

Intellectual Property and Consolidation in the Seed Industry

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ABSTRACT

Intellectual property protections on seeds have increased dramatically in recent decades, from the granting of patent-like protections on certain types of seeds in 1970 to the enforcement of contract provisions for seeds beyond the first sale in 2013. During this same period, the seed industry has experienced rapid consolidation. Although as recently as the 1970s, it was characterized by thousands of small, mostly family-owned business, by 2011, just three agrochemical firms controlled more than half of the global proprietary seed market. These trends have resulted in rapidly increasing prices for commodity seeds and reduced farmers' ability to save seeds. Given these important negative impacts, why do these trends continue? Expanding intellectual property protections and reducing the number of competitors are strategies that the largest firms understandably employ to increase their power but government support has also been essential to their success. Policy changes have reduced the enforcement of antitrust laws and increased the enforcement of alleged intellectual property infringements. In addition, synergies between stronger intellectual property protections and consolidation have further reinforced the dominance of top firms at the expense of a freely competitive industry. A better understanding of these trends is unlikely to reverse them in the near term but may increase the effectiveness of creating alternatives to a seed oligopoly.

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UNTIL THE LAST century, seeds were a common resource. Their use was not controlled by governments, and innovations could potentially benefit anyone. The situation has changed substantially since then. In a process frequently compared to the enclosure or privatization of the commons in England between the 16th and 19th centuries, the right to save and replant seeds has been increasingly restricted (Kneen, 1993; Kloppenburg, 2010; Peekhaus, 2013). The firms involved in the seed industry have also transformed from thousands of competing, independent seed firms in the United States a few decades ago to domination by a handful of multinational corporations. In addition, until recently, most of these dominant firms were focused on the production of agrochemicals. These two trends are not a coincidence but are the result of the largest corporations successfully finding means to increase their power (Nitzan and Bichler, 2009).

For most of the 20th century, seed firms tended not to be involved in other industries. Their success in convincing governments to increase intellectual property protections, however, eventually attracted interest from even larger firms. In the 1970s, new protections for hybrid seeds led to the entrance of oil, pharmaceutical, and grain trading companies, particularly for corn (*Zea mays* L.) seeds. By the 1980s, agrochemical corporations were experiencing declining profit opportunities as a result of increased regulations and fewer markets in which to expand (Lewontin 2000). In response, they built on their existing relationships with farmers to enter into another, more promising agricultural input industry: the seed industry.

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A key motivation was the granting of full patent protections on soon-to-be commercialized transgenic seeds and the expectation of strong government enforcement of these monopolies (Matson et al., 2014). Much of this transformation was not a result of outcompeting more established seed firms, but by acquiring them. Each acquisition not only increased the agrochemical companies' market shares but also added to their germplasm and seed distribution resources. As these agrochemical companies bought out hundreds of formerly independent biotechnology and seed companies, they also merged with each other, eventually reducing the number of global agrochemical firms to just six, consolidating the seed industry even further (Howard, 2009).

These changes have had predictable effects for farmers, such as reducing the rates of saving seeds, increasing the prices of purchased seeds, and requiring the purchase of proprietary or additional inputs at greater expense. The commercial hybridization of some key commodity seeds resulted in rapidly declining rates of seed saving in the early 20th century: as low as 5% for corn by 1960 (Fernandez-Cornejo, 2004). Although hybrids were a technical means of discouraging seed saving, the legal means of patents have proved just as effective (Kloppenborg, 2004). Rates of saving soybean [*Glycine max* (L.) Merr.], which had resisted hybridization efforts, for example, declined from approximately 33% in 1991 to 10% by 2001 (Mascarenhas and Busch, 2006).

With a diminished ability to save seeds and fewer options in the market, the price of commodity seeds has increased as much as 30% annually in recent years, significantly higher than the rate of inflation (Hubbard, 2009). Contracts for transgenic seeds also frequently require the purchase of proprietary inputs such as glyphosate herbicides, and this precedent is even being extended to non-transgenic seeds. Although these impacts have served to increase the profits and market capitalization of dominant firms, they have reduced options for farmers.

Why do these trends continue? Government support has been essential to their success. Without policy changes to enable broader intellectual property protections, strong enforcement of these protections, and reduced antitrust enforcement, these firms would not have been able to increase their power to such a great extent. Although corporate and government actions have been resisted by social movements, these efforts have not accomplished enough to reverse the increasing influence of the largest agrochemical–seed firms. In addition, the synergistic or mutually reinforcing nature of dominant institution actions creates a snowball effect, in which the big get bigger and even more powerful.

INCREASING INTELLECTUAL PROPERTY PROTECTIONS

The United States and other industrialized countries have a long history of expanding intellectual property protections on seeds and other living organisms. Some of the key changes in the United States are listed in Table 1. Beginning in 1930 with the Plant Patent Act (1930), firms were able to restrict the use of organisms that resulted from their breeding efforts. These protections were expanded to seeds in 1970, but with exceptions that allowed farmers to save seeds after the first sale, and to conduct breeding and research efforts. Full utility patents were not allowed on most living organisms until 1980, as a result of a narrowly decided US Supreme Court decision for transgenic bacteria. This precedent was then expanded to seeds and plants with *Ex parte Hibberd* (1985) in 1985.

As seed firms and their parent corporations became more powerful, they were able to increase the amount of resources invested in expanding intellectual property protections. Expensive new technologies have been a useful tool with which to leverage wider intellectual property claims, such as the insertion of a single patented gene as a means to place restrictions on the entire seed (Matson et al., 2014). Farmers' legal abilities to save seeds have been rapidly eroded as a result, most recently via a court decision upholding the enforcement of seed contract provisions indefinitely, even for those who have received second or later generations of seed without signing contracts. This applies if a farmer purchases commingled soybeans from a grain elevator, for example, and the majority of these seeds contain proprietary traits (*Bowman vs. Monsanto*, 2013).

The increasingly broad nature of intellectual property protections has, at times, led to intra-industry conflicts. One example was a soybean patent filed by Agracetus that would grant it a monopoly on all transgenic soybeans, regardless of the genes inserted into the target organism. This patent claim was opposed by Monsanto, which filed a 292-page statement listing its objections—until Monsanto acquired Agracetus for \$150 million and immediately put its resources into supporting the broad patent application it now owned (Bowring, 2003). The European Patent Office conceded to Monsanto and initially upheld the claim, although opposition from competitors, particularly Syngenta, led to it being revoked a few years later (Stafford, 2007). Another example of a broad claim is Monsanto's patent on broccoli (*Brassica oleracea* L. *italica*) with protruding crowns for ease of harvest, which was granted in 2011. The firm is currently trying to apply this patent to any broccoli expressing such a trait, not just those with the associated gene sequences identified; this claim was rejected by the patent office but is being appealed in hopes that their lawyers can wear down the patent examiners (Hamilton, 2014).

The United States is typically the leader in setting new intellectual property precedents for seeds, which are

Table 1. Intellectual property protections for living organisms: Key U.S. policy changes.

Year	Policy	Impact
1930	Plant Patent Act (1930)	Patents on asexually reproducing plants
1970	Plant Variety Protection Act (1970)	Patent-like protections for sexually reproducing plants
1980	Bayh–Dole Act (1980)	Patents allowed for publicly funded research outputs
1980	Diamond vs. Chakrabarty (1980)	Transgenic organisms patentable
1985	Ex parte Hibberd (1985)	Plants patentable under general utility patent provisions
1987	Ex parte Allen (1987)	Multicellular animals patentable
1994	Amendments to the Plant Variety Protection Act (1970)	Selling seed without a license from the owner prohibited
1995	Asgrow vs. Winterboer (1985)	Increased restrictions on selling saved seed
2001	JEM Agricultural Supply vs. Pioneer Hi-Bred (2001)	Saving seeds with utility patents prohibited
2013	Bowman vs. Monsanto (2013)	Enforces contract provisions beyond the first sale

then followed by other nations. One important exception, however, was amending the U.S. Plant Variety Protection Act in 1994 to match the European Union's 1991 restrictions on selling or exchanging seeds without a license from the owner. These precedents have also expanded geographically through the negotiation of global trade agreements. Trade negotiators from more industrialized countries have pushed less industrialized countries to accept stronger intellectual property protections, including for seeds. Some nations, such as China, Brazil, and Argentina, have resisted these efforts and continue to maintain the less restrictive 1978 version of the International Union for the Protection of Varieties of Plants, which allows farmers to exchange seeds (Li et al., 2013).

The largest seed firms have also been very effective in enlisting government support to enforce their intellectual property claims against farmers who have allegedly saved seeds, particularly in the United States. The Center for Food Safety estimates that Monsanto collected \$23.7 million in recorded judgments against farmers by 2013, and received additional payments of \$85 to \$160 million from settlements outside of court by 2006 (Barker et al., 2013). In addition, at least one farmer, Kem Ralph, was sentenced to 8 mo in prison for his seed-saving activities, despite claiming he never signed a contract (Meek, 2006). Monsanto was the leader in lawsuits against farmers, but DuPont is now copying this strategy, including hiring private detectives to police farmers' fields for evidence of seed saving (ETC Group, 2013a).

Efforts by farmers to use U.S. courts to counter broad intellectual property claims, in contrast, have been denied in nearly every case, frequently on technicalities (Dupraz, 2012). In developing nations where the legal system is not

as effective in punishing perceived transgressors of intellectual property protections, seed firms have utilized other means to increase revenues. In Brazil, for example, Monsanto worked with the world's four largest grain traders to charge an "indemnity fee" to collect royalties on soybeans they believed had been obtained from other farmers (Peschard, 2012). These successes have encouraged agrochemical firms to acquire even more seed companies and consolidate their control of the industry.

INCREASING INDUSTRY CONSOLIDATION

Consolidation in the seed industry is not new but has accelerated rapidly since the mid-1990s, when patented, transgenic crops were commercialized. At the same time that agrochemical companies were taking over the seed industry, they were also combining into fewer and fewer firms. What were once 30 separate firms in the 1970s became just Monsanto, DuPont, Syngenta, Bayer, Dow, and BASF by 2001 (Moretti, 2006). Estimates from 2011 indicate that these Big Six agrochemical companies controlled 60% of global proprietary seed market, with the top three (Monsanto, DuPont, and Syngenta) controlling more than 53%; in addition, the Big Six firms controlled 76% of the global agricultural chemical market (ETC Group, 2013b). Their domination of seed patents in the U.S. is even higher, with the top three owning 85% of corn patents and 69.6% of non-corn patents (Glenna and Cahoy, 2009).

Institutional economists suggest that when four firms control 40 to 50% of a market, it is no longer competitive, as dominant firms can simply signal their intention to raise prices and the other will find it in their interest to follow suit (Scherer and Ross, 1990). High levels of concentration also make it easier for firms to go further and explicitly conspire to fix prices. DuPont claimed that Monsanto was using its dominance in transgenic seed traits to directly pressure competitors to keep prices high in the late 1990s (Borger, 2004). The U.S. government appeared to be moving toward antitrust action when it launched an investigation of these alleged anticompetitive practices in 2010. Ultimately, however, the investigation was dropped without any enforcement action. The closure was not even announced by the Department of Justice and it only became public knowledge via Monsanto's media relations department (Philpott, 2012); interestingly, Monsanto and DuPont announced they had resolved a number of lawsuits and created new technology-sharing agreements just a few months later (Gillam, 2013). A summary of joint workshops held by the U.S. Departments of Justice and Agriculture noted that because of the way federal judges currently interpret antitrust laws, enforcement efforts that were common in agricultural industries before the 1980s now have little chance of success (Department of Justice, 2012).

These changes in antitrust regulations have encouraged more acquisitions, which have only rarely required concessions for government approval (one example was Monsanto's divestment of Stoneville as a condition of acquiring Delta and Pine Land in 2007). By the 1990s, when transgenic crops were commercialized, agrochemical companies were increasingly acquiring seed companies as a delivery vehicle for their patented traits. From 1996 to 2013, for example, the top 10 seed firms fully subsumed nearly 200 seed companies and purchased equity stakes in dozens more. These acquisitions initially focused on commodity crops but soon expanded to fruit and vegetable seed companies, such as Monsanto's buyouts of Seminis in 2005 and De Ruiter in 2008. The valuations for many of these acquisitions were extremely high relative to previous seed industry norms, reflecting an expectation of increased market power, and much greater rates of profit in the future. Interestingly, these takeovers are often hidden from farmers, particularly the buyouts of more than two dozen Midwestern corn and soybean seed companies by Monsanto through its holding company, American Seeds Incorporated (Howard, 2009).

Firms based in the United States, Europe, and Japan have also expanded globally, frequently through acquisitions and joint ventures in emerging markets such as India, China, Brazil, and South Africa. These ownership changes have been assisted by increased intellectual property protections in these countries, facilitated by global trade agreements. As in the United States, antitrust regulations in these countries have also been weakened. In South Africa, the government initially opposed DuPont and Pioneer's proposed 80% stake in Pannar Seeds in 2010, as it would create a national duopoly, controlled by DuPont and Monsanto. DuPont fought the decision, however, and prevailed at the Supreme Court of Appeal of South Africa after a legal battle of nearly 3 yr (Pitt, 2013).

Agrochemical firms have also altered their strategies to focus even more on seeds as a source of revenue. Monsanto derives approximately 80% of its growth in profits from seeds and competitors like Dow have announced their intention to follow this example and increasingly shift resources away from chemicals (Howard, 2009). This increases the likelihood that seed company acquisitions will continue and that farmers will experience additional price increases in the future. It is also likely to accelerate the synergistic effects of consolidation and increasing intellectual property protections.

SYNERGIES

As the firms that now dominate the global seed industry increase their size and expand intellectual property protections, the disadvantages for their smaller competitors multiply. The expense of developing transgenic traits and identifying gene sequences, for example, creates a strong barrier to entry for smaller firms. The Big Six

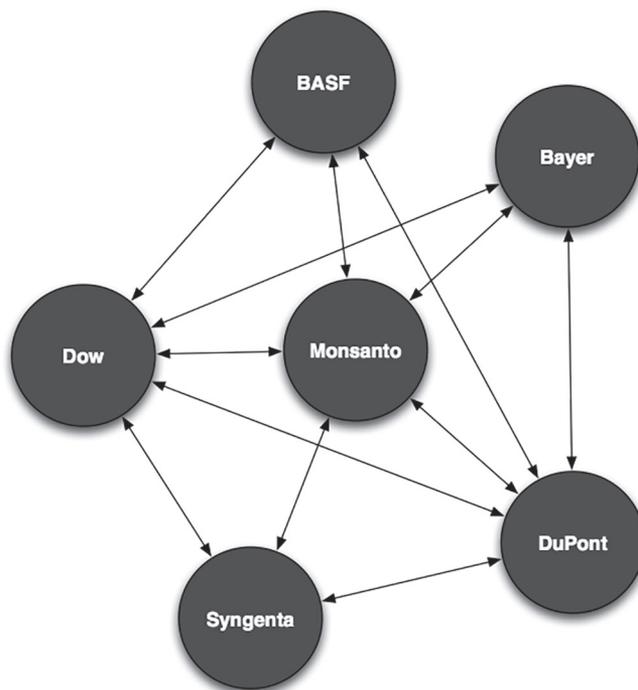


Figure 1. Cross-licensing agreements for transgenic seed traits.

agrochemical–seed firms, on the other hand, engage in a web of cross-licensing agreements to share these technologies (Fig. 1), particularly for transgenic crops with stacked traits. Smartstax corn, for instance, includes eight different transgenic traits as a result of agreements between Monsanto and Dow (although the Cry34 and Cry35 toxins could be considered a single trait). The effect is similar to the formation of a shared monopoly or cartel to exclude other potential competitors. Seed industry participants have expressed this in blunt terms, suggesting that many remaining small firms will “have to consider strategic alliances (with larger firms) or exit strategies” (Overwater, 2009).

Agrochemical–seed firm relationships are not always so cooperative, however, and they have filed numerous lawsuits against each other. These create “patent thickets”, in which broad claims overlap. Such thickets make it difficult to bring a product to market without potentially infringing on a patent, thus creating another barrier to entry for small firms (Boyd, 2003; Glenn and Cahoy, 2009). For dominant firms, however, legal disputes are sometimes resolved with agreements to share technologies, as with the Monsanto–DuPont agreements announced in 2013, or by simply acquiring the smaller firm, as with Monsanto's takeover of Agracetus. Patent thickets may also present a barrier even when patents expire, due to intellectual property claims that extend beyond the patent itself. Large firms have developed voluntary agreements, ostensibly to ensure access to seed traits with expired patents, but it remains to be seen if the fine print does not actually create additional problems for smaller firms.

Some very large seed firms have responded to the entrance of agrochemical companies by increasing their pace of acquisitions as a defensive maneuver. This prevents agrochemical–seed competitors from eventually buying these firms to increase their market share but further accelerates consolidation. A notable example is the French farming cooperative Groupe Limagrain and its seed subsidiary Vilmorin, which is the fourth largest seed company in the world (ETC Group, 2013b). Vilmorin has long used acquisitions to achieve growth but has recently relied on this strategy much more heavily. Its joint ventures and buyouts in the last few years include seed firms in China, Brazil, and South Africa, along with Campbell's Soup Company's vegetable seed division in the United States.

Agrochemical–seed firms have been very effective in tying a monopoly in one industry to create a monopoly in another (Harl, 2000). Monsanto, for example, was able to maintain an 80% market share in the herbicide glyphosate 6 yr after the patent expired by tying its use to proprietary Roundup Ready seeds, even though its prices were three to four times higher than generic glyphosate. This led to an antitrust lawsuit, Pullen Seeds & Soil vs. Monsanto Co. (2007), but it was dismissed by a federal court in Delaware, because of a clause in the technology agreement that specified that disputes must be filed in a St. Louis, MO, court (Dupraz, 2012). Syngenta was the first firm to tie the purchase of proprietary inputs for nontransgenic seeds and required a variety of hybrid barley (*Hordeum vulgare* L.) to be bundled with a fungicide (Blake, 2003). More recently, it has become difficult for farmers to buy commodity seeds without neonicotinoid coatings, despite little evidence of its effectiveness when applied so indiscriminately (Goulson, 2013). It is estimated that more than 90% of corn seeds in North America are treated with these substances, making it very difficult for farmers to find alternatives, either to reduce their costs or to minimize the potential impacts on pollinators (Stevens and Jenkins, 2014).

The market power exercised by larger firms limits farmers' choices and further reinforces current trends. Dominant seed firms, for example, are providing dealers with incentives to limit access to seeds with weaker intellectual property protections. They are reducing the availability of nontransgenic varieties and increasing the prices of the remaining nontransgenic varieties to further discourage their use. A survey in Illinois in 2009, for example, found that 40% of farmers reported they did not have access to any nontransgenic high-yielding corn varieties (Gray, 2011). The same strategy is being applied to stacked transgenic traits: there are fewer options for seeds with single traits and the prices of these seeds are rising to become closer to seeds stacked with multiple traits (Hubbard, 2009). Even if a farmer does not need multiple transgenic traits, supplied by a dominant seed firm, they may not have the option to avoid purchasing them.

CONCLUSIONS

The negative impacts of the increasing power of the agrochemical–seed industry, such as increased seed prices and the reduced ability of farmers to save seeds, have encouraged a number of civil society groups to coalesce around a campaign to ban patents on all living organisms (Then and Tippe, 2009). Such a change would not only reverse the expansion of intellectual property protections, it would probably also slow the rate of consolidation and result in more competition in the seed industry. In other words, there would be more firms and the market shares of Monsanto, DuPont and Syngenta's seed divisions would decline. In addition, firms conducting research and development would be less likely to focus only on innovations with the potential for blockbuster profits (Schurman and Munro, 2010) and increase investments in other traits, such as varieties adapted to local conditions and fewer chemical inputs. They would also be likely to market more nontransgenic varieties than they do currently for farmers who do not want to adopt these technologies.

Such a policy outcome is not very likely, however. Governments have vested interests in promoting the goals of large firms and most political systems are highly skewed to protect their interests, at the expense of other members of society (Bartels, 2010; Schlozman et al., 2012; Gilens, 2014). The decline in stock prices and the market capitalization of dominant firms that would result from such regulatory changes would be unacceptable to most high-level government officials, even in the absence of the strong corporate lobbying efforts such proposals would provoke. This situation has encouraged efforts to create alternatives to the increasingly privatized and concentrated seed industry, and to challenge the legitimacy of intellectual property monopolies.

One such effort is to develop “open source” versions of seeds that use intellectual property protections to encourage fewer restrictions on the use of seeds (see Luby et al., 2015; Kloppenburg, 2010, 2014). Another is to take desirable traits from hybrid seeds and breed them into heirloom varieties, such as carried out by a farmer in California who is developing an heirloom version of Monsanto's Early Girl tomato (Duggan, 2014). There is increasing public interest in heirloom seeds and many seed firms that specialize in such varieties, such as Baker Creek Heirloom Seed Company and Terroir Seeds, are experiencing very rapid growth. Seed libraries and exchanges are another method of distributing seeds while avoiding monetary exchange entirely. There are more than 300 U.S. libraries that allow people to check out seeds at the beginning of the growing season and return seeds harvested from their gardens for others to check out the following season. Although all of these efforts are tiny in scale in comparison to the world's largest seed companies, this has not prevented them from facing opposition from government regulators. In Pennsylvania and Maryland, for example, some seed libraries

have been shut down by the state officials for failure to conduct expensive germination tests (Maher, 2014).

A more hypothetical possibility would be to incorporate information about seed practices into ecolabeling. Given the market success of ecolabels such as organic and fair trade (Howard and Allen, 2010), consumers may prefer products that embody support for seed saving, the use of heirloom or open-source seeds or independent seed-breeding efforts. In the long term, this might require developing a set of standards for a label that supports the decentralization of power in the seed industry and a certification process to verify claims. In the short term, however, the idea could be tested with first-party claims, particularly in direct markets. Farmers' markets, where consumers have an opportunity to interact with producers and have a higher degree of trust in sellers, are a potential site for testing the feasibility of including such additional seed information. Although such initiatives would not confront the power of dominant seed firms directly, they would provide engaged citizens and producers with more alternatives to a seed oligopoly.

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