COMPETITION, INTELLECTUAL PROPERTY RIGHTS, AND TRANSGENIC SEED

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I. INTRODUCTION

U.S. agriculture has been the testing ground for rapid innovation and penetration of transgenic crop technologies, particularly for row crops such as corn, cotton, and soybeans. Intellectual property ("IP") rights ideally promote innovation in agricultural biotechnology and crop science by allowing patent holders to appropriate the value of their investments in research and development ("R&D") that lead to commercialization of new genetic traits ("traits") and traited seed. These technologies, which command substantial price premiums through technology fees and royalties, cover a range of agronomic plant performance features, such as herbicide tolerance ("Ht"), insect resistance ("Bt"), and drought resistance. These technologies also cover other value added characteristics, such as superior amino acid balance. The enormous value and broad scope of IP rights involving transgenic seed, which some argue is a "self-replicating" technology, are best illustrated by the steady march of patent infringement claims over the last decade.¹

The courts have fairly consistently found for patent holders in major infringement cases. Antitrust counterclaims by growers, seed companies, and competing traits developers have fared poorly in most cases. At the same time, the courts have avoided providing clear guidance on distinguishing the type of conduct that "crosses the line" between: (1) what is legitimately within the scope of an IP right, versus (2) what exceeds the bounds of that right through the exercise of market power that is strategically designed to limit or control competition.² Without clear calls on "balls and strikes" on such cross-over points, IP law threatens to work at cross-purposes to competition law. This presents a difficult tension given that both areas of law share a common goal of promoting innovation. IP law accomplishes this directly while antitrust law works to protect competition—a major driver of innovation.

The need for guidance from antitrust enforcers and/or the federal judiciary on the question of what constitutes the appropriate balance between IP and

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^{1.} See generally Monsanto Co. v. McFarling, No. 4:00-CV84CDP, 2001 WL 34082053 (E.D. Mo. Apr. 18, 2001); Monsanto Co. v. Scruggs, 345 F.App'x 552 (Fed. Cir. 2009); Monsanto Co. v. Scruggs, No. 3:00CV-161-P-D, 2009 WL 536833 (N.D. Miss. Mar. 3, 2009); Monsanto Co. v. E.I. du Pont De Nemours & Co., No. 4:09CV00686 ERW, 2009 WL 3012584 (E.D. Mo. Sept. 16, 2009); Monsanto Co. v. Bowman, 686 F. Supp. 2d 834 (S.D. Ind. 2009).

^{2.} The Supreme Court was tasked with deciding the patent exhaustion question in the context of seed saving outside the proprietary (i.e., "commodity") channel in *Bowman v. Monsanto. See* Monsanto Co. v. Bowman, 657 F.3d 1341, 1347 (Fed. Cir. 2011), *cert. granted*, 133 S. Ct. 420 (2012).

antitrust in transgenic seed is driven by observations on more recent data and analysis on transgenic seed markets. These observations range from: a weakening correlation between R&D and market concentration; to a possible slow-down in the pace of innovation and adoption of transgenic technologies; to price increases for technology that outpace improvements in productivity. Such observations are not definitive of a cause-and-effect relationship between innovation and market structure. However, they suggest the importance of further inquiry into the potential that the effects of high concentration and single firm dominance in transgenic seed have on competition and consumers. Two major competitive issues are of particular concern, both of which have broader, systemic effects on prices, choice, and innovation. These include the effect of market structures and IP licensing practices on the: (1) innovation of important "stacked" (i.e., combined) trait products and (2) potential impairment of alternative channels of distribution to proprietary seed, including the "commodity" (i.e., seed purchased from grain elevators) and generic channels.

The risk of suppressing competition and the consumer harm that accompanies an imbalance between IP rights and competition in transgenic seed punctuates the importance of finding workable solutions. This may require legislative policy intervention if the issues remain unresolvable by IP or antitrust enforcement alone. This article proceeds in Section II by examining the state of play in antitrust enforcement and patent infringement involving transgenic seed.³ Section III discusses recent developments regarding the performance of transgenic seed markets, against which the tension between IP rights and competition should be carefully evaluated.⁴ Section IV considers the broader systemic competitive implications of these developments, including effects on trait stacking and alternative channels of distribution to proprietary seed.⁵ Section V concludes with policy implications.⁶

II. THE FACE-OFF BETWEEN INTELLECTUAL PROPERTY AND ANTITRUST IN TRANSGENIC SEED

In 2010, the U.S. Department of Agriculture ("USDA") and U.S. Department of Justice ("DOJ") held a series of joint workshops to examine competitive issues in U.S. agriculture. One of the five workshops addressed the topic of transgenic seed. The product of the USDA-DOJ effort appeared in a May 2012 report. The summary highlighted, among other things, farmer reports lamenting high prices and lack of choice in transgenic seed and the "fear that the best and newest genetics will only be introduced with expensive patented traits stacked into them."⁷ In response to public concerns over price and choice

^{3.} See infra Part II.

^{4.} See infra Part III.

^{5.} See infra Part IV.

^{6.} See infra Part V.

^{7.} U.S. DOJ, COMPETITION AND AGRICULTURE: VOICES FROM THE WORKSHOPS ON AGRICULTURE AND ANTITRUST ENFORCEMENT IN OUR 21ST CENTURY ECONOMY AND THOUGHTS ON THE WAY FORWARD 13 (2012), *available at* http://www.justice.gov/atr/public/reports/283291.pdf.

involving transgenic seed, the DOJ noted the tension between patent law and antitrust law, explaining:

However, if conduct goes beyond the appropriate use of intellectual property and harms competition, it should be disciplined by appropriate antitrust enforcement. The Division stands ready to take the appropriate action in those cases. Thus, if the patent holder has crossed the bounds of the antitrust laws and abused his rights in a manner that leads to competitive harm, the Division is prepared to challenge that action. There may also be opportunities for clarification of how patent and antitrust law should align.⁸

A test of the DOJ's position was not long in coming. In late 2012, the agency closed its investigation into Monsanto's competitive practices in genetic traits and traited crop seed markets. Notable was the lack of public transparency regarding the Antitrust Division's findings that could have shed some light on the fundamental tension between IP rights and competition that the DOJ posed in its May 2012 report.

In early 2013, the DOJ again opined on the issue of IP rights in the government's amicus curiae brief in Bowman v. Monsanto, on appeal in the Supreme Court from the Federal Circuit.⁹ The case frames the question of whether the patent exhaustion or "first sale" doctrine extends not just to saving of the progeny of seed purchased from proprietary outlets, but also to the saving of progeny of seed purchased from grain elevators (i.e., "commodity" seed). The DOJ came down on the side of IP rights, in support of the Federal Circuit, while other amici highlighted the competitive implications of creating a carve-out in the patent exhaustion doctrine (i.e., a "Bowman rule") for self-replicating technologies.¹⁰ The tension between IP and competition law is also evident in a number of other prominent biotechnology patent infringement cases and antitrust counterclaims. These cases highlight innovators' focus on "how to license" (as opposed to "whether to license"). The major issues center on whether licensing restrictions placed on growers, seed companies, and rival biotechnology firms fall within the scope of patent-holders' rights or go beyond those rights in an attempt to limit, shape, or control competition.¹¹

^{8.} Id. at 23.

^{9.} See generally Brief for the United States and Amicus Curiae Supporting Affirmance, Bowman v. Monsanto, 133 S. Ct. 420 (2012) (No. 11-796), 2013 WL 137188 (arguing that the authorized sale of one generation of a patented seed does not exhaust a patent-holder's right to control subsequent generations of that seed).

^{10.} See generally Brief of Amici Curiae The American Antitrust Institute, National Farmers Union, Food & Water Watch, Organization for Competitive Markets, & National Farmily Farm Coalition In Support of Petitioner, Bowman, 133 S. Ct. 420 (No. 11-796), 2012 WL 6208274 (arguing that restraints on products embodying patent components should be governed by contract law). The patent exhaustion doctrine is intended to facilitate downstream or secondary markets in IP-protected products. It precludes patent holders from using their IP rights to create or enhance market power in markets other than the market for the patented technology.

^{11.} See generally U.S. DOJ & FTC, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION (2007), available at http://www.ftc.gov/reports/ innovation/P040101PromotingInnovationandCompetitionrpt0704.pdf (discussing refusals to license, as opposed to licensing restrictions).

SOUTH DAKOTA LAW REVIEW

Antitrust counterclaims in patent infringement cases fall in three general categories. One class of issues involves alleged exclusionary practices. For example, plaintiff seed companies alleged variously that Monsanto imposed minimum percentage purchase requirements and bundling requirements across multiple product lines, engaged in exclusive dealing, and denied access to important inputs.¹² In these cases, licensing restrictions were alleged to have exclusionary effects, such as erecting barriers to entry in traits markets and limiting rivals' ability to license other rivals' traits. A second category of competitive concerns goes to the question of whether seed saving restrictions violate the patent exhaustion doctrine.¹³ Antitrust counterclaims in these cases invoke illegal tying arguments, whereby growers were allegedly required to purchase new transgenic seed every year as a condition of the initial purchase of proprietary seed. A final set of issues involves restrictions on how rivals can combine or stack their traits with competitors' traits. Such restraints allegedly had the effect of foreclosing rivals from access to inputs necessary to create new stacked products.¹⁴

Antitrust counterclaims to patent infringement allegations involving transgenic seed have not fared well in the federal court system. On the merger side, the story is somewhat different. For example, in the proposed merger of Monsanto and cottonseed giant Delta and Pine Land in 2007, the Antitrust Division extracted remedies that addressed the competitive effects of IP licensing, including the condition that Monsanto remove anti-stacking restrictions in its licenses.¹⁵ This condition, together with the divestiture of germplasm and seed assets, was most likely designed to ensure rivals' access to the technologies necessary to bring new transgenic cotton products to market. Likewise, in Monsanto's 1998 acquisition of corn seed company DeKalb, the government required the wide licensing of corn germplasm.¹⁶ Coupled with the

^{12.} See, e.g., Am. Seed Co., Inc. v. Monsanto Co., 271 F. App'x 138 (3d Cir. 2008); Syngenta Seeds, Inc. v. Monsanto Co., No. Civ. 04-908-SLR, 2005 WL 678855 (D. Del. Mar. 24, 2005); Am. Seed Co., Inc. v. Monsanto Co., 238 F.R.D. 394 (D. Del. 2006). See generally 1 HERBERT HOVENKAMP, MARK D. JANIS, & MARK A. LEMLEY, IP AND ANTITRUST: AN ANALYSIS OF ANTITRUST PRINCIPLES APPLIED TO INTELLECTUAL PROPERTY LAW (2007) (examining intellectual property from an antitrust perspective).

^{13.} See, e.g., Monsanto Co. v. McFarling, 302 F.3d 1291 (Fed. Cir. 2002); Monsanto Co v. Bowman, 657 F.3d 1341 (Fed. Cir. 2011); Monsanto Co. v. Scruggs, 459 F.3d 1328 (Fed. Cir. 2006).

^{14.} See, e.g., Defendants' Amended Answer and Counterclaims at ¶¶ 39, 75, Monsanto Co. v. E.I. DuPont de Nemours and Co., 4:09-cv-00686 (ERW), 2009 WL 2589331 (E.D. Mo. July 10, 2009). The district court found for Monsanto on the infringement claims, which alleged that DuPont Pioneer infringed on Monsanto's patent by stacking its Optimum GAT herbicide (glyphosate) tolerance soybean trait with Monsanto's Roundup Ready I soybean trait. See Monsanto Co. v. E.I. du Pont De Nemours & Co., No. 4:09CV00686 ERW, 2012 WL 3095539 (E.D. Mo. July 30, 2012) (denying DuPont Pioneer's motion for summary judgment on willful infringement). The antitrust counterclaims in the case, which were split off from the patent infringement litigation, will not be heard until later in 2013. See Monsanto Co. v. E.I. du Pont De Nemours & Co., No. 4:09CV00686 ERW, 2009 WL 3012584 (E.D. Mo. Sept. 16, 2009).

^{15.} See United States v. Monsanto Co. & Delta & Pine Land Co., No. CIVA 1:07-CV-00992, 2008 WL 5636384 at *1 (D.D.C. Nov.6, 2008).

^{16.} Press Release, U.S. DOJ, Justice Department Approves Monsanto's Acquisition of Dekalb Genetics Corporation: Divestiture of Transformation Technology Rights and Licensing of Corn Germplasm Implemented (Nov. 30, 1998), *available at* http://www.justice.gov/atr/public/press_releases/

spin-off of agrobacterium-mediated transformation technology, the remedy, as the DOJ explained: "preserve[d] competition in this newly emerging market for corn with transgenic improvements."¹⁷

This brief history of the relationship between IP rights and competition in transgenic seed highlights a number of key points. For example, the failure of antitrust counterclaims to gain traction against patent infringement cases punctuates either the general difficulty associated with mounting successful cases under Section 2 of the Sherman Act¹⁸ or a judicial preference for relatively expansive interpretation and enforcement of IP rights involving transgenic technologies, or both. A second observation is that the DOJ has been more aggressive or successful in extracting remedies that address the intersection between IP rights and competition in the area of merger enforcement. One reason for this is that merger enforcement is less fraught with the difficulties associated with Section 2 enforcement. But, merger enforcement is also not burdened with the necessity of interpreting the scope of a patent-holder's IP rights. Regardless of the interpretation, the mixed record of IP and antitrust provides an important backdrop against which enforcers and policymakers should evaluate more recent developments in the biotechnology and traited crop seed markets and their implications for competition and consumers.

III. TROUBLE IN TRANSGENIC PARADISE?

Since their advent, transgenic crop technologies have been heralded as the major source of gains in agricultural productivity. This goal has extended beyond the U.S. to other countries faced with the challenges of feeding increasing populations. Since transgenic technologies are still relatively novel, economic analysis has been somewhat limited by the availability of long-term data. However, recent data and analysis on R&D and innovation, market concentration, and prices and productivity raise fundamental questions regarding the performance of markets for traits and traited crop seed. These observations do not establish any definitive relationship between innovation and market structure, but they frame a potentially important backdrop against which competitive issues might be evaluated. Three major observations stand out, including recent evidence on: (1) the relationship between market concentration and R&D, (2) the pace of innovation and adoption of transgenic technology, and (3) recent indicators involving prices and productivity.

A. CONCENTRATION V. R&D

Since scrutiny of the transgenic seed industry intensified in the late 2000s, more attention has focused on the effect of mergers and strategic conduct on prices, choice, and innovation. The first stop in most assessments of competition

^{1998/2103.}htm.

^{17.} Id.

^{18.} See 15 U.S.C. § 2 (2006).

is market concentration. Recent analysis indicates that of all agricultural input sectors, the level of concentration and increases in concentration are the highest in crop seed.¹⁹ For example, between 1994 and 2009, the market share of the four largest firms in the crop seed industry more than doubled to 54%.²⁰ In 2007, the four largest companies held 72% of the U.S. corn seed market and 55% of the U.S. soybean seed market.²¹ Monsanto's shares in the markets for traited corn and soybeans in 2009 were upwards of 55%.²² In 2009, the top four companies held 95% of the market for cottonseed, with Monsanto and Bayer accounting for the lion's share.²³ In the traits markets, the "Big 6" (Monsanto, Syngenta, Dow, Bayer, DuPont, and BASF) biotechnology firms held greater than 95% of trait acres for corn, soybeans, and cotton in the U.S. in 2009, with Monsanto alone accounting for 90% of these acres.²⁴ In the same year, Monsanto traits were reportedly planted on about 77% of total cotton acres, about 82% of corn acres, and 95% of soybean acres.²⁵

Concentration levels in transgenic seed are likely the result of multiple factors. One may be organic growth of biotechnology and seed companies, fueled by successful innovation and successful commercialization of new products, but merger activity can produce the same result. For example, two waves of consolidation stand out in the transgenic seed industry over the last 20 years—one in the mid-1980s and a second over the last decade.²⁶ During the

24. Keith O. Fuglie et al., Econ. Research Serv., USDA, *Rising Concentration in Agricultural Input Industries Influences New Farm Technologies*, AMBER WAVES, December 2012, at 4, *available at* http://www.ers.usda.gov/media/960711/risingconcentration.pdf.

25. See MONSANTO, SUPPLEMENTAL INFORMATION FOR INVESTORS 3, 5-6 (2012), available at http://www.monsanto.com/investors/Documents/2012/FINAL_Q2_Investor_Supplement_04.03.2012.pd f. Note, however, that USDA data may indicate higher Monsanto shares in the cotton traits market. See MOSS, supra note 22, at 13.

26. The second wave brought a number of large mergers, including the formation of Syngenta from AstraZeneca and Novartis Seeds in 2000, Bayer's acquisition of Aventis Crop Sciences in 2002, and BASF's takeover of Cyanamid in 2000. It was during this period that seed companies such as Pioneer, DeKalb, Trojan, Northrup-King, Cargill, and Golden Harvest were acquired. *See* JORGE FERNANDEZ-CORNEJO, ECON. RESEARCH SERV., USDA, AGRICULTURE INFORMATION BULLETIN NO. 786, THE SEED INDUSTRY IN U.S. AGRICULTURE 32-34 (2004), available at http://www.ers.usda.gov/media/260

729/aib786_1_.pdf; Carl Pray et al., Innovation and Dynamic Efficiency in Plant Biotechnology: An Introduction to the Researchable Issues, 8 AGBIOFORUM 52, 60 (2005), available at http://agbioforum.org/v8n23/v8n23a01-oehmke.pdf; UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT, TRADING THE TREND TOWARDS MARKET CONCENTRATION: THE CASE OF THE AGRICULTURAL INPUT INDUSTRY 5, 9-10 (2006), available at http://unctad.org/en/Docs/ditccom200516 _en.pdf; Gregory D. Graff et al, Agricultural Biotechnology's Complementary Intellectual Assets, 85

^{19.} KEITH O. FUGLIE ET AL., ECON. RESEARCH SERV., USDA, REPORT NO. 130, RESEARCH INVESTMENTS AND MARKET STRUCTURE IN THE FOOD, PROCESSING, AGRICULTURAL INPUT, AND BIOFUELS INDUSTRIES WORLDWIDE, at vi (2011), available at http://www.ers.usda.gov/media/199879 /err130 1 .pdf.

^{20.} Id. at 14.

^{21.} Id. at 35.

^{22.} See MONSANTO, SUPPLEMENTAL TOOLKIT FOR INVESTORS 6, 9 (2010), available at http://www.monsanto.com/investors/documents/supplemental_toolkit.pdf; see also DIANA L. MOSS, AM. ANTITRUST INST., TRANSGENIC SEED PLATFORMS: COMPETITION BETWEEN A ROCK AND A HARD PLACE? 13-14 (2009), available at http://www.antitrustinstitute.org/~antitrust/sites/default/files/AAI_P latforms%20and%20Transgenic%20Seed_102320091053.pdf.

^{23.} FUGLIE ET AL., *supra* note 19, at 35. Monsanto reported a 44% share of the cottonseed market in 2009. MONSANTO, *supra* note 22, at 8.

late 1990s through 2000s, for example, Monsanto alone acquired almost 40 companies, including agricultural biotechnology firms and independent seed companies that historically held the substantial base of seed germplasm needed by traits developers to breed new varieties.²⁷ Also, between 1985 and 2000, the Big 6 biotechnology firms acquired about 75% of small to medium size enterprises engaged in biotechnology research.²⁸

There are a number of possible drivers of consolidation in high technology industries, including: securing economies of scale in R&D, acquiring complementary market assets, and enhancing market power. For example, R&D programs in genomics may be possible only under relatively large scale.²⁹ Additionally, exploiting complementarities between traits and traited seed assets may achieve vertical efficiencies such as reduced transactions costs and economies of coordination.³⁰ The prospect of such efficiencies drives the compilation of packages of research tools, genes for traits, and germplasm integration that may result in the more efficient creation of new transgenic varieties.³¹

Despite these arguments, the startling levels of concentration and single firm dominance in transgenic seed raise fundamental questions. For example, is innovation facilitated by horizontal and vertical integration achievable on a scale that will support only a few firms in the industry?³² Or, is increasing concentration the result of strategies designed to extend IP rights beyond their legitimate bounds in an effort to limit competition? Recent analysis casts some doubt on the former rationale, which has enjoyed a significant base of support for some time, not only in transgenic seed but also in other high technology industries. For example, the most rapid growth in R&D spending in various agricultural input sectors occurred in crop seed and biotechnology. Between 1994 and 2010, growth in real spending was 138%.³³ And, while R&D intensity (as measured as a percentage of industry sales) increased from the late 1990s to early 2000s, by the late 2000s, it had dropped to the mid-1990s level.³⁴ More importantly, increasing levels of concentration in agricultural input markets (including crop seed) are no longer generally associated with higher R&D or a

REV. ECON. STAT. 349, 360-61 (2003).

^{27.} Monsanto acquired biotechnology firms and seed companies such as Agrecetus, Calgene, Holdens, Asgrow, and Delta and Pine Land.

^{28.} Fuglie et al., supra note 24, at 4.

^{29.} Nicholas Kalaitzandonakes, Biotechnology and the Restructuring of the Agricultural Supply Chain, 1 AGBIOFORUM 40, 40 (1998).

^{30.} See Rachel E. Goodhue et al., Biotechnology, Intellectual Property, and Value Differentiation in Agriculture 1, 8-9 (Univ.of Cal. at Berkeley Dep't of Agric. & Res. Econ. & Policy, Working Paper No. 901, Rev. 2002), available at http://escholarship.org/uc/item/9w85z5r6; Graff et al, supra note 26.

^{31.} See Graff et al., supra note 26, at 349; see also FUGLIE ET AL., supra note 19, at 16, 36.

^{32.} Contra, Geoffrey A. Manne, et al., Comment on Intellectual Property, Concentration and the Limits of Antitrust in the Biotech Seed Industry 1 (Lewis & Clark Law Sch. Legal Research Paper No. 2010-9, 2010), available at http://ssrn.com/abstract=1553064 (highlighting the benefits of IP protection but not accounting for the unique fact pattern in the transgenic seed industry that bears importantly on this discussion).

^{33.} FUGLIE ET AL., supra note 19, at 16.

^{34.} Id. at 15.

permanent rise in R&D intensity.³⁵

B. INNOVATION AND ADOPTION OF NEW TECHNOLOGIES

The foregoing concerns provide a segue to a closer look at the pace of innovation and rates of technology adoption by growers. Indeed, declines in R&D intensity may be reflected in the pace of innovation, as measured by growth in the stock of transgenic technology. Figure 1 shows, for example, the cumulative number of genetic events approved for environmental use in the U.S. for corn, cotton, and soybeans from 1994 to 2011.³⁶





The accumulation of these genetic events can be viewed as the "stock" of biotechnology innovation (i.e., the output of R&D effort) over time. Figure 1 highlights the disparities in the stocks of innovation across crops. Corn displays the greatest growth, with a total of 30 events by 2011, or an average of about 1.67 additions to the innovation stock per year. Contrast this with cotton, with 12 events accumulating over the period and an average of about 0.67 additions per year, and soybeans, with 10 events by 2011 and an average of only 0.56 additions per year. If measured by a simple "count" of genetic events, growth in the stock of innovation in cotton and soybeans has therefore lagged behind corn.

^{35.} Id. at 2, 15. USDA examined whether market concentration was correlated with the share of industry revenues invested in R&D.

^{36.} See Int'l Life Sci. Inst., GM Crop Database, CTR. FOR ENVTL. RISK ASSESSMENT, http://ceragmc.org/index.php?action=gm_crop_database (select "Cotton," "Maize," and "Soybeans" for "Crop Plant"; then select "United States" for "Country"; enter "1994" and "2011" for "Year(s) Approved"; then select "Submit") (last visited Apr. 13, 2013).

More sophisticated measures of innovation would account for the relative impact of each genetic event on productivity.

Another important observation is that the rate of adoption of stacked trait varieties by U.S. growers has recently fallen off. For example, average annual growth rates for stacked trait transgenic corn varieties fell from 57% per year between 2001 and 2009 to only 44% per year between 2001 and 2012. For cotton, these same growth rates fell from 11% per year to 9% per year. The slowing trend in transgenic penetration rates, particularly for stacked traits, is evident in the ratio of transgenic seed price to yield, as shown in Figure 2. These trends could display the typical S-curve pattern of technological adoption, particularly in natural environments where capacity constraints are relevant, but they could also reflect broader competitive concerns and the effects of high prices for transgenic technologies.

C. WHAT PRICE TECHNOLOGY?

Despite the productivity-enhancing effects of transgenic technology, a number of more recent observations may undercut arguments that high prices are generally justified by the benefits of innovation. Technology fees and royalties, for example, represent a significant proportion of the cost of seed. Traits accounted for 80% of the total value of cottonseed in the U.S. in 2007.³⁷ For corn, traits accounted for 37% of the total value in 2009.³⁸ In soybeans, the same percentage fluctuated between 30% and 42% for much of the past decade.³⁹ Equally revealing is how seed prices themselves have changed relative to other indicators. For example, the prices of all farm inputs generally have risen faster than the prices U.S. farmers receive for their output (e.g., crops and livestock) over the last two decades. Among all farm inputs, crop seed prices increased most over the period 1994 to 2010,⁴⁰ more than doubling relative to the price received for crop commodities.⁴¹

When viewed relative to changes in yields—a major driver behind the adoption of transgenic seed—price increases should garner even more scrutiny. Figure 2 shows the ratio of transgenic seed price to yields for soybeans, corn, and cotton from 2001 to 2012.⁴²

41. Id. at 13.

42. See Commodity Costs and Returns, ECON. RESEARCH SERV, USDA, http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx (for soybean yield, select

^{37.} FUGLIE ET AL., supra note 19, at 29.

^{38.} Id.

^{39.} Id. at 28-29. See generally Kalaitzandonakes et al., A Worrisome Crop?: Is There Market Power in the U.S. Seed Industry? 33 REG. 20 (2010) (analyzing the pricing of different types of traits); Guanming Shi et al., An Analysis of the Pricing of Traits in the U.S. Corn Seed Market, 92 AM. J. AGRIC. ECON. 1324 (2010) (investigating the pricing of traits in the U.S. corn seed market under imperfect competition); Guanming Shi et al., An Analysis of Pricing in Horizontal and Vertical Markets: The Case of the U.S. Cottonseed Market, 42 AGRIC. ECON. 77 (2010) (investigating the price impacts associated with structural changes in the U.S. cottonseed market from 2002 to 2007); Guanming Shi et al., Pricing of Herbicide-Tolerant Soybean Seeds: A Market Structure Approach, 12 AGBIOFORUM 326 (2009) (investigating the effects of supply-side factors on the pricing of soybean seeds).

^{40.} FUGLIE ET AL., *supra* note 19, at 11-13.



Figure 2: Ratio of Transgenic Seed Price to Yield (2001-2012)

These ratios increased steadily beginning in the mid-2000s, indicating that increases in seed prices have outpaced increases in yields. The yield data reflect all crop seed. However, since transgenic varieties account for a significant percentage of acreage planted, total yields provide a fairly accurate indication of transgenic yields.⁴³

The USDA posits that increases in seed prices are due at least in part to the value of the new seed traits resulting from research investments made by innovators.⁴⁴ But, the agency further notes, "farmers are willing to pay higher prices so long as the gains from higher productivity outweigh their higher costs."⁴⁵ Indeed, the foregoing analysis suggests that increasingly higher prices paid by growers for transgenic technology may not be accompanied by commensurate increases in productivity.

Without additional economic modeling, it is difficult to isolate the source of changes in prices and productivity. Explanations could range from (1) diminishing returns to innovation, (2) constraints introduced by limited arable crop acreage and environmental concerns, to (3) the effects of high market concentration on competition and consumers. Regardless of the cause, the

[&]quot;Recent Costs and Returns: Soybeans" for "Data"; then select "U.S.: 1997-2001, 2002-05, 2006-11") (for corn yield, select "Recent Costs and Returns: Corn" for "Data"; then select "U.S.: 1996-2000, 2001-04, 2005-09, 2010-11") (for cotton yield, select "Recent Costs and Returns: Cotton" for "Data"; then select "U.S.: 1997-2002, 2003-06, 2007-11") (last updated Oct. 1, 2012); *Quick Stats*, NAT'L AGRIC. STAT. SERV., USDA, http://quickstats.nass.usda.gov/results/B8A1E7EB-71E6-390F-8CDF-B482990B5523 (surveying prices paid for biotech corn, cotton, and soybeans).

^{43.} Adoption of Genetically Engineered Crops in the U.S., ECON. RESEARCH SERV., USDA, http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx (last updated July 12, 2012). Acreage penetration in 2012 was 93% for soybeans, 88% for cotton, and 88% for corn. *Id.*

^{44.} Fuglie et al., *supra* note 24, at 5.

^{45.} *Id*.

foregoing observations create a troubling landscape against which the tension between IP rights and competition should be evaluated.

IV. "SYSTEMIC" COMPETITIVE CONCERNS

Recent evidence regarding the performance of traits and traited crop seed markets for corn, cotton, and soybeans may signal fundamental underlying completive problems that deserve attention, not only by the courts and antitrust enforcers, but by agriculture policymakers. Such systemic problems generally suppress competition, raise prices, hamper innovation over time, and punctuate the importance of the friction between IP rights and competition. Two problems are of particular concern – constraints on stacking traits and impairment of alternative channels of distribution for trait crop seed.

A. CONSTRAINTS ON STACKING GENETIC TRAITS AND STANDARDIZING ON A DOMINANT TECHNOLOGY PLATFORM

Stacked traits have quickly become the industry standard in corn and cotton and are beginning to emerge in soybeans, which have until recently been singletraited (Ht) products. The USDA notes, "tracking traits will become increasingly complex as multiple GM [genetically modified] traits from a variety of firms are inserted into individual varieties."⁴⁶ Stacking addresses multiple issues, including the drive for higher yields from multiple modes of action (e.g., Bt-Ht or Ht-Ht). But, stacking also addresses "refuge" concerns through requirements that growers plant both conventional and non-transgenic seed to combat growing resistance of insects to a particular aging mode of action.

To better grasp the competitive implications of stacking, it is helpful to trace the penetration of single versus stacked traits over time. For example, between 2000 and 2012, the percentage of acreage planted with single traited varieties of corn increased from 24% to 36%.⁴⁷ For cotton, single-traited varieties planted decreased from 41% to 36%⁴⁸ and for soybeans increased from 54% to 93%.⁴⁹ The pace of adoption of stacked traits, however, is far more dramatic. In 2000, just 1% of corn acres and 20% of cotton acres were planted with stacked trait varieties.⁵⁰ These each increased to 52% by 2012.⁵¹ Of the forty-five total trait profiles on the market in 2009, single traits accounted for just over one-third of total profiles, and the remainder were conventional or stacked trait profiles.⁵² Twenty-nine of those trait profiles are corn, five are

553

^{46.} FUGLIE ET AL., supra note 19, at 44.

^{47.} See Nat'l Agric. Statistics Serv., 2000 USDA ACREAGE 29, available at http://usda01.library. cornell.edu/usda/nass/Acre//2000s/2000/Acre-06-30-2000.pdf; Nat'l Agric. Statistics Serv., 2012 USDA ACREAGE 25, available at http://usda01.library.cornell.edu/usda/current/Acre/Acre-06-29-2012.pdf.

^{48.} See 2000 USDA ACREAGE, supra note 47, at 29; 2012 USDA ACREAGE, supra note 47, at 26.

^{49. 2000} USDA ACREAGE, supra note 47, at 28; 2012 USDA ACREAGE, supra note 47, at 27.

^{50. 2000} USDA ACREAGE, supra note 47, at 29.

^{51. 2012} USDA ACREAGE, supra note 47, at 25, 26.

^{52.} See DMRKYNETEC & MONSANTO, CORN TRAIT PROFILES, COTTON TRAIT PROFILES, AND SOYBEAN TRAIT PROFILES 1-3 (2009), available at http://www.monsanto.com/newsviews/Documents/

[Vol. 58

soybeans, and eleven are cotton.



Figure 3: Percent of U.S. Corn, Soybean, and Cotton Acres Planted with Transgenic Seed (2000-2012)

Stacking requires adoption of a more novel way of thinking about competitive paradigms vis-à-vis IP rights in transgenic seed. For example, new stacked trait profiles are possible through "intra-firm" stacking—a single innovator combining its own traits. In 2009, 38% of all stacks were intra-firm combinations.⁵³ A second possibility is "inter-firm" stacking—combinations of multiple rival innovators' traits. These accounted for 62% of total stacks.⁵⁴ Monsanto traits appear in 91% of intra-firm stacks.⁵⁵ Based on the 2009 trait profile data for all three crops, therefore, only about 3% of the market for stacked traits was "open" to non-Monsanto innovators for intra-firm stacking.⁵⁶ At the crop level, this statistic is 5% for corn and 0% for cotton.⁵⁷ In other words, there are no intra-firm stacks in cotton that are not Monsanto stacks.⁵⁸ As of 2009, there were no intra-firm soybean stacks on the market.⁵⁹

The more prevalent form of stacking is inter-firm collaboration. Here,

corn_and_soybean_agronomic_traits.pdf.

^{53.} See id.

^{54.} See id.

^{55.} See id.

^{56.} See id.

^{57.} See id.

^{58.} See id.

^{59.} See id.

Monsanto traits appear in 50% of inter-firm stacks.⁶⁰ All inter-firm stacks in soybeans and cotton involve a Monsanto trait whereas about 36% of inter-firm corn stacks involve Monsanto traits.⁶¹ Thus, about 30% of the market for stacked traits is open to inter-firm stacks that do not contain Monsanto traits.⁶² At the crop level, this statistic is about 40% for corn and 0% for cotton and soybeans.⁶³ Similar to intra-firm stacks, there are no inter-firm stacks in cotton and soybeans that do not contain a Monsanto trait.⁶⁴

The underlying structure of the genetic traits markets has a number of competitive implications for stacking competition. First, growers benefit when there is competition between both intra-firm and inter-firm stacks. Competition means choice in comparable stacked products, vigorous price competition, and ongoing pressure on rivals to innovate. However, head-to-head competition between intra-firm stacks is limited because such a small percentage of the market is open to non-Monsanto stacks. The inherent difficulty associated with intra-firm stacking by firms that are not dominant creates pressure for innovators to engage in inter-firm stacking.

A second observation on the dynamics of stacking traits is that successful inter-firm stacking requires inter-rival collaborations. Markets with multiple, similarly situated competing innovators create the most potential for numerous collaborations and minimize incentives for a single competitor to refuse to license or to impose discriminatory restrictions in cross-licensing agreements. The competitive success of inter-firm stacking, however, is limited by a number of factors. First, the presence of a dominant traits "platform" serves as a barrier to entry or expansion to competing inter-firm stacks that do not contain Monsanto traits. Indeed, the 30% of the market that is open to inter-firm stacks not containing Monsanto traits is occupied mostly by collaborations between the same three firms—Dow, Bayer, and Syngenta. Second, inter-firm stacking that involves collaborating with a dominant firm is potentially limited by licensing conduct of the sort that has been the subject of antitrust counterclaims in patent infringement cases. This includes selective or discriminatory royalties and cross-licensing or outlicensing requirements.

A third competitive issue surrounding inter-firm stacking is that the "ubiquity" of a dominant firm's traits in inter-firm stacks creates incentives for both seed companies and rival biotechnology developers to "standardize" on that platform.⁶⁵ This dynamic is responsible in part for the large number of inter-firm stacks that contain Monsanto traits.⁶⁶ Seed saving restrictions exacerbate this problem. For example, such licensing restrictions assure a future revenue

66. Id.

^{60.} See id.

^{61.} See id.

^{62.} See id.

^{63.} See id.

^{64.} See id.

^{65.} Peter Carstensen, Post-Sale Restraints via Patent Licensing: A "Seedcentric" Perspective, 16 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 1053, 1073 (2006).

stream from repeated annual sales by forcing growers back to the primary proprietary seed market. This guarantee incents firms to innovate new trait products if there is vigorous competition and the possibility of multiple collaborations for cross-licensing agreements. But, in the presence of a dominant firm with ubiquitous trait(s), rivals' incentives can be to "free ride" on recurring annual sales from trait stacks based on the dominant platform. This dampens the incentive for rivals to compete hard to create rival stacked trait systems.

Fourth, observations on innovation and adoption rates, coupled with the state of play in stacking, may indicate that the competitive dynamics in corn are somewhat different than in cotton and soybeans. More of the market is "open" to rivals for inter-firm stacking collaborations in corn that do not involve Monsanto. Nevertheless, the ratio of transgenic corn prices to yields has increased steadily, along with cotton and soybean ratios, leaving questions about high concentration (versus single-firm dominance) on the table. Moreover, whether inter-firm collaborations that do not involve Monsanto traits can inject sufficient competitive discipline in the market for stacked traits remains unclear. It is also unclear whether stacks containing Monsanto traits are making their way to market at a rate that would reflect more competitive market conditions.

Since 2009, the firms that occupy the portion of the inter-firm stacking market that do not involve Monsanto collaborations have largely continued their associations. For example, Dow and Syngenta have reached an agreement to cross-license corn traits. Likewise, in 2010, Dow entered into cross-licensing agreements with Bayer and Syngenta to develop stacked trait cotton varieties.⁶⁷ Also worthy of note is that Monsanto and DuPont-Pioneer recently reached an agreement to resolve their longstanding patent infringement and antitrust counterclaim issues relating to stacking traits.⁶⁸ The settlement includes a licensing agreement that would, in part, allow DuPont-Pioneer to stack traits in exchange for Monsanto's access to DuPont-Pioneer technologies for disease and defoliation control.⁶⁹ Among other things, this development punctuates the importance of stacking in the race to bring more complex transgenic crop seed

^{67.} See News Release, Syngenta, Dow AgroSciences Agree to Cross License Corn Traits (Apr. 1, 2009), available at http://www.syngenta.com/global/corporate/en/news-center/news-releases/Pages/en-090401.aspx; News Release, Dow AgroSciences, Bayer CropScience Sign Global Cotton Technology Cross-Licensing Agreements (May 20, 2010), available at http://newsroom.dowagro.com/press-release/dow-agrosciences-bayer-cropscience-sign-global-cotton-technology-cross-licensing-agree; News Release, New Dow AgroSciences Herbicide Tolerant Trait Technology Stays On Schedule (Mar. 03, 2010), available at http://www.dowagro.com/newsroom/corporate/2010/20100303a.htm; News Release, Syngenta, Dow AgroSciences Sign Cotton Technology Licensing Agreements (Jan. 5, 2010), available at http://newsroom.dowagro.com/press-release/2010/syngenta-dow-agrosciences-sign-cotton-technology - licensing-agreements. Dow also entered into agreements with DuPont-Pioneer and with Monsanto to develop soybean technologies. See News Release, Monsanto and Dow AgroSciences Reach New Licensing Agreement On Roundup Ready 2 Yield® Soybean Technology (June 2, 2010), available at http://www.dowagro.com/newsroom/corporate/2010/20100602a.htm.

^{68.} News Release, DuPont and Monsanto Reach Technology Licensing Agreements on Next-Generation Soybean Technologies (Mar. 26, 2013), *available at* http://monsanto.mediaroom.com/index .php?s=27632&item=135196.

^{69.} Id.

products to market.⁷⁰

B. LOSS OF ALTERNATIVE CHANNELS TO PROPRIETARY SEED

Another systemic competitive effect of high concentration and single firm dominance in genetic traits and traited seed involves alternative "channels" of distribution to proprietary seed. Sources of seed for growers include proprietary seed (conventional and transgenic), public commercial seed, saved seed, and soon generic seed.⁷¹ In most industries, alternatives to the primary channel through which goods and services are distributed provide an important source of competitive discipline. For example, the advent of the secondary textbook market and online book retailing has challenged the market position of textbook publishers and university bookstores. In pharmaceuticals, generic competition has generated significant benefits to consumers in the form of lower prices, choice, and innovation.

Broad construction of IP rights in transgenic seed has likely stymied the development of alternative channels of distribution. For example, a Supreme Court decision in *Bowman v. Monsanto* that upholds the Federal Circuit's finding that patent exhaustion does not apply to the saving of progeny from plantings of commodity seed would impair competition from the commodity channel.⁷² Preserving competition from grain elevators would require that operators sort seed into conventional, transgenic, and even organic channels, an expensive process with costs that would likely be passed on to purchasers. In the absence of sorting arrangements, competition from elevators would only occur at the risk of patent infringement litigation, which would also impose additional costs on growers.⁷³

The tension between competition and IP rights has also affected the development of generic competition in genetic traits. As a relatively young industry, some of the first traits patented in the early 1990s will soon expire. The first of these is Monsanto's patent on the Roundup Ready 1 ($RR1^{TM}$) soybean trait, due to expire in 2014. Much like in generic pharmaceuticals, expiration of the patent opens the door for rivals to introduce a generic version of the trait, thus providing growers more choice and lower prices. The success with which this process develops, however, will be a function of the unique factors that distinguish the transgenic seed markets.

Much like other R&D-intensive products, lead-time is necessary to develop, test, and secure necessary regulatory approvals to bring new products to market. Innovators must test and breed out new generic products with lead-time

^{70.} Id.

^{71.} FUGLIE ET AL., *supra* note 19, at 26. For example, saved seed accounted for just over 20% of the global market for seed in 2006. *See id.* In the U.S., where transgenic seed has made significant inroads into acreage penetration and where growers are subject to technology agreements that prohibit seed saving, this is likely to be a smaller percentage.

^{72.} See Monsanto Co. v. Bowman, 657 F.3d 1341, 1347 (Fed. Cir. 2011), cert. granted, 133 S. Ct. 420 (2012).

^{73.} See Brief of Amici Curiae the American Antitrust Institute, supra note 10, at 29.

sufficient to allow market entry at the time of patent expiry, which is particularly important because of the significant export market for U.S. seeds. Many foreign authorities require that individual traits and trait stacks gain necessary approvals (i.e., registrations) before they can be imported.⁷⁴ Without access to the patentholder's data packages that would allow for advance development and testing, generic developers would need to re-create data packages, a time consuming prospect. The recent settlement between DuPont-Pioneer and Monsanto resolving patent infringement and antitrust counterclaims included a provision for access to Monsanto's regulatory data for corn and soybeans going off patent.⁷⁵ Presumably, this provision will facilitate DuPont-Pioneer's ability to develop generic varieties in advance of patent expiration.⁷⁶

The patent-holder's policies on enforcing its patents against generic rivals are likely to influence how generic competition develops. This includes testing stacked trait varieties in advance of patent expiration and the terms of licensing agreements that allow generic rivals access to the trait for stacking purposes. To date, progress in facilitating generic competition in RR1[™] soybeans has been slow, thus raising concerns about the timing of generic entry relative to patent expiration. This is exacerbated by the presence of a second-generation Ht technology, RR2[™] soybeans, which was introduced well in advance of patent expiry for RR1[™].⁷⁷ How the process of generic competition is handled in RR1[™] soybeans will set the stage for upcoming patent expirations of other crop traits.

V. CONCLUSION

The foregoing analysis considers recent, potentially troubling indicators of performance in the transgenic seed industry. These warning signs are even more important in light of the fact that: transgenic crop seed products are becoming increasingly complex through trait stacking that necessitates collaborations among competitors; and competition from the commodity and generic channels will be some of the few (if any) outlets left for growers to avoid high prices for transgenic products. Such concerns rise to the level of broad, systemic competition policy issues that are unlikely to be addressed by IP or antitrust law alone but nonetheless make a strong case for revisiting the IP-competition balance in transgenic seed.

Given the backdrop of high market concentration and single firm dominance in transgenic markets, perhaps the most important question facing

^{74.} See, e.g., AM. SEED TRADE ASS'N. & BIOTECHNOLOGY INDUS. ORG, THE ACCORD: GENERIC EVENT MARKETABILITY AND ACCESS AGREEMENT IS OPEN FOR SIGNATURE (2012), available at http://www.agaccord.org/include/facts.pdf.

^{75.} DuPont and Monsanto Reach Technology Licensing Agreements on Next-Generation Soybean Technologies, *supra* note 68 (Mar. 26, 2013), *available at* http://monsanto.mediaroom.com/index.php ?s=27632&item=135196.

^{76.} See id.

^{77.} See Roundup Ready Soybean Patent Expiration, MONSANTO, http://www.monsanto.com/new sviews/Pages/roundup-ready-patent-expiration.aspx (last visited April 18, 2013).

antitrust enforcers, the courts, and agriculture policy makers therefore is how the tension between IP rights and competition can best be resolved. Undoubtedly, significant merger activity has contributed to the current high levels of concentration in the industry. Merger control therefore remains an important way to promote competition. And, the competitive concerns raised in antitrust counterclaims in patent infringement cases remain within the bailiwick of Section 2 enforcement. But, judicial decisions that tend to almost always favor the IP rights of the patent-holder, even in the face of anticompetitive outcomes, complicate antitrust enforcement.

Broader legislative initiatives geared toward remedying entrenched market concentration and single firm dominance may be necessary, including parameters for how IP policy should appropriately interface with competition. Absent a more unified policy that considers the intersection of IP and competition, continuing on the current course will likely cause additional harm to competition, growers, consumers, and ultimately, the innovators themselves that consumers have come to rely on to improve productivity in U.S. and global agriculture.