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Journal of Intellectual Property Law

Volume 14 | Issue 2 Article 2

April 2007

Alternative Business Strategies in Weak Intellectual Property Environments: A Law and Economics Analysis of the Argo-Biotechnology Firm's Strategic Dilemma

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ALTERNATIVE BUSINESS STRATEGIES IN WEAK INTELLECTUAL PROPERTY ENVIRONMENTS: A LAW AND ECONOMICS ANALYSIS OF THE AGRO-BIOTECHNOLOGY FIRM'S STRATEGIC DILEMMA

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* Assistant Professor of Agricultural Law, University of Illinois. This research is supported by the Cooperative State Research Education & Extension Service, USDA, Project No. ILLU-470-309 and Project No. 483-611. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the funding agencies. The authors extend their appreciation to Saeho Yi, J.D., 2006, Wan Peng, M.S., 2006, and Joann Schmidt, J.D. expected 2008, for their excellent research assistance.

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I. INTRODUCTION

Maximizing return on research and development investment for the life science firm relies on the continued effectiveness of the social contract between buyer and seller and institutional backing of the underlying agreement. Intellectual property protection and institutional enforcement structures commonly fail for firms conducting business in developing countries. Most commentators claim that a strong intellectual property environment is essential for profitability, and we agree. But what do firms do in the short term when an effective social contract is not possible? The authors argue that a firm can achieve success by first recognizing its status in the social construct and then adopting tactics that do not depend on an effective social construct between buyer and seller. Specifically, the authors utilize an economic model of the agro-biotechnology industry to demonstrate four responses for firms when operating within weak intellectual property rights environments: dynamic pricing mechanisms, product bundling, use restriction technologies, and reduced investment.

"[I]n the state of nature, Profit is the measure of Right."[1] Although profit assuredly is the overarching objective of most firms, the state of nature in the Hobbesian view—in which there is no common power, no law, and where "Force[ ] and Fraud"[2] are regarded as "Cardinall vertues"[3]—is anathema to the efficient operation of the firm and its subsequent drive for profit maximization. Accordingly, the firm, like society in general, seeks to avoid an otherwise "poore, nasty, brutish and short"[4] existence by entering into a social contract for protection from this state of nature.

In return for these restrictions on its liberty,[5] the firm receives varied protections[6] and, ideally, an institutionalized legal system to enforce these mutual obligations. This social contract extends as well to the buyer-seller relationship. Consumers receive various protections from predation by the firm and, in the case of intellectual property rights, the firm can rely on the higher authority to

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1 THOMAS HOBBES, DE CIVE 48 (Howard Warrender ed., Clarendon Press 1983) (1651).

2 THOMAS HOBBES, LEVIATHAN 90 (Richard Tuck ed., Cambridge Univ. Press 1991) (1651).

3 *Id.*

4 *Id.* at 89. For example, Comment c to the Restatement 2d of Torts § 901 notes that

> [o]riginally the primary purpose of the law of torts was to induce the injured party and members of his family or clan to resort to the courts for relief, rather than taking the law into their own hands by attempting to wreak vengeance on the wrongdoer or by resorting to violent means of self-help.

RESTATEMENT (SECOND) OF TORTS § 901 cmt. c (1979).

5 An example of restrictions of a firm's liberty would be profit maximization without regard to the rights of others.

6 Rules restricting unfair competition would serve as an example of a protection received by the firm.

punish consumers attempting to breach the social contract by duplication or unauthorized use of protected property.

Once removed from this "state of nature," the firm can develop a strategic plan to maximize its profits—in the case of the life science industry, most critically, its return on investment for biotechnology research and development. This plan, however, relies on the continued effectiveness of the social contract. When this social contract fails, the firm must respond in a manner consistent with its profit maximization strategy. This Article examines the breakdown in intellectual property protection and institutional enforcement structures within the context of agricultural production, specifically the profit maximization options available to United States-based agro-biotechnology firms operating in the relatively weak intellectual property and institutional environments of South America. In order to explore the effectiveness of the various economic, technological, and legal strategies available to protect private intellectual property and maximize return on investment, this Article formalizes the seed company's problem and relies upon economic simulation to analyze possible strategies. While most commentators claim that a strong intellectual property environment is essential for profitability in the agro-biotechnology industry,[7] this Article postulates that an agro-biotechnology company can achieve profitability in weak institutional environments if it adopts a dynamic pricing strategy as a next best

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[7] Debra L. Blair, *Intellectual Property Protection and its Impact on the U.S. Seed Industry*, 4 DRAKE J. AGRIC. L. 297, 330–31 (1999) (discussing the value of intellectual property to seed development firms); Jim Chen, *The Parable of the Seeds: Interpreting the Plant Variety Protection Act in Furtherance of Innovation Policy*, 81 NOTRE DAME L. REV. 105, 157 (2005) (noting the failure of the Plant Variety Protection Act to protect firm investments and spur further innovation because of the statute's limited scope of protection); Mark D. Janis & Jay P. Kesan, *U.S. Plant Variety Protection: Sound and Fury . . . ?*, 39 HOUS. L. REV. 727, 777 (2002) (suggesting proponents of stronger intellectual property protection for plants should focus on reforming the relatively stronger utility patent system); Jay P. Kesan, *Intellectual Property Protection and Agricultural Biotechnology: A Multidisciplinary Perspective*, 44 AM. BEHAV. SCI. 464, 471 (2000) (noting that it is "critical to fashion IP regimes that adequately reward the inventor for his or her efforts and provide enough economic stability to promote investment in the inventive endeavors"); Jay P. Kesan & Andres A. Gallo, *Property Rights and Incentives to Invest in Seed Varieties: Governmental Regulations in Argentina*, 8 AGBIOFORUM 118, 125 (2005), *available at* http://www.agbioforum.org/v8n23/v8n23a08-kesan.pdf (concluding that property rights regimes are important for agricultural research and development, and that self-pollinating seeds such as soybeans need patent protection); Lawrence Kent, Intellectual Property Problems and Other Obstacles to Sharing the Benefits of Crop Biotechnology with Developing Countries, Presentation at Seeds of Change: Intellectual Property Protection for Agricultural Biotechnology (Apr. 8–10, 2004) (on file with authors).

strategy rather than following traditional monopolistic pricing[8] that may be most appropriate under relatively strong institutional environments.

A dynamic price strategy, as outlined below, allows the firm with innovative products to enter a market immediately, while continuing conventional long-term approaches such as lobbying for stronger intellectual property rights. Moreover, even after imposition of robust intellectual property rules, firms must wait for the evolution of social norms that respect these rights, often through the instillation of discipline within a legal enforcement system, before taking full advantage of the monopolistic position provided by the underlying intellectual property right. Because most high technology firms, however, operate on relatively short-term business plans of three to five years, the innovative firm faces an immediate need for a workable strategy such as dynamic pricing, especially during periods of rapid growth, as opposed to relying on development of new legal structures.

For example, the soybean production area in Argentina nearly doubled from 6 to 11 million hectares in a five-year period.[9] Agro-biotechnology firms could focus their efforts on lobbying activities for improved intellectual property protection before entering the market, but in the interim, they would miss the opportunity to capture market share and substantial revenue. On the other hand, firms could enter the market using the traditional business model based on the social contract in place in North America. Subsequent complaints of "theft" of their intellectual property, however, most likely would fall upon deaf ears in the local environment. Therefore, an alternative strategy that incorporates and accounts for the heterogeneous social contracts and business opportunities under which an agro-biotechnology company must operate in the global agricultural marketplace is an important development.

Although the context of this Article is agricultural production, the strategic decisions faced by the firm operating in an international environment with variable institutional settings and serving customers bounded by norms that fail to coincide with the firm's ideal social contract is directly analogous to other industries with products capable of easy consumer duplication, such as music and

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[8] Under pure monopoly pricing, the first firm is able to maximize profitability as there is no competition. An inferior state for the firm occurs with monopolistic competition whereby a firm's pricing power is constrained by other competitors. The degree of competition is central to the arguments advocated in this Article. The greater number of available substitutes the more limited the price setting ability of the firm. HAL R. VARIAN, MICROECONOMIC ANALYSIS 92–93 (2d ed. 1984).

[9] Peter D. Goldsmith et al., *Intellectual Property Piracy in a North-South Context: Empirical Evidence*, 35 AGRIC. ECON. 335, 341 (2006). In contrast, the rate of growth in acres planted in soybeans in the United States was only 5.6% over the same time period. http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp (calculated by the authors using the Quick Stats Database compiled by the National Agricultural Statistics Service; database on file with the authors).

software.[10] Accordingly, the economic model, consequences, and possible alternative strategic decisions developed below, such as dynamic pricing mechanisms, product bundling, use restriction technologies, and reduced investment, are relevant to the strategic decisions faced in a wide array of industries.

Part II of this Article provides background on genetic engineering and production of agricultural commodity crops. Particular attention is paid to the structural changes resulting from the advent of genetic engineering technologies in the commodity-based food and feed supply chains. Part II describes the legal environment for intellectual property rights in plants and the efficacy of court systems to enforce these rights. The United States, considered one of the friendliest legal environments for biotechnology inventors,[11] is used as a baseline for comparison with the relatively weak legal systems found in some southern hemisphere nations. Part III of this Article employs a dynamic gaming model under asymmetric information to demonstrate how seed development companies and farmers will behave under complete and perfect information in an effective legal system.

The global agricultural marketplace (like many international markets), however, is far from homogeneous. Firms, therefore, must have multifaceted approaches to managing their intellectual property. High potential growth markets are often characterized by weak institutional environments, with varying risk preferences among market actors and asymmetric information. In this Article simulation is used to reduce the complexity of the strategic alternatives available for firms seeking recovery of research and development expenses. This Article, concludes with a discussion of how to apply the simulation results to aid policymakers seeking to balance the needs of farmers with the underlying necessity of innovation. Dynamic pricing, product bundling, use restriction technology, and reduced investment are offered as possible second-best alternatives to maximize firm profit in weak institutional environments.

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[10] *See* Dan L. Burk, *DNA Rules: Legal and Conceptual Implications of Biological "Lock-Out" Systems*, 92 CAL. L. REV. 1553, 1556 (2004) (comparing reproducible plants to other areas of innovation such as books and music); Chen, *supra* note 7, at 128 (comparing seed saving to copyright law's "first sale" doctrine); Peter D. Goldsmith, *Innovation, Supply Chain Control, and the Welfare of Farmers: The Economics of Genetically Modified Seeds*, 44 AM. BEHAV. SCI. 1302, 1317–19 (2001) (discussing product durability as "the bane of the monopolist," especially in the life science industry).

[11] Kesan & Gallo, *supra* note 7, at 119.

II. GENETIC ENGINEERING AND AGRICULTURE: THE SECOND "GREEN" REVOLUTION?

Advancements in genetic engineering technologies[12] in the last decade have transformed post-modern agriculture at a rate faster than even the widely-hailed chemical and fertilizer bonanza of the first "Green Revolution."[13] Farmers in 2005, as in each year since the commercial introduction of genetically engineered plants in 1996, converted from conventionally bred seed to genetically engineered varieties at a double-digit rate.[14] In total, the global biotech crop area has increased more than fifty-fold within this first decade of commercialization.[15]

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[12] "Genetic engineering technologies" refers to the creation of new varieties of animals, plants, and microorganisms "in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination." Council Directive 2001/18, art. 2(2), 2001 O.J. (L 106) 1 (EC). The EU Directive, probably the most commonly accepted definition of genetic engineering, further defines genetic modification as using the techniques of

> (1) recombinant nucleic acid techniques involving the formation of new combinations of genetic material by the insertion of nucleic acid molecules produced by whatever means outside an organism, into any virus, bacterial plasmid or other vector system and their incorporation into a host organism in which they do not naturally occur but in which they are capable of continued propagation; (2) techniques involving the direct introduction into an organism of heritable material prepared outside the organism including micro-injection, macro-injection and micro-encapsulation; [or] (3) cell fusion (including protoplast fusion) or hybridisation techniques where live cells with new combinations of heritable genetic material are formed through the fusion of two or more cells by means of methods that do not occur naturally.

Id. at Annex I.A., pt. 1.

[13] *See* CLIVE JAMES, INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, EXECUTIVE SUMMARY, BRIEF 34, GLOBAL STATUS OF COMMERCIALIZED BIOTECH/GM CROPS: 2005 iii (International Service for the Acquisition of Agri-Biotech Applications) (2005), *available at* http://www.isaaa.org/resources/publications/briefs/34/download/isaaa-brief-34-2005.pdf; *see also* Patricia R. McCoy, *Biotech Adoption Most Rapid Event in Ag*, CAP. PRESS AGRIC. WKLY., Jan. 27, 2006, http://www.capitalpress.info/main.asp?SectionID=67&SubSectionID=792&ArticleID=22611. For a contemporary definition and summary of the first "Green Revolution" and the contributions of Norman Bourlag, see Wikipedia, Green Revolution, http://en.wikipedia.org/wiki/Green_revolution (last visited Apr. 7, 2007). The purported benefits of this revolution, however, are also subject to criticism. *See* Debbie Collier, *Access to and Control over Plant Genetic Resources for Food and Agriculture in South and Southern Africa: How Many Wrongs Before a Right?*, 7 MINN. J.L. SCI. & TECH. 529, 535–36 (2006) (detailing detrimental effects of the Green Revolution on many African communities).

[14] JAMES, *supra* note 13, at 3, 4.

[15] *Id.* at 3. The global value of biotech crops in 2005 was $5.25 billion, representing 15% of the commercial seed market. *Id.* at 7.

As in any system, physical or social, technological advances have the potential to disrupt settled practices.[16] Application of genetic engineering technologies to the agricultural production system is no different.[17] Several commentators have noted disruptions to land use practices,[18] the influx of written contracts into long-standing informal buyer-seller relationships,[19] international trade restrictions,[20] and the concerns of upstream participants in the supply chain,[21] including consumers.[22] Despite these drawbacks, many American farmers have welcomed agricultural biotechnology with open arms. United States Department of Agriculture (USDA) planting statistics from 2006 estimate that 89% of soybean

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[16] Kim Solez & Sheila Moriber Katz, *Cybermedicine: Mainstream Medicine by 2020/Crossing Boundaries*, 19 J. MARSHALL J. COMPUTER & INFO. L. 557, 561 (2001) (noting the disruptive power of many modern technologies along with cybermedicine, such as "the computer disk drive, discount retailing and home centers, tabletop photocopiers, mini mill steel technology, and hydraulic excavation machines (power diggers)").

[17] R. James Cook, *Biotechnology: Cause and Consequence of Change in Agriculture*, *in* BIOTECHNOLOGY: SCIENCE AND SOCIETY AT A CROSSROAD 39, 40–41 (Allan Eaglesham et al. eds., 2003) (describing agriculture as a system and biotechnology as one of several innovations to the industry).

[18] A. Bryan Endres, *"GMO": Genetically Modified Organism or Gigantic Monetary Obligation? The Liability Schemes for GMO Damage in the United States and the European Union*, 22 LOY. L.A. INT'L & COMP. L. REV. 453, 488–94 (2000) (discussing strict liability and nuisance); Margaret Rosso Grossman, *Biotechnology, Property Rights and the Environment*, 50 AM. J. COMP. L. 215, 231–36 (Supp. 2002) (discussing common law nuisance and trespass aspects of biotechnology).

[19] Lawrence Busch, *Lessons Unlearned: How Biotechnology is Changing Society*, *in* BIOTECHNOLOGY: SCIENCE AND SOCIETY AT A CROSSROAD 27, 31 (Allan Eaglesham et al. eds., 2003) (noting the introduction of complex contracts to seed sales); A. Bryan Endres, *Coexistence Strategies in a Biotech World: Exploring Statutory Grower Protections*, 13 MO. ENVTL. L. & POL'Y REV. 206, 209 n.11 (2006) (discussing liability exposure from contractual agreements); Goldsmith, *supra* note 10, at 1313 (discussing effect of premiums and technology fees on farmers).

[20] Thomas P. Redick & Michael J. Adrian, *Do European Union Non-Tariff Barriers Create Economic Nuisances in the United States?*, 1 J. FOOD L. & POL'Y 87, 102–08, 116–24 (2005) (describing consequences of coexistence and traceability measures in the European Union on the international shipment of commodity crops); A. Bryan Endres, *Risk Management Strategies for Identity Preserved Grain Exports*, 15 AGRIC. L. (Ill. St. Bar Ass'n) Sept. 2005, at 1.

[21] Busch, *supra* note 19, at 32 (describing reactions of Frito-Lay and McDonald's to the introduction of genetically engineered food). *See also Genetic Engineering: Major Companies Reject GM-Food*, EUR. AGRI, June 4, 1999, *available at* 1999 WLNR 4604597 (noting GMO-free policy of European food producers Nestle and Unilever); Nicholas Kalaitzandonakes et al., *Global Identity Preservation Costs in Agricultural Supply Chains*, 49 CAN. J. AGRIC. ECON. 605, 605 (2001) (noting intensified growth in identity preservation programs to avoid genetically engineered foods).

[22] Busch, *supra* note 19, at 33 (describing reactions of consumers); EUROPEAN COMMISSION, RISK ISSUES: SPECIAL EUROBAROMETER 238, at 24 (2006), *available at* http://www.eFSA.EUROPA.eu/etc/medialib/efsa/about_efsa/communicating_risk/risk_perception/1339.par.0001.file.dat/comm_report_eurobarometer_en2.pdf (finding 62% of Europeans either "very worried" or "fairly worried" "about genetically modified products in food or drinks").

acres,[23] 61% of corn acres,[24] and 83% of cotton acres[25] were planted with varieties derived through genetic engineering. An analysis of why so many farmers have embraced this technology is beyond the scope of this article, but a quick review of the literature identifies, at least with respect to soybeans, a single predominate reason—reduced management costs that enable the farmer to manage ever larger fields without the necessity of hiring and supervising additional workers.[26]

In addition to reduced on-farm management costs, adoption of agricultural biotechnology has changed the nature of farmer interactions with other elements of the supply chain, perhaps none more important than relationships with farm input suppliers.[27] Throughout history, farmers planted, harvested, saved, and

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[23] USDA/ERS, Adoption of Genetically Engineered Crops in the U.S.: Soybeans, http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable3.htm.

[24] USDA/ERS, Adoption of Genetically Engineered Crops in the U.S.: Corn varieties, http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable1.htm.

[25] USDA/ERS, Adoption of Genetically Engineered Crops in the U.S.: Cotton Varieties, http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable2.htm.

[26] *See* Claudio Soregaroli & Justus Wesseler, *Minimum Distance Requirements and Liability: Implications for Co-Existence, in* ENVIRONMENTAL COSTS AND BENEFITS OF TRANSGENIC CROPS 165, 166 (J.H.H. Wesseler ed., 2005) (finding flexibility in growing practices, which reduces the time specificity of labor and capital, as an important factor in farmers selecting genetically engineered crops and noting no particular profitability impacts from yield or cost savings); David S. Bullock & Elisavet I. Nitsi, *Roundup Ready Soybean Technology and Farm Production Costs: Measuring the Incentive to Adopt Genetically Modified Seeds*, 44 AM. BEHAV. SCI. 1283, 1298 (2001) (finding that "much of the cost savings from adopting Roundup Ready technology must come from saving management costs and avoiding risk" as "farmers need to put in much less time and effort scouting for and identifying weeds and figuring out how to spray them"). A simple example of this transformation is the demise of the "bean buggy." The bean buggy, to the extent it is still used, is a tractor pulling a tank of herbicides driven by the farmer with a row of seats on the front bumper occupied by teenagers on summer vacation holding spray guns. Interview with J.M. Endres in Hurley, S.D. (July 25, 2006). The job of the teenagers is to precisely aim the spray at weeds in the bean field without any residue touching the bean plant. *Id.* The farmer, meanwhile, drove the tractor and supervised the spraying activity. *Id.* The adoption of Roundup Ready® soybeans in almost 90% of soybean acres, see *supra* note 23, has eliminated, in large part, the need for the bean buggy and precise spraying techniques (not to mention the elimination of the rural equivalent of the summer lifeguard job—sitting on a seat in a bathing suit getting a tan while pretending to pay attention). Roundup Ready® soybeans are tolerant to the herbicide and a "blanket" herbicide application may be made over the field (sometimes even via aerial spraying), thereby saving the farmer valuable management time. Janet Carpenter & Leonard Gianessi, *Herbicide Tolerant Soybeans: Why Growers Are Adopting Roundup Ready Varieties*, 2 AGBIOFORUM 65, 65 (1999), *available at* http://www.agbioforum.org/v2n2/v2n2a02-carpenter.pdf.

[27] *See* A. Bryan Endres, *State Authorized Seed Saving: Political Pressures and Constitutional Restraints*, 9 DRAKE J. AGRIC. L. 323, 335–41 (2004) (discussing changes in the relationship between farmers and input suppliers precipitated by imposition of limited license agreements and state political responses).

replanted seed from season to season.[28] Farmers also received free seed from the USDA.[29] In the late-1800s, farmers gradually began to purchase seed from commercial seed suppliers and, in 1924, the USDA ceased its free distribution of seeds.[30] Most seed businesses at the time were small and had a primary role in the multiplication of seed varieties developed in the public domain by land grant institutions and public breeding projects.[31] Limited financial resources[32] and the inability to preclude competitors from immediately appropriating new varieties as their own constrained basic research and development in the private sector. As a result, the seed business was a monopolistic competitive market with differentiation based on unique and local varietal characteristics of adaptability and performance.[33]

The genetic engineering revolution precipitated a structural change within the seed industry. An industry formerly characterized by local firms, which utilized publicly developed varieties and provided modest product differentiation, was replaced, in part, by multi-national life science firms engaging in proprietary research activities, offering distinct products with transgenic properties.[34] Accompanying this structural shift was a change in research and development expenditures from public to private sources[35] with almost all commercialization of genetically engineered seeds completed by private firms.[36] In a private sector

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[28] Collier, *supra* note 13, at 537 (noting cooperation between farmers and public research institutions and saving of seeds for exchange, sale, and cultivation); Endres, *supra* note 27, at 324.

[29] Keith Aoki, *Weeds, Seeds & Deeds: Recent Skirmishes in the Seed Wars*, 11 CARDOZO J. INT'L & COMP. L. 247, 264–66 (2003).

[30] *See* Endres, *supra* note 27, at 327–28 (describing formation of the American Seed Trade Association and lobbying efforts to end the government's free distribution of seed). *See also* 7 U.S.C. § 2201 (2000) (stating the mission of the USDA is in part "to procure, propagate, and distribute among the people new and valuable seeds and plants").

[31] JORGE FERNANDEZ-CORNEJO, THE SEED INDUSTRY IN U.S. AGRICULTURE: AN EXPLORATION OF DATA AND INFORMATION ON CROP SEED MARKETS, REGULATION, INDUSTRY STRUCTURE, AND RESEARCH AND DEVELOPMENT 25 (USDA Econ. Res. Serv., Agric. Info. Bulletin No. 786, 2004).

[32] *See* NEIL MCMULLEN, SEEDS AND WORLD AGRICULTURAL PROGRESS 210 (1987); Donald N. Duvick, *The United States*, *in* MAIZE SEED INDUSTRIES IN DEVELOPING COUNTRIES 193, 200 (Michael L. Morris ed., 1998).

[33] Goldsmith, *supra* note 10, at 1303.

[34] BIOTECH 2005 LIFE SCIENCES: A MOVE TOWARD PREDICTABILITY 259, 263–69 (Stephen Burrill ed., 2005) [hereinafter BIOTECH 2005] (noting seed industry consolidation as the two largest players positioning themselves to dominate the market and decline of the small, "Agbio" company).

[35] FERNANDEZ-CORNEJO, *supra* note 31, at 41–47 (discussing shifting roles of public and private sector research and development).

[36] Carl E. Pray & Anwar Naseem, *Biotechnolgy R&D: Policy Options to Ensure Access and Benefits for the Poor* (ESA Working Paper No. 03-08 2003), *available at* ftp://ftp.fao.org/docrep/fao/007/ae041e/ae041e00.pdf.

theoretically responsive to the demands of shareholders, development of new, genetically engineered seed varieties is a high-risk enterprise, requiring up to ten years and $300 million in up-front developmental costs.[37] How to recapture these massive research and development expenditures,[38] obviously, is of central concern to the new breed of seed suppliers.

Intellectual property protections, in the form of trade secrets, plant variety protection certificates, and utility patents, prevent competitors from adopting these innovations and gaining market share.[39] The farmer, however, has historically operated under a different social construct, unconstrained by formal intellectual property rights. In many circles, saving seed from year to year is regarded as a traditional right of farmers.[40] This leakage to the firm's return on investment caused by seed saving is particularly acute for self-pollinating, high yield crops such as soybeans and cotton.[41] Other cultivars, such as hybrid corn, provide a natural method of protecting agro-biotechnology firms' investments because saved hybrid seed lacks vigor and produces substantially lower yields, thereby forcing farmers to purchase new seed each growing season.[42]

The resulting tension between the input supplier (seed developer) and the farmer seeking to minimize costs by saving seed is the essence of this article. Life science firms invest tremendous amounts of money in developing new genetically engineered seed varieties[43] and must recover these costs through profitable

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[37] Rick Weiss, *Farmers Fear Loss of Freedom, Monsanto Seed Policy Threatens Land Rights*, CAP. TIMES (Madison, WI), Feb. 4, 1999, at 1B, *available at* 1999 WLNR 2494275.

[38] Monsanto Company, the developer of more than 90% of the seeds planted worldwide of herbicide-tolerant or insect-tolerant crops, estimated research and development expenditures at $1.5 million/day on seeds and biotech, and no longer invests in new chemicals. BIOTECH 2005, *supra* note 34, at 259. In contrast, many of the developments of the Green Revolution arose from public breeding programs carried out by land grant institutions with a statutory mandate to share these discovering with the farming population. *See* JACK RALPH KLOPPENBURG, JR., FIRST THE SEED: THE POLITICAL ECONOMY OF PLANT BIOTECHNOLOGY 12–14 (2d ed. 2004)

[39] *See infra* Part III for a thorough discussion of intellectual property regimes.

[40] *See* Endres, *supra* note 27, at 326–27 (noting historical seed saving practices and government encouragement of the same). Congress codified this tradition in the Plant Variety Protection Act, 7 U.S.C. § 2543 (2000).

[41] Self-pollinating plant varieties, such as soybeans, cotton, and wheat, reproduce true-to-type and can be saved from one crop harvest and planted the next without significant losses in yield or plant vigor. FERNANDEZ-CORNEJO, *supra* note 31, at 18.

[42] *See id.* at 20 (noting diminished yields of second generation hybrid seed); Jim Waltrip, Seminis Seeds, Hybridization: A Phenomenon that Feeds Us Well, *available at* http://www.humeseeds.com/hybrdlvr.htm (last visited Apr. 7, 2007) (discussing the negative effect of using second-generation hybrid crops).

[43] *See supra* note 38 and accompanying text (discussing extent of private research and development costs). *See also* Jorge Fernandez-Cornejo & David Schimmelpfennig, *Have Seed Industry Changes Affected Research Effort*, AMBER WAVES, Feb. 2004, at 14, 16 (detailing increase in private

commercialization. Intellectual property laws, often supplemented by limited license purchase agreements, provide one model for cost recovery vis-à-vis the farmer. The reality, however, is that many nations lack institutional controls, such as robust intellectual property laws and effective court systems to enforce intangible property rights and contractual arrangements.[44] Accordingly, farmers operating in regions without institutional controls have a greater economic incentive to disregard intellectual property rights and contractual restrictions and save their seed to reduce production costs. Moreover, the areas of potential growth for input suppliers tend to be not in the established farm belts of North America, but in southern regions, such as Argentina and Brazil, or eastern areas, such as China, where respect for private intellectual property rights historically lacks institutional support.

In an increasingly global market for commodity agricultural products, farmers in the United States must compete for markets not only among themselves, but also with producers globally.[45] The implication with respect to intellectual property is that, absent a level playing field, foreign producers have lower costs of production because farmers in the United States incur the research and development costs for improved plant varieties. Foreign farmers free-ride on technical innovations and increase the world supply of the commodity, which lowers the price for all producers.

A similar situation occurs in the development and distribution of therapeutic drugs. The United States serves as the profit center for pharmaceuticals while distribution to other nations is either at a loss or on a break-even basis.[46]

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sector spending from $2.0 billion in 1970 to $4.2 billion in 1996 while public sector spending remained relatively flat).

[44] *See* ANDREA YANKELEVICH, USDA FOREIGN AGRICULTURAL SERVICE, GAIN REPORT NO. AR5033, ARGENTINA BIOTECHNOLOGY ANNUAL 2005, at 9 (concluding that "judicial enforcement procedures in Argentina . . . are ineffective as a mechanism to prevent the unauthorized commercial use of protected varieties").

[45] RANDALL D. SCHNEPF ET AL., USDA, AGRICULTURE & TRADE REP. WRS-01-3, AGRICULTURE IN BRAZIL AND ARGENTINA: DEVELOPMENTS AND PROSPECTS FOR MAJOR FIELD CROPS 53 (2001), *available at* http://usda.mannlib.cornell.edu/reports/erssor/international/wrs-bb/2001/wrs013/pdf (finding "the United States lags slightly behind Argentina and Brazil in soybean export cost competitiveness"); Stu Ellis, The Soybean Tango, Starring the Peso, the Real, and the Dollar, http://www.farmgate.uiuc.edu/archive/2006/02/post_8.html (2006) (describing the change in soybean marketing accompanying the increasing production in South America and the impact of exchange rates on the prices farmers receive in the United States).

[46] Compared to consumers in other nations, new drugs are disproportionately costly to the American consumer as the American free market system ensures that pharmaceutical firms can recoup research and development costs by charging as much as the market will bear, maximizing profits. In contrast, other industrialized nations use a variety of direct and indirect price-control mechanisms to reduce the cost to consumers by 35% to 55%. Eduardo Porter, *Importing Less Expensive Drugs Not Seen as Cure for U.S. Woes*, N.Y. TIMES, Oct. 16, 2004, at 1. As a result,

Although U.S. citizens are quick to complain about high drug prices, they are at least not in direct competition with those able to purchase pharmaceuticals at a lower cost. In the agricultural context, however, there is a different paradigm. The low cost, third-country seed purchaser/farmer is in direct competition in the international commodity market with the high cost, domestic seed purchaser/farmer. The price differential places the domestic farmer, *ceteris paribus*, at a disadvantage with respect to total production costs and even has led some prominent farm organizations to demand lowering domestic intellectual property standards to level the playing field.[47]

Other alternatives include pressuring nations to elevate intellectual property standards and institutional structures to the level found in the United States[48] or

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consumers in the United States shoulder a disproportionate share of the expense for new drug development. Mark B. McClellan, Commissioner, FDA, Remarks at the First International Colloquium on Generic Medicine (Sept. 25, 2003), *available at* http://www.fda.gov/oc/speeches/2003/genericdrug0925.html. The manufacturing and other short-run costs of producing a new drug accounts for only a fraction of the total drug development expense, estimated at approximately 30%. *See* JOHN E. CALFEE ET AL., AN EXPLORATORY ANALYSIS OF PHARMACEUTICAL PRICE DISPARITIES AND THEIR IMPLICATIONS AMONG SIX DEVELOPED NATIONS 5 (AEI-Brookings Joint Ctr. for Regulatory Studies, Working Paper No. 06-07, 2006), *available at* http://www.aei-brookings.org/admin/authorpdfs/page.php?id=1265. Once research and development costs have been recovered in the United States by pricing new drugs according to market demand, the pharmaceutical company's cost of production is reduced to manufacturing and short-run costs and the drug may be sold for a profit even in countries with stringent price controls. *Id.* at 1–3. These data suggest that price controls in other nations effectively shift the financial burden of new drug development to the United States with a corresponding reduction in the pharmaceutical industry's reliance on other markets for recovery of development costs. *Id.*

[47] Specifically, the Illinois Farm Bureau, a steadfast proponent of strong property rights, has called for Congress to amend the Plant Variety Protection Act to supersede utility patent protection for plants and provide for the saving of seeds from year to year for on-farm use. Repps Hudson, *Illinois Farmers Want to be Able to Keep Some Patented Seeds*, ST. LOUIS POST-DISPATCH, Dec. 7, 2005, at B1; *see also* Ill. Farm Bureau, 2006 Position Statements: Plant Patents and Plant Variety Protection, http://www.ilfb.org/uploads/adhoc/policies/policies2005/072/htm (supporting the Plant Variety Protection Act as the exclusive statute governing intellectual property rights for plant varieties).

[48] *See* Andres A. Gallo & Jay P. Kesan, *Property Rights Legislation in Agricultural Biotechnology: United States and Argentina*, 7 MINN. J.L. SCI. & TECH. 565, 584 (2006) (describing political pressure to strengthen intellectual property laws); The International Association of Plant Breeders for the Protection of Plant Varieties (ASSINSEL), Position Paper on Farm Saved Seed, http://www.worldseed.org/Position_papers/FSSe.htm (advocating strong intellectual property protection and limits to farm saved seed); U.S. Chamber of Commerce, Intellectual Property Rights, http://www.uschamber.com/issues/index/international/ipr.htm (describing failure of many U.S. trading partners to provide adequate intellectual property protection). *See also* Susan K. Sell, *Industry Strategies for Intellectual Property and Trade: The Quest for TRIPS and Post-TRIPS Strategies*, 10 CARDOZO J. INT'L & COMP. L. 79, 83–85 (2002) (describing industry lobbying ("private sector activism") of foreign governments to increase intellectual property protection in a variety of industries). Gallo & Kesan, *supra*, at 596, also describe a third strategy—the imposition of a tax on farmers—rather than patent

developing within the plant's genome barriers to duplication similar to those in hybrid corn.[49] In the interim, faced with rising input costs and steady-to-declining output revenues,[50] some domestic farmers may choose to violate intellectual property rights and/or contract obligations and save seed for on-farm use. Accordingly, the implications to the domestic seed-producing firm operating in foreign regions with lower intellectual property and enforcement standards may have spillover effects on customer relations in their home country. On the other hand, the agro-biotechnology firm can engage in a variety of strategic actions to curb seed saving and capture revenue. Before proceeding to the economic model and a discussion of the firm's responses in Part IV, an evaluation of institutional standards is helpful to provide context.

III. A NORTH-SOUTH COMPARATIVE EVALUATION OF THE LEGAL ENVIRONMENT FOR INTELLECTUAL PROPERTY PROTECTION FOR PLANTS

Although the domestic legal environment for intellectual property protection for plants is well documented,[51] a brief summary is warranted for contextual

royalty fees, that would be distributed to seed producers as compensation for inadequacies in the intellectual property enforcement system.

[49] Perhaps the most discussed development in this field is the genetic use restriction technology known as "Terminator technology." *See, e.g.*, Sina Muscati, *Terminator Technology: Protection of Patents or a Threat to the Patent System?*, 45 IDEA 477, 478–81 (2005); Jeremy P. Oczek, *In the Aftermath of the "Terminator" Technology Controversy: Intellectual Property Protections for Genetically Engineered Seeds and the Right to Save and Replant Seed*, 41 B.C. L. REV. 627, 647 (2000); Samantha M. Ohlgart, *The Terminator Gene: Intellectual Property Rights vs. The Farmers' Common Law Right to Save Seed*, 7 DRAKE J. AGRIC. L. 473, 474 (2002); Haley Stein, *Intellectual Property and Genetically Modified Seeds: The United States, Trade, and the Developing World*, 3 NW. J. TECH. & INTELL. PROP. 160, 168 (2005); Barnaby J. Feder, *Plant Sterility Research Inflames Debate on Biotechnology's Role in Farming*, N.Y. TIMES, Apr. 19, 1999, at A18. In 1998, Delta & Pine Land & Company and the USDA jointly secured a patent on a method of genetically engineering plants to ensure that second generation seeds are sterile. U.S. Patent No. 5,723,765, claim 10 (filed Mar. 3, 1998) ("A method for producing seed that is incapable of germination. . . ."). Monsanto Co. subsequently acquired the patent rights, but has yet to commercialize the technology due, in part, to significant public opposition. Stephanie Strom, *Rockefeller Foundation Head to Quit*, N.Y. TIMES, Dec. 9, 2003, at A22 (describing the Rockefeller Foundation's opposition to Monsanto's plan to commercialize terminator technology due to concerns regarding the impact on farmers in the developing world). Other patents with similar technology have since been issued to fellow agro-biotech company AstraZeneca, see U.S. Patent No. 5,808,034 (filed Sept. 15, 1998) (Plant Gene Construct Comprising Male Flower Specific Promoters), and others, see Muscati, *supra*, at 479, n.10 (listing patent numbers).

[50] *See* Frederick Kirschenmann, *Technologies for a Sustainable Future: Therapeutic Intervention Versus Restructuring the System*, *in* BIOTECHNOLOGY: SCIENCE AND SOCIETY AT A CROSSROADS 73, 82 (Allan Eaglesham et al. eds., 2003) (noting "that while *gross* farm income grew dramatically since 1960, *net* farm income remained essentially flat . . .").

[51] *See, e.g.*, Blair, *supra* note 7, at 315–19 (discussing utility patent intellectual property protection

purposes and to set a baseline for comparison of the U.S. system with other institutional systems such as that in Argentina. The analysis incorporates the availability of common law and statutory forms of intellectual property applicable to plants, as well as the efficacy of the respective judiciary to enforce these rights and ancillary contract rights.

A. PLANT INTELLECTUAL PROPERTY PROTECTION IN THE UNITED STATES: A HISTORICAL SUMMARY

Statutory-based intellectual property protection for plants, when viewed in the historical context of plant breeding, is a relatively new concept.[52] Early farmers selected, saved, and traded with their neighbors unique seeds created as a result of chance mutations and selective breeding.[53] Although seeds were considered chattel and subject to personal property rules, the underlying genetics remained within the public domain.[54] Beginning in the 1840s, the Patent and Trademark Office's (PTO) Division of Agriculture distributed seeds to the nation's farmers for free.[55] The USDA later assumed the PTO's outreach responsibilities and distributed novel seed varieties developed at land grant colleges and agricultural experiment stations.[56] After years of lobbying by the commercial seed industry, Congress ceased the free seed distribution program in 1924.[57]

In 1930, Congress passed the first *sui generis* intellectual property scheme for plants, the Plant Patent Act of 1930 (PPA). The PPA provided a plant patent for novel, asexually reproduced varieties—protection for the nursery, rather than the commercial grain and oilseed industry. Seed saving and "brown bagging"[58] remained a legal and common practice among farmers.[59] Forty years later, Congress enacted an intellectual property regime for varieties reproduced by

for plants); Chen, *supra* note 7, at 121–40 (discussing the Plant Variety Protection Act); Endres, *supra* note 27, at 329–32 (discussing historical intellectual property protection); Janis & Kesan, *supra* note 7, at 745–53 (discussing the Plant Variety Protection Act); Kesan, *supra* note 7, at 492–99 (outlining utility patent intellectual property protection for plants, in general); Michael T. Roberts, *National Aglaw Center Research Article,* J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred International, Inc.*: Its Meaning and Significance for the Agricultural Community*, 28 S. ILL. U. L.J. 91, 121–24 (2003) (discussing utility patent protection for genetically engineered plants).

[52] Endres, *supra* note 27, at 326.

[53] *Id.*

[54] *Id.*

[55] Aoki, *supra* note 29, at 265–67.

[56] *Id.* at 266.

[57] Endres, *supra* note 27, at 328.

[58] Brown-bag seed sales are another name for saved seeds resold in the secondary market. *See id.* at 330.

[59] *Id.* at 329.

seed.[60] The Plant Variety Protection Act (PVPA) granted seed breeders exclusive rights to commercialize new[61] seed varieties.[62] As originally passed, the PVPA allowed farmers to save harvested seed and either sell or trade it to third parties.[63] The 1994 amendments to the PVPA eliminated the statutory right of farmers to sell saved seed protected by a Plant Variety Protection Certificate.[64] Farmers, however, could still save the seed for planting on their own farm.[65]

Utility patents offered agro-biotech firms an even stronger form of intellectual property protection to combat leakages on investment returns. In *Diamond v. Chakrabarty*,[66] the Supreme Court opened the door to utility patents for living inventions. The Court found the genetically engineered bacteria at issue in *Chakrabarty* to be "the result of human ingenuity and research" rather than a mere discovery of nature's handiwork.[67] As an invention made by man, the bacteria comprised a manufacture or composition of matter under § 101 of the Patent Act.[68] In *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred International, Inc.*,[69] the Court applied the same logic as *Chakrabarty* and held that subject matter available for utility patent protection extended to genetically engineered plants.[70] Utility patents, when combined with license agreements at the individual farmer level, discussed below,[71] effectively foreclosed legal seed saving in the United States.

In addition to statutory regimes, a rich history of common law intellectual property protection, including the protection of trade secrets[72] and trademarks,[73]

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[60] *Id.* at 330.

[61] In addition to being "new," the seed breeder must establish that the variety also is distinct, uniform, and stable before a plant variety protection certificate will issue. *Id.* at 329 n.44 (citing 7 U.S.C. § 2402(a) (2000)).

[62] 7 U.S.C. § 2541 (2000).

[63] Endres, *supra* note 27, at 330.

[64] *Id.*

[65] *Id.*

[66] 447 U.S. 303, 311–12 (1980) (noting that patent claims directed to live organisms were not outside the scope of patentable material).

[67] *Id.* at 313.

[68] *Id.* at 309–10 ("His claim is not to a hitherto unknown natural phenomenon, but to a nonnaturally occurring manufacture or composition of matter--a product of human ingenuity 'having a distinctive name, character [and] use.' ") (citation omitted).

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

[70] *Id.* at 142–43. *See also* Roberts, *supra* note 51, at 104–05 (discussing the majority opinion in *J.E.M. Ag Supply*). An example of the ubiquitous nature of utility patents in the current agro-biotech field is Monsanto's Roundup Ready® soybeans, which incorporate eight separate patents. *See* MONSANTO CO., 2006 TECHNOLOGY/STEWARDSHIP AGREEMENT 1, http://www.farmsource.com/images/pdf/2006%20EMTA%20Rev3.pdf#search=%22monsanto%20technology%20stewardship%20agreement%22 (on file with authors).

[71] *See infra* notes 88–94 and accompanying text.

[72] In addition to common law, trade secrets are now "a matter of international law, through

applies to agricultural seed production.[74] Most state trade secret laws protect information that (1) has an independent economic value as a result of it not being generally known and not readily ascertainable by proper means and (2) is subject to reasonable efforts to maintain its secrecy.[75] Like the formula and process for manufacturing Coca-Cola, hybrid corn seed is an excellent candidate for trade secret protection.[76] Hybrid corn seed is the result of the cross-pollination of pollen from two parent seeds resulting in a "hybrid" with enhanced characteristics.[77] Examination of the hybrid offspring does not reveal the genetic composition of the two parent seed lines.[78] Moreover, because the hybrid does not reproduce true-to-type, the same cross-pollination of the two parents must be performed each time to produce the hybrid variety.[79] As a result, hybrid corn seed breeders are able to keep the genetic composition of the parent lines secret when marketing their distinct hybrid seeds.[80]

B. THE INSTITUTIONAL ENVIRONMENT IN THE UNITED STATES

A strong institutional environment serves to uphold and enforce the private intellectual property rights conferred via the various statutes and common law doctrines discussed above. In recent years, much attention has focused on court cases alleging infringement of utility patents owned by the Monsanto Company for Roundup Ready® soybeans.[81] A study of private party enforcement data compiled from PACER found an average of over twelve lawsuits filed each year from 1998 through 2004.[82] When presented with these disputes, courts at the trial

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Article 39 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)." Mark D. Janis, *Supplemental Forms of Intellectual Property Protection for Plants*, 6 MINN. J.L. SCI. & TECH. 305, 306 (2004).

[73] *See id.* at 313–19 (discussing role or trademarks, in conjunction with designations under the Federal Seed Act, 7 U.S.C. §§ 1551–1611 (2000), as a means for protecting goodwill associated with seeds).

[74] *See, e.g.*, Pioneer Hi-Bred Int'l, Inc. v. Holden Found. Seeds, Inc., 35 F.3d 1226 (8th Cir. 1994).

[75] *See* UNIF. TRADE SECRETS ACT § 1.

[76] *Pioneer Hi-Bred Int'l, Inc. v. Holden Found. Seeds, Inc.*, 35 F.3d 1226 (8th Cir. 1994), is the leading case regarding trade secret protection for plants. *See* Janis, *supra* 72, at 305–13 (discussing trade secret protection for plant germplasm).

[77] Pioneer Hi-Bred Int'l, Inc. v. Holden Found. Seeds, Inc., No. 81-60-E, 1987 WL 341211, at *46 n.5 (S.D. Iowa Oct. 30, 1987).

[78] *Id.* at *2–3.

[79] *Id.*

[80] *Id.*

[81] *See, e.g.*, Aoki, *supra* note 29, at 255 (discussing seed saving and utility patent litigation).

[82] In a separate study, the Center for Food Safety identified ninety lawsuits filed by Monsanto for seed saving. CTR. FOR FOOD SAFETY, MONSANTO V. U.S. FARMERS 31 (2005). On average,

and appellate level have uniformly upheld utility patent rights conferred to the seed developer and awarded significant damages for the infringement.[83] The average judgment totaled $2.1 million and ranged from $16,874 to $14.5 million.[84]

The act of filing a lawsuit and proceeding to final judgment, however, is a measure of last resort. Most allegations of seed saving in the United States are resolved before filing a complaint in court, and most complaints are settled before trial or summary judgment. For example, Monsanto reported that from November 2004 through June 2005 it opened 191 new seed saving investigations,[85] and on average investigates approximately 500 farmers annually.[86] Of those investigations resulting in lawsuits, pre-judgment settlements ranged from $390 to $3 million, with an average settlement value of $88,808.[87]

In addition to utility patent and plant variety protection certificate rights, contracts, in the form of technology use agreements, play an important role in protecting intellectual property in the United States. Each sale of genetically engineered seed typically requires execution of an accompanying technology use agreement by the purchaser.[88] This "seed contract" restricts the purchaser's use of the seed with the embedded technology to a single growing season and prohibits saving any crop for future planting.[89] A measure of the institutional environment within the United States with respect to intellectual property,

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Monsanto investigates approximately 500 farmers each year for seed saving. *Id.* at 24.

[83] *See* Donald L. Uchtmann, *Can Farmers Save Roundup Ready® Beans for Seed?* McFarling *and* Trantham *Cases Say "No"*, 19 AGRIC. L. UPDATE, Oct. 2002, at 4 (describing two cases upholding intellectual property rights).

[84] *See* Peter D. Goldsmith & A. Bryan Endres, *Soybean Intellectual Property and R&D Incentives: Strategic Implications and Prescription for a Post-Modern Agriculture*, Presentation to the Federal Reserve Bank of Chicago, Ag Biotech and Midwest Rural Development (Sept. 8, 2005), presentation slides *available at* http://www.chicagofed.org/news_and_conferences/conferences_and_events/files/2005_ag_goldsmith.pdf. Recovery of attorneys' fees and costs may also be included in these judgment amounts. *Id.*

[85] MONSANTO CO., SEED PIRACY UPDATE (2005) (on file with author). On average, Monsanto investigates approximately 500 farmers each year for seed saving.

[86] CENTER FOR FOOD SAFETY, *supra* note 82, at 24 (citing Chris Clayton, *Suspicious Soybeans: Bean Detectives Visit Nebraskan*, OMAHA WORLD-HERALD, Nov. 7, 2004, at 1D).

[87] *See* Goldsmith & Endres, *supra* note 84. This data, collected from PACER, did not include settlement amounts from several cases in which the amount was not disclosed in public court documents.

[88] *See* MONSANTO CO., 2006 TECHNOLOGY USE GUIDE 2, *available at* http://www.monsanto.com/monsanto/us_ag/content/stewardship/tug/2006TUGPDF.pdf (on file with the authors).

[89] *See* MONSANTO CO., *supra* note 70, at 2 ("GROWER AGREES . . . [t]o use Seed containing Monsanto Technologies solely for planting a single commercial crop. Not to save any crop produced from Seed for planting and not to supply Seed produced from Seed to anyone for planting other than to a Monsanto licensed seed company.").

therefore, must account for these additional restrictions placed on use of the technology via contracts.

Not surprisingly, courts have enforced these contractual limitations as well.[90] In *Monsanto Co. v. McFarling (McFarling I)*,[91] the Court of Appeals for the Federal Circuit upheld express conditions in a technology use agreement that prevented seed saving. Specifically, the court held that the general rules of patent exhaustion did not apply because the technology use agreement conferred a limited license to use the product rather than outright sale.[92] In *Monsanto v. Scruggs*,[93] the Federal Circuit expanded upon the *McFarling* precedent and held that Monsanto's policy of prohibiting the replanting of saved seed is "a valid exercise of its rights under the patent laws" and not in violation of § 1 of the Sherman Act.[94]

In sum, a wide range of intellectual property protection exists for agro-biotech firms operating in the United States. Moreover, an active and stable judiciary has consistently ruled in favor of these intellectual property rights when asserted against farmers caught saving seed. Although these lawsuits are evidence of a breakdown in the social contract (i.e., farmers breaking contracts in which they covenant not to save seed), when considered in light of the immense scale of genetically engineered plantings in the United States,[95] the breakdown is minor, isolated, and demonstrates that the broader social contract between buyer and seller in the agricultural input market remains in effect.

C. PLANT INTELLECTUAL PROPERTY PROTECTION IN ARGENTINA

In contrast to the United States, Argentina's legal framework for protecting the intellectual property interests of the agro-biotech company is "far from . . .

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[90] *See generally* Janis, *supra* note 72, at 333 (concluding, based on the cases to date, that agro-biotech firms have "considerable latitude to employ contract provisions" to bolster intellectual property rights).

[91] 302 F.3d 1291 (Fed. Cir. 2002).

[92] *Id.* at 1299 ("The original sale of the seeds did not confer a license to construct new seeds, and since the new seeds were not sold by the patentee they entailed no principle of patent exhaustion."). *See also* Janis, *supra* note 72, at 327–28 (discussing the holding in *McFarling I* and patent exhaustion as a "default" rule subject to modification by contract, rather than an absolute rule); Endres, *supra* note 27, at 335–39 (discussing limiting doctrine of patent exhaustion through limited license agreements).

[93] Monsanto Co. v. Scruggs, 459 F.3d 1328 (C.A. Fed. Cir. 2006).

[94] *Id.* at 1340.

[95] In 2006, U.S. farmers planted 89% of the soybean acres with genetically engineered varieties. *See* USDA/ERS Data Sets: Adoption of Genetically Engineered Crops in the U.S.: Extent of Adoption, http://www.ers.usda.gov/Data/BiotechCrops/adoption.htm. None of the farmers were authorized to plant the crops with saved seeds.

comprehensive."[96] The first *sui generis* intellectual property protection for seed breeders operating in Argentina was the 1973 "Law of Seeds."[97] Unfortunately, implementation of the law did not occur until 1978.[98] The Law of Seeds provided the seed breeder exclusive commercialization rights for a period of years.[99] Similar to the Plant Variety Protection Act, the law gave farmers the right to use saved seeds from a previous harvest and competitors the right to use the seed to experiment and develop their own new varieties.[100]

In 1991, the Argentine government created the National Seed Institute (Instituto Nacional de Semillas, INASE) to improve the enforcement and control of these property rights.[101] Professors Gallo and Kesan, however, citing a U.S. General Accounting Office report, found the Law of Seeds ineffective in reducing theft of plant-based intellectual property.[102] In 1996, INASE attempted to minimize seed saving abuses by requiring the farmer desiring to save seed to prove that the foundation seed was originally purchased legally, that the saved seed was harvested from the legally purchased seed, that the saved seed was segregated from the other seed, and that transfer or sale of the saved seed had not occurred.[103] The Secretary of Agriculture, however, due to economic crisis, closed INASE in 2000, thereby abandoning governmental oversight of plant intellectual property rights.[104] The government reopened INASE in 2004[105] and implemented a resolution requiring each sack of seed offered for sale to "be labeled with quantity, unit price, total sales price, and seed species, type or variety."[106]

As discussed above, Plant Variety Protection-based intellectual property provides only one of the possible intellectual property options in the United States. Seed breeders desiring additional protection may also apply for utility patents. Like many countries, however, Argentina's patent laws specifically exclude plants from eligibility for utility patents.[107] Although subsequent

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96 Gallo & Kesan, *supra* note 48, at 581.

97 *Id.* at 582.

98 *Id.*

99 *Id.*

100 *Id.* The Plant Variety Protection Act recognizes farmer's rights to save seed at 7 U.S.C. § 2543 (2000) and the research exemption at 7 U.S.C. § 2544 (2000).

101 Gallo & Kesan, *supra* note 48, at 585–86.

102 *Id.* at 586 (citing U.S. GENERAL ACCOUNTING OFFICE, BIOTECHNOLOGY: INFORMATION ON PRICES OF GENETICALLY MODIFIED SEEDS IN THE UNITED STATES AND ARGENTINA 15–16 (2000)).

103 *Id.* at 587 (citing Secretaria de Agricultura Ganaderia y Pesca, Resolucion INASE No. 35/96, art. 1), *available at* http://www.upov.int/en/publications/npvlaws/argentina/farmersprivilege.pdf).

104 Gallo & Kesan, *supra* note 48, at 588.

105 *Id.*

106 Yankelevich, *supra* note 44, at 10.

107 Gallo & Kesan, *supra* note 48, at 594. *See also* Averie K. Hason & Jean E. Shimotake, *Recent*

amendments to the Argentine patent laws may open the door to utility patents for plants, there is considerable uncertainty over the state of the law.[108]

In addition to relatively weak statutory intellectual property rights, the institutional environment (i.e., governmental enforcement of rights) falls below the standards found in the United States. The USDA's Foreign Agricultural Service (FAS) characterized the "[p]enalties for unauthorized use of protected seed varieties" as "negligible."[109] Moreover, the FAS found the judicial enforcement procedures available to prevent the unauthorized use of seed varieties protected by the Law of Seeds ineffective.[110] As a result of this weak institutional environment, the seed sales prohibitions introduced in 2004[111] failed to halt the unauthorized sale of saved seed,[112] and, from the perspective of the agro-biotech firm, renders the intellectual property system inadequate.[113]

IV. THE THEORY OF THE DYNAMIC GAMING MODEL

Underlying the seed company's problem of leakages in return on investment is a fundamental principal-agent (P-A) relationship between farmers and the seed development firm.[114] In typical P-A relationships, the principal relies on the agent's effort, but may lack full information regarding the efforts or actions necessary to incentivize the agent.[115] In the case of the seed industry, farmers (the

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Developments in Patent Rights for Pharmaceuticals in China and India, 18 PACE INT'L L. REV. 303, 305–06 (2006) (noting that China's patent laws specifically exclude animals and plants); Franz-Josef Simmer & Svenja Sethmann, *Act Implementing the Directive on the Legal Protection of Biotechnological Inventions in Germany (BIOPATG)*, 24 BIOTECHNOLOGY L. REP. 561, 563 (2005) (detailing amendment to German patent laws to exclude plants and animals unless the technical feasibility of the invention is not confined to a particular plant or animal variety).

[108] Gallo & Kesan, *supra* note 48, at 594.

[109] Yankelevich, *supra* note 44, at 9.

[110] *Id.*

[111] *Id.* at 10 (discussing Resolution 44/2004 that required labels for each sack of seeds).

[112] *Id.* (discussing continuation of illegal seed sales).

[113] *Id.*

[114] S. Umeno, *Economics of the Farmer-Saved-Seed: A Challenge for the Enforcement of Intellectual Property Rights in Agriculture* (2006) (Unpublished manuscript on file with the authors); Peter D. Goldsmith et al., *Intellectual Property and the Seed Breeder's Problem* (2006) (Working Paper, The Department of Agricultural and Consumer Economics, University of Illinois) (on file with authors).

[115] JEAN-JACQUES LAFFONT & JEAN TIROLE, A THEORY OF INCENTIVES IN PROCUREMENT AND REGULATION 82–84 (1993) (documenting optional contract arrangements for P-A relationships in the presence of asymmetric information and the challenge of determining the appropriate incentive to induce desired behavior); Peter D. Goldsmith & Rishi Basak, *Incentive Contracts and Environmental Performance Indicators*, 20 ENVTL. & RES. ECON. 259, 261–62 (2001) (discussing P-A relationships in the context of environmental monitoring systems); Henrik Vetter & Kostas Karantininis, *Moral Hazard, Vertical Integration, and Public Monitoring in Credence Goods*, 29 EUR. REV.

agents) have an information advantage over the seed developer (the principal) because it is costly to determine whether the second generation crop was grown from purchased or illegally saved seed. Farmers, on the other hand, know their own risk preferences and costs for saving seed,[116] which may translate into their willingness to circumvent intellectual property rules or breach contractual agreements.

A. MONITORING STRATEGY TO REDUCE INFORMATION ASYMMETRY

A principal may reduce the level of asymmetric information via costly monitoring activities to alter the probabilities of apprehension and increase the costs to agents of deviating from the contract or infringing intellectual property rights.[117] Sophisticated monitoring approaches, such as random or stratified targeting,[118] may affect significantly the likelihood of apprehension and reduce the overall cost of monitoring.[119]

A real-world example of monitoring within the context of the seed industry is the well-publicized effort of industry-leader Monsanto to monitor and aggressively prosecute unauthorized seed saving in the domestic market.[120] As noted in Part III.B, above, Monsanto actively investigates allegations of seed saving to protect its intellectual property.[121] The Center for Food Safety reported that Monsanto employs seventy-five individuals and budgets $10 million annually to investigate and prosecute seed saving.[122] In addition, Monsanto solicits individuals to confidentially report suspected seed saving via a toll-free number or letter.[123] In addition to securing monetary awards for infringement of its

AGRIC. ECON. 271, 271–72 (2002) (discussing moral hazard and P-A relationships in the food production context).

[116] Costs for saving seed may include cleaning and conditioning costs, as well as costs of storage in appropriate climatic conditions to ensure germination the following season. Jan Spears & Randy Weisz, *Planting Farmer Saved Wheat Seed: Are You Really Saving Money?*, *in* SMALL GRAINS PRODUCTION GUIDE (2004–2005), *available at* http://www.smallgrains.ncsu.edu/Guide/Chapter4.html.

[117] Goldsmith et al., *supra* note 114, at 27.

[118] *See* Mark A. Cohen, *Empirical Research on the Deterrent Effect of Environmental Monitoring and Enforcement*, 30 ENVTL. L. REP. 10245, 10247–48 (2000) (discussing effectiveness of alternative monitoring strategies).

[119] Goldsmith et al., *supra* note 114, at 27.

[120] *See supra* notes 85–86 and accompanying text (discussing the amounts of Monsanto's seed saving investigations).

[121] *See supra* notes 85–86 and accompanying text (discussing the amount of Monsanto's seed saving investigations).

[122] CTR. FOR FOOD SAFETY, *supra* note 82, at 23.

[123] MONSANTO CO., 2006 MONSANTO TECHNOLOGY USE GUIDE, *supra* note 88, at 1.

intellectual property, these well-publicized legal actions undoubtedly serve as a deterrent and may reduce the overall cost of monitoring for the firm.

In sum, private sector monitoring plays an important role in reducing information asymmetry inherent in the principal-agent relationship characterizing the market for genetically engineered seed.

B. RISK AVERSION IN THE AGRICULTURAL CONTEXT

Standard tort theory posits that punishment, in the form of damages, will deter bad conduct.[124] Punishment, however, requires detection and identification of the wrongdoer and successful enforcement of any subsequent judgment. Accordingly, a potential tortfeasor contemplating a wrongful act will consider the probability of apprehension and likelihood of enforcement as components of the damages (potential loss) function. In the agricultural context, farmers, as rational economic actors, will refrain from saving seeds only if their possible losses from getting caught exceed the benefits of lowering their production costs from using saved seed.[125] The institutional environment (i.e., ability to enforce legal rights), therefore, is an important factor for the farmer considering saving seeds[126] and a critical component to disincentivize inappropriate action.[127] Farmers will adjust their risk-taking behaviors to coincide with different enforceable standards.

Adjustments in behavior at the farmer (agent) level depend upon the underlying tolerance for risk. "[T]he level of perceived risk, shaped by the severity of the consequences and the probability of occurrence, determines both the contractual terms and the nature of incentives designed to induce the agent's cooperation."[128] The effectiveness of an enforcement strategy for seed saving in a given institutional environment, therefore, is determined in part by the degree of the farmers' risk aversion and the cost structure of monitoring compliance.[129]

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[124] RESTATEMENT (SECOND) OF TORTS § 901(c) (1979).

[125] Stated another way, "[a farmer] will [only] commit the act [of saving seed] if and only if his expected utility from doing so, taking into account his gain and the chance of his being caught and sanctioned, exceeds his utility if he does not [save seed]." A. Mitchell Polinsky & Steven Shavell, *The Economic Theory of Public Enforcement of Law*, 38 J. ECON. LITERATURE 45, 47 (2000).

[126] *See id.* at 64 (noting that an increase in the expected penalty reduces the level of violation of agents).

[127] *See generally* Louis Kaplow & Steven Shavell, *Optimal Law Enforcement with Self-Reporting of Behavior*, 102 J. POL. ECON. 583, 601–02 (1994) (discussing optimal strategies of enforcement to deter undesired conduct); Arun S. Malik, *Self-Reporting and the Design of Policies for Regulating Stochastic Pollution*, 24 J. ENVTL. ECON. & MGMT. 241, 242 (1993) (discussing institutional environments and self reporting).

[128] Goldsmith et al., *supra* note 114, at 8.

[129] Adam Ozanne et al., *Moral Hazard, Risk Aversion and Compliance Monitoring in Agri-Environmental Policy*, 28 EUR. REV. AGRIC. ECON. 329, 330 (2001).

A higher degree of risk aversion allows convergence of the second-best outcome with the first-best solution.[130]

Conventional assumptions that a principal is risk neutral while an agent is risk-averse[131] hold true in the agricultural context. Numerous commentators have found farmers, as a whole, to exhibit risk-averse behavior.[132] Faced with uncertain weather conditions and generally tight budget constraints, farmers demonstrate this risk-averse behavior by minimizing their chances of falling below some subsistence minimum, even if this means sacrificing some income on the average.[133] Large-scale farmers, however, may be less risk-averse because they can diversify more easily than smaller farmers.[134] Accordingly, under a base setup, the relatively risk-averse (smaller) farmer would save less seed than the more risk-neutral (larger) farmer, and be willing to give up some profit in exchange for a more stable income.[135]

The implication from this conclusion in the seed market is troubling to the agro-biotech firm contemplating expansion into weak institutional regions. Seed companies have an incentive to deal with customers sensitive to risk (small farmers), but their best customers—the ones who purchase the most seed and generate economies of scale for the seed company—may, *ceteris paribus*, be less sensitive to risk and, therefore, more inclined to save seed. Two important questions arise: (1) How does a seed company elicit risk-averse behavior within weak institutional environments and (2) how does the firm achieve this behavioral

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[130] Goldsmith et al., *supra* note 114, at 17–18 (modeling dynamics of saving seed).

[131] *See* LAFFONT & TIROLE, *supra* note 115, at 82; Jean-Paul Chavas & Matthew T. Holt, *Acreage Decisions Under Risk: The Case of Corn and Soybeans*, 72 AM. J. AGRIC. ECON. 529, 535 (1990) (modeling risk-responsive acreage decisions); Joseph Henrich & Richard Mcelreath, *Are Peasants Risk-Averse Decision Makers?*, 43 CURRENT ANTHROPOLOGY 172, 172 (2002) (finding peasants risk-averse because of their uncertain and precarious economic situation).

[132] PETER B.R. HAZELL & ROGER D. NORTON, MATHEMATICAL PROGRAMMING FOR ECONOMIC ANALYSIS IN AGRICULTURE 77 (MacMillan 1986) (finding agents generally risk averse); Jean-Paul Chavas & Matthew T. Holt, *Economic Behavior Under Uncertainty: A Joint Analysis of Risk Preferences and Technology*, 78 REV. ECON. & STAT. 329, 335 (1996) (finding "decreasing absolute risk aversion and downside risk aversion").

[133] *See* HAZELL & NORTON, *supra* note 132, at 94 (examining the maxi-min strategy arising from farmers' pessimistic view of their reliance on nature and selection of a maximum outcome under the worst possible state of nature); Bruce Winterhalder et al., *Risk-Sensitive Adaptive Tactics: Models and Evidence from Subsistence Studies in Biology and Anthropology*, 7 J. ARCHAEOLOGICAL RES. 301, 334 (1999) (discussing risk mitigation strategies by early Native American subsistence farmers).

[134] Goldsmith et al., *supra* note 114, at 16 (citing Working Party on Agricultural Policies & Markets, OECD, Risk Related Non-Price Effects of the Cap Arable Crop Regime: Results from an FADN Sample 10 (2003), *available at* http://www.oecd.org/dataoecd/24/30/25314276.pdf ("[S]mall farms . . . [are] the most risk averse, . . . while the degree or (relative) risk aversion decreases with size . . . and for large farms it becomes virtually [risk neutral] . . . .")).

[135] *See supra* notes 133–34 and accompanying text (describing risk aversion in relation to scale).

shift among its larger and more profitable customers? The answer lies, in part, on pricing strategy and monitoring efforts to maximize profits under sub-optimal institutional environments.

C. PRICING STRATEGY FOR SEEDS SUSCEPTIBLE TO SAVING

Goldsmith et al. developed a theoretical game model for an optimal seed contract[136] (limited license agreement) involving a two-period game between a seed firm (principal) and a farmer (agent).[137] In modeling seed saving, the farmer confronts a variety of risks: seed quality,[138] yield drag,[139] and, as noted above, potential penalties for using seed for a second harvest without authorization. In addition, feedback in period two regarding the probability of apprehension factors into the degree of risk felt by the farmer. *Ceteris paribus*, lowering the price of seed, higher seed saving costs, increasing penalties for seed saving, increasing the probability of apprehension, and high yield drag discouraged farmers from saving seeds.[140] In the baseline case, with a strong intellectual property environment, the agro-biotech firm would set a seed price such that farmers receive their reservation utilities and the firm recoups its research and development costs for genetically engineering and producing the seed. In addition, the firm could forgo

[136] *See supra* notes 88–89 and accompanying text (describing typical provisions of seed contracts).

[137] Goldsmith et al., *supra* note 114, at 10–22 (describing theoretical framework of the model).

[138] Seed quality is a broad term that reflects both the homogeneity of the seed product and the likelihood the seed performs as expected. P. McMahon et al., Fruit and Seed Quality, at http://quorumsensing.ifas.ufl. edu/HCS200/SeedLab.html. Homogeneity can be compromised by the inclusion in the seed bag of: weed seed, non-seed foreign matter (e.g., stems or dirt), other seed cultivars (e.g., corn seed in a soybean seed bag), other seed varieties, and microscopic materials (e.g., fungi). Seed performance, such as low germination rates, can be adversely affected by the inclusion of cracked or damaged seeds, poor initial selection processes, and non-optimal moisture levels. In the United States, the Federal Seed Act, 7 U.S.C. §§ 1551–1611, regulates, at least minimally, some aspects of seed quality. For a more complete discussion of the Federal Seed Act and quality, with respect to genetically engineered seed, see A. Bryan Endres, *Revising Seed Purity Laws to Account for the Adventitious Presence of Genetically Modified Varieties: A First Step Towards Coexistence*, 1 J. FOOD L. & POL'Y 131, 156–59 (2005).

[139] Yield drag, in general, occurs when an agricultural practice is performed on a crop that results in a decrease in yield. Karen Coaldrake, *Trait Enthusiasm Does Not Guarantee On-Farm Profits*, 2 AGBIOFORUM, 118, 124 (1999), *available at* http://www.agbioforum.org/v2n2/v2n2a09-coaldrake. htm (discussing potential causes of yield drag). When farmers save seed they engage in a practice that substitutes the last (inferior) generation of seed for the current (superior) generation. They accept the slightly lower yield of the last generation because they lower their costs of production by not purchasing seed. Engaging in the same practice with hybrid seed corn incurs a yield drag far in excess of the cost benefits of avoiding corn seed purchases. Thus the practice of hybrid corn seed saving does not occur.

[140] Goldsmith et al., *supra* note 114, at 33.

monitoring efforts because of a robust institutional environment backed by strong individual adherence to a social contract that respects intellectual property rights. Moreover, farmers operating in this robust legal environment may continue to purchase seeds the second year, even if prices rise, because of their concern for apprehension and imposition of penalties. In this case, the monopolist seed company can capture economic rents in the second period.

The role of risk, however, also plays an important part in pricing strategy. In a robust institutional environment (characterized by strong intellectual property laws and an efficient court system to impose penalties), only the risk-neutral farmer would save seeds. In a weak institutional environment, however, the probability of being caught and having a penalty enforced dramatically decreases. The behavior of the risk-neutral farmer would not change, but farmers with risk-averse preferences will now save more seed, forcing the seed company to lower prices to attract more buyers and lower the marginal benefit of saving seed. Seed companies, therefore, in choosing an appropriate price strategy, need accurate information about the farmer's production characteristics and risk preference.

A quick comparison between the experiences in the United States and Argentina illustrates this point. In the United States, less than 8% of soybean seed is thought to be saved seed, while in Argentina, informal marketing, either using on-farm saved seed or purchasing seed saved by a neighbor rather than a seed company, dominates up to 90% of the market.[141] One could presume that the price of seed would be lower in the United States than Argentina to induce such a high level of annual purchasing. Likewise, one would predict that commercial seed prices in Argentina were high and, therefore, encouraged seed saving. The actual commercial price in the United States, however, was $17/fifty lbs from 1998–2000, while in Argentina, the soybean seed price was only $11, $8 and $7/fifty lbs in the respective years,[142] resulting in an average price differential between the countries of 49%. Moreover, any effort to raise prices in Argentina is likely to be met by an increase in the rate of saved seeds, resulting in offsetting revenue losses.[143] In contrast, the price for corn seed in Argentina averaged 93% of the U.S. price.[144] The difference between the two seeds—corn and soy—appears to be the natural resistance to saving seed as a result of hybridization. Absent the natural barrier to duplication provided by

[141] Peter Goldsmith et al., *A Tale of Two Businesses: Intellectual Property Rights and the Marketing of Agricultural Biotechnology*, CHOICES, Aug. 2003, at 25, 26.

[142] *See* U.S. GENERAL ACCOUNTING OFFICE, BIOTECHNOLOGY: INFORMATION ON PRICES OF GENETICALLY MODIFIED SEEDS IN THE UNITED STATES AND ARGENTINA 17–18 (2000); E. Accari, *Argentina Planting Seeds Annual*, USDA/FAS Gain Report (2000); USDA, Nat'l Agric. Stat. Serv., *Agricultural Prices* (2001).

[143] Goldsmith et al., *supra* note 9, at 341–42 (discussing demand elasticity).

[144] Kesan & Gallo, *supra* note 7, at 121 tbl. 1.

hybridization, strong intellectual property protection, such as found in the United States, appears, at first glance, necessary to maintain prices and is the primary reason for the price differential in soybean seed.

Using a theoretical game model, Goldsmith et al. identified that the institutional environments in which seed companies operate influence the behavior of farmers and firms.[145] When intellectual property rights are robust and enforcement is efficient, no seeds will be saved and seed company profit is maximized. On the other hand, when institutional structures are low or zero, *ceteris paribus*, farmers begin to save seed. This would confirm most commentators' claims that a strong intellectual property environment is necessary for profitability.[146] The simulation conducted by Goldsmith et al., however, demonstrated that a seed company can achieve comparable profits, even in a weak institutional environment, if the firm adopts a non-monopolistic price strategy.

For example, if the probability of apprehension is low and the farmer is concerned about total utility over a two-year period, the farmer may be willing to pay a high price in year one and accept a lower year one utility. In year two, however, the farmer would save the seed, avoid seed purchase costs, and experience super-normal utility. This can be thought of as a "pump-priming" scenario whereby the monopolist seed seller and the farmer-buyer know that monopoly power is sustainable for only a single period.[147] The seller would maximize price in year one and forego profits in year two.[148] The buyer would accept a lower utility in year one because he knows that yield drag would be minimal in year two and he could exploit the technology by saving the seed not only in year two, but possibly beyond.[149] In a separate study, Goldsmith et al.

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[145] Goldsmith et al., *supra* note 114, at 14–15.

[146] Kesan & Gallo, *supra* note 7, at 121.

[147] A similar process occurs in the metal industry. For example, in the landmark antitrust case, *United States v. Aluminum Co. of America*, 148 F.2d 416 (2d Cir. 1945), defendant Alcoa attempted to refute antitrust allegations by arguing that it lacked control of the secondary market. *Id.* at 424. Once Alcoa released its "virgin" aluminum ingots to the market, scrap dealers could manufacture "secondary" aluminum ingots that, although not competing in all uses, for most purposes were substantially equivalent with "virgin" ingots. *Id.* at 424. Accordingly, the court found that "at any given moment . . . 'secondary' competes with 'virgin' in the ingot market . . . and probably . . . set[s] a limit or 'ceiling' beyond which the price of 'virgin' cannot go, for the cost of [secondary ingot's] production will in the end depend only upon the expense of scavenging and reconditioning." *Id.* In the seed market, there is a ceiling as well. The cost of second year (saved) seed only involves the expense of cleaning, conditioning and storing for the following growing season.

[148] *See* DENNIS W. CARLTON & JEFFREY M. PERLOFF, MODERN INDUSTRIAL ORGANIZATION 637 (citing Darius W. Gaskins, Jr., *Alcoa Revisited: The Welfare Implications of a Secondhand Market*, 7 J. OF ECON. THEORY 357–59 (1974) for an explanation as to why the first-period price is higher than the short-run monopoly price because higher production and lower costs in the short run would lead to a larger stock of aluminum scrap and more competition from the secondary market).

[149] Goldsmith et al., *supra* note 114, at 26.

found empirical evidence of this in the Argentinean seed market where commercial soybean seed prices actually rose over time in response to aggressive seed saving and brown-bag sales as the commercial sellers realized that their seed served only as foundation seed to prime the pump of the extensive brown-bag industry.[150]

Although theoretically possible, the feasibility of a pump-priming pricing strategy ultimately depends upon the underlying research and development costs of the firm, farmers' utility perspectives, and the availability of credit for the farmer.[151] If the initial price is too high, farmer's utility in year one would decline below a point where the increased utility in year two would not achieve the

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[150] Goldsmith et al., *supra* note 9, at 346.

[151] A complete discussion of credit availability is beyond the scope of this Article but warrants mentioning in some detail. In Argentina, traditional cash credit is not available to farmers. Interview by Peter D. Goldsmith with Alejandro Muñoz, CEO, Pioneer Argentina S.A., in Buenos Aires, Arg. (May 2001). Rather, a quasi-barter system exists in which input suppliers (including land owners) agree to delayed payment for a set quantity of the expected harvest. *Id.* This "bag of beans" credit system transfers some of the price risk to the input suppliers (i.e., the price of beans drops on the commodity markets below the price/quantity of beans agreed upon at the time the supplier entered into the bargain). *Id.* The importance of a stable and enforceable credit system in the agricultural context recently played out via the introduction of genetically engineered cotton in the Makhathini Flats region of South Africa. Marnus Gouse et al., *Bt Cotton In KwaZulu Natal: Technology Triumph But Institutional Failure*, AGBIOTECHNET, Mar. 2005, 1, 1–7. In 1998, a group of farmers in the Makhathini Flats region experimented with cultivation of genetically engineered (Bt) cotton. *Id.* at 1. After widespread reporting of large yield increases and reduced labor input, demand for the seeds skyrocketed. *Id.* at 1–2. The South African government-funded Land Bank extended credit for the seeds with collateral in the forthcoming crops. *Id.* at 7. An estimated 90% of the regions' farmers adopted the technology. Elfrieda Pschorn-Strauss, *Bt Cotton in South Africa: The Case of the Makhathini Farmers*, SEEDLING, Apr. 2005, at 13–24. A single cotton gin, Vunsia Cotton, existed in the area and would withhold a portion of the farmers' harvest proceeds for repayment of the Land Bank loans. Gouse et al., *supra*, at 2. A devastating flood in 2000 followed by two successive seasons of drought and plummeting cotton prices left many farmers with low yields and mounting debt. Pschorn-Strause, *supra*, at 16, 17 tbl. 1. The appearance of the new Makhathini Cotton Company cotton gin (funded by Danish donors and local government) provided farmers with another outlet for their crops. *Id.* at 20–21. The new cotton ginning company did not automatically withhold loan payments for Land Bank and an estimated 80% of the farmers defaulted on their loans. *Id.* at 21. Vunisa Cotton folded, the Land Bank ceased direct credit support to the farmers, and the number of farmers growing Bt cotton decreased by 80%. *Id.* at 21. The initial technical success of Bt cotton, followed by a rapid reduction in cotton farming, highlights the importance of a stable credit extension system in economically disadvantaged farming regions when adopting the more expensive genetically modified seed varieties. Gouse and others argue that monopsony (only one available buyer) was appropriate for cotton production in the Makhathini Flats area in order to ensure that the lender recovered its seed loans. Gouse et al., *supra*, at 7. The introduction of a second gin provides a route for default, which is followed by future lack of credit availability and an overall decline in production. *Id.*

farmer's reservation utility.[152] However, if the yield drag from saved seed remains at only 1% to 2% and yearly innovation levels are moderate, farmers could use the saved seed over a longer time period, say three to four years, before returning for fresh commercial seed. This long-term view of utility could justify, from the farmer's perspective, a higher price in year one.

On the other hand, an active innovation strategy, whereby seed genetics were outdated after two years, might reestablish the firm's monopolist position by increasing yield drag and significantly changing the seed saving calculus such that farmers would prefer to purchase new seed in year two. Rapid innovation thus serves as an alternative to the pump-priming strategy. The challenge though is that rapid innovation may require extensive investment, and may be either technically infeasible or costly. Examples where rapid innovation strategy successfully maintains a firm's pricing power monopoly can be seen in the fashion and consumer products industries.

D. NON-PRICE RELATED STRATEGIC OPTIONS FOR THE FIRM

In addition to the dynamic pricing options identified by the model, other non-price related strategic options may be available for the firm. A brief discussion of these alternatives follows.

1. Product Bundling. Product bundling presents a near-term, non-price strategy for the agro-biotech firm already offering multiple inputs to the agricultural system. In the United States, some bundling schemes may implicate antitrust concerns or the doctrine of patent misuse.[153] For firms operating in areas that lack both antitrust and intellectual property rules, a product bundling strategy, however, may be viable.[154]

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[152] In addition, if the farmer's utility is separable such that there is a reservation utility for each period, the farmer-buyer will not accept high first period pricing (and lower utility) even though he knows the total utility he can achieve through a two-year period equals or exceeds his reservation utility.

[153] *See* STEPHEN F. ROSS, PRINCIPLES OF ANTITRUST LAW 274 (Foundation Press, Inc., 1993) (noting that § 3 of the Clayton Act, 15 U.S.C. § 14, "bars a seller from conditioning the sale of a good on the purchaser's forbearance from purchasing a competitor's products . . ."); *see also* Jefferson Parish Hosp. Dist. No. 2 v. Hyde, 466 U.S. 2 (1984) (establishing five elements of illegal tying arrangements). In *Motion Picture Patents Co. v. Universal Film Manufacturing Co.*, 243 U.S. 502 (1917), the Supreme Court applied the doctrine of patent misuse to prohibit a similar tying of goods, in this case the purchase of a patented movie projector (of which there were no substitutes in the market) with patented film (substitutes available).

[154] The extent to which extraterritorial actions might violate United States antitrust or unfair competition laws is an interesting issue, but beyond the scope of this Article. *See* 1 SPENCER WEBER WALLER, ANTITRUST & AM. BUS. ABROAD § 11:19 (3d ed. 1998) (noting that § 3 of the Clayton Act does not apply to foreign sales, but that a significant foreclosure of other American firms to foreign

Two types of product bundling alternatives are available for the agro-biotech firm attempting to sell self-pollinating seeds. The "mild" version is the loss leader strategy. Seed companies often are part of larger "life science" firms that offer a full range of agricultural inputs such as fertilizers, pesticides, a variety of seed species (e.g., corn, soybean, cotton) and advice regarding the optimal use of these products (e.g., soil samples or consulting). The firm adopting a loss leader strategy could "give away" self-pollinating soybean seed in order to attract customers to its single use products such as corn seed and the necessary agro-chemicals. Of course, this strategy is effective only to the extent that the firm has other goods desired by customers. The alternative bundling option is to play "hard ball" and refuse outright to sell improved varieties of hybrid corn seed or chemicals unless the farmer also purchases (or pays a royalty) for soybean seed.[155]

2. Genetic Use Restriction Technologies. Genetic Use Restriction Technologies (GURTs) attempt to insert a sterility feature into the plant's genome whereby second generation seeds will not germinate. Variations of this strategy include second generation seeds that do not contain the enhanced technology (e.g., saved Roundup Ready® soybean seeds that no longer tolerate Roundup) or insertion of "gene keys" whereby the desirable trait is "turned on" via application of a single use spray (the key). From the agro-biotech firm's perspective, GURTs present an incredibly efficient method of protecting intellectual property and returns on investment. Private monitoring and enforcement through the court system would be superfluous, even in the weakest of institutional environments. But this seemingly simple and efficient solution, what some have coined "terminator technology,"[156] engenders significant controversy and warrants further scholarly analysis regarding the policy and environmental implications before commercialization.[157] Moreover, securing approval to market seeds containing GURTs may prove difficult in many regions of the world. As a result, although the technology is feasible (and in the innovation pipeline) a GURT-oriented strategy remains a "longer-term" strategy because of social, political and environmental concerns.

3. Reduce Investment in Perilous Products. When intellectual property is vulnerable, agro-biotech firms, as a last resort, may employ a reduced investment strategy or minimal product support as a risk attenuating mechanism. If there is

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business opportunities as a result of the tying arrangement could be subject to the Sherman Act).

[155] Some domestic firms attempt to bundle sales of seed with chemicals by conditioning any warranty on the seed with the use of the same firm's agricultural chemicals. For example, in its technology use agreements from 1996 to 1998, Monsanto required growers to use Monsanto's Roundup glyphosate herbicide rather than other glyphosate brands on Roundup Ready® plants. *See* Monsanto Co. v. Scruggs, 459 F.3d 1328, 1339 (C.A. Fed. Cir. 2006).

[156] *See* Muscati, *supra* note 49, at 478–81.

[157] *See id.*

no investment, then any sale of seed, regardless of price, will have a high "return on investment." Although some argue that farmers will suffer in a strong intellectual property rights environment because of monopoly pricing by the input suppliers,[158] the converse may also hold true. If agro-biotechnology firms adopt a reduced investment strategy due to a weak environment for intellectual property rights, farmers also may suffer in the long run due to outdated technology as a consequence of underinvestment in improving crop varieties.[159] Furthermore, this may have ramifications on the supply chain beyond the individual farm operators. Soybean crushers and processors rely on a river of beans.[160] Falling yields due to outdated technology could shrink the river of beans and cause disruptions throughout the supply chain.

V. CONCLUSION

Although some may criticize the business environment in the United States as burdensome and over-regulated, when domestic firms leave these relatively friendly confines to pursue business opportunities in the developing world, they often must enter an environment with a different social contact between sellers and buyers. A firm reliant on Western-based abstractions such as intellectual property, therefore, must have multiple approaches to profit maximization or they will quickly find their new operating environment "nasty, brutish and short."[161] When the legal process fails (or is non-existent) and lawyers, as litigators, are irrelevant, the solutions offered above can make the second best outcome converge with the optimal alternative (efficient enforcement of intellectual property rights) to create a beautiful world. In sum, firms must adapt to the systems into which they venture.

Farmer-saved seed and the associated impact on profitability remains a major concern for agro-biotech companies investing in genetically engineered seed. The relative status of the intellectual property right environment is not the only consideration for recovery of research and development expenditures. Farmer

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[158] *See* Andrew T. Mushita & Carol B. Thompson, *Patenting Biodiversity? Rejecting WTO/TRIPS in Southern Africa*, 2 GLOBAL ENVTL. POL. 65, 71–72 (2002); Keith Aoki, *Neocolonialism, Anticommons Property, and Biopiracy in the (not-so-brave) New World Order of International Intellectual Property Protection*, 6 IND. J. GLOBAL LEGAL STUD. 11, 55–56 (1998).

[159] *See* Goldsmith & Endres, *supra* note 84; P.D. Goldsmith et al., *Seed Biotechnology, Intellectual Property, and Global Agricultural Competitiveness*, *in* SEEDS OF CHANGE: AGRICULTURAL BIOTECHNOLOGY IN THE 21ST CENTURY (Jay Kesan ed., Elsivier Press, forthcoming 2006).

[160] Similar arguments have been made with respect to agribusiness giants Cargill and ADM and their reliance on "a river of corn." MICHAEL POLLAN, THE OMNIVORE'S DILEMMA 63, 86 (Penguin Press, 2006).

[161] HOBBES, *supra* note 2, at 89.

risk preferences, the cost of saving seed, monitoring costs, and farmer size distribution influence seed company strategies. Farmer-saved seed may not be a serious problem for the seed company, even in weak intellectual property environments, if the firm can deploy dynamic pricing, product bundling, or genetic use restrictions. Moreover, to the extent farmers are willing to consider satisfying their reservation utility over longer time periods (e.g., two or more years), a pump-priming pricing strategy may provide seed companies adequate return on investment if they set a higher price in year one. Product bundling, to the extent it does not conflict with host country antitrust rules, genetic use restriction technologies, or, as a last result, reduced research and development investment, present additional alternatives for the firm.

The implications for this alternative view of strategy are important. Many of the newly emergent food producing countries either lack strong intellectual property rights or the institutional environment to enforce these rights against infringers. In these weak institutional environments, the alternative profit maximization strategies may counter leakages to return on investment resulting from saved seed. Moreover, as these regions develop stronger institutional mechanisms to enforce property rights and farmers adjust their social norms to recognize these rights, the agro-biotechnology firm can subsequently shift their strategies back to more legalistic approaches, such as the limited license agreements used in the United States. Until then, firms must consider alternative short-run strategies or risk losing out on significant business opportunities in many rapidly expanding markets.