CONSOLIDATION AND CONCENTRATION IN AGRICULTURAL BIOTECHNOLOGY: NEXT GENERATION COMPETITION ISSUES





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CPI ANTITRUST CHRONICLE JANUARY 2020

Consolidation and Concentration in Agricultural Biotechnology: Next **Generation Competition Issues** By Diana L. Moss



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CPI Antitrust Chronicle January 2020

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I. INTRODUCTION

As this article is written, the most recent wave of consolidation among large incumbent firms in the agricultural biotechnology sector will be essentially complete. Three major mergers — Bayer-Monsanto, Dow-DuPont, and ChemChina-Syngenta - have reduced the number of rivals from six players in the last few years to a tight oligopoly of three mega-firms, with BASF trailing in last place. The mergers, and the fundamental restructuring of U.S. agricultural biotechnology they have wrought, raise seminal issues for competition in the sector and adverse effects on growers and consumers, who potentially face even higher input and food prices, lower quality, less innovation, and higher risks to food security.

Similar to healthcare and communications, consolidation in the agricultural biotechnology sector has largely flown "under the radar" as enforcers, Congress, and the media focus on the high-profile digital technology markets. This disproportionate focus is unfortunate, as the agricultural biotechnology sector is poised to launch yet another phase of consolidation. These are acquisitions of smaller, innovative digital farming rivals that are also likely to fly under the radar as enforcers struggle to evaluate and challenge similar types of deals in the digital technology sector.

This article focuses on key competition issues that flow from sweeping consolidation that has produced the "Big 3." It begins with a brief review of the startling pace of consolidation in the sector and high levels of concentration in the markets that comprise it. It then moves on to raise key guestions about the effects of consolidation and high concentration on innovation. This is followed by the implications of the shift in the competition paradigm from rivalry at individual levels of genetic traits ("traits"), genetically modified ("GM") crop seed, and crop protection (i.e. chemicals), to highly integrated, exclusive proprietary cropping systems that are now fueled by acquisitions of digital farming assets.

II. A BRIEF TOUR OF CONSOLIDATION IN AGRICULTURAL BIOTECHNOLOGY

A. The Rise of GM Crop Seed

The percentage of acreage planted with GM crop seed has increased dramatically since its introduction in the 1990s. In 2019, almost all corn (92 percent), cotton (98 percent) and soybean (94 percent) acreage was planted with GM varieties. The traits that are incorporated into GM crop seed confer on plants a variety of characteristics such as herbicide tolerance, insect resistance, and other functional attributes (e.g. high oleic soybeans). These attributes are made possible by combining patented genetic events that often result from collaborations between agricultural biotechnology developers and embodied in cross-licensing agreements. Combinations of genetic events enable different plant traits, which often appear in multiples or "stacks" in GM crop seed.

Trait profiles have increased in complexity over time. This complexity is designed to combat growing resistance of weeds and insects to an aging mode of action, generates higher profit margins from higher value products, and purportedly generates higher yields for growers. The average number of traits in commercialized corn and cotton trait profiles increased from two to six and two to four, respectively, between 1995 and 2013. For example, Syngenta's Agrisure Duracade 5222 corn trait profile contains five separate GM events developed by Syngenta, Monsanto, and Dow.³ Those five events confer six different traits for herbicide tolerance, insect resistance, and metabolic characteristics. The percentage of U.S. acreage planted with stacked varieties has also increased. Only 1 percent of corn acres and 24 percent of cotton acres were planted with stacked varieties in 2000. By 2019, 80 percent of corn acres and 89 percent of cotton acres were planted with stacked varieties.

B. From the "Big 6" to the "Big 3" in Only a Few Years

The Big 3 agricultural biotechnology firms are the product of a spate of mergers between large incumbents over the last few years. The then Big 6 were the result of two previous waves of consolidation, one in the mid-1980s through the late 1990s and a second from the late 1990s through the mid-to-late 2000s. Between 1985 and 2000, about 75 percent of the small to medium-size enterprises engaged in biotechnology research were acquired by larger firms. In the second wave, Monsanto alone acquired almost 40 agricultural biotechnology firms and independent seed companies. The most recent wave of consolidation is distinguished by the sharp reduction in the number of very large rivals in crop traits, GM crop seed, and crop protection, and a parallel spate of acquisitions of small digital farming startups.

Relative to other agricultural input sectors, the level of concentration and increases in concentration over time are the highest in crop seed. The market share of the four largest firms more than doubled to 54 percent between 1994 and 2009.8 After completion of the Syngenta-ChemChina, (2018), Dow-DuPont (2017) and Bayer-Monsanto (2018) mergers, the Big 3 now account for the majority of output in the seed and traits markets for cotton, corn, and soybeans and.9

2 U.S. Dep't. of Agric., Nat'l Agric. Stat. Serv., Acreage (June 30, 2001 and June 30, 2019) https://downloads.usda.library.cornell.edu/usda-esmis/files/j098zb09z/0k225n39n/jw827p632/acrg0619.pdf. In 2001, only 26 percent of corn acres, 69 percent of cotton acres, and 68 percent of soybean acres were planted with GM varieties.

3 Event Name: 5307 x Mir604 x Bt11 x TC1507 x GA21 x MIR162, ISAAA, http://www.isaaa.org/gmapprovaldatabase/event/default.asp?EventID=331 (last visited Nov. 26, 2019)).

4 USDA, supra note 2.

5 See Diana L. Moss, Competition, Intellectual Property Rights, and Transgenic Seed, 58 S.D. L. Rev. 543, 551-52 (2013). See also Gregory D. Graff, Gordon C. Rausser & Arthur A. Small, Agricultural Biotechnology's Complementary Intellectual Assets, 85 Rev. Econ. & Stat. 360-61 (2006).

6 Keith Fuglie, John King, Paul Heisey & David Schimmelpfennig, *Rising Concentration in Agricultural Input Industries Influences New Farm Technologies*, Amber Waves (Dec. 3, 2012), https://www.ers.usda.gov/amber-waves/2012/december/rising-concentration-in-agricultural-input-industries-influences-new-technologies/.

7 See Carl Pray, James F. Oehmke & Anwar Naseem, *Innovation and Dynamic Efficiency in Plant Biotechnology: An Introduction to the Researchable Issues*, 8 AgBioForum 52, 60 (2005); U.N. Conf. on Trade and Dev., Tracking the Trend Towards Market Concentration: The Case of the Agricultural Input Industry 5, 9-10 (Apr. 2006).

8 Keith O. Fuglie, et al., *Research Investments and Market Structure in the Food, Processing, Agricultural Input and BioFuels Industries Worldwide*, U.S. Dep't of Agric., Econ. Res. Serv. Rep. No. 130 (Dec. 2011), vi, https://www.ers.usda.gov/webdocs/publications/44951/11777_err130_1_.pdf?v=0.

9 Letter from AAI, FWW, and NFU to Principal Deputy Assistant Attorney General Renata Hesse (May 21, 2016), https://www.antitrustinstitute.org/wp-content/uploads/2018/08/AAI-FWW-NFU_Dow-Dupont_5.31.16_0.pdf; Letter from AAI, FWW, and NFU to Acting Assistant Attorney General Andrew Finch (Jul. 17, 2017), https://www.antitrustinstitute.org/wp-content/uploads/2018/08/White-Paper Monsanto-Bayer 7.26.17 0.pdf.

The significantly enhanced market power held by the Big 3, if exercised either unilaterally or in coordination with rivals, will be borne directly by growers and ultimately by consumers. Growers already pay persistently high prices for GM crop seed, even for earlier generation technologies. They also see little price transparency due to the practice of rolling technology prices into the total price of seed. This makes it harder for growers to compare seed costs over time.

Growers also see less or lower quality innovation. For example, the herbicide Roundup is, as a result of weed resistance, no longer as effective as it once was. The industry's response to declining effectiveness of genetic technologies has been to develop more expensive, complex traits that combat resistance but do not improve yields. Growers have also seen the elimination of independent conventional and hybrid seed breeders. Industry sources reported in 2009, for example, that "[s]eed companies have either cut back on non-biotech offerings or have dropped them." 10

III. COMPETITION AND INNOVATION IN AGRICULTURAL BIOTECHNOLOGY

A. The "Concentration Drives Innovation" Fallacy

Contrary to long-standing claims that higher concentration is needed to spur investments in research and development ("R&D"), empirical analysis of the agricultural biotechnology sector supports the notion that concentration can actually stifle incentives to innovate. The U.S. Department of Agriculture Economic Research Service ("ERS") observed in 2012, for example, that spending on R&D in GM crop seed and biotechnology between 1994 and 2010 grew 138 percent, the highest rate across agricultural input sectors. ¹¹ The ERS reported that the four-firm concentration ratio in crop seed and traits increased from about 21 percent in 1994 to 54 percent in 2009. ¹² At the same time, R&D intensity, as measured by the ratio of R&D investment to net sales, was 11 percent in 1994, increased to 15 percent in 2000, but declined to 10.0 percent in 2009. ¹³ Given consolidation over the last decade and the elimination of three of six rivals, the four-firm ratio in traits and GM crop seed is even higher and the decline in R&D intensity potentially commensurately greater.

As noted by the ERS, increases in concentration do not persistently lead to greater incentives to innovate. Moreover, "beyond some high level of concentration, further increases could actually reduce the incentive to innovate." A number of factors support this proposition. First, firms can appropriate returns from innovation more easily with less competition. Rather than stealing sales from rivals in more competitive markets, new product development with fewer rivals increases the risk that an innovator cannibalizes its own sales of existing products,. This deters innovation.

With less competition, there is also less fear of losing to an innovative rival's new product with less competition, which dampens incentives to stay ahead of the innovation curve and enhances incentives to use intellectual property to shape or control competition. For example, well in advance of Roundup Ready 1 soybeans coming off patent in 2014, Monsanto attempted to switch farmers to the newly patented, marginally different, and more expensive Roundup Ready 2 soybeans.¹⁵ This "hard switch" strategy met with some resistance, but apparently was successful, since only one generic soybean using the RR1 trait was introduced in 2015.¹⁶

10 Lynn Grooms, Non-Biotech Soybean Seed: Is There Enough?, CORN & SOYBEAN DIGEST (Apr. 1, 2009), http://www.cornandsoybeandigest.com/non-biotech-soybean-seed-there-enough.

11 Fuglie, et al, *supra* note 8, at 16.

12 Id.

13 *ld*. at 15.

14 James. M. MacDonald, *Mergers and Competition in Seed and Agricultural Chemical Markets*, Amber Waves (Apr. 3, 2017), https://www.ers.usda.gov/amber-waves/2017/april/mergers-and-competition-in-seed-and-agricultural-chemical-markets/.

15 See Diana L. Moss, *Generic Competition in Transgenic Soybeans*, Am. Antitrust Inst. (Aug. 16, 2011), http://www.antitrustinstitute.org/sites/default/files/AAI%20Paper%20 generic%20comp%20TG%20seed8.16.11.pdf; see also Daryl Lim, *Living with Monsanto*, 2015 MicH. St. L. Rev. 559, 584 n.134 (2015).

16 The University of Arkansas released UA 5414RR. See Seedworld.com (June 2015), 15, http://www.seedworld.com/flipbook_june2015//files/inc/c409c86a78.pdf.

B. Consolidation Eliminates "Parallel Path" R&D and Pro-Competitive Collaborations

The U.S. Department of Justice ("DOJ") and Federal Trade Commission Horizontal Merger Guidelines articulate concerns over the effects of mergers on R&D competition. They explain that a merger may diminish innovation competition through curtailment of "innovative efforts below the level that would prevail in the absence of the merger." In the proposed merger of Applied Materials and Tokyo Electron, for example, the parties abandoned the deal after pushback from DOJ. The agency stated that the deal "...combined the two largest competitors with the necessary know-how, resources and ability to develop and supply high-volume non-lithography semiconductor manufacturing equipment." The DOJ also challenged the merger of Halliburton and Baker-Hughes, explaining that the merger would harm innovation by combining companies that "compete to...develop next generation technologies that will allow them to drill deeper and operate in ever-more challenging conditions."

The Guidelines explain that adverse effects on innovation are particularly likely when the merging parties are "two of a very small number of firms with the strongest capabilities to successfully innovate in a specific direction" and that "...[e]xplicit or implicit evidence that the merging parties intend to...curtail research and development efforts after the merger[...] can be highly informative in evaluating the likely effects of a merger." ²¹ The "parallel path" R&D that is implicitly identified by the Guidelines is vitally important. Two leading economists explain, for example, that in pharmaceutical R&D "[t]echnological progress is best achieved in a field like pharmaceuticals when there is widespread dispersion of R&D initiatives both across companies and within them through the exploration of multiple technical paths."²²

Rivalry in agricultural biotechnology innovation is essential for maintaining incentives to continue existing and prospective product development programs. This is particularly true when the time required to perform R&D, field-test, obtain regulatory approvals, and market new technology to growers collectively create a long pipeline to commercialization and market penetration. Before the mergers of Dow-DuPont and Bayer-Monsanto, each standalone company had strong capabilities to successfully innovate. For example, the Monsanto and Bayer R&D pipelines were associated with specific assets and features in genetics, plant breeding, and germplasm programs.²³ R&D "synergies," which can translate directly to cuts in R&D, were identified as major categories of cost savings in both mergers, highlighting the Guidelines' admonition that the loss of R&D competition and evidence of curtailing R&D efforts factor prominently into evaluating the likely effects of mergers.²⁴

Consolidation also eliminates opportunities for independent rivals to engage in pro-competitive R&D collaborations to develop new stacked trait profiles. The effects of these more limited collaboration opportunities among a tight oligopoly of rivals could have a number of effects. These include refusals to license technology or to license it on discriminatory terms. With a tight oligopoly, there are also stronger incentives to tacitly agree, for example, on which firms specialize in certain crops and traits. This could lead to trait profiles that do not meet the growing region or climate-appropriate needs of growers, such as resistance to insects that are not regionally common or tolerance to herbicides that they do not intend to use.

The significant loss of R&D competition from the recent spate of agricultural biotechnology mega-mergers undercuts arguments that combining R&D pipelines can produce significant countervailing efficiencies. This very concern was at the center of the court's decision to uphold the DOJ's challenge of the merger of health insurers Anthem and Cigna: "[T]he district court reasonably determined that Anthem failed to show the kind of 'extraordinary efficiencies' that would be needed to constrain price increases in this highly concentrated market, and to mitigate the threatened loss of innovation."²⁵

17 U.S. Dep't of Justice & Fed. Trade Comm'n, Horizontal Merger Guidelines (2010) [hereinafter Guidelines], § 6.4.

18 *ld.*

19 Press Release, U.S. Dep't of Justice, Applied Materials Inc. and Tokyo Electron Ltd. Abandon Merger Plans After Justice Department Rejected Their Proposed Remedy (Apr. 27, 2015), https://www.justice.gov/opa/pr/applied-materials-inc-and-tokyo-electron-ltd-abandon-merger-plans-after-justice-department.

- 20 Complaint at 2, United States v. Halliburton Co., 1:16-cv-00233-UNA (D. Del. Apr. 6, 2016), https://www.justice.gov/atr/file/838661/download.
- 21 Guidelines, supra note 17, at 2.2.1.
- 22 William S. Comanor & F.M. Scherer, Mergers and innovation in the pharmaceutical industry, 32 J. Health Econ. 106, 107 (2013).
- 23 Annual R&D Pipeline Review, Monsanto (Jan. 2017), 13-15, https://monsanto.com/app/uploads/2017/05/2017.01.05_q1f17_mon_pipeline_update.pdf.
- 24 DuPont and Dow to Combine in Merger of Equals, (Dec. 15, 2015), 7, http://www.dow.com/en-us/investor-relations/investor-presentations; Creating a Global Leader in Agriculture (Sept. 14, 2016), 20, https://www.investor.bayer.de/en/handouts/archive-investor-handouts/.
- 25 United States v. Anthem, Inc., 855 F.3d 345, 364 (D.C. Cir. 2017).

IV. EFFECTS OF INTEGRATED, PROPRIETARY CROPPING SYSTEMS THAT NOW DOMINATE THE INDUSTRY

A. The Shift in Competition Paradigm

The most recent series of agricultural biotechnology mergers have created large, integrated, proprietary cropping systems of traits, GM crop seed, and crop protection. Such systems were evident as early as first-generation technologies, such as Monsanto's early generation glyphosate herbicide Roundup and Roundup Ready 1 soybeans. Even then, the exclusive nature of systems was evident, as one farmer aptly noted: "[I] can't mix chemicals with other companies' products to remedy Roundup resistance." More recently, Monsanto extended its newer generation RR2 soybean platform to encompass more complex traits and herbicides with its Roundup Ready 2 Xtend dicamba-tolerant integrated cropping system. Dow-DuPont made a similar move with its Enlist 2,4-D tolerant system.

Recent merger proposals are motivated, among other reasons, by the drive to build out integrated, proprietary systems that do not interoperate with rivals' products. This goal was apparently behind Monsanto's failed bid for Syngenta which "...would [have] enable[d] the combined company to deliver integrated and sustainable solutions across all the major technology-driven platforms of breeding, biotechnology, crop protection, microbials and precision agriculture." Monsanto and Bayer also touted integrated solutions as a major strategic benefit of their proposed merger. When the proposed merger is a major strategic benefit of their proposed merger.

Integrated, proprietary systems raise a number of troubling issues. First, economic evidence from soybeans and cotton indicates that seed prices under vertical integration tend to be higher than under licensing arrangements across firms. This suggests that vertical integration may increase the exercise of market power and firms' ability to extract economic benefits from seed dealers and farmers.²⁸ Second, integration enhances both the ability and incentive to bundle proprietary products in proprietary systems that do not interoperate with rival technologies.²⁹ This is likely to raise entry barriers for unintegrated rivals competing at standalone levels such as seeds or crop protection and that cannot enter at multiple levels. Such smaller rivals may be victims of exclusionary conduct, for example, if the Big 3 induce distributors to accept bundled products.

A third problem is that proprietary systems of integrated, proprietary technologies shifts the competitive paradigm from competition at the individual levels of traits, GM crop seed, and crop protection to competition between systems. Arguably, a sector dominated by only three large firms will not provide sufficient head-to-head competition between systems to facilitate beneficial market outcomes. This poses significant risks for growers, who could be locked into single proprietary cropping systems at higher prices, with limited flexibility and choice. It would also harm consumers, who could pay higher prices and lose choice in how their food is grown and sourced.

B. The Role of Digital Farming Acquisitions in Fostering Integrated, Proprietary Systems

Digital farming is one of the most innovative areas at the intersection of agriculture and big data. The field of companies that specialize in agricultural data analytics and intelligence has expanded over the last decade. Digital farming is defined as the use of "[e]xtensive data collection and computation" and "[p]redictive analytics"...to provide data-based insights to optimize field-specific decision-making."³⁰ It encompasses data collection through satellite or other aerial monitoring, on-the-ground sensors, historical crop yield data, weather data, and soil databases; and data capture and analysis. Collectively, these functions facilitate decision-making on what varieties growers should plant, appropriate nutrients, plant protection, and when and how to optimize a harvest.³¹

26 Letter from Hugh Grant, CEO, Monsanto (Jun. 6, 2015), https://www.syngenta.com/global/corporate/SiteCollectionDocuments/pdf/media-releases/en/monsantoletters-2015. pdf. Note that this presentation is no longer accessible.

27 Creating a Global Leader in Agriculture, *supra* note 24, at 10.

28 Kyle W. Stiegert, Guanming Shi & Jean Paul Chavas, *Innovation, Integration and the Biotechnology Revolution in U.S. Seed Markets*, Choices Magazine (2nd Q. 2010), http://farmdoc.illinois.edu/policy/choices/20102/2010202/2010202.pdf.

29 Letter to Andrew Finch, supra note 9.

30 Creating a Global Leader in Agriculture, *supra* note 24, at 11.

31 Id. at 15.

Digital farming features centrally in the mergers that have produced the Big 3. Bayer and Monsanto explained that their merger would enable the buildout and strengthening of a digital farming platform that would generate numerous benefits, including "convenience, improved sourcing, improved yields, optimized inputs, and sustainable farming." While touted as innovation, these claims are in reality a response to a need to combat flagging yields and resistance with more complex and expensive products.

Farming data is quickly becoming a critical input for the Big 3. As one scholar wrote: "By amassing huge quantities of previously proprietary, private, or untapped farming data, companies are gaining a privileged position with unique insights into what farmers are doing around the clock, on a field-by-field, crop-by-crop basis[,] into what is currently a third or more of the U.S. farmland."³³ The integration of traits, GM crop seed, and crop protection are inextricably linked to digital farming. For example, digital farming will likely enhance incentives to amass and appropriate valuable farm data for potential use as a strategic competitive asset. Leveraging data across integrated, proprietary cropping systems is likely to strengthen them and increase the lock-in effect for growers.

With a tight oligopoly, the Big 3 have stronger incentives to appropriate data from farmers through terms and conditions of licensing and technology agreements. It comes as no surprise that the Big 3 have begun to sweep up digital farming startups. One industry commentator noted that "[f]ollowing the recent purchase of Climate Corp. [in 2013], Monsanto is currently the most prominent biotech agribusiness to buy into big data."³⁴ Other large biotechs have joined the acquisition spree. In 2017, BASF made a bid to acquire U.S. based ZedX, a leader in digital agriculture intelligence. Also in 2017, DuPont agreed to acquire U.S.-based Granular, a "leading provider of software and analytics tools that help farms improve efficiency, profitability and sustainability."³⁵ Such acquisitions could well follow in the path of the largely uninterrupted string of acquisitions of startups by the largest digital technology rivals. Had enforcers more carefully scrutinized and potentially challenged some of those transactions, such startups could potentially have grown into significant rivals.

V. CONCLUSIONS

The rapid pace of early innovation in the agricultural biotechnology sector was driven by competition. Much of that is gone, with the collapse of the industry into the Big 6, and now the Big 3. Consolidation has largely been allowed to proceed by antitrust enforcers, either outright or with potentially ineffective remedies.³⁶ This has created entities with the ability and incentive to exercise significant market power, to the detriment of growers, consumers, and the safety, security, and diversity of the food supply system. The loss of R&D competition, coupled with the fundamental shift to integrated, proprietary cropping systems limits choice for growers, raises input prices for traits, GM crop seed, and crop protection, and will likely harm consumers.

As these effects become apparent, the key question is how antitrust enforcement will respond. With merger control all but exhausted in controlling consolidation, the avenues available to enforcers include bringing claims regarding alleged exclusionary conduct or anticompetitive coordination against any or all of the Big 3. As with other sectors that are undergoing the same types of sea-change, we wait to see how aggressive enforcers will be in promoting competition and how legislators choose to address competitive problems through new proposals to strengthen the antitrust laws to support competition and protect growers and consumers.

32 Id. at 10-12.

33 Isabelle M. Carbonell, *The Ethics of Big Data in Big Agriculture* 5 Internet Policy Review 2 (Mar. 31, 2016), https://policyreview.info/articles/analysis/ethics-big-data-big-agriculture.

34 Id. at 2.

35 DuPont Acquires Ag Software Company Granular to Accelerate Digital Ag Strategy and Help Farmers Operate More Profitable Businesses, DuPont (Aug. 8, 2017), http://www.dupont.com/corporate-functions/media-center/press-releases/dupont-acquires-ag-software-company-granular-to-accelerate-digital-ag-strategy.html.

36 AAI Says Government Remedy in Monsanto-Bayer Merger Raises Significant "Execution Risk" (May 29, 2018), https://www.antitrustinstitute.org/work-product/aai-says-government-remedy-in-monsanto-bayer-merger-raises-significant-execution-risk/.



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