandoned or withdrawn by the applicant.³⁶ Since 1971, a very small share (just 1.2 percent) of the total applications were either denied or ruled ineligible by the PVP office.

Figure 3 plots trends in the changing status of PVP rights over time. At the outset, during the early 1970s, slightly more than 60 percent of the applications were eventually issued, while the remainder was either withdrawn or abandoned. Almost 90 percent of the applications lodged during the 1980s were ultimately granted a PVP certificate, with abandoned or withdrawn applications accounting for less than 10 percent of the total applications. However, during the 1990s, the share of voluntary withdrawals

³⁵ The same is true of plant patents, which require an up-front payment and no renewal fees.

³⁶ Obviously, in December 2008 some rights were no longer in force simply because the term of the granted right had expired.

or abandonments increased gradually, accounting for more than 27 percent of the total applications during the period 1995–1998.

[Figure 3: *Changing disposition of PVP applications, 1971-2008*]

Although the odds of rejection are extremely low, a measurable share of the applicants apparently concluded that the value of a PVP did not justify the cost of obtaining a right because 14 percent of all the applications lodged since 1971 were either withdrawn or abandoned. Moreover, when administrative delays substantially lengthened the lags in processing applications, almost one quarter of the applications were withdrawn or abandoned in the 1995-2000 period, suggesting that a significant share of the value of the protection rests in the immediacy of the exclusionary rights related to the marketing of protected varieties. Thereafter the withdrawal cum abandonment rate (i.e., 6.2 percent during the period 2001-2008) reverted to just below the long-run average.

Prevalence of Varietal Rights

Figure 1 provides a sense of the magnitude and shifting structure of the varietal rights being sought (applied for) since 1930. It does not provide information on the prevalence of the granted varietal rights in force during this period. Given that rights expire or are abandoned, a simple accumulation of granted rights overstates the extent of prevailing intellectual property protection at any point in time. After factoring in the expiration of granted rights, Figure 4 shows the (cumulative) prevailing IP rights that are legally binding for each type of protection. In constructing this series, the term of protection for both plant and utility patents was 17 years from the grant date for applications lodged prior to June 8, 1995, and 20 years from the earliest filing date for

applications lodged thereafter. Similarly, the term for plant variety protection increased from 17 years from the date of issue (extended to 18 years with the 1980 amendment to the PVP act), and then to 20 years from the date of the original grant (or 25 years from the date of issue for tree or vine plants) starting on April 4, 1995. Utility patents are subject to maintenance fees paid 3.5, 7.5 and 11.5 years after the grant date, and so a substantial number of patents do not run to full term.³⁷ Notwithstanding this reality, for the prevailing IP estimate presented in Figure 4 we assumed all utility patents pertaining to plant varieties ran their full term.

[Figure 4: *Prevailing protection for plant varieties, 1931-2008*]

We estimate that a total of 19,346 plant varieties were subject to either PVP, utility or plant patent protection in the United States in 2008. Around 61 percent of the prevailing rights were plant patents. Although similar numbers of claims for utility patents and PVP certificates were lodged in 2008, the longer history of PVP rights means that there were 10 percent more PVPs than utility patents in force that year. Because intellectual property rights persist for 17 or 20 years (depending on the filing date of right), the number of prevailing varietal rights grew at a much faster pace (4.4 percent per year from 1931-2008) than the number of applications for these rights (2.4 percent per year) (Figure 4, inset).

4.2 Crop Landscapes

The policy and practical concerns that arise from enabling property rights with respect to plant varieties are myriad. Notwithstanding the farmer's and breeders' exemptions

³⁷ Bessen (2008) reports that about 42 percent of all the U.S. patents issued in 1991 were renewed to full term, with significant variations by assignee type, size of applicants and technology category. Publicly listed firms had a 50 percent renewal rate versus individuals who had a 22 percent renewal rate; large firms (48 percent) versus small firms (25 percent); and computers and communications (53 percent) versus mechanicals (39 percent).

features of PVP rights, some policy analysts and many commentators suggest that varietal rights restrain access to germplasm that in turn slows the pace of crop varietal innovation (see, for example, Nouwaars et al. 2005). Corollaries to this fundamental access and use concern are that a) varietal rights limit the exchange of germplasm among countries, thus circumscribing international R&D spillovers, b) they shift the balance of varietal innovation effort from freely accessible to pay-for-use (proprietary) research, or more generally from public to privately performed research, c) these, and other follow-on effects of varietal rights, put in peril the ability of subsistence farmers to feed their families, undercut the ability of some (especially developing) countries to conduct agricultural R&D, and raise concerns about the ability to sustainably feed future generations in the face of substantial and continued growth in the demand for food in the decades ahead.³⁸ Others find little evidence that plant varietal protection stimulates the rate of innovation or crop productivity growth (see, for example, Alston and Venner 2002 and Heald and Chapman 2011).³⁹

Substantiating these claims is especially difficult, not least because linking any one of these myriad effects to the presence or absence of varietal rights is a tall order. But to

³⁸ See Kimbrell (2002) and the chapters therein as well as ETC Group (2008b) and Tansey (2002) for examples of these perspectives. Often the effects ascribed to varietal rights are in fact intertwined with a multitude of other aspects, including changing market structures, trade and agricultural policies generally, or commodity-specific policies in particular. Another commonly expressed concern deals with the degree to which varietal rights allow companies or individuals to charge unduly high prices for varietal innovations that were hitherto provided at prices below their costs of creation and production due to publicly supported R&D (e.g., Mittal 2002, p. 303).

³⁹ The evidence is mixed. In a study of yield trial data of wheat varieties from Washington state, Kolady and Lesser (2009, p. 77) report that their "...study supports the 'strong' hypothesis that private open pollinated varieties, which exist only because of PVP, are higher yielding. We also find supporting evidence for the 'medium' hypothesis that protected varieties are more productive in the case of SWW wheat. The evidence is not so strong for HRS, where most public varieties are protected mainly because of the strong private breeding programme in that wheat class." See also Perrin, Hunnings and Ihern. (1983) who found that the rate of yield improvement in soybean varieties from North Carolina, Louisiana and Iowa was (positively) related to IPR protection, while Babcock and Foster (1991) found no such evidence for tobacco varieties from North Carolina.

even begin to disentangle these linkages requires some concrete evidence on the types of plants being protected, by whom, and by what property rights instrument, and how all these aspects have evolved over time.

Table 2 provides a summary of the total number of varietal rights lodged in the period 1930-2008 grouped into three broad classes of plants (and nine sub-groups) according to the three types of rights on offer. Contrary to popular perceptions, cereals (including corn, wheat, rice, and others) account for a comparatively modest share of the varietal rights (13 percent of the total rights sought), and, similarly, oilseed crops (soybeans, rapeseed, and olive) made up a further 10 percent of the total. The lion's share of the rights (65 percent) pertains to higher-valued specialty crops (specifically ornamentals, fruits and vegetables). Ornamentals alone constitute half the total varietal right applications during this period, with fruits and vegetables making up a further 15 percent of the total. Grasses account for a small but notable share (4 percent), so that the combined total number of rights sought to protect horticultural crops (ornamentals, fruits, vegetables and grasses) over the 1930-2008 period was 23,789 (69 percent of the total).

[Table 2: *Varietal rights by crop class and type of right, 1930-2008*]

As one would expect given the subject matter restrictions of each type of varietal right, virtually none of the (sexually reproduced) cereal or oilseed varieties are protected by plant patents. Almost all the crops protected by plant patents are ornamental plants which include roses, chrysanthemums, geraniums, and impatiens (and are typically propagated by vegetative means such as grafting, budding, rooting cuttings, or dividing bulbs). Ornamentals, accounting for 81 percent of all plant patents, while fruit crops account for 14 percent. A much more diverse set of crop classes are subject to plant

variety protection, including cereals (29 percent), oilseeds (20 percent), vegetables (20 percent), grasses (12 percent), and fiber crops (6 percent). While all plant types are eligible for utility patents, just two specific cereal crops dominate this type of protection: corn varieties constituted 46 percent of the 3,719 utility patents sought from 1982 to 2008 and soybeans accounted for 38 percent of the total. Vegetables made up a smaller but notable share (5 percent), with less than 2 percent of the utility patents protecting ornamental, fruit, and tree crops.

The structure of rights has changed substantially over time, not least in response to the change in the rights on offer (plant patents since 1930, PVPs since 1971, and utility patents since 1980). Figure 5, Panel c summarizes changes since the middle of the 20th century in the composition of crop classes subject to varietal protection. During the 1950s, before PVPs and utility patents were possible, specialty crops accounted for 95 percent of the rights issued, with ornamentals alone accounting for 76 percent of the total. Fifty years later, during the period 2000-2008, the annual rate of applications had grown markedly from an average of 98 applications per year during the 1950s to 1,600 per year in the 2000s. Specialty crops were still the dominate type of plants being protected, but they constituted a much reduced share of the rights granted (63 percent of the total, with ornamentals accounting for 52 percent).

[Figure 5: *Changing composition of varietal rights by crop, 1930-2008*]

Figure 5, Panel d shows the crop structure of varietal rights across the three types of protection averaged over the last nine years in our time series (2000-2008). Ornamentals and fruits account for 96 percent of the plant patents, while 87 percent of the utility patent protection pertains to cereals and oilseeds. A more detailed time-series

presentation of the changing structure of varietal rights over time is given in Panels a and b of Figure 5 and Appendix Figure 1.

Rose varieties accounted for the largest share of all the varietal rights combined over the entire 1930-2008 period, but all those rights are issued as plant patents. Moreover, roses have lost some ground, slipping to the third-ranked crop during the last five years of our sample.⁴⁰ Notwithstanding the dominance of horticultural crops (accounting for 69 percent of all the rights, Table 2), corn and soybean varieties are now the top two ranked crops overall. Notably they accounted for around one-third of all the PVP applications in the 2004-2008 period and dominated the pool of utility patents (accounting for more than four-fifths of all the utility patents sought during this same period). Cotton ranked third in terms of utility patents and fifth in terms of PVP applications.

The crop concentration varies markedly among the types of rights. While just two crops accounted for substantially more than half the utility patent applications lodged during the period 2004-2008, it took four crops (soybean, corn, wheat, and turf grasses) to reach a 50 percent market share for PVPs during this same period, and 10 crops to account for half the plant patents.

4.3 Applicant Landscapes

The pool of applicants seeking varietal protection has changed substantially over the years. Both the amount and share of the rights sought by private firms have risen dramatically (Figure 6 and inset). During the 1930s and 1940s, private firms, be they

⁴⁰ Roses accounted for 49 percent of plant patent applications during the period 1930-1950, dropping to just a 7.7 percent share during the last five years of our sample. In contrast, and reflecting changes in the demand for bedding and potted plants vis-à-vis cut flowers, chrysanthemums, geraniums and impatiens now account for 17.7 percent of all plant patents compared with just 10 percent in the pre-1950 period.

U.S. or foreign entities, applied for varietal rights at an average rate of 28 applications per year: about 55 percent of all the rights sought during this period. During the last five years in our time series (2004-2008), private firms lodged an average of 1,467 applications per year: 82 percent of all applications from all sources. While the balance in U.S. varietal rights applications has shifted clearly in favor of the corporate sector, since the early 1980s applications from foreign firms grew at a faster rate than those from U.S. companies such that foreign corporations accounted for 31 percent of all U.S. applications originating from firms in 2008.⁴¹

[Figure 6: *The agency and country-of-origin structure of applications for U.S. varietal rights, 1930-2008*]

During the 1930s, U.S. individuals lodged applications at about the same rate as U.S. corporations (Figure 7, Panel a). While the rate of applications from U.S. individuals inched up over the years (an average of 20 applications per year in the 1930s versus 91 applications per year in the 2000s), these applicants now constitute just 4 percent of all varietal right applications. Similarly, the individual share of foreign applications fell precipitously (from 66 percent of a small number of applications in the 1930s and 1940s to 17 percent in the 2000s), underscoring the massive shift in both domestic and foreign markets towards corporate sources of varietal innovations. This change in the structure of intellectual property activity most likely reflects more fundamental changes in the structure and cost of doing and paying for research, and equally if not more importantly, marketing new seed and crop varieties (see, for example, Tansey 2002 and Marco and Rausser 2007).

⁴¹ Prior to 1982 foreign firms accounted for about 10 percent of varietal rights issued in the United States. During the 1983-2000 period their share grew to around 20 percent, and have been in the 30 to 40 percent range since 2001.

[Figure 7: *Changing composition of applicants, 1930-2008*]

Applications from public agencies (including U.S. and foreign universities, research foundations, and government agencies such as USDA) increased over the years (averaging just 0.3 applications per year in the 1930s versus 114 applications per year in the 2000s). The preponderance of these applications came from U.S. universities, who accounted for 81 percent of all publicly-sourced applications in the 2000s. Nonetheless, in 2008 universities lodged just 5.6 percent (106 applications) of the 1,882 total applications made that year, less than the number of applications lodged by individuals (270 applications, 32 percent of whom were U.S. based).

These overall trends mask a good deal of variation in the types of applicants seeking particular types of varietal rights. Setting aside the 1980s, when just a handful of varietal-related utility patent applications were lodged, U.S. corporations have consistently accounted for 90 percent or more of all the utility patent applications in the United States (Figure 7, Panel b).⁴² PVP applications were also mainly sought by corporations, with individual innovators accounting for a very small (always less than 2 percent) and declining share. In contrast, U.S. plant patent applications were dominated by individual applicants (50 percent of all applications in the 1930s), but their share has fallen to 20 percent in the 2000s. The inflation-adjusted value of floriculture and nursery imports (including cut flowers, nursery stock and bulbs) increased six-fold from 1976 to 2006 (i.e., from \$220 million to \$1.4 billion, 2004 prices) (Jerardo 2007), so it should be no surprise that foreign entities (mainly firms) accounted for 64 percent of all the plant

⁴² For example, from 2004-2008, two U.S. corporations (Pioneer Hi-Bred International, now Pioneer-Dupont, and Monsanto) lodged 1,074 applications, foreign firms 173 applications and individuals 11 applications.

patent applications lodged in the United States in 2008 (compared with 21 percent in 1984).⁴³ We estimate that 62 percent of the foreign plant patent applications in 2008 came from just four countries—the Netherlands, Germany, United Kingdom and Japan (Figure 8). The share of plant patent applications coming from private U.S. firms peaked in the 1950s and 1960s (averaging 60 percent of the applications during this period), declining thereafter to around 49 percent of the total in the last five years of our time series (Appendix Figure 2, Panel a).

[Figure 8: *Country composition of U.S. plant patents, 1930-2008*]

Figure 9 plots the cumulative share of varietal right applications for each of the three types of rights on offer against the cumulative number of applicants arrayed from left (largest) to right (smallest) in terms of the total number of applications lodged per applicant (other than individuals) during the 1930-2008 period. Curves that lie in the upper left-hand corner of the figure indicate highly concentrated holding of rights; those to the lower right indicate a more even distribution of applications among applicants. Plant patent applications are quite dispersed, with half the total pool of applications spread among 79 agencies (i.e., firms, universities and other institutional entities). In contrast, just two applicants (Pioneer Hi-Bred and Monsanto) account for nearly half the utility patent applications, while 22 applicants were needed to account for half the PVP applications. As firms within the U.S. seed sector in particular and plant innovation markets more generally have consolidated (Fernandez-Cornejo 2004) so too has the pool of applicants for varietal rights become more concentrated (as indicated by the upward

⁴³ Notably, seed imports into the United States also increased from an estimated \$90 million in 1984 (Fernandez-Cornejo 2004, Table 8) to \$747 million in 2009 (ISF 2011). Summing over all three forms of varietal rights, foreign applications accounted for 18 percent of the U.S. applications lodged in 1984 and 41 percent in 2008.

shift of the respective plots in Figure 9). Just 43 applicants accounted for half the plant patent claims during the 2000s, while 11 applicants lodged half the PVP applications. The increase in agency-concentration is less pronounced for utility patents in more recent years. This is because comparatively few firms lodged claims for utility patents during the entire three decades during which these varietal rights have been on offer, and, notably, comparatively few utility patents have been sought since the first such U.S. patent was granted in 1985 (3,716 applications through to the end of 2008, compared with 15,171 applications for plant patents and 7,719 PVPs over the same period).

[Figure 9: *Increasing concentration of varietal right applications, 1930-2008*]

Figure 10 draws together the crop and applicant orientation of these varietal rights and further underscore the complex and changing nature of these rights since WWII. During the 1950s, the bulk of the varietal rights pertained to ornamentals, fruits and vegetables and were claimed by U.S. firms (Figure 10, Panel a). During the decade immediately following the introduction of PVP rights, the U.S. private sector shares (especially related to ornamentals, fruits and vegetables) were still predominant but with a much larger absolute and relative presence of the U.S. public sector, which at that time emphasized cereal and oilseed crops (Figure 10, Panel c). The early stages of an increasing foreign presence in the U.S. intellectual property market for varietal rights are also evident in the 1970s data. In more recent years, U.S. companies still dominate, but foreign firms have gained a much larger share of this intellectual property market, with a heavy presence in ornamentals (Figure 10, Panel c). As the pace of utility patenting picked up, the attention of U.S. firms began to shift towards intellectual property protection for cereals, oilseeds and grasses (here included in the “other” category). The

crop orientation of the varietal rights sought by public entities has followed suit, although PVP certificates are the preferred mode of plant protection for this group of applicants.⁴⁴

[Figure 10: *Changing structure of applicants by crop, 1950s, 1970s, and 2000s*]

Grouping agencies and individuals into broad categories (e.g., public versus private, domestic versus foreign) helps to summarize broad trends but obscures the changing institutional complexity of these evolving intellectual property markets. Table 3 hints at that complexity. We list in rank order the top 10 applicants for each of the three forms of varietal rights on offer during the five years (2004-2008), plus the top ten applicants for plant varietal rights irrespective of the type of right.⁴⁵ These details reveal a major institutional dichotomy between the agencies most active in the utility patent and PVP segments of this market and those with a major stake in the plant patent segment. Only one company (Syngenta) that shows up in the top ten list for plant patents also appears in the top ten list for the other forms of protection. In contrast four firms are cross listed among the top ten for PVPs and utility patents. This suggest that the technical (e.g., breeding and multiplication) and marketing requirements for the vegetatively propagated (mainly ornamental) crops are distinct from the sexually reproduced crops that constitute most of the utility and (all the) PVP claims, so, apparently, there are less compelling scientific or commercial rationales for integrating operations among sexually and asexually reproduced crops (at least to this point in time).

[Table 3: *Top ten applicants by varietal rights, 2004-2008*]

⁴⁴ See also Appendix Figure 2 for more details of the trends in rights for applicants stratifies by type of right.

⁴⁵ This listing masks the reality that some companies may still be operating under their own name even though they have been acquired by other companies. For example, in the early 1990s Alfonso Romo, a Mexican bakery, beverage and cigarette mogul, began acquiring firms such as Petoseeds (which had recently purchased the Dutch firm Royal Sluis), Asgrow, and dozens of Asian seed companies to build Seminis into a large fruit and vegetable seed company, which was sold to Monsanto Corporation in 2005.

5. Final Remarks

When plant varietal rights were first offered in the United States in 1930 (as the Great Depression took hold), the agriculture sector, including horticulture, produced \$10.2 billion worth of output (15.8 percent of which came from horticulture, including ornamentals), there were 6.5 million farms employing 25 percent of the U.S. workforce, and the average farm size was 151 acres. Almost 80 years later, the U.S. agricultural economy had grown to produce \$240.3 billion in output in 2006 (22.5 percent coming from horticulture) and the farm sector had massively consolidated (down to 2.1 million farms averaging 446 acres in size and employing a smaller absolute amount and relative share, 0.96 percent, of the U.S. workforce). Moreover, 70 percent of the agricultural production (by value) came from 152,000 farm operations representing just 7 percent of all commercial farms in the United States in 2003 (Jones et al. 2006).

Across the board, U.S. farms are less reliant on farm-produced inputs. Farm-produced power, mainly horses and mules for traction, has given way to off-farm traction and energy sources, a substantial share of animal feeds are now grown off the farms where they are used, and purchased chemicals (herbicides, pesticides, and fertilizer) have grown as a share of the total cost of farm production. Notably, and of particular relevance for this paper, significant amounts of seed are now purchased annually rather than saved and reused.

Thus the input, including seed, markets servicing U.S. agricultural have evolved and adjusted accordingly. The scientific basis for manipulating cultivated crops has also changed radically as well over the past 80 years, again changing the incentives and structures of the crop breeding, multiplication and marketing sectors. Along with these

broader market changes have come changes in the U.S. markets for intellectual property generally, and for plant varieties in particular. In this paper we described the changing legislative and legal structures that directly affect plant varieties, as well as the marked changes in the crop, applicant, and types of varietal rights being sought since 1930.

Benchmarking these evolving intellectual property rights as we have done provides a basis for beginning to understand the complex interplay between the legal, scientific, and market forces that have shaped these varietal rights in the United States. A better understanding of these intellectual property markets can guide the policy and practice of varietal rights in the United States while also informing the international dimensions of these markets that are inextricably intertwined by way of international treaties along with trade in seeds, other plant propagation material, grain for food and feed, and other products of agriculture.

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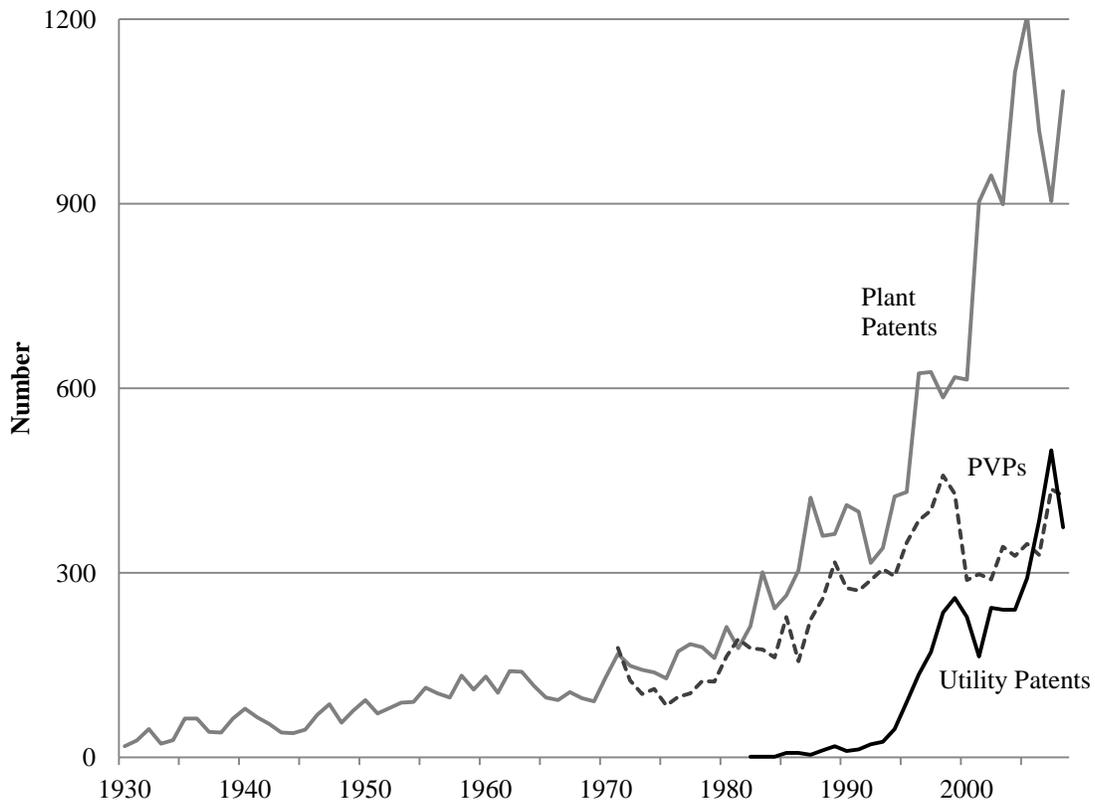
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Figure 1: US varietal rights, 1930-2008



Source: Compiled by authors based on data obtained from USDA, GRIN (various years) for PVPs, and USPTO (June 2009 and various earlier years for on-line database queries) and Thomson Innovation (2011) for plant and utility patents.

Notes: PVP indicates plant variety protection certificates. All data are reported by the year of application. The PVP series represents the number of certificate applications, while the utility and plant patents are the number of granted patents taken here to represent patent applications.

Table 1. Changing structure of plant variety rights, 1930-2008

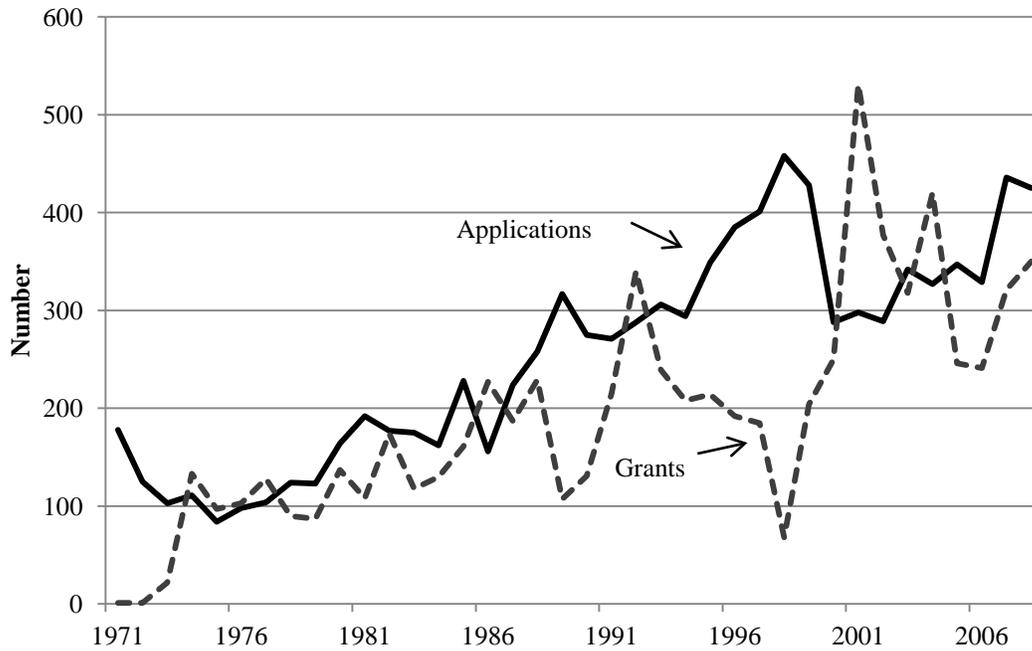
Type of protection	1951 - 1960	1971 - 1980	1991 - 2000	2001 - 2008
<i>Counts per period</i>				
Number of rights applied				
Plant patent	1,018	1,633	4,977	8,072
Plant variety protection	-	1,214	3,468	2,793
Utility patent	-	-	1,223	2,436
Total	1,018	2,847	9,668	13,301
<i>percent</i>				
Share of total				
Plant patent	100	57	51	61
Plant variety protection	0	43	36	21
Utility patent	0	0	13	18
Total	100	100	100	100

Source: See Figure 1.

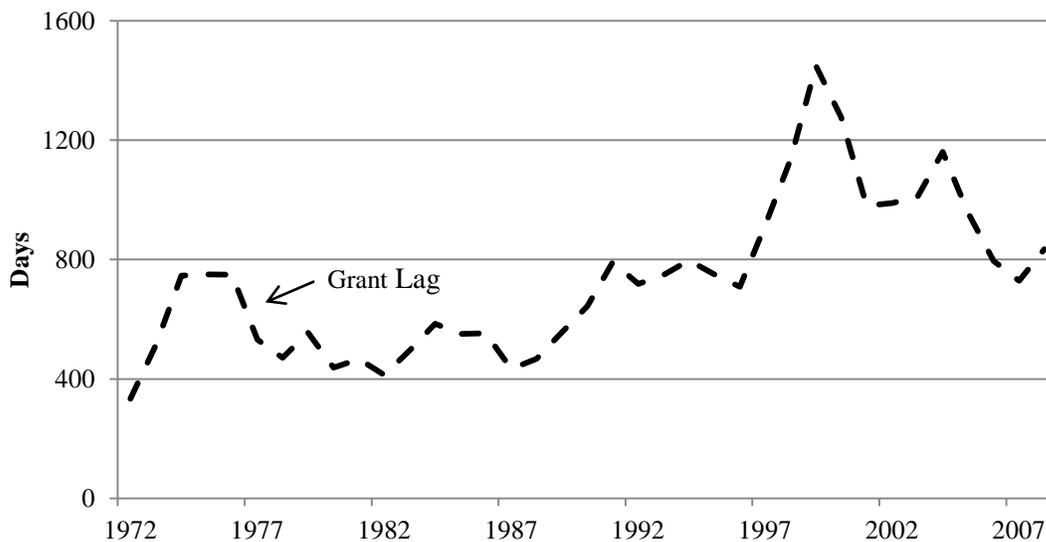
Notes: Entries in the upper half of table represent the total number of applications for each period.
Entries in the lower half of table are the respective shares of the total number of applications for each type of application in each period.

Figure 2. PVP applications, grants, and grant lags, 1971-2008

Panel a: *PVP applications and grants*



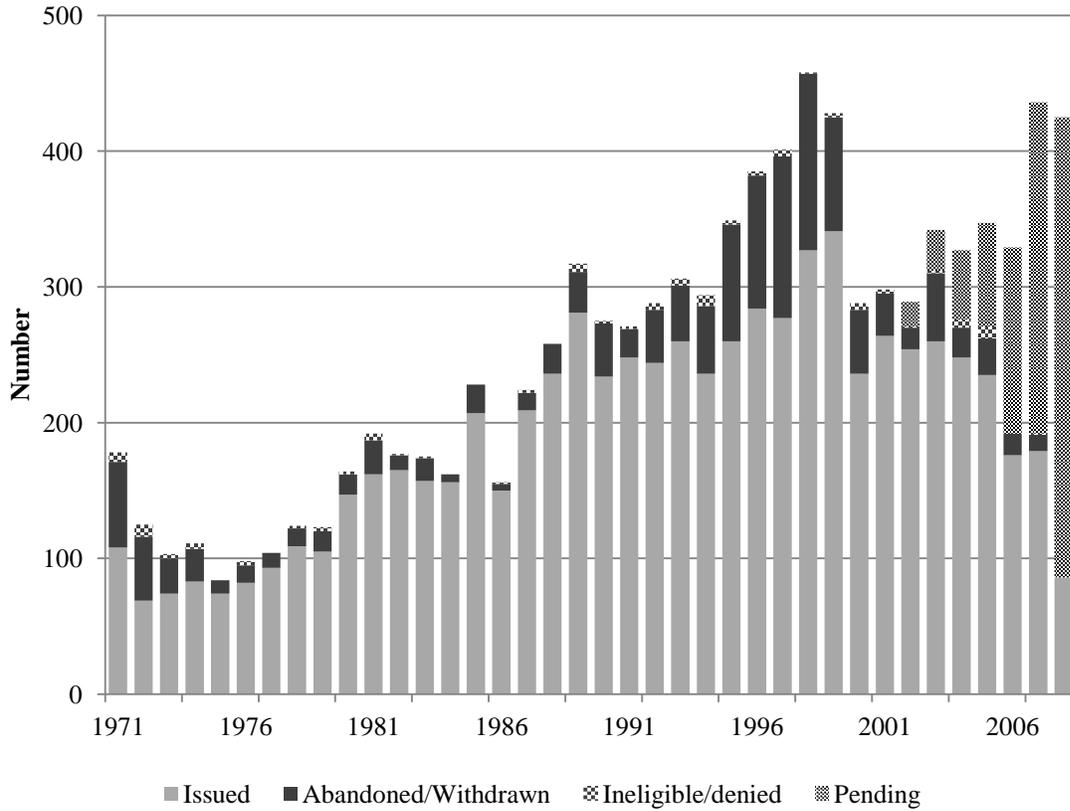
Panel b: *PVP grant lag*



Source: See Figure 1.

Notes: Panel a reports the number of PVP applications lodged and granted. The grant lag in Panel b is the lag in days from the date of filing to the date of issue of the PVP certificate.

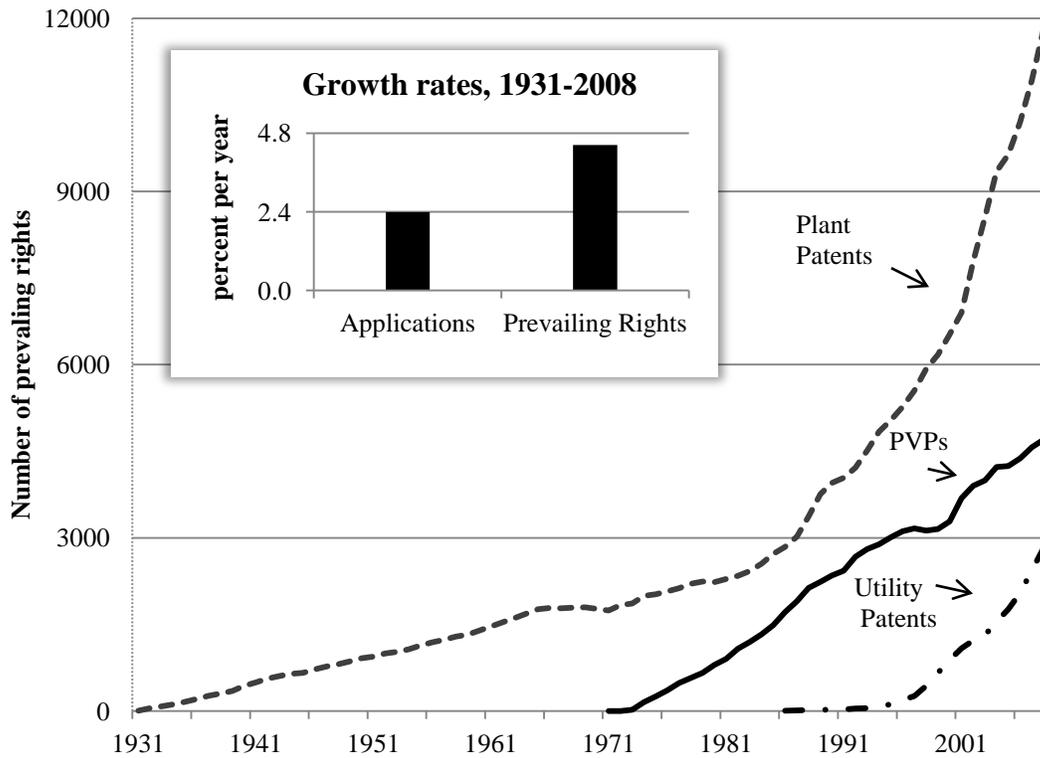
Figure 3. Changing disposition of PVP applications, 1971-2008



Source: See Figure 1.

Notes: These PVP rights are designated according to the classifications found in USDA, GRIN (various years).

Figure 4. Prevailing protection for plants varieties, 1931-2008



Source: See Figure 1.

Notes: Data reported by year of grant. Prevailing rights estimated as a cumulative count of all rights, taking account of the (changing) length of exclusionary rights for each type of right. Utility patents were assumed to run to term.

Table 2. Varietal rights by crop class and type of right, 1930-2008

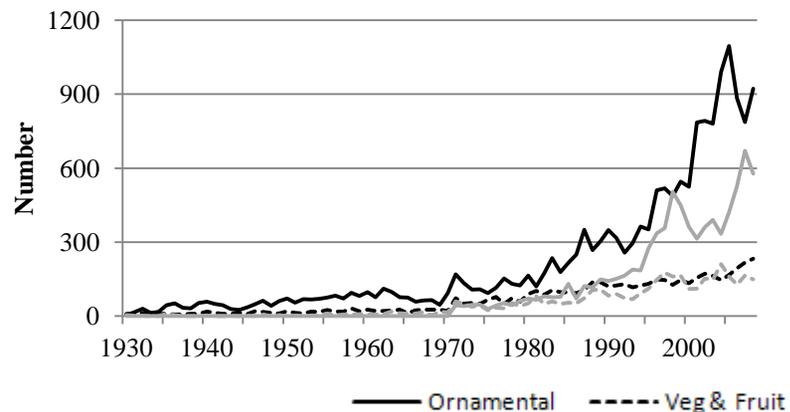
Crop group	Plant patent	Plant variety protection	Utility patent	Total
Number of rights			<i>count</i>	
Horticulture	20,188	3,373	228	23,789
Ornamental	16,962	289	31	17,282
Fruit	2,976	10	2	2,988
Vegetable	79	1,898	173	2,150
Grass	171	1,176	22	1,369
Cereal and oilseeds	19	4,778	3,294	8,091
Cereal	6	2,810	1,804	4,620
Oilseed	13	1,968	1,490	3,471
Others	775	1,488	197	2,460
Fiber	0	617	117	734
Tree	487	1	0	488
Assorted	288	870	80	1,238
Total	20,982	9,639	3,719	34,340
Share of total			<i>percent</i>	
Horticulture	96	35	6	69
Ornamental	81	3	1	50
Fruit	14	0	0	9
Vegetable	0	20	5	6
Grass	1	12	1	4
Cereal and oilseeds	0	50	89	24
Cereal	0	29	49	13
Oilseed	0	20	40	10
Others	4	15	5	7
Fiber	0	6	3	2
Tree	2	0	0	1
Assorted	1	9	2	4
Total	100	100	100	100

Source: See Figure 1. Varieties grouped into market categories according to the schema in (FAO 2005) and USDA-NASS (2000).

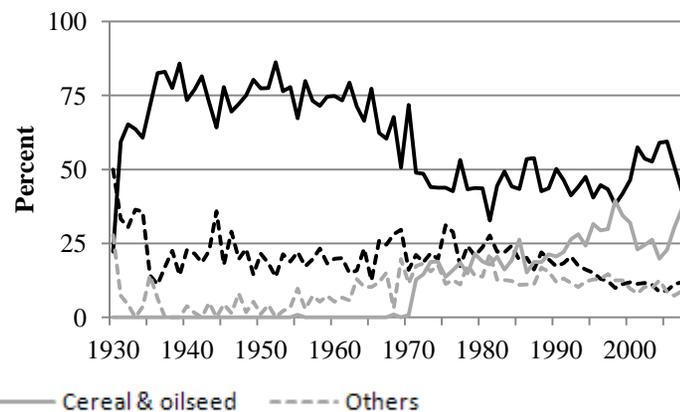
Notes: Assorted category includes crops classified as beverage and spice, fodder, legume, sugar crops, medicinal crops, and tree nut crops.

Figure 5: Changing composition of varietal rights by crop, 1930-2008

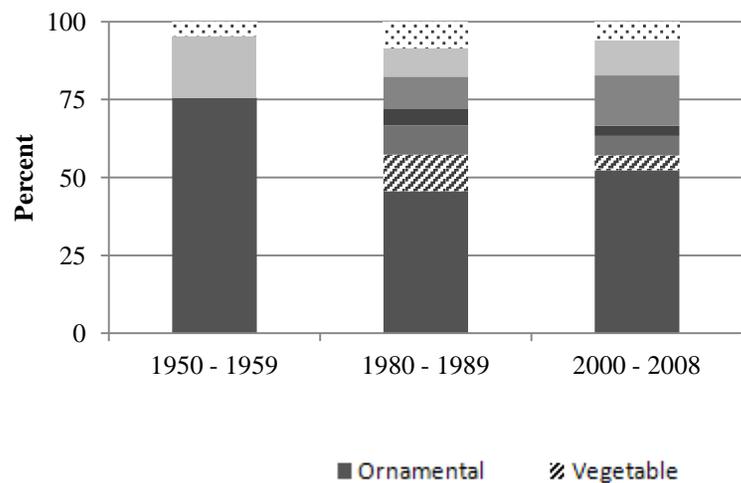
Panel a: *Crop applications by all varietal rights, 1930-2008*



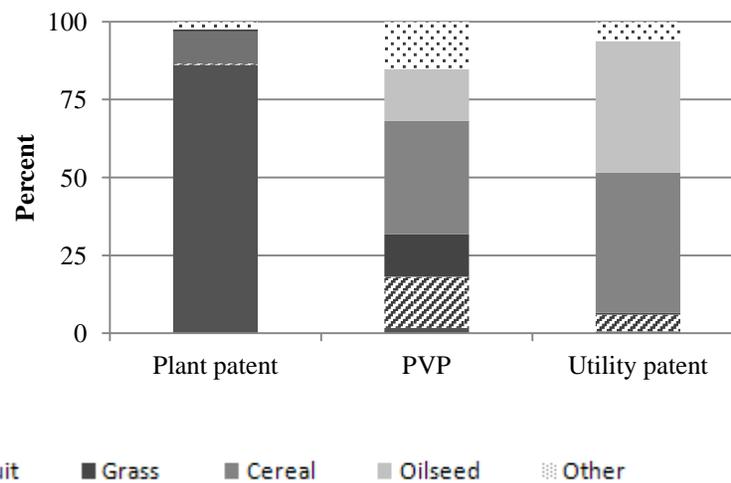
Panel b: *Crop shares by all varietal rights, 1930-2008*



Panel c: *Crop composition by all varietal rights, 1950-2008*

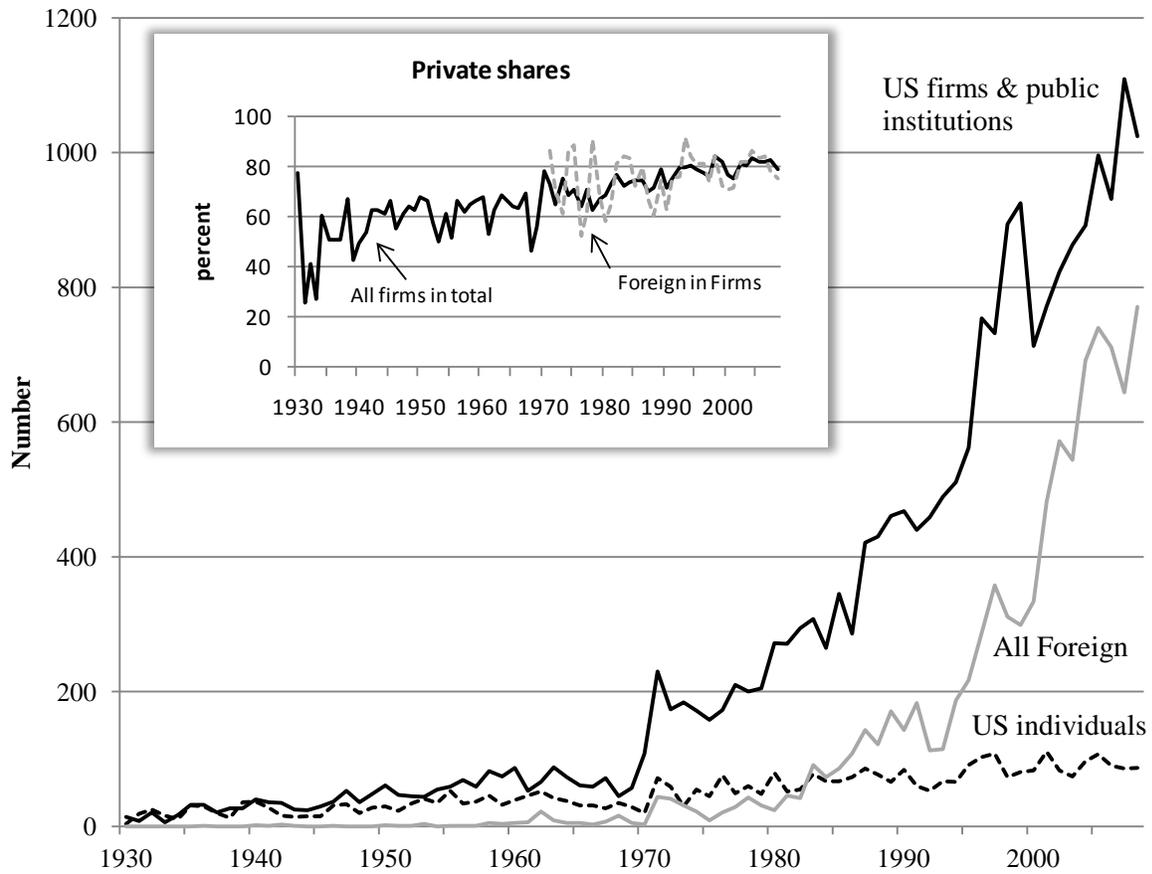


Panel d: *Crop composition by type of right, 2000-2008*



Source: See Figure 1 and Table 2.

Figure 6: The agency and country-of-origin structure of applications for U.S. varietal rights, 1930-2008

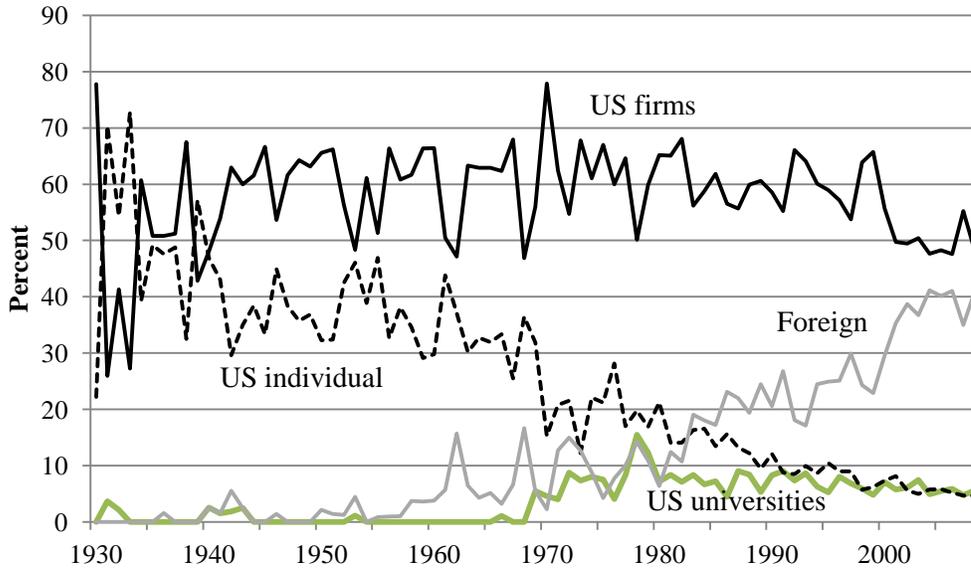


Source: See Figure 1 and Table 2.

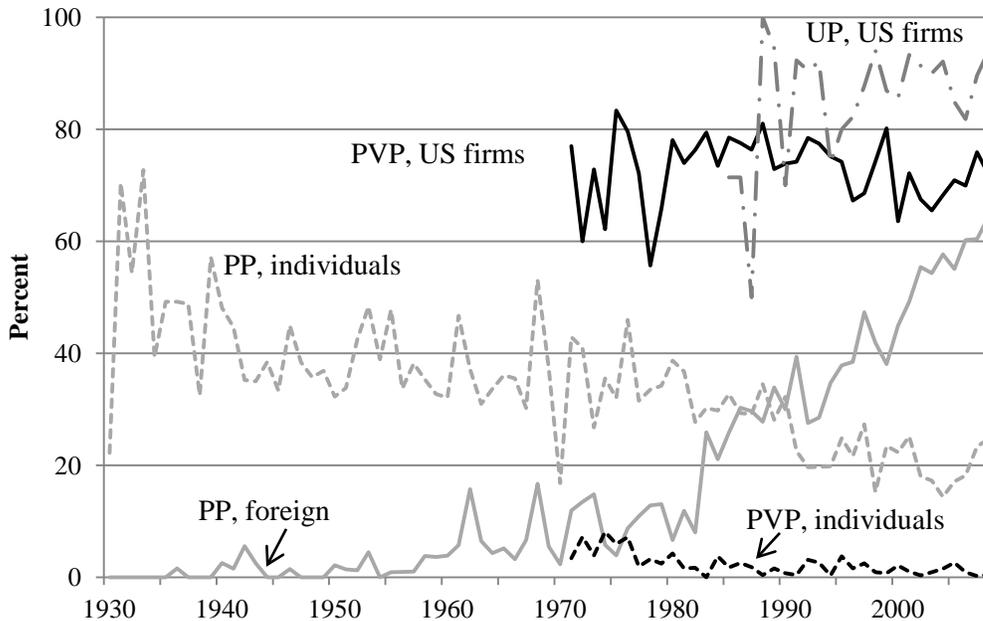
Notes: Agency designation (i.e., individuals and public institutions which includes universities, government agencies and research foundations) plus private firms and country-of-origin (i.e., United States and foreign) designations determined by authors based on name and location details of original applicants.

Figure 7: Changing composition of applicants, 1930-2008

Panel a: *Applicant type, all varietal rights*



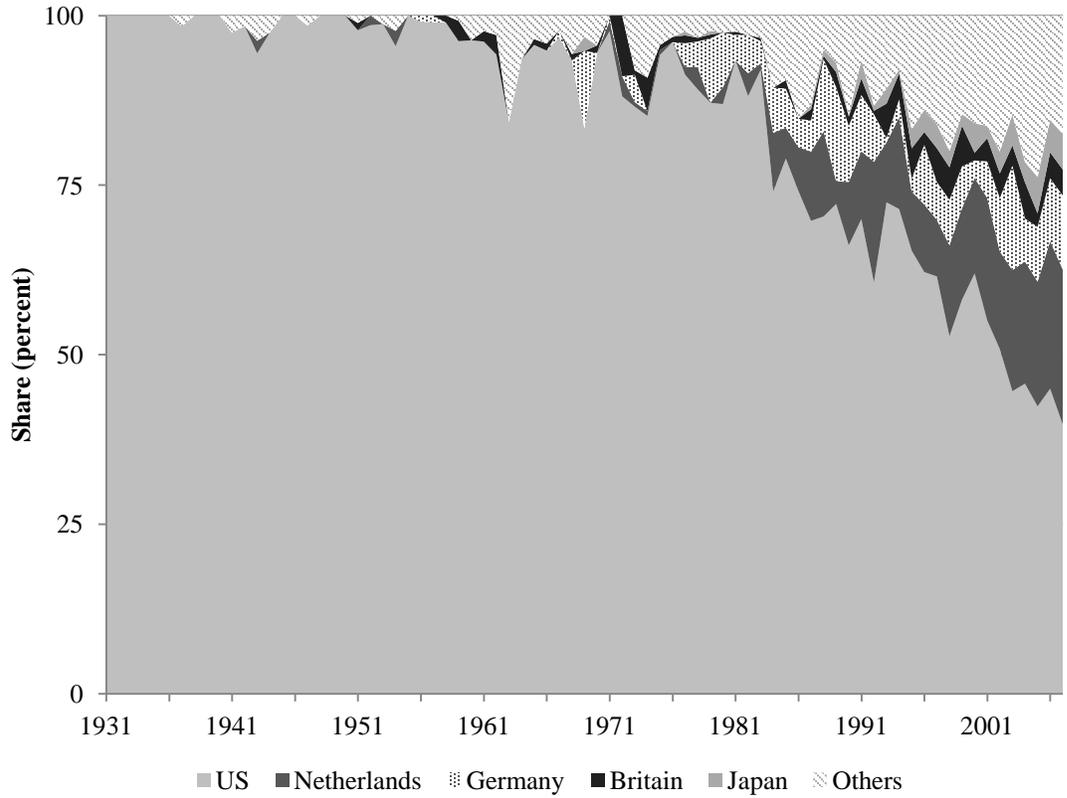
Panel b: *Applicant type by type of right*



Source: See Figure 1 and Table 2.

Notes: See Figure 6. While we made a substantial effort to standardized applicant names for rights spanning the same entity (firm) filing from different countries, we did not adjust the original location of the filing entity. For example, While the rights sought by Bayer CropScience AG are reported as foreign applications (Germany), those sought by Bayer CropScience LP are reported as US firms. However, both cases are treated as a single applicant "Bayer CropScience."

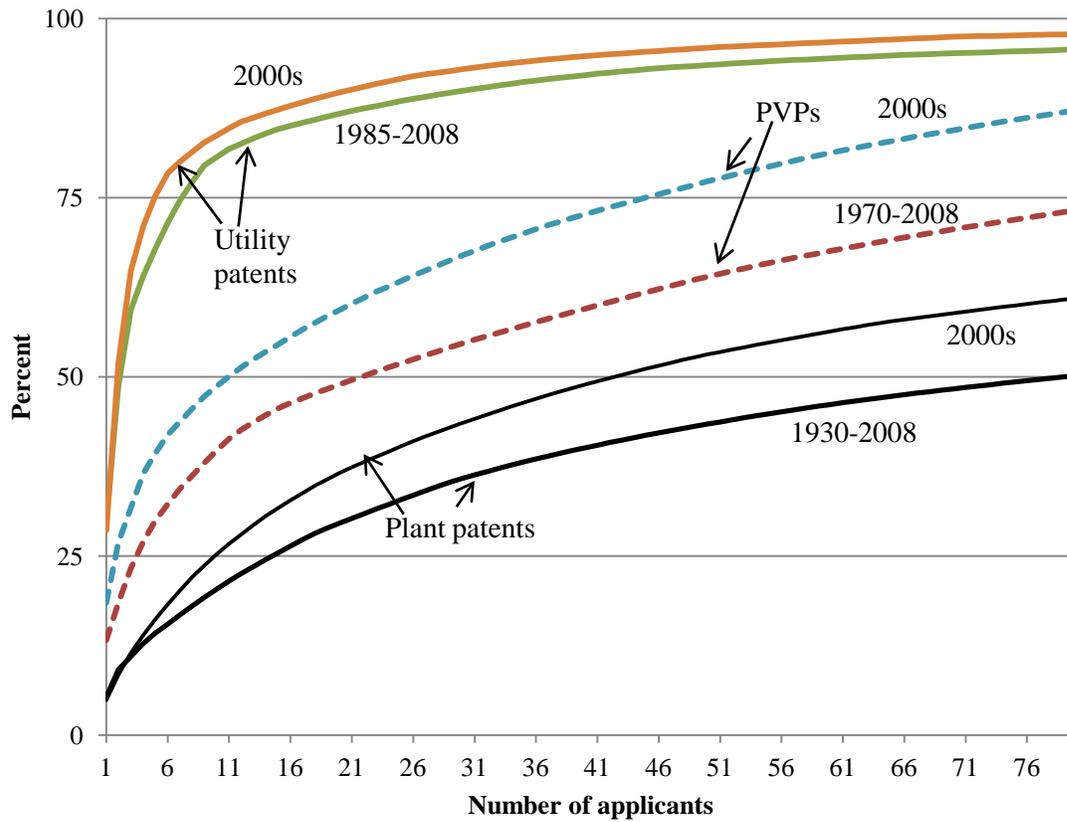
Figure 8: Country composition of U.S. plant patents, 1930-2008



Source: See Figure 1 and Table 2.

Notes: See Figure 6.

Figure 9: Increasing concentration of varietal rights applications, 1930-2008

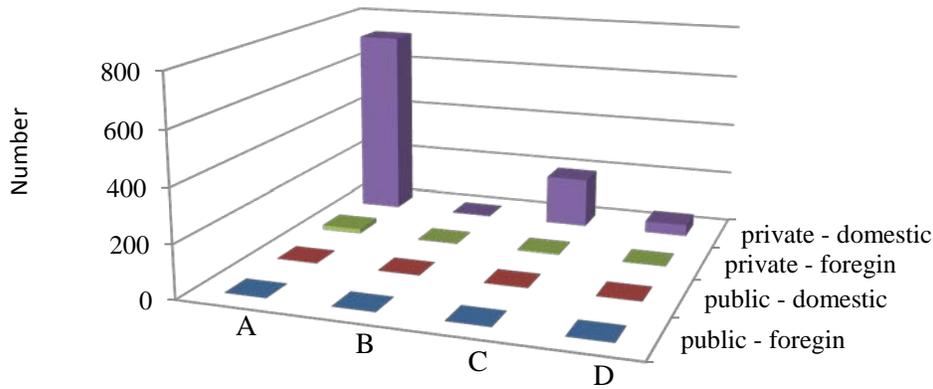


Source: See Figure 1 and Table 2.

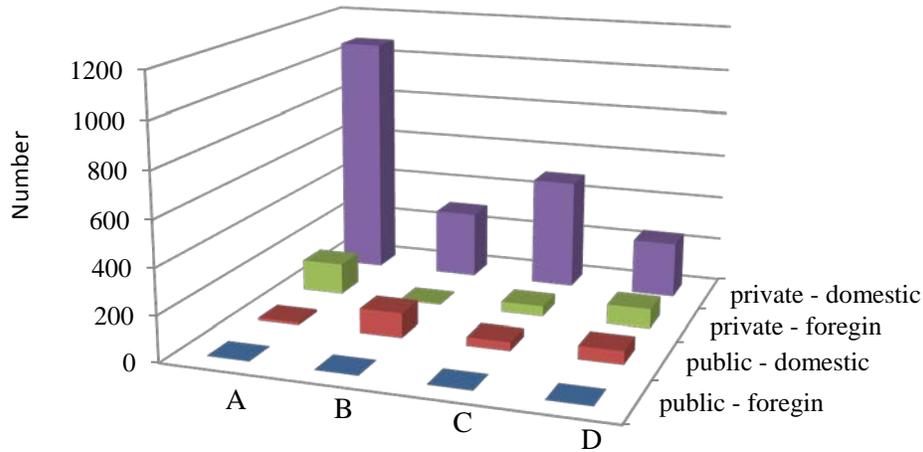
Notes: Plots represent cumulative share of each form of protection held by each applicant in each period, arranged by descending order of the size of each firms varietal rights holdings.

Figure 10: Changing structure of applicants by crop, 1950s, 1970s, and 2000s

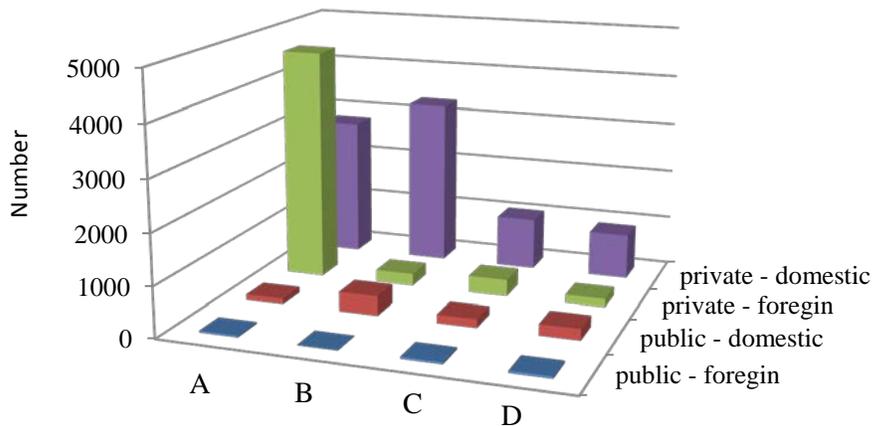
Panel a: 1950s



Panel b: 1970s



Panel c: 2000s



A=Ornamental; B=Cereal and Oilseed; C=Vegetables and fruit; D=Others

Source: See Figure 1 and Table 2.

Notes: Bars indicate number of applicants for all three types of US varietal rights in each period.

Table 3: Top ten applicants by varietal rights, 2004-2008

Plant patent			Plant variety protection			Utility patent			All IP		
Applicant name	Number	Share	Applicant name	Number	Share	Applicant name	Number	Share	Applicant name	Number	Share
	<i>count</i>	<i>percent</i>		<i>count</i>	<i>percent</i>		<i>count</i>	<i>percent</i>		<i>count</i>	<i>percent</i>
Yoder Brothers, Inc.	239	4.5	Pioneer Hi-Bred International Inc.	360	19.3	Monsanto	558	31.2	Pioneer Hi-Bred International Inc.	876	9.8
Syngenta	228	4.3	Monsanto	196	10.5	Pioneer Hi-Bred International Inc.	516	28.8	Monsanto	754	8.4
Goldsmith Seeds, Inc.	182	3.4	Seminis Vegatable Seeds Inc.	108	5.8	Stine Seed Farm, Inc.	172	9.6	Syngenta	466	5.2
Ball Horticultural Company	164	3.1	Syngenta	104	5.6	Syngenta	134	7.5	Yoder Brothers, Inc.	239	2.7
Suntory	157	2.9	D&PL Company	50	2.7	Mertec LLC	73	4.1	Goldsmith Seeds, Inc.	182	2.0
Klemm & Sohn Gmbh & Co. Kg	128	2.4	Pure Seed Testing, Inc.	49	2.6	D&PL Company	59	3.3	Ball Horticultural Company	176	2.0
Terra Nova Nurseries Inc.	115	2.2	Bayer CropScience	43	2.3	Shamrock Seed Company, Inc.	25	1.4	Stine Seed Farm, Inc.	172	1.9
Poulsen Roser A/S	103	1.9	Rutgers University	43	2.3	Seminis Vegatable Seeds Inc.	23	1.3	Suntory	157	1.7
Danziger - "Dan" Flower Farm	72	1.4	WestBred, LLC	42	2.3	Bayer CropScience	16	0.9	Seminis Vegatable Seeds Inc.	131	1.5
CP Delaware Inc.	71	1.3	North Dakota State University	34	1.8	Dow Agrosciences LLC	15	0.8	Klemm & Sohn Gmbh & Co. Kg	128	1.4
Top 10 applicants	1,459	27.4		1,029	55.2		1,591	88.9		3,281	36.5
Top 20 applicants	2,026	38.1		1,228	65.9		1,668	93.2		4,103	45.7
All applicants	5,324	100.0		1,864	100.0		1,789	100.0		8,977	100.0

Source: See Figure 1 and Table 2.

Notes: Data represent count and share of each type of right held by granted applicant. Consolidation of holdings due to subsequent merger and acquisition activity (e.g., Monsanto's acquisition of Seminis in 2005) are not reflected in this compilation.

Appendix Table 1. U.S. legal and regulatory framework for intellectual property rights affecting plant varieties, 1790-2011

Year	Legislation, ruling, or event	Notes
1790	Patent Act of 1790	First U.S. statute pertaining to patents (as referenced in Article 1, Section 8 of the U.S. Constitution).
1836	Patent Act of 1836	Created Patent Office and gave it the power to examine (and refuse) patents; the underpinnings of modern patent law.
1889	<i>Ex Parte Latimer</i> , 12 Mar 1889, CD., 46 O.G. 1638, Decisions of the Commissioner of Patents	A claim for an isolated plant fiber was rejected on the basis of lack of novelty and because it was unchanged from its form in the natural state. Because there was no new property of the fiber, it was not patentable subject matter.
1930	Plant Patent Act (P.L. 71-245) 35 U.S.C. §§ 161 -164.	First legislation providing patent protection for plants, specifically asexually reproduced plants. Provides protection to those who invent or discover new and distinct varieties of asexually propagated plants, other than a tuber propagated plant. Algae and macro fungi are regarded as plants, bacteria are not. The grantee was given the right to exclude others from asexually reproducing the plant or selling or using the plant so reproduced. Act did not protect sexually propagated plants, plant parts, or plants found in an uncultivated state. Duration of plant patent was same as for utility patents.
1936	<i>Cole Nursery Co. vs. Youdath Perennial Gardens, Inc.</i> , 17 F. Supp. 159 (Dist. Ct. N.D. Ohio, 1936), <i>appeal denied</i> 101 F.2d 1007 (6 th Cir., 1939)	The principle of excluding plants that had been introduced before the Plant Patent Act was affirmed in <i>Cole Nursery Co. vs. Youdath Perennial Garden</i> (1936) over a potential infringement of Plant Patent 110, claiming the Horvath Barberry plant. The Court invalidated the patent because the Horvath plant was known to the public prior to the Plant Patent Act, and in any case for more than the two years grace period.
1952	Patent Act of 1952 (P.L. 82-593) 35 U.S.C. § 101 et seq.	The basic structure of current patent law was set out in this Patent Act. Major changes made codified the patentability requirement for novelty, defined infringement, and clarified that processes are patentable subject matter.
1954	Amendment to the Plant Patent Act (P.L. 83-775)	Patentable subject matter was expanded to include cultivated sports, mutants, hybrids, and newly found seedlings when asexually reproduced.
1961	International Convention for the Protection of New Varieties of Plants (UPOV)	Internationally coordinated framework for protection of plant varieties (called plant breeders' rights) adopted in Paris by five UPOV member countries (Belgium, France, Germany, Italy and Netherlands). The Convention was subsequently revised in 1972, 1978 and 1991. The United States is bound by the 1991 Convention.

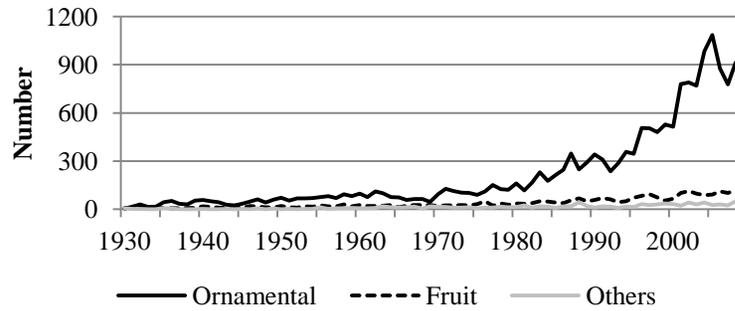
Year	Legislation, ruling, or event	Notes
1970	Plant Variety Protection Act (PVPA) (P.L. 91-577)	Protects sexually propagated plant varieties for 17 years from date of issuance. Includes breeders' and farmers' exemptions. PVP Office responsible for administering the Act is organized within the Agricultural Marketing Service of the U.S. Department of Agriculture.
1970	Patent Cooperation Treaty (PCT)	Provided a means to preserve rights to file patent applications in multiple countries for up to 30 months. The PCT, administered by the World Intellectual Property Organization (WIPO), Geneva, was concluded in 1970, amended in 1979, and modified in 1984 and 2001.
1976	Yoder Brothers, Inc. v. California-Florida Plant Corp. , 537 F.2d. 1347 (5 th Cir. 1976)	Court interpreted standards of patentability for asexually reproduced plants. "New and distinct" variety did not have to be novel in terms of never having existed before. A sport could have appeared in the past, but until someone recognized its uniqueness and preserved traits by asexual reproduction, no patentable plant would exist.
1980	Amendment to Plant Variety Protection Act (P.L. 96-574)	Scope of PVPA expands to encompass "soup vegetables" such as okra, carrots, celery, tomatoes, peppers, and cucumbers. Extends term of protection to 18 years from date of issue.
1980	Diamond v. Chakrabarty , 447 U.S. 303 (1980)	Supreme Court found that patentable subject matter includes "anything under the sun that is made by man", including microorganisms modified to metabolize oil (the invention in this case).
1985	Ex parte Hilbberd , 227 USPQ 433 (Bd. Pat. App. & Interf. 1990)	PTO held that seeds and plants may be protected by utility patents. No longer was an inventor limited to applying for a PVPC or plant patent.
1987-88	Ex part Allen , 2 USPQ2d 1425 (Bd. Pat. App. & Interf. 1987), aff'd mem. , 846 F.2d 77 (Fed. Cir. 1988)	PTO held that multicellular organisms (in this case polyploidy oysters) were patentable subject matter.
1994	Amendment to Plant Variety Protection Act (P.L. 103-349)	Brought U.S. IP Plant Variety Protection Act in line with 1991 UPOV Convention. Established that seed could be saved for replanting on the farmer's land, but it could not be sold to another farmer for production. Amendment extended protection to varieties that are "essentially derived" from the protected variety. Tuber propagated plants could also be protected by PVP, and the term of protection increased to 20 years for most crops and to 25 years for trees and vines.
1994	Pioneer Hi-Bred Int'l, Inc. v. Holden Foundation Seed Inc. , 35	Plants could also be subject to trade secret law. Identification by private code of fields of inbred parent lines of corn deemed sufficient to constitute a reasonable effort to maintain secrecy of inbred lines to qualify as trade secrets.

Year	Legislation, ruling, or event	Notes
	F.3d 1226 (8th Cir. 1994)	
1995	<i>Imazio Nursery, Inc. v. Dania Greenhouse</i> , 69 F.3d 1560 (Fed. Cir. 1995), <i>cert. denied</i> , 518 U.S. 1018 (1996)	Court held that to show infringement of a plant patent, the patent owner must prove that the alleged infringing plant is actually an asexually reproduced progeny of the patented plant. A mere demonstration of morphological identity between the patented and alleged infringing varieties is not sufficient; actual evidence of “copying” was required. Independent creation can be a defense to plant patent infringement.
1995	<i>Asgrow Seed Co. v. Winterboer</i> , 513 U.S. 179 (1995)	The Supreme Court held that under the farmer’s saved seed exemption of the PVP Act, a farmer can sell for reproductive purposes only the amount of saved seed that would be required for the purpose of replanting the farmer’s own acreage.
1998	Plant Patent Amendment Act (Pub.L. 105-289)	Extended the life of a plant patent to 20 years. Rights prior to 1998 enabled grantee to exclude others from asexually reproducing the plant or selling or using the plant so reproduced. To these rights were added exclusion rights for offering for sale the protected plant or any of its parts, and from importing the plant
2001	<i>J.E.M. Ag Supply, Inc v. Pioneer Hi-Bred , Inc.</i> , 534 U.S. 124 (2001)	Supreme Court held that plants are eligible for utility patents and thus that the PVPA and PPA are not the exclusive means of obtaining protection of plant varieties.
2007	<i>Monsanto Co. v. McFarling</i> , 488 F.3d 973 (Fed. Cir. 2007), <i>cert. denied</i> , 128 S.Ct. 871 (2008)	In earlier litigation (<i>McFarling I</i> and <i>McFarling II</i>), Farmer McFarling was found to be an infringer of Monsanto’s patents when he created second generation seeds by growing soybeans from patented seeds. Because the patents cover the seeds and Monsanto did not sell the new seeds to McFarling, there was no exhaustion of patent rights. Moreover, the Technology Agreement between Monsanto and McFarling wasn’t a patent misuse, so that the licensing restrictions on the products of the licensed soybean seed are not beyond the scope of a patent grant.
2011	Leahy-Smith America Invents Act (Pub L. 112-29)	While no amendments were made directly to the Plant Patent Act (35 U.S.C. §§ 161 et seq.), the amendments of patent law in the AIA apply equally to applications for a plant patent and a utility patent. Some of the major changes include expansion of prior art categories, abolishment of the 1-year grace period for sales and offers for sale, and award of a patent to the first-in-time inventor to file. In addition, several new post-grant procedures to attack a patent will become available.

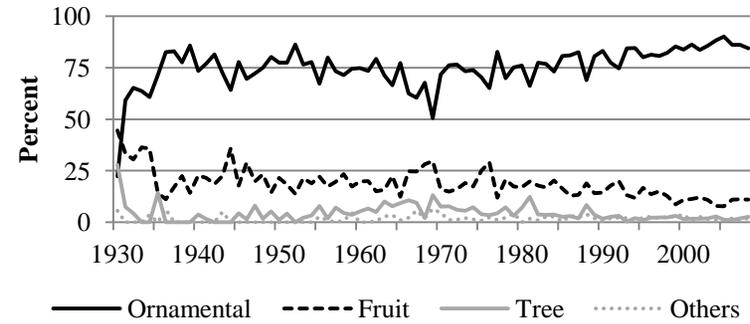
Source: Pardey et al. (2004), Hanson and Highlander (2004), Wright et al. (2007), and USDA (2005), plus specified in body of table.

Appendix Figure 1: Details of varietal rights by crop class, 1930-2008

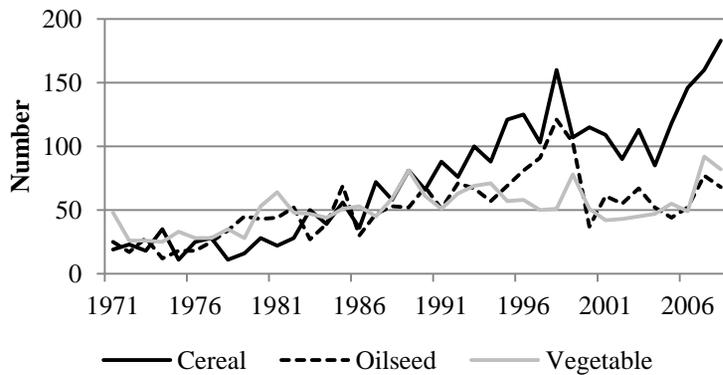
Panel a: Plant patent applications, 1930-2008



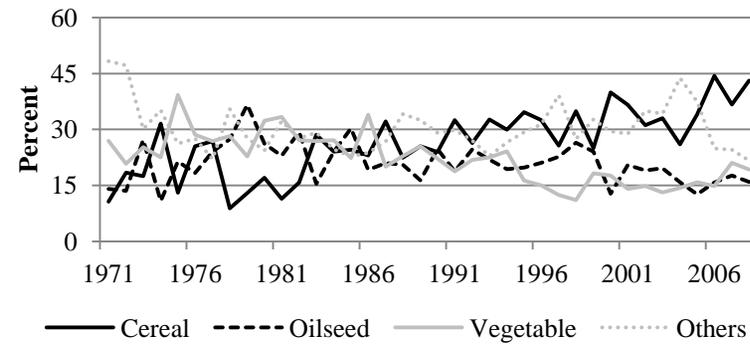
Panel d: Share of plant patents, 1930-2008



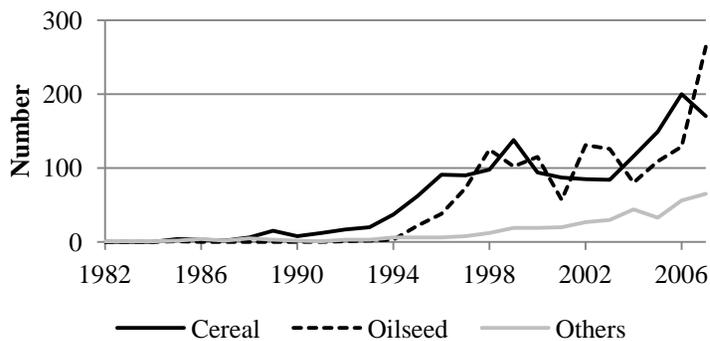
Panel b: Plant variety protection applications, 1971-2008



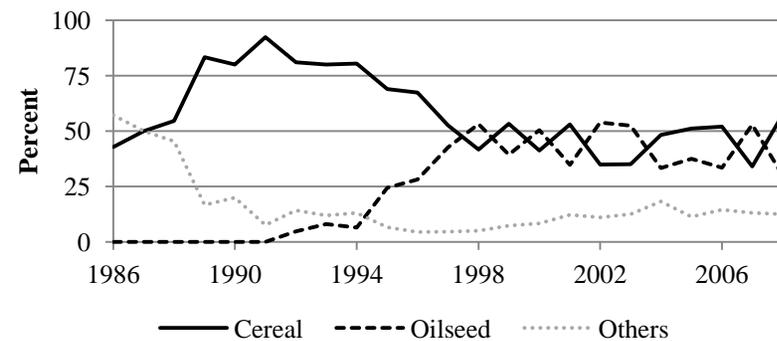
Panel e: Share of plant variety protection certificates, 1971-2008



Panel c: Utility patent applications, 1982-2008

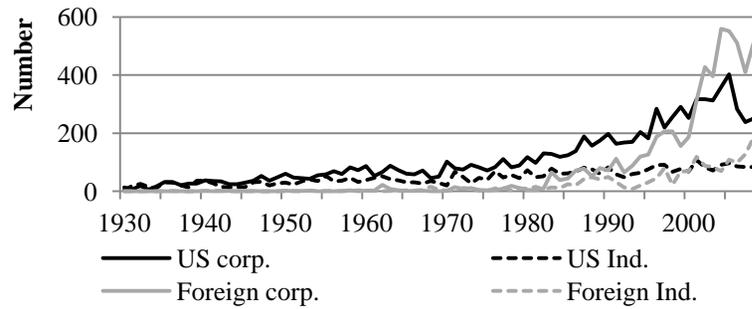


Panel f: Share of utility patent, 1986-2008

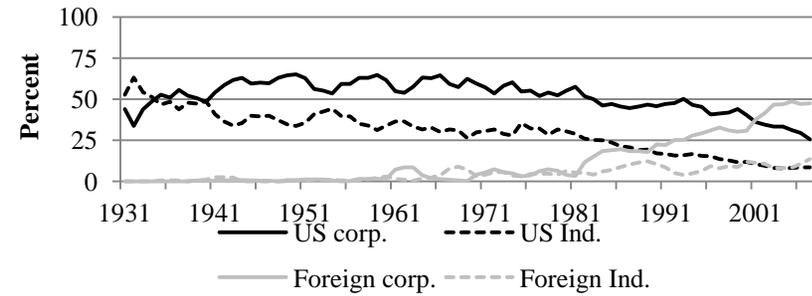


Appendix Figure 2: Details of varietal rights by type of applicant, 1930-2008

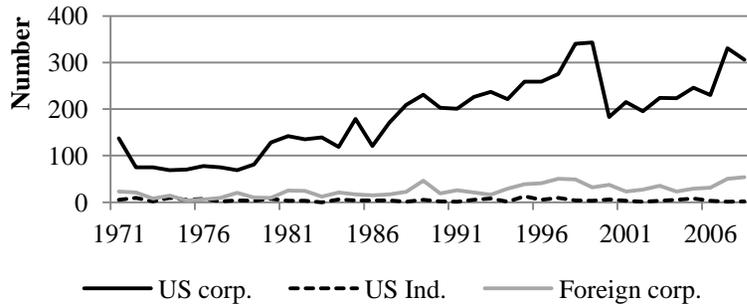
Panel a: *Plant patent applications, 1930-2008*



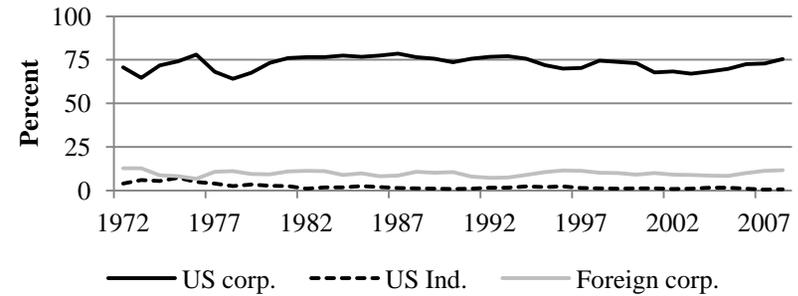
Panel d: *Share of plant patents, 1930-2008*



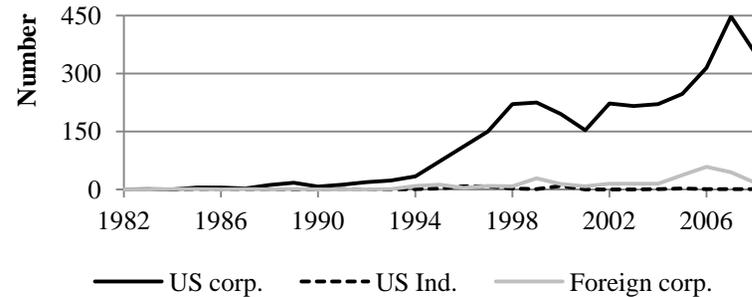
Panel b: *Plant variety protection applications, 1971-2008*



Panel e: *Share of plant variety protection certificates, 1971-2008*



Panel c: *Utility patent applications, 1982-2008*



Panel f: *Share of utility patents, 1982-2008*

