



ALBERTA INSTITUTE
OF AGROLOGISTS

*AIA Conference
on Agriculture, Food and the Environment*

The Rise of Mega-companies in the Global Food System: Implications for Economic and Environmental Sustainability

Jennifer Clapp

**Professor and Canada Research Chair in Food Security and Sustainability
School of Environment, Resources and Sustainability
University of Waterloo**



**The Rise of Mega-companies in the Global Food System:
Implications for Economic and Environmental Sustainability**

Jennifer Clapp
Professor and Canada Research Chair in Food Security and Sustainability
School of Environment, Resources and Sustainability
University of Waterloo

February 28, 2019

Prepared for presentation at the Alberta Institute of Agrologists 15th Annual General
Meeting and Conference, Banff, Alberta, March 28, 2019

Introduction

The global food system is increasingly dominated by a shrinking number of ever larger firms that command enormous influence over their respective markets. These firms, which I refer to in this paper as “mega-companies,” are central players in what can only be described as a profound reconfiguration of the world food economy. All along agrifood supply chains, from inputs such as seeds, chemicals, and farm equipment, to commodity trading, to food processing and retail, just a handful of very large firms tower over the scene. What, precisely, this trend toward consolidation means for the agrifood system as a whole is not always clear. There are divergent perspectives with respect to what growing consolidation means for both economic and environmental sustainability in the food system. On one hand, a diverse set of critics have raised a number of concerns about heightened concentration in the sector. Food justice advocates and many farmer groups, for example, argue that growing corporate control over the food system, in particular the industrial agriculture model these firms promote, has contributed to heightened economic vulnerability for farmers and consumers, and has undermined the environmental sustainability of food systems. Many economists have also been concerned about growing concentration in the sector, in particular because having fewer dominant firms can threaten competition, which in turn can undermine efficiency, innovation, and social welfare. On the other hand, the firms that are key players in the sector portray their consolidation as beneficial for the food system, as they claim it promotes innovations that bring social and environmental benefits.

This paper examines these trends and provides an analysis to help inform future policy directions regarding corporate consolidation in the sector. The analysis focuses on four key questions:

1. *What is the current state of corporate dominance in the agrifood system today?*
2. *What are the main drivers that explain growing concentration in the agrifood system?*
3. *What are the key debates over the implications of growing corporate concentration for economic and environmental sustainability in the food system?*
4. *What are the implications for policy and governance?*

In answering the first question, the paper provides a snapshot of the state of corporate consolidation in the agrifood system as a whole, from inputs and farm equipment, to commodity trading, and lastly to food processing and retail. The analysis then focuses in on the agricultural input sector, specifically the companies that dominate the chemical and seed markets, in answering questions two and three. The reason for this focus is that there are multiple drivers of corporate consolidation, some of which are industry-specific, and focusing on a case example helps to illustrate the complexities and nuances of the

impacts. Similarly, the debates about the implications associated with concentration are also specific to a particular sector. The agricultural input industry is especially relevant to examine at this time, because of the recent merger activity in the sector, as well as its significance with respect to determining the model of agricultural production that dominates within the food system. As such, it has important significance for both economic and ecological outcomes. In answering the fourth question, the analysis examines how broader debates about concentration in the agrifood sector matter for policy and governance.

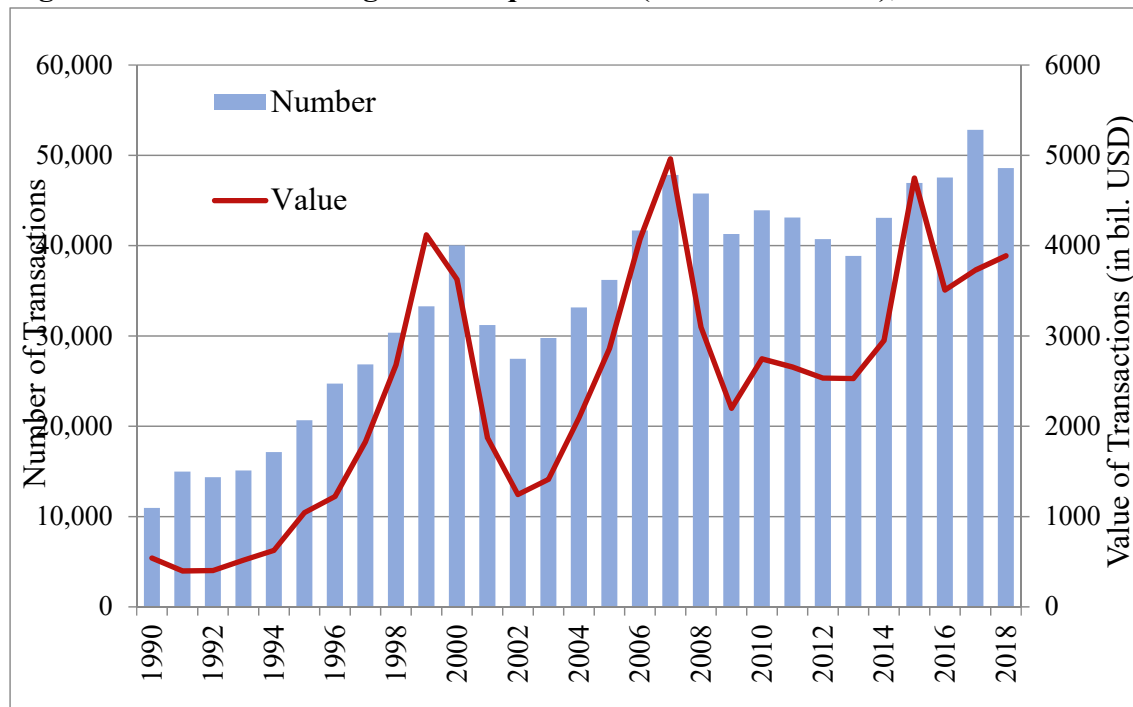
The paper advances several arguments. First, there has been a dramatic increase in concentration all across the agrifood sector over the past few decades, with a number of recent high-profile mergers that have reduced the number of major players in the system considerably. Second, both technological and economic factors have been key forces driving the most recent round of consolidation in the agricultural seed and chemical industry. Third, there are competing discourses with respect to the implications for the food system as a result of growing corporate concentration in the seed and agrochemical industries, which must be evaluated in future research. Interestingly, this debate is not of a “left vs. right” nature. Rather, scholars from across the political spectrum have raised concerns about anticompetitive behavior in a highly concentrated market, while it is the firms themselves that have been the primary champions of what they see as the benefits of greater consolidation. Finally, this debate is of enormous significance for public policy regarding corporate consolidation, which in turn is important for the future of food and agriculture.

1. What is the current state of corporate concentration in the agrifood system today?

The global economy is currently undergoing a phase of heightened corporate consolidation that has given rise to truly massive firms that dominate in key sectors. These giant corporations are the product of a spate of mergers and acquisitions that have intensified over the past five years in particular. Since 2014, the megadeals have been absolutely huge, hitting a record value of US\$4.8 trillion in 2015 and hovering between US\$3.6-US\$3.8 trillion in more recent years (See Figure 1). Much of the media and scholarly attention has focused on the growing size and dominance of big tech companies like Amazon and Google, as well as on mergers and acquisitions such as the 2018 US\$85 billion AT&T - Time Warner deal and the US\$71 billion Disney-20th Century Fox deal.¹

¹ E.g. Khan 2017; Wu 2018.

Figure 1: Worldwide Mergers & Acquisitions (across all sectors), 1990-2018



Source: Institute for Mergers, Acquisitions and Alliances (IMAA) 2018.

The agrifood sector has been no exception to this broader trend of mega-company market dominance. Indeed, the expression of corporate consolidation has been particularly striking all along agrifood supply chains, with the size and scope of the mergers and acquisitions in the sector on par with some of the biggest corporate tie-ups in the global economy over this period. Recent corporate merger deals in the sector, such as Kraft - Heinz, Dow - Dupont, and Anheuser Busch InBev - SAB Miller, each topped US\$100 billion and are among the 4 largest merger deals of the past decade. These recent corporate tie-ups have occurred on top of what was already a highly concentrated agrifood sector. Today, just a handful of corporations tend to dominate large shares of the market all along agrifood supply chains, including seeds and agrochemicals, farm machinery, fertilizers, bulk trade in agricultural commodities, and the firms that dominate food distribution and retail, as outlined below.

There has been a major shakeup among the firms that dominate the agricultural seeds and chemicals industry in recent years, with a series of mergers and acquisitions that reduced

the number of dominant players in the sector from six to just four.² This reconfiguration of firms in the sector saw Bayer acquire Monsanto, a merger of equals between Dow and DuPont, and the purchase of Syngenta by ChemChina, one of the largest chemical companies in China. BASF, one of the original 6 companies that dominated the sector, has grown in size as it has purchased assets from the other companies that were required to sell them in order for their merger plans to be approved by regulators. Even prior to these mergers, the ‘Big Six’ firms commanded a 75 percent share of the US\$54 billion pesticide industry, as well as a 62 percent share of the US\$39 billion global seed market. Post-mergers, the top four agro-chemical firms (Bayer-Monsanto, ChemChina-Syngenta, BASF, and Corteva Agriscience—the new agricultural division of DowDupont) hold 70 percent of the global pesticide market, and the top four seed firms (Bayer-Monsanto, Corteva Agriscience, ChemChina-Syngenta, and Limagrain) hold a 67 percent share of the global seed market.³ This most recent wave of consolidation is only the latest to occur within the input sector. In the decade before being swallowed by Bayer, for example, Monsanto had purchased over 20 companies.⁴ The historical trajectory of consolidation in this sector will be examined in more detail in section 2.

Other industries in the input sector have also seen growing consolidation. The global fertilizer market, although not as concentrated as seeds and chemicals on a global scale, is quite concentrated in some countries. Two giant Canadian fertilizer firms—Agrium and Potash Corp. —the first and fourth largest global fertilizer companies, merged in 2016 to create a new US\$30 billion firm, now known as Nutrien, which is now the largest fertilizer company in the world. Around 25 percent of the US\$180 billion global fertilizer market was controlled by the top four firms in 2013,⁵ a figure that is no doubt higher now, following the merger that created Nutrien. Excluding China, just four firms (Agrium, Yara, Mosaic, and Potash Corp) accounted for over half of the production in producer countries just prior to this most recent merger.⁶

Concentration is also high in the farm equipment sector. Just four companies—Deere & Co, CNH Industries, AGCO, and Kubota—together command nearly 40 percent of the US\$115 billion market.⁷ These firms are increasingly purchasing software firms in order to acquire platforms to equip farm machinery with both soft and hard infrastructure for “digital farming”, which seeks to bring big data to bear on farm decision-making, from seed choice to fertilizer and pesticide application. The integration of the hardware and the software is a key area of interest for these firms. Deere & Co, for example, has purchased

² Clapp 2018; IPES Food 2017.

³ Mooney 2018.

⁴ Heisey and Fuglie 2011, p. 33.

⁵ ETC Group 2015, p. 7.

⁶ Chemnitz et al. 2017, p. 19.

⁷ Mooney 2018.

several tech firms specializing in precision planting in the past few years in its quest to become a leader in the digital agriculture market.⁸

The commodity trading sector is also highly concentrated, with the ABCD firms (Archer Daniels Midland, Bunge, Cargill, and Louis Dreyfus) dominating the trade. Reliable statistics on market shares of the biggest players are notoriously hard to pin down, in part due to the secretive nature of the firms, several of which (for example: Cargill and Louis Dreyfus) are privately owned and thus are not required to report publicly on their activities. Some estimates put the market share of these four firms in the range of 70 to 90 percent.⁹ Although the ABCD firms have dominated the commodity trading sector for decades, they are increasingly being challenged by new players, including several Asian trading firms such as Singapore based Wilmar and the Chinese state trading firm COFCO.¹⁰ There was a move in early 2018 by ADM to take over Bunge. Although this deal ultimately did not materialize, such a merger is also not completely off the table for the future. Bunge, the world's largest oil seed trader, was caught off guard in the trade dispute between the US and China, where China placed a 25 percent tariff on US soybeans, which affected its earnings, making it vulnerable to take over. However, any potential acquisition of the firm by ADM is likely to raise antitrust concerns, as it would mean just three firms would dominate the bulk of the commodity trading market.¹¹

The food processing and distribution sector is also characterized by extensive levels of concentration. The top 10 food and beverage companies command nearly 40 percent of the market share of the top 100 firms in the sector. These top ten firms each bring in over US\$35 billion in revenue per year.¹² There has been a fairly regular parade of mergers and acquisitions in this sector in recent years. Some examples of the largest mergers include: the combining of Kraft and Heinz in 2015 in a deal that created a firm worth US\$100 billion; the merger of InBev (Anheuser Busch) and SAB Miller in 2016, which created a US\$275 billion firm that commands some 30 percent of the global beer market; and the 2018 acquisition of Dr. Pepper Snapple Green Mountain by JAB Holdings, a hedge fund, in a US\$20 billion deal.¹³ In 2017, Kraft Heinz attempted to purchase Unilever for US\$143 billion, but the acquisition ultimately fell through. Global snack giant Mondelez (which was originally a spinoff out of Kraft) sought to purchase Hershey in recent years, but it was also unsuccessful. Even though these latter deals did not

⁸ Cornish 2017.

⁹ Murphy et al. 2012.

¹⁰ Clapp 2015.

¹¹ Meyer and Fontanella-Khan 2018.

¹² IPES Food 2017, p. 38.

¹³ On the Kraft Heinz deal, see Fontanella-Khan et al. 2015a; On the InBev-SAB Miller deal, see Fontanella-Khan et al. 2015b; On the Dr. Pepper-JAB deal, see Massoudi and Fontanella-Khan 2018.

materialize, the attempts by some firms to take over other large firms in the sector indicates that incentives to consolidate remain strong.

The US\$7.5 trillion dollar grocery market is dominated by a small number of retail firms. Although traditionally more dispersed and specific to different countries, the retail sector is becoming both more globalized and more concentrated. The top four firms globally are Walmart, Schwarz Group, Kroger, and Aldi. Not far behind in terms of size are Costco, Carrefour, and Tesco. By 2014, the top ten retailers controlled nearly 30 percent of the global grocery retail market.¹⁴ Within countries, markets are typically much more concentrated. For example, in the US, the top four grocery retail firms command approximately 40 percent of the grocery retail market.¹⁵ This sector has not been immune to the merger dance that is occurring in other parts of agrifood supply chains. In Canada, Sobeys and Safeway merged in a US\$5.5 billion deal in 2014. In 2017, the sector was shaken up when Amazon, the world's leading online retailer, purchased Wholefoods in a US\$13.7 billion deal, after the latter had been pushed to restructure by activist investor Jana Partners.¹⁶ In 2018, a proposed deal to bring together two of the largest food retailers in the UK, Asda and Sainsburys, has attracted considerable scrutiny due to its likely effects on market concentration.¹⁷

The result of these various mergers and acquisitions is a remarkable level of concentration all along agrifood supply chains from inputs and machinery, to trade, to processing and retail. The situation is one where food travels from one concentrated sector to another on its journey from farm to plate. It is important to understand how we have arrived at a system that was once highly decentralized and farm centric, to one that is highly concentrated and centred around global corporations. The next section explores this question with respect to consolidation in the seed and agrochemical sector.

2. What are the main drivers that explain growing concentration in the agrifood system?

Agriculture and food systems have been largely place-based for most of human history. The development of agriculture some 10,000 years ago encouraged people to settle in communities centred on agricultural production and distribution at a very local level. Farmers selected the best seeds and planted them the following season. Foods were traded, processed, and consumed largely within local regions. It is only in the past few hundred years that food production, distribution, and consumption systems became truly

¹⁴ IPES Food 2017, p. 43.

¹⁵ IPES Food 2017, p.44.

¹⁶ Nicolaou et al. 2017.

¹⁷ Eley and Massoudi 2019.

globalized via global trade and transnational corporate activity.¹⁸ When considered in the longer-term context of the transition from hunter-gatherer to geographically dispersed agricultural societies, which took thousands of years, the most recent transition from geographically decentralized food systems to a highly centralized global industrial system was remarkably rapid, and the changes this transition brought are particularly stark. The changes over the course of the past 100 years were especially important for cementing in corporate control over the food system. A closer look at the historical developments in the farm seed and agrochemical industries helps to illustrate the scale and speed of this transition and is important for interpreting more recent trends of concentration in the input sector.

Factors Driving Consolidation in the Seed and Agrochemical Industries Over the Past Century

Technological and intellectual property development played a large role in the early consolidation among the firms that dominate the production of agricultural seeds and chemicals. These drivers emerged only in the 20th century, and until that time these industries were not characterized by significant consolidation. Up until and including the 19th century, farmers still typically selected and saved their own seeds for planting the following season, which they often openly shared with their neighbours. The agricultural practices of the First Nations peoples in North America were highly sophisticated, including seed selection and intercropping, including key crops of maize, squash, sunflower and beans. Colonial settlers from Europe introduced new agricultural practices that in some cases supplanted, and in other integrated, with First Nations agricultural systems.¹⁹

In the late 19th and early 20th centuries, seed certification programs that promised better and more uniform seed quality began to spread in the US and Canada, prompting farmers to increasingly source seeds from small family-run enterprises that specialized in multiplying certified seed varieties.²⁰ The seed varieties available to these firms were typically those developed by researchers in publicly funded land-grant universities and publicly funded research stations and experimental farms.²¹ Governments largely considered seed research to be a public good because the cost to develop new crop seeds was high, which dissuaded private sector firms from entering the market.

The development of hybrid corn seed varieties by public sector plant breeders in the late 1920s and early 1930s in North America marked an important moment that set off major

¹⁸ Clapp 2016.

¹⁹ Kuyek 2007, p.33.

²⁰ Fernandez and Just 2007; Kuyek 2007.

²¹ Moretti and Matringe 2006.

change in the sector. Hybrid seeds outperformed earlier varieties, and they offered built-in intellectual property (IP) protection for plant developers because they could not be saved from season to season and deliver the same yield. These characteristics of hybrid seed varieties encouraged more private firms to enter the field of seed research and development,²² and from the 1930s onward, private-sector breeding became a major source of crop seeds.²³ The use of hybrid seed varieties expanded rapidly in this context.²⁴ By 1965 in the US, for example, over 95 percent of the US corn crop was sown with hybrid seeds.²⁵ And in developing countries, by the 1990s some 60-70 percent of rice, wheat, and maize crops were planted with modern varieties.²⁶

The advent of hybrids, when combined with the adoption of intellectual property rights for plant varieties in the 1960s and 70s, resulted in increased consolidation in the sector.²⁷ Private firms increased their research and development (R&D) expenditure in the seed industry because the new IP protections enabled firms to recoup costs by giving them exclusive market rights for their varieties for 20-25 years.²⁸ It was in this period that a large number of smaller, independent seed companies were bought out by larger companies, the latter including some chemical firms that specialized in pesticides. Some of the larger chemical companies such as Ciba Geigy, Sandoz, and Royal Dutch/Shell purchased seed companies as a means by which to capitalize on the profit potential in the seed industry at a time of weak profits in the chemical sector.²⁹

Intellectual property protection over seeds solidified over the course of the 1980s, with the extension of patent rights to genetically engineered microorganisms as well as to seed and plant varieties derived from agricultural biotechnology.³⁰ These new IP protections spurred an intensification of private sector research into agricultural biotechnology for commercial purposes, leading to the development of genetically modified (GM) seeds.³¹ By the mid-1990s, following the approval of genetically modified crops for commercial planting in a number of countries, another wave of mergers, acquisitions, and joint ventures transformed the sector. Firms in this wave of consolidation sought to capitalize on economies of scale in the face of high R&D costs for agricultural biotechnology. These mergers, which continued through the mid 2000s, as explained below, further cemented the linkage between the agricultural chemical and seed industries.

²² Fernandez-Cornejo 2004; Howard 2015, p. 2.

²³ Moretti and Matringe 2006.

²⁴ Fernandez-Cornejo and Just 2007, p. 1270.

²⁵ Fernandez-Cornejo 2004, p. 25.

²⁶ (Byerlee 1996, pp. 698-99)

²⁷ Howard 2015; Fernandez-Cornejo 2004, p. 26.

²⁸ Fernandez-Cornejo and Just 2007, p. 1270.

²⁹ Moretti and Matringe 2006. Fulton and Giannakas 2001; Hayenga 1998. Fernandez-Cornejo 2004, p. 26

³⁰ Lesser 1998; Fernandez-Cornejo 2004, p. 21.

³¹ Howard 2015, p. 2.

Agrochemical firms bought up small and medium-sized enterprises in both the seed industry and the biotech sector as they sought to capitalize on the prospects for biotechnology to enhance product complementarity between seeds and agrochemicals.³²

Patents held by these firms on many of the primary agrochemicals were nearing their expiry dates in the late 1990s and early 2000s, and the development of new seeds that were designed to work with specific chemicals was a strategy firms embraced as a way to lock in sales of both seeds and chemicals. Firms in the sector developed seed and chemical technologies together in an integrated way, which was less expensive than developing these products separately. Several firms, for example, developed plant varieties that were resistant to the application of their own brand of agrochemicals. The idea was that farmers could spray chemical herbicides (the largest class of pesticides) to control weeds without worry that those chemicals would damage the crops. Monsanto, for example, engineered crops that were resistant to Roundup, its top herbicide, based on the chemical glyphosate. This move was attractive to farmers who wanted easy solutions to save time and effort, but it effectively locked customers into purchasing both products. Most mergers and acquisitions at that time resulted from firms seeking access to seeds, genes, and the platform technologies needed to develop these integrated seed and agrochemical products.³³

From the mid-1990s to the early 2010s, a rash of mergers and acquisitions led to further consolidation in which hundreds of smaller seed companies were purchased by larger firms.³⁴ DuPont, a chemical company, acquired the largest seed company at the time, Pioneer Hi-Bred, in 1999. Pioneer had itself acquired a number of smaller seed companies throughout the 1970s and 1980s, in previous merger rounds. In 2000, AstraZeneca and Novartis, both specializing in pharmaceuticals and chemicals, merged and spun off their own agricultural chemical arm to form Syngenta.³⁵ Monsanto also purchased a number of seed and biotech companies in the 1990s, and merged with pharmaceutical firm Pharmacia & Upjohn in 2000, from which its agricultural input business was spun off as Monsanto in 2002.³⁶ Dow Chemical purchased Mycogen, a seed and biotech firm in the mid-1990s, and also purchased various seed, chemical, and biotech firms after 2000 to form Dow AgroSciences. And in 2002 Bayer acquired Aventis, which itself was the product of a merger of AgrEvo and Rhone Poulenc in 1999. The result of these rapid and extensive mergers in the 1990s-early 2000s was that just six massive firms controlled around 75 percent of the agricultural input market by 2009. The four largest seed firms nearly tripled their market share, from 21 percent in 1994 to 58%

³² Fuglie et al. 2012.

³³ Fuglie et al. 2011; see also Moretti and Matringe 2006.

³⁴ Howard 2015. Fuglie et al. 2012.

³⁵ Lipin et al. 1999.

³⁶ Fernandez-Cornejo 2004, p. 32-33.

in 2013. In agricultural chemicals, the share of the top four firms more than doubled from 29 percent to 62 percent over that same period.³⁷

Drivers of Consolidation in the Current Context

Is the most recent round of consolidation among the world's leading agricultural seed and chemical firms simply a continuation of efforts to take advantage of technological developments bolstered by stronger IP rules? The most recent mergers in the sector do consist of combinations of firms that bring together those with more expertise on the seed breeding side of the equation with those with more expertise on the agrochemical side of the equation. A closer look at the specifics of the three most recent megamergers in the agricultural input sector (Bayer + Monsanto, Dow + DuPont, and Syngenta + ChemChina), however, reveals that while dynamics around access to plant genetic material and IP may remain important to the firms, there are other economy-wide factors that help to explain this most recent round of corporate consolidation.

Cementing Technological Integration

The newly formed mega-companies in the agricultural input sector are still very much committed to a strategy of linking genetically modified seeds and agrochemicals in stylized packages as a key product line. In the DowDuPont case, for example, DuPont brought superior seed breeding capacities and access to extensive plant genetic material, while Dow Chemical Corporation brought more expertise in the crop protection chemical market. Similarly, the matchup of Bayer and Monsanto brought together the former's dominance in the agrochemical market with the latter's dominance in the genetically modified seed market. And Syngenta, despite having held the largest share of global agrochemical sales of the Big Six firms prior to the mergers, also had important research and development in agricultural biotechnology seed development that was attractive to ChemChina, which had been solely a chemical company with no expertise in seed development. Each merger, then, can be seen as one which brought seeds and chemicals into closer complementarity within the resulting firms.

While there are some indications that the desire to further integrate seed and chemical technologies is a factor in these most recent mergers and acquisitions, there are important differences in the technological picture when compared with the past. The mergers in previous decades directly followed a strengthening of IP protections on plant genetic material that rewarded larger R&D operations that could spawn innovation such as agricultural biotechnology designed to work with specific chemicals. This time around, however, there were no major changes to IP rules for plant genetic material that preceded

³⁷ Maisashvili et al. 2016, p. 2; see also Moretti and Matringe 2006, p. 7.

the latest mergers. And a number of the patents on first-generation genetically modified traits have already expired or are due to expire in the coming years.

Some analysts have suggested that patents are no longer spurring innovation in any case, now that the market shares of the top firms have gotten so big.³⁸ The mergers could thus simply be an attempt to command a larger market share of the sales of existing genetically modified traits, albeit in new combinations. Most of the new varieties on offer from the dominant firms are seeds that contain multiple existing seed traits, many of which are made available from other firms through cross licensing agreements that have the same effect as patent protection. Bringing new genetically modified (GM) crop and chemical products to market still requires a large R&D budget, as the costs of development and regulatory approval remain high.³⁹ Several of the largest input firms are also currently securing research collaborations and licensing arrangements to access gene editing technology—specifically CRISPR-Cas technologies—which promises even lower costs than conventional agricultural biotechnology. Gene editing technology also offers a faster means by which to alter the genetic makeup of seed varieties, with less regulatory oversight.⁴⁰ Whether the current push for consolidation is about expanding market share or further development of chemically tied seed packages, or both, the interlocking of seed and agrochemical technologies appears to be an ongoing strategy for these firms.

Also relevant to the technological explanation is the strengthening of information platforms to support farming, as big data has become increasingly applied to farming contexts.⁴¹ These new farming information platforms rely on satellite images and sophisticated software programs that can analyze climate and soil conditions in individual fields, giving farmers specific prescriptions regarding which seeds, chemicals, and other inputs are required in order to maximize yields. The software packages behind this digital revolution of agriculture are protected by copyright, not patents, and are often easier and cheaper to roll out, yet they still provide firms with IP protection. In the case of Bayer-Monsanto, this move toward digital farming appears to be a large motivation for consolidation, to bring together the seed-chemical package offered by the firm with new computer-based information systems. In 2012, for example, Monsanto purchased Climate Corp., which is a leading developer of this type of digital farming technology (which it combines with the provision of crop insurance). The Bayer and Monsanto merger announcement emphasized these technological programs, which it refers to as “integrated

³⁸ ETC Group 2015, p. 14.

³⁹ ETC Group 2015.

⁴⁰ Hayley 2016.

⁴¹ Bronson and Knezevic 2016.

solutions,”⁴² alongside its seed traits and chemical products, such that the firm can be a “one-stop shop” for farmers.⁴³

Locking farmers into these information technology platforms can serve the purpose of replacing the need for patents on plant genetic material. Farmers who sign onto these platforms are often asked to send data from their fields to the firm via satellite, and they become reliant on the firm for input prescriptions based on that data. These platforms are increasingly being tied to specific equipment companies, such as John Deere tractors.⁴⁴ The development of digital farming platforms, while expensive, is very different from the development of crop chemicals and traits as the digital platforms face far fewer regulatory hurdles and as such are much easier to bring to market.⁴⁵ Increasing their size via mergers can enable firms to use less expensive technological innovation to lock in sales of their own brands of seeds and chemicals that are designed work with the specific software and hardware associated with digital farming. There are already significant licensing agreements between the large seed and chemical firms and major farm equipment manufacturers, which could lead to future mergers down the road.⁴⁶

Broader Economic Drivers

As noted in the first section of this paper, the mergers that have recently taken place in the agricultural input sector are not isolated cases in the global economy. Rather, mergers and acquisitions are happening all along agrifood supply chains as well as in a host of other sectors. These trends suggest that there are broader forces beyond technological ones that are spurring corporate consolidation. In today’s globalized world economy, financial motives and incentives loom large in economic decision-making, in what a number of analysts refer to as a process of ‘financialization’.⁴⁷ In such a context, firms face increasing pressure to shore up profits in order to satisfy shareholders, and are lured by financial incentives to make acquisitions when credit is cheap. These sorts of economic dynamics have played into each other in ways that help to explain the scope and timing of the recent merger activity among the Big Six firms in the agricultural input industry, and similar dynamics offer insights into the mergers occurring in other parts of the agrifood supply chain.

While stock markets in North America have been largely buoyant in the 2009-2018 period, the relative performance of different sectors can have enormous influence on

⁴² Bayer 2016.

⁴³ Chazan 2016.

⁴⁴ Lianos et al. 2016.

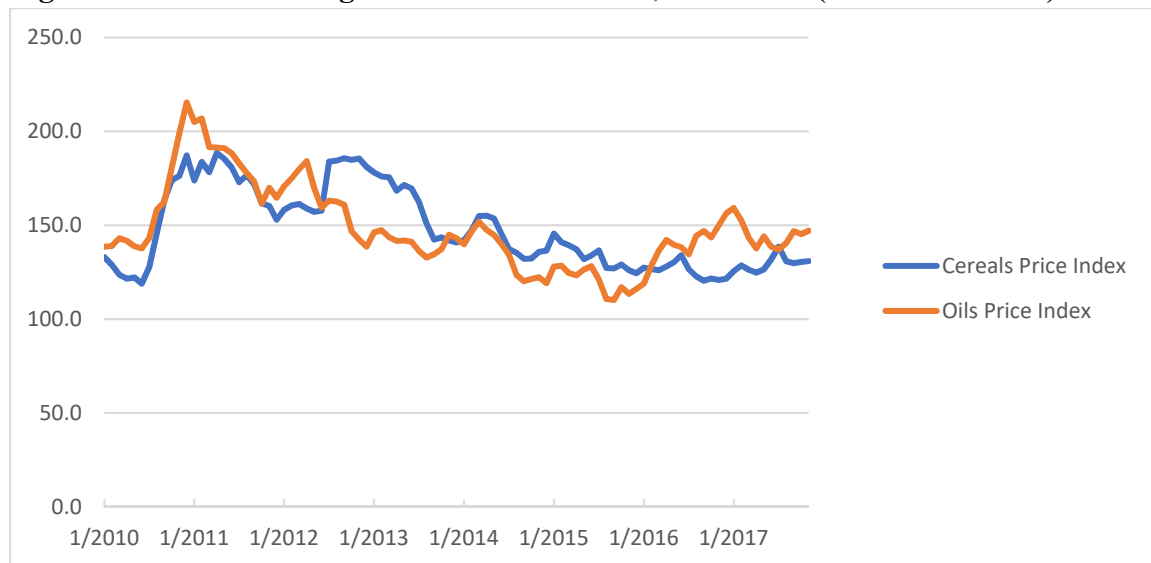
⁴⁵ Burwood-Taylor 2016.

⁴⁶ ETC Group 2015.

⁴⁷ Clapp and Isakson 2018.

investor decision-making. In the few years just prior to the recent mergers, the Big Six agricultural input firms had been experiencing relatively weak performance compared to the S&P 500 stock index. In the early 2000s through the 2008-12 food crisis, agricultural commodity prices were generally high, albeit somewhat volatile. This situation fueled agricultural expansion, particularly in emerging countries, such as Brazil and Argentina, which meant higher demand for the seeds and chemicals sold by the Big Six firms, and hence higher share prices. But after 2013, when agricultural commodity prices began to fall (as shown in Figure 2 below), growth weakened in key agricultural economies, especially in Latin America, which had become an important market for agricultural inputs.⁴⁸ This weaker growth translated into lower demand for seeds and chemicals sold by the Big Six firms, which in turn led to relatively weaker profits.⁴⁹

Figure 2: Cereal and Vegetable Oil Price Index, 2010-2016 (2002-2004 = 100)



Source: FAO Data

It was in this broader context that shareholder pressure came down on agribusinesses to improve their financial returns, including pressure to restructure as a means to save costs and shore up profits. Shareholder activism—when one or several investors purchase a large number of shares in a firm that they consider undervalued and then exert pressure on the firm’s management to increase its returns—has been on the rise in a financialized global economy.⁵⁰ Activist investors, even with just a few percentage points of the shares, can push for major changes within firms. As McGregor and Lorsch note of activist investors: “With increasing frequency they get deeply involved in governance—

⁴⁸ ETC Group 2015.

⁴⁹ Noel 2016; Mordock 2016

⁵⁰ Stockhammer 2010.

demanding board seats, replacing CEOs, and advocating specific business strategies.”⁵¹ The preferred strategies of activist investors can include pressure to restructure, including undertaking mergers and acquisitions.⁵² In the case of the DowDuPont merger, there were several activist investors pushing the two firms to make the structural changes that ultimately led to the merger: Nelson Peltz’s Trian hedge fund and Daniel Loeb’s Third Point hedge fund, each of which acquired over a 2 percent stake in the firms. Both investors felt the firms were not performing at their full potential, and made their assessments clear to the firms’ leadership.⁵³ The Dow-DuPont merger came shortly thereafter.

In addition to encouraging activist investors, financialization in the agrifood sector has influenced corporate consolidation in the sector in other ways, including through corporate ownership patterns. Institutional shareholders, such as asset management firms, increasingly hold shares in a range of firms within the same sector, including firms that are typically seen as competitors. This phenomenon, referred to as ‘common ownership’, has become more prominent in recent years, with institutional investors typically holding around 70-80 percent of US publicly traded firms.⁵⁴ The top asset management firms—namely BlackRock, Vanguard, and State Street—collectively own some 15-30 percent of most American companies, including those in the same sectors.⁵⁵ The fact that asset management companies are large shareholders in most major firms gives them influence over firm strategies.⁵⁶ Brooks et al., for example, found that merger and acquisition events are more likely to occur in commonly owned firms.⁵⁷ Most of the large firms that dominate along agrifood supply chains have a significant proportion—some 10-30 percent—of their shares owned by the same set of five large asset management companies. For example, just prior to the recent mergers in the sector, these five large asset management firms owned over 30 percent of DuPont’s shares, over 20 percent of Monsanto and Dow’s shares, over 15 percent of Bayer’s shares, and over 10 percent of Syngenta’s shares.⁵⁸

Adding to these ownership dynamics is a context of very low interest rates, which made corporate borrowing highly attractive at the time of the agrifood mergers. Seven years of historically low interest rates globally following the 2008 financial crisis (see Figure 3 below) made corporate borrowing not only cheap, but also easy, which was a key source of financing for the giant mergers. The *Financial Times* reported in 2015 that many firms

⁵¹ George and Lorsch 2014.

⁵² Ferreira et al. 2009, p. 4.

⁵³ Crooks 2015.

⁵⁴ Azar et al. 2018.

⁵⁵ *The Economist* 2016.

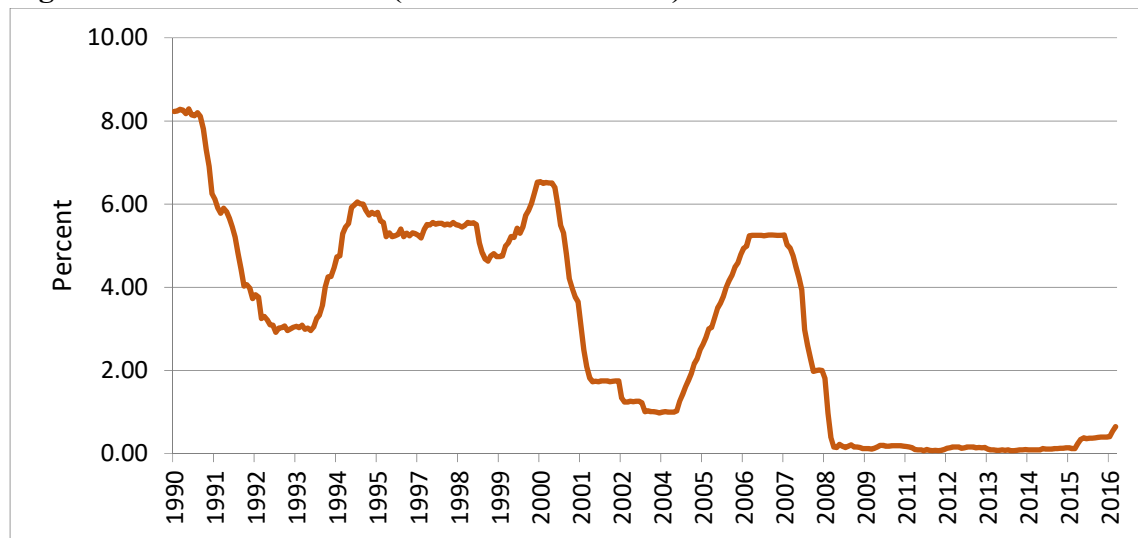
⁵⁶ Azar et al. 2018.

⁵⁷ Brooks et al. 2018.

⁵⁸ Clapp 2019.

were also “sitting on large piles of cash” which has encouraged them to make deals.⁵⁹ Investment banks have also actively sought to encourage the financing of merger deals as a way to increase their own profits.⁶⁰ As a result of these conditions, firms were borrowing money to pay dividends to shareholders and to buy back shares to raise capital. This is evident in the agricultural input sector acquisitions as ChemChina’s purchase of Syngenta was mostly financed through debt,⁶¹ and Bayer’s net debt was expected to quadruple when it acquired Monsanto.⁶² Both ChemChina and Bayer borrowed from a suite of banks and lending institutions to finance the deals.⁶³

Figure 3: US Interest Rates (Federal Funds Rate)



Source: St. Louis Federal Reserve

3. What are the key debates over the implications of growing corporate concentration for economic and environmental sustainability in the food system?

There is considerable debate over how exactly corporate consolidation matters for social equity and ecological sustainability in the food system. On one hand, the corporations pursuing mergers that result in ever-larger firms make the argument that they need to be larger in size in order to deliver products that are essential to both feeding the world and doing so in an ecologically sound manner. They present the case that a small number of large firms does not undermine competition, and that large firms deliver innovation, greater income for farmers, and sustainable agricultural solutions. Critics, on the other

⁵⁹ Fontanella-Khan and Massoudi 2015.

⁶⁰ Turner 2016.

⁶¹ Kynge et al. 2016.

⁶² Massoudi, Fontanella-Khan, and Chazan 2016.

⁶³ Massoudi, Fontanella-Khan, and Chazan 2016; Massoudi, Weinland, Atkins, Donnan, and Jopson 2016; The Dow & Dupont deal was a merger of equals and thus did not require financing.

hand, including a range of farmer groups, food justice advocates, and economists, are not always convinced by these arguments, and stress that consolidation can undermine the goals of equitable and sustainable food systems. They point out the dangers of concentration in the form of weakened competition that results in higher prices, dampened incentives for innovation, a rise in inequity combined with a loss of farmer autonomy, and a lock-in of industrial agricultural models with severe environmental consequences.

What is interesting about these debates is that they are not typical “left vs. right” debates. Analysts across the political spectrum have expressed concern about the effects of corporate concentration. For many economists, especially those who promote free markets, corporate consolidation is seen as a problem, as it can dampen market competition and result in inefficient outcomes that can have harmful social effects. For food justice advocates and farmer groups, concentrated markets that are dominated by just a handful of firms are seen to result in a loss of farmer and consumer autonomy, which can have enormous social and environmental consequences. Those who stand to benefit from corporate mergers, including the firms themselves as well as their investors, stress that these concerns are over-stated, especially because they see the positive aspects of consolidation outweighing any potential costs. The contours of this debate are outlined in more detail below. The aim here is not to adjudicate this debate, and indeed that would be difficult given the very recent nature of the latest wave of mergers across the agrifood sector and the lack of data on their effects in practice thus far. Rather, this review is intended to provide an overview of the discourse on both sides, and to demonstrate the significance of this debate for public policy.

Competition

Economists have long had an interest in corporate concentration, as there is a risk that too much concentration distorts markets in ways that can foster inefficiencies and other effects that can be harmful to society. Responding to these concerns, most countries have regulations in place to ensure that markets remain competitive. But the effects of corporate mergers are not always straightforward. As King notes, mergers and acquisitions can have both positive and negative impacts with respect to competition. If they result in market dominance that will stifle competition and raise prices, then the effects are most likely to be negative. But if they result in more efficient markets and lower prices, even if there are fewer suppliers in the market, then they can be interpreted more positively.⁶⁴

⁶⁴ King 2001.

Economists who focus on the effects of corporate mergers and acquisitions typically look to several measures to gauge their effect on competition. One measure is the concentration ratio of the top four firms (CR4) in a sector or market, measured as the percentage of the market controlled by the top four firms. Economists typically consider markets with a CR4 rating under 40 percent to be very competitive. Markets with a CR4 rating in the 40-60 percent range are considered to be moderately concentrated. And markets with a CR4 over 60 percent are considered to be highly concentrated.⁶⁵ The Herfindahl Hirschman Index (HHI) is another indicator that economists examine as a means of estimating when markets become uncompetitive. The HHI is calculated by adding the square of the market share of each firm participating in the market for a particular product. If only one firm was present in the market, the HHI would be 10,000, indicating a monopoly. If there are thousands of suppliers within a market, the HHI would be closer to zero, signalling a competitive market. If the HHI is below 1500, the market is generally considered to be competitive. If the HHI is in the range of 1500 to 2500, the market is normally considered to be moderately concentrated. And HHI levels that exceeds 2500 are typically considered to be highly concentrated.

The three large mergers that took place in the agricultural input industry in 2017-18 resulted in a significant increase in the market share of the top four firms, and an increase in their HHI. Post mergers, for example, the CR4 level is 67 percent for seeds and 70 percent for chemicals, as shown in Figure 4 below.⁶⁶ This level of concentration is up considerably from previous years and certainly over the 60 percent threshold for what is widely considered to be a highly concentrated market. While a post-merger HHI calculation is not readily available, calculations made prior to the mergers about their likely impact indicated that the HHI for specific seeds, would exceed levels normally considered competitive once the mergers took place. Bryant et al. found that the HHI in the US prior to the mergers was already greater than 2500 for corn and cotton, and for soy it was close to that figure, at 2360.⁶⁷ Even prior to the mergers, seeds for each of these crops had HHIs that were close to or well within the “highly concentrated” category. These same researchers calculated what a post-merger HHI was likely to be for each type of seed, which placed corn at 3110, cotton at 5205, and soy at 2701- well above the 2500 threshold for what is considered highly concentrated.⁶⁸

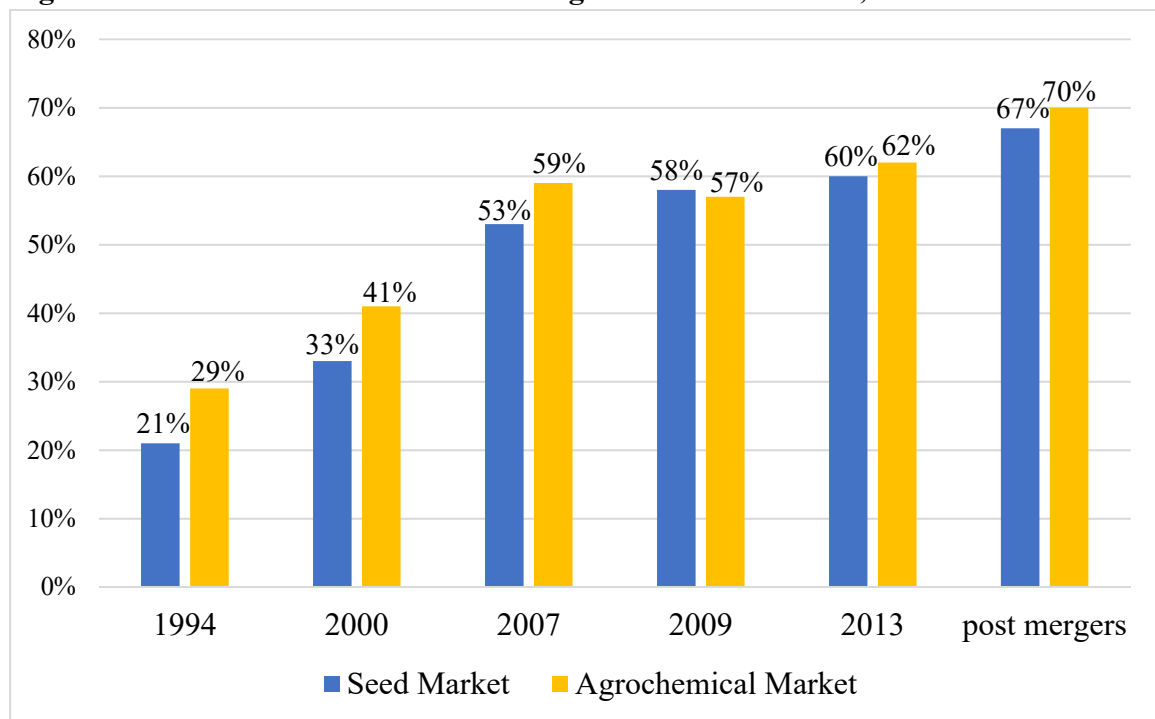
⁶⁵ Naldi and Flamini 2014.

⁶⁶ Mooney 2018, p.4.

⁶⁷ Bryant et al. 2016, p. 24.

⁶⁸ Bryant et al. 2016, p. 24.

Figure 4: Global CR4 for the Seed and Agrochemical Markets, 1994-2018



Sources: Fuglie et al. 2011, and Mooney 2018

The debate, however, is not so much about whether concentration increased, but rather, whether this increased concentration will stifle competition, which could result in increased prices. The firms involved in these mergers have stressed that there are no anticompetitive effects from the corporate tie-ups. They point out that the products in which each firm specializes is differentiated enough, with little overlap, that they are more complementary than competing. Thus, for them, the mergers will not affect competition or prices in any significant way. Monsanto CEO Hugh Grant, for example, noted in a joint investor conference call the day Monsanto's acquisition by Bayer was announced that "Monsanto and Bayer are two different, but highly complementary businesses."⁶⁹ In testimony to the US Senate Judiciary committee in 2016, Dow AgroScience executive Tim Hassinger promised that the merger with DuPont would "bring more competition to the market, not less".⁷⁰ In the case of the acquisitions of Monsanto by Bayer and Syngenta by ChemChina, the firms also added that they have different regional strengths, such that the mergers would not result in excessive concentration in any one region.

⁶⁹ Monsanto 2016.

⁷⁰ Quoted in Cornish 2018.

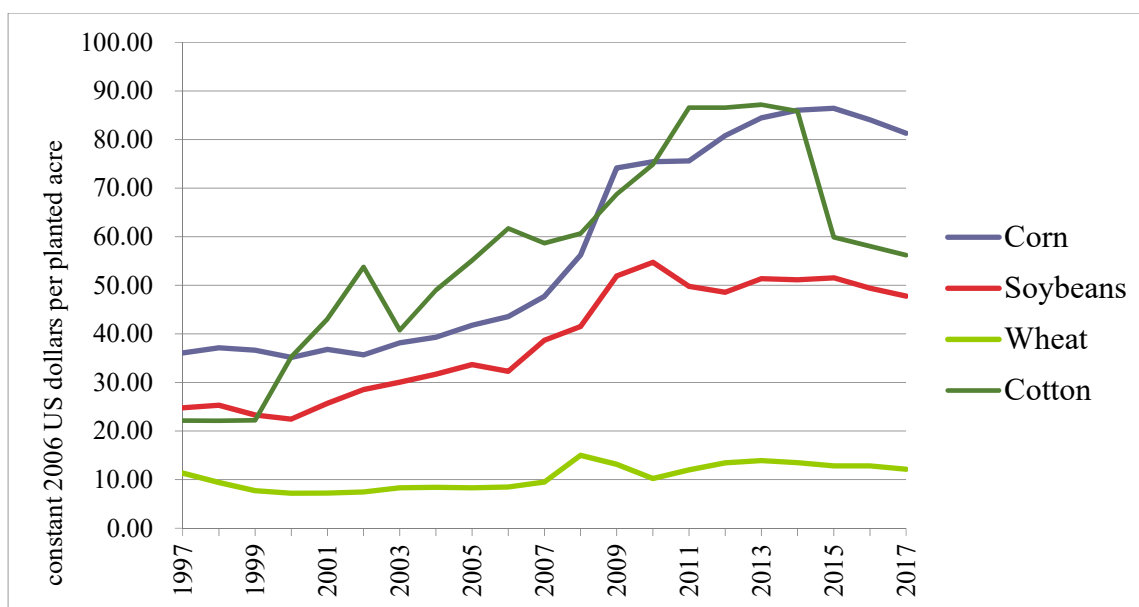
Critics, on the other hand, have raised concerns about highly concentrated agricultural input markets, as they foresee the resulting concentration will lead to higher prices without any improvements in the quality of the products produced by the merged firms. They point out that while each merger on its own would affect the market in specific ways (which each firm focused on in its justification to regulators), the impact of all three mergers on the market at the same time could have much wider ranging effects in terms of stifling competition. In this context, critics have expressed concern that the mergers have resulted in concentration levels that are within what economists consider to be highly concentrated levels, which raises concerns about whether price increases will result simply as a product of greater market power, rather than due to product improvements.

Seed price trends over the 1975-2017 period, which captures previous waves of consolidation in the sector, can help give insight into likely price trends from the most recent round of mergers. USDA data show that the price of corn and soy seed as a percentage of the amount of revenue farmers received for those crops (per acre) nearly tripled for both crops over this 20 year period. Seed prices for corn and soy also increased by more than the rate of inflation over the same period (See Figure 5 below). There are many factors that affect changing farm input prices, which make it difficult to isolate the effect of market power from others.⁷¹ A recent study, however, has shown that market concentration and common ownership are responsible for approximately 28 percent of seed price increases for soy, corn, and cotton over the 1997-2017 period.⁷² However, as Figure 5 shows, wheat seed prices have not seen a similar pattern of increase, which is interesting because wheat seed is not genetically modified, and thus does not have technology fees associated with it. Moreover, there is relatively little private sector R&D for wheat seeds. For corn and soy, if the firms continue to market primarily genetically modified seeds that have high technology fees, it is unlikely that seed prices will decrease.

Figure 5: Inflation Adjusted US Seed Costs, 1975-2017

⁷¹ Fuglie et al. 2012; See also Torshizi and Clapp 2019.

⁷² Torshizi and Clapp 2019.



Source: USDA data

Moreover, some studies have found that seed prices tend to be higher when firms integrate into one firm, compared to seed prices under cross-licensing arrangements.⁷³ Studies that predicted price trends resulting from the Dow-DuPont and Bayer-Monsanto mergers, for example, bear out the concerns about higher prices. Bryant et al. projected that seed price increases for corn are likely to be in the 1.6 to 6.3 percent range, and the price increase for soybean seed is likely to be in the 1.3 to 5.8 percent range. The predicted effect of the Bayer-Monsanto merger on cotton seed prices is much more pronounced, at a 17.4 to 19.2 percent increase.⁷⁴

Innovation

The mergers will likely have important implications for innovation in the sector, but proponents and critics of the mergers have different views on exactly how these effects will play out. The question is whether consolidation dampens competition enough to reduce a firm's incentives to innovate in order to improve its market share. In some cases, consolidation can enable more innovation by improving the capital available to a firm to engage in expensive research and development. But in other cases, it could stifle innovation because fewer firms with more market power could dampen incentives to develop new products in order to compete. Whether one effect overpowers the other is not always easy to predict. According to a study by the US Department of Agriculture, mergers of smaller firms to form larger firms in the seed sector did result in larger R&D

⁷³ Stiegert et al. 2010.

⁷⁴ Bryant et al. 2016, p. 26.

budgets in the past.⁷⁵ The consolidation of the sector in the 1970s and again in the 1990s enabled companies to develop new seed traits and varieties, as outlined in section 2 above. But whether the innovation effects of the latest round of mergers in the sector is likely to be positive or negative, is widely debated.

How the innovation effects of corporate concentration play out matters enormously, as public funding for agricultural R&D has declined sharply in recent decades, marking an important shift. Many governments, including Canada and the US, put priority on funding seed improvements in the century from the 1880s to the 1980s—a period that saw the development of hybrid seeds and the green revolution. But as governments embraced a neoliberal economic model starting in the 1980s, they scaled back spending and increasingly relied on the private sector to fund agricultural R&D. It was in this context that the big agribusiness firms invested heavily in agricultural biotechnology, which helps to explain why those innovations were largely about ensuring corporate profit.⁷⁶

The companies participating in the current restructuring of the sector have in fact justified the mergers and acquisitions on the grounds that they will spur further innovation, which they argue will result in improved farm productivity.⁷⁷ Bayer, for example, has focused on developing integrated farming solutions, combining seed traits, crop protection, and digital farming platforms, as noted above.⁷⁸ Bayer's acquisition of Monsanto was crucial for the firm to move in this direction, as Monsanto was a leading firm in the development of digital farming platforms prior to its takeover. As Monsanto executive Hugh Grant noted when the merger was announced, the combination of the two firms would deliver “an innovation engine that pairs Bayer's crop protection portfolio with our world-class seeds and traits and digital agriculture tools to help growers overcome the obstacles of tomorrow. Together Monsanto and Bayer will build on our proud tradition and respective track records of innovation in the agriculture industry, delivering a more comprehensive and broader set of solutions to growers.”⁷⁹

DowDupont similarly focused on innovation in explaining the merger decision, seeing the combination of the two firms as an opportunity to develop new farm technologies. DowDupont is pursuing both digital agriculture through its digital farming division, Granular, which is developing software platforms as well as satellite connections through its cooperation with satellite firm Planet.⁸⁰ It is also pursuing gene editing technologies

⁷⁵ Fuglie et al. 2012.

⁷⁶ Parayil 2003; Wield et al. 2010.

⁷⁷ Massoudi 2016.

⁷⁸ Buck 2019a.

⁷⁹ Bayer 2016.

⁸⁰ Scoles 2018.

such as CRISPR-Cas. As Pierre Flye Saint Marie of DowDupont notes, “It’s an enormous opportunity to bring innovation in the seeds sector in a faster and better way.”⁸¹

Critics have been skeptical about the innovation effects of the mergers. A study by the USDA shows that by the late 2000s, increased concentration in the seed sector slowed the intensity of private research on biotech corn, cotton, and soy relative to what would have been the case without that level of concentration.⁸² As Diana Moss from the American Antitrust institute notes, when fewer firms are in the market, there are fewer opportunities to collaborate on new and innovative seed traits.⁸³ This outcome may be related to the point, noted above, that market concentration tends to be associated with fewer patents, indicating a lower incentive to innovate as market share rises.⁸⁴

Critics have also pointed to the announcements by the merging firms that they plan to make cutbacks to R&D budgets, rather than increasing them, post-mergers, which could dampen rather than incentivize innovation at the firms. Both Dow-DuPont and Bayer-Monsanto have widely advertised that their mergers would result in significant “synergies”, referring to cost savings as a result of their ability to eliminate duplicative R&D expenditures. Although the firms noted that these cost savings would not likely result in job losses in research divisions, jobs were cut in practice, as discussed below in the discussion of equity effects.

Those opposing the mergers, including food justice advocates, have also expressed skepticism about the purported benefits of the technological innovations that the firms are promoting as part of their merger plans. Most of these critiques relate to challenges to farmer autonomy from the digitalization of agriculture, and the claims of environmental sustainability associated with those technologies. These critiques are discussed in the sections on equity and environment below.

Equity

As mergers and acquisitions have continued apace across a range of sectors, a wider public debate has emerged about whether this concentration among firms is a contributing factor to growing economic inequality in the economy more broadly, both domestically and globally.⁸⁵ If concentration gives more power to a few firms to undertake price markups without improving product or service quality, then the effect is a

⁸¹ Michalopolous 2018.

⁸² Fuglie et al. 2012.

⁸³ McLaughlin 2016.

⁸⁴ Maisashvili et al. 2016.

⁸⁵ Khan and Vaheesan 2017; Wu 2018.

massive transfer of wealth from consumers to firms, exacerbating what is already a highly unequal wealth distribution in the economy. This transfer of wealth by such a mechanism works to dampen economic growth because consumers are spending more of their income to simply stand still. A slow-down in the broader economy puts a drag on job creation and wages, which further exacerbates inequality. A recent IMF study, for example, finds that when dominant firms are able to mark up prices beyond what would be normal considering product quality, a lower share of income goes to the workers, thus fueling inequality in the wider economy.⁸⁶

The companies involved in the agricultural input sector mergers have argued that farmers and consumers will be better off as a result of the consolidation of the major firms in the sector. In particular, they point to their planned innovations, which they argue will be necessary to improve crop productivity to meet the world's food needs, which they predict will double by 2050.⁸⁷ They note that improved crop yields will not only help meet the world's food needs, but will also translate into higher incomes for farmers. As a Monsanto document about the mergers noted: "With our combined expertise, we'll reduce loss to disease and increase yields, putting more money per acre in your pocket. Our innovation will continue to be broadly licensed so farmers can enjoy choice – the products you want from the suppliers you choose."⁸⁸

Critics have expressed concern that the mergers are likely to result in higher prices without any associated increase in product quality or productivity, as outlined above. Higher prices for inputs would increase production costs for farmers, and there is a risk that those costs could also be passed on to consumers in the form of higher food prices.⁸⁹ These price effects for both farmers and consumers are likely to occur on a global scale. Less industrialized countries are especially vulnerable to price increases for inputs and food because many of these countries have a higher proportion of the population engaged in farming, and people in those countries typically spend a high proportion of their income on food than is the case in rich industrialized countries. We witnessed the effects of higher prices during the 2008 food crisis exacerbated hunger and poverty, and sparked riots in a number of countries.⁹⁰ In addition to fears of higher costs for farmers and consumers, the mergers have also raised concerns about job losses in the firms themselves. In early 2019, for example, Bayer announced that it was eliminating 12,000 jobs, which accounted for a full 10 percent of the newly merged firm's workforce.⁹¹

⁸⁶ Díez et al. 2018, 16.

⁸⁷ Varinsky 2017.

⁸⁸ Monsanto "It's Time to Grow" 2019; see also Gullickson 2018.

⁸⁹ Friends of the Earth 2017. See also Goodman and Finke-Haynes 2018.

⁹⁰ Headey and Fan 2008; Bush 2010.

⁹¹ Buck 2019b.

Combined, these trends of fewer jobs and higher costs are important potential drivers of wider inequality trends.

Moreover, critics warn, as firms consolidate, product choice, and thus farmer autonomy, can be seriously compromised. Critics base these concerns on past experience from previous mergers. It is increasingly difficult for farmers in North America, for example, to access non-genetically modified seeds for crops in which GM seeds have become dominant—in particular corn, soy, cotton, and canola. Howard, for example, notes that 40 percent of farmers in Illinois in 2009 could not access non-GM seed.⁹² As a result, farmers increasingly are feeling stuck on a GM technology treadmill. A coalition of farmer and civil society groups highlighted growing farmer dependence on high tech seeds and chemicals in a letter to US regulators opposing the merger of Dow and DuPont: “The seed companies have fostered a dependence on seed and chemical cropping systems with declining effectiveness – and the industry’s response has been to develop newer and more expensive traits.”⁹³ This dependence is particularly acute for small-scale farmers in developing countries, who face an unfair playing field in the face of higher prices and reduced choice.

Environmental Sustainability

While economic studies on consolidation focus more on its effects on pricing, innovation, and equity, there is less focus in those studies regarding the environmental consequences of mergers and acquisitions. Yet there is a robust debate in the public sphere about the environmental impact of consolidation in the sector, as became clear when the recent mergers and acquisitions in the agricultural input sector were announced.⁹⁴

In fact, the large agricultural input companies have based much of their rationale for consolidation on the idea that the innovations they are pursuing as newly merged firms are in the name of protecting the environment. As Bayer CEO Werner Bauman noted when the merger with Monsanto was announced, the combination of Bayer and Monsanto “represents the kind of revolutionary approach to agriculture that will be necessary to sustainably feed the world as we enable growers with a broad set of enhanced agricultural solutions.”⁹⁵ The company has held up its digital agriculture technologies as an example of a climate smart approach to production. As outlined above, a key dimension of the approach is to use big data “to help mitigate climate change and adopt to its effects on agricultural productivity, while continuing to be a positive force in

⁹² Howard 2009.

⁹³ American Antitrust Institute et al. 2016.

⁹⁴ Clapp 2018.

⁹⁵ Quoted in Massoudi 2016.

the fight against it.”⁹⁶ The firm has also presented its digital agriculture platform as a key way to improve resource efficiency, so as to enable more food to be grown on less farmland.⁹⁷

Similarly, DowDupont has justified its merger on the grounds that consolidation will help to solidify its development of drought and pest resistant seeds that will deliver higher yields using fewer external inputs.⁹⁸ The firm is developing these seeds with gene editing technologies, a controversial approach to seed breeding that is much faster than genetic modification of the 1990s. Advocates of this new approach to plant breeding argue that it enables modifications with more accuracy, and that the process is more similar to conventional plant breeding techniques than it is to the kind of agricultural biotechnology used in previous decades because it makes smaller and more precise edits to the seed’s genetic makeup.

Critics have expressed concern that the seed and chemical packages that the newly merged companies plan to offer are largely based on their continued push of genetically modified crops, whether by more conventional agricultural biotechnology or gene-editing processes. These high tech seeds are promoted alongside a large-scale industrial farming model that has been associated with a narrowing of crop genetic resources. The big firms that dominate in the sector tend to specialize in GM crop seed, primarily corn, soy, canola, and cotton. These crops are typically grown in a large-scale monoculture fashion that poses a threat to agricultural biodiversity.⁹⁹ The spraying of herbicides such as glyphosate and other agrochemicals onto fields planted with herbicide resistant crops can cause damage to plant genetic diversity in and around fields. It can also pose a threat to wildlife in farm fields, including key pollinators such as bees and butterflies that rely on those plants for their survival.¹⁰⁰ The merged firms may also make fewer seed varieties available as a result of cuts to their research and development budgets.

Critics also note that the corporate claims that pesticide applications (i.e. insecticides as well as herbicides) can be reduced using these new seeds and digital farming technologies should be viewed with caution, especially as the same claims were made when agricultural biotechnology came onto the scene in the wave of mergers that took place in the 1990s. By 2007, nearly all of the global acreage planted with GM crops was already sown with seeds supplied by the Big Six companies, and of the GM crops that are planted, over 85 percent of them are engineered to be resistant to the application of chemical herbicides, the most common being glyphosate, the active ingredient in

⁹⁶ Monsanto 2017.

⁹⁷ Monsanto 2016.

⁹⁸ Michalopolous 2018.

⁹⁹ Altieri 1999; Brown et al. 2016.

¹⁰⁰ Brown et al. 2016.

Monsanto's Roundup.¹⁰¹ Other companies have engineered seeds that are resistant to other chemicals, such as Bayer's Liberty herbicide. When herbicide tolerant seed varieties were first introduced, the companies argued that they would bring environmental benefits because they would allow farmers to spray their fields less often, and with chemicals that are less toxic than other chemical crop sprays.

As GM crop acreage has grown globally over the past two decades, however, so has the application of herbicide sprays. A study by Benbrook notes that from 1996 to 2014, global agricultural glyphosate use increased nearly 15-fold.¹⁰² This increase is the product not just of growing acreage planted with GM crops, but also an increased rate of application as weeds have become increasingly resistant to the chemical. The increased application of herbicides presents numerous environmental and health risks. Although initially the herbicide glyphosate was promoted as a relatively benign chemical, there are growing concerns about its safety. In 2015, the World Health Organization issued a statement naming glyphosate as "probably carcinogenic to humans",¹⁰³ although a later study concluded that exposure through diet was unlikely to cause cancer.¹⁰⁴ There remains controversy, however, over its effects in both occupational and dietary exposure.¹⁰⁵ In 2018, a US court awarded US\$289 million to a school groundskeeper who sued Monsanto for his exposure to glyphosate from his use of Roundup, which he argued gave him terminal cancer. Bayer, which took over Monsanto that same year, now faces over 11,000 court cases alleging a connection between Roundup and cancer.¹⁰⁶

More broadly, critics of consolidation in the agrifood sector are concerned that corporate concentration effectively crowds out efforts to foster other forms of sustainable agriculture at a smaller scale, such as through the promotion of agroecology. Food sovereignty activists, for example, call for farmer-to-farmer research and extension programs to promote agroecological practices that do not rely on purchased external corporate-controlled inputs.¹⁰⁷ This approach has been scientifically shown to be carbon absorbing and more resilient than the kinds of monocultural and high-tech practices promoted by the largest agribusiness firms.¹⁰⁸ It is also more accessible to farmers because it is not reliant on corporate provided inputs.

4. What are the implications for policy and governance?

¹⁰¹ ISAAA Data 2016.

¹⁰² Benbrook 2016.

¹⁰³ WHO 2015.

¹⁰⁴ Kelland 2016.

¹⁰⁵ Myers et al. 2016.

¹⁰⁶ Buck 2019.

¹⁰⁷ Holt-Giménez and Altieri 2013.

¹⁰⁸ Altieri 1999.

The debates over corporate concentration matter as they are highly relevant to regulatory decisions made by governments on whether to approve mergers and acquisitions within a sector. The debates discussed above are relevant to concentration in the agricultural input industry, but similar debates regarding competitiveness, innovation, equity, and sustainability are taking place with respect to corporate consolidation at other points along agrifood supply chains. Government regulators typically evaluate merger and acquisition proposals based on their likely impact on competitiveness and innovation.

The merger enforcement guidelines in the US, EU, and Canada focus almost exclusively on the effect of mergers on competition, and use measures such as the HHI and CR4 in their evaluations.¹⁰⁹ A focus on competition effects helps to determine whether further consolidation in a sector might lead to higher prices due to the increased market power of the firms that dominate in a particular market. Whether market concentration translates into market power depends on the extent to which new firms in the sector face barriers to entry. If it is difficult for new firms to even enter the sector, concentration can result in anticompetitive practices such as collusion among the dominant firms to raise prices.¹¹⁰ The competition focus also helps to give regulators a sense of how mergers might influence future innovation, with competitive markets being seen as generally conducive to innovation.¹¹¹

It is not a foregone conclusion that regulators will consider increased market share as evidence of harm to competition. Rather, they take a number of issues into account. If they consider that efficiencies are likely to result from a merger deal that would result in lower prices for consumers, they may be willing to allow larger market shares for the leading firms in the sector. Such efficiencies might result from economies of scale, or from new innovation that transforms the sector. Making such exceptions based on expected efficiencies has increasingly become the norm in merger control, especially in the past few decades with the rise in attention to consumer welfare and pricing as key guiding principles for evaluating mergers.¹¹²

Merger and acquisition evaluations can take months or even years to complete, as regulators must evaluate the market implications in detail in order to arrive at their decisions. The recent giant mergers in the agricultural input sector, for example, took well over a year to be completed by regulatory bodies. Because the companies are active in dozens of countries around the world, they needed to seek approval in each of those

¹⁰⁹ EU 2004; US Department of Justice 2010; Canada Competition Bureau 2011.

¹¹⁰ OECD 2007.

¹¹¹ Shapiro 2002.

¹¹² Wu 2018.

countries, each of which conducts its own analysis based on the effects of the mergers in that particular country.

Although the agricultural input firm mergers were hotly debated with significant protest and concern from critics in countries around the world, they were eventually approved, albeit with conditions.¹¹³ In each case, the firms involved were required to provide at least some ‘remedies’ to enable the deal to go through. That is, they each had to divest from certain products or businesses in order to lessen regulators’ concerns about the effects on competition. For example, Bayer was required by Canada, the US, and the EU to divest some of its assets in order to reduce the likelihood that the merger would lessen competition. In Canada, Bayer was required to divest from its canola seed business because the merger would have resulted in one company owning 95 percent of the canola seed traits sold in Canada.¹¹⁴ In the EU, the requirement was that Bayer sell some of its vegetable seed business, as well as some of its seed traits and pesticides business, as well as its digital agriculture business.¹¹⁵ In the US, it had to divest of its seed and herbicide business, along with its digital agriculture unit.¹¹⁶ Most of Bayer’s divested assets in these cases were purchased by BASF, one of the original Big Six firms that was not involved in the most recent mergers.

In the case of other recent mergers in other parts of agrifood supply chains, similar kinds of decisions are made by regulators. The Canadian Competition Bureau, for example, posts its decisions indicating either that it is satisfied that the products of the merging firms are sufficiently differentiated such that it does not raise anticompetitive concerns, or that remedies have been undertaken that substantially lessen the likelihood of anticompetitive effects. The European Commission and the US Department of Justice follow similar practices.

The focus on competition by regulators is important, but it does not capture all of the issues that are being debated in the public sphere regarding consolidation in the sector. *The Economist Magazine*, for example, notes that regulators’ narrow focus on competition is limited even in an economic sense, because antitrust authorities do not typically review the broader impact of patent holdings, and can only touch on institutional shareholder ownership effects on competition.¹¹⁷ They typically do not even consider other possible impacts of corporate mergers, such as their potential effects on broader social equity and the environment.

¹¹³ MacDonald 2019.

¹¹⁴ Canada Competition Bureau 2018.

¹¹⁵ Stam 2018; McLaughlin et al. 2018.

¹¹⁶ Fung and Dewey 2018.

¹¹⁷ *The Economist* 2016.

A narrow focus on competition also fails to consider questions of political power, which are of central importance to corporate concentration. Simply put, if there are fewer, more powerful firms vying for air time with policymakers, there is a high likelihood that those the views of those firms will hold the most sway in shaping government policy.¹¹⁸

Corporate lobbying has increased markedly in the last 20 years, including by agribusiness. The agricultural input firms, for example, have spent millions of dollars in lobbying policymakers in both the US and the EU in recent years.¹¹⁹ Their concentrated lobbying has pushed a message that a large-scale industrial agricultural model should be prioritized in policymaking, which weakens prospects for alternative models such as those based on smaller-scale farm systems based on agroecological principles.

The merger review process is also highly secretive when it is ongoing, and although the decisions of regulatory bodies are typically explained to some extent, the details of their proceedings are not typically made public, so we cannot see how exactly they arrived at their decisions. Although most merger review processes, including those in Canada, the US, and the EU, allow for some public comment into the process, it is not clear whether and how this input is considered. In the European Union, for example, some 50,000 emails and 5,000 letters were received regarding the Bayer-Monsanto merger. Many of these public inputs included concerns about the potential environmental and health consequences of the mergers. Because the EU merger control processes are focused so narrowly on competition, however, the EU merger review commissioner, Margrethe Vestager, felt compelled to issue an open letter to explain why she was not able to take much of that input into account.¹²⁰

There is growing public pressure for a renewed public conversation about corporate concentration in the economy more widely, as corporate consolidation continues apace, accompanied by rising inequality and concern for the environment as mega-companies become ever bigger.¹²¹ Corporate consolidation in the agrifood sector has been particularly pronounced in this current era, and a growing number of civil society organizations and scholars have sought to bring these trends to our attention.¹²² These are important conversations to have, not just among agrifood experts, but with the public more broadly, in rich and poor countries alike. It is vital for society to understand how corporate concentration and associated political power of mega-companies can determine the shape and impact of food systems around the world. And it is important for societies to collectively decide how much concentration they are willing to accept in the agrifood system. But to be inclusive of the full range of potential effects of concentration in the

¹¹⁸ Khan and Vaheesan 2017; Clapp 2019.

¹¹⁹ Clapp 2018.

¹²⁰ Vestager 2017.

¹²¹ See Wu 2018; Khan 2018.

¹²² IPES Food 2017; Mooney 2018; Chemnitz et al. 2017.

food and agriculture sector, it is important to widen the scope of regulatory processes that govern corporate mergers and acquisitions. It is also important to open up the consultation process, both to involve more participants, and to increase transparency with respect to how those decisions are made.

Conclusion

This paper has provided an overview of key issues and concerns regarding corporate consolidation in the agrifood sector. It has shown that there are high levels of market concentration among leading firms in all stages of agrifood supply chains, from agricultural inputs, to farm equipment, to commodity trading, to food processing and retailing. Concentration in these sectors has become more pronounced in recent years, as a growing number of mergers and acquisitions have taken place at different points along supply chains.

The recent mergers in the agricultural input sector provide a stark example of this concentration. The drivers of these recent mergers have been a mix of both technological and economic factors. While a desire to capitalize on further complementarity between seed and chemical technologies has been one trend, broader forces have also been behind this consolidation trend. These include the rise of digital technologies, including in the agricultural sector. They also include economic forces such as financialization, low interest rates, common ownership of firm shares, and pressure from activist investors. There have been intense debates over the implications of corporate mergers in this sector, with advocates of consolidation making the case that it will bring more innovative technologies that are both economically and environmentally beneficial. Critics, on the other hand, are concerned that concentration will lead to higher prices, less farmer choice, and lock-in what they see as environmentally harmful practices associated with high-tech monoculture agriculture.

These debates are significant for public policy. Patterns of concentration in the agrifood sector matter for the future of our food and agricultural systems. These trends are also occurring in a wider context of corporate consolidation in the global economy more generally, and provide an important example of the issues at stake. It is as yet unclear how these broader debates over corporate concentration and power will play out in policy circles, but important lessons can be learned from an analysis of the debates over the recent food and agriculture sector mergers. This analysis suggests that we need a wider approach to assessing mergers and acquisitions, beyond just matters of market concentration and potential innovation effects, to also include analyses of the effects of consolidation on broader social equity, on the environment, and on the distribution of

political power in society, not just at the national scale, but also globally. It also suggests that merger and acquisition review processes need to be more transparent and open to more formal inputs from a wider range of affected actors.

References:

- Altieri, Miguel A. 1999. "The Ecological Role of Biodiversity in Agroecosystems." *Agriculture, Ecosystems & Environment*, 74(1): 19–31.
- American Antitrust Institute, Food & Water Watch, and National Farmers Union. 2016. *Letter to U.S. Department of Justice Re: The Proposed Dow-DuPont Merger*. May 31. Online at: https://www.google.ca/search?q=food+and+water+watch+antitrust+institute&ie=utf-8&oe=utf-8&gws_rd=cr&ei=JlybWL2bPI7ljwSeg6eYAw
- Azar, José, Martin C. Schmalz, and Isabel Tecu. 2018. "Anti-Competitive Effects of Common Ownership." *Journal of Finance*, 73(4): 1513–65.
- Bayer. 2016. *Bayer and Monsanto Create a Global Leader in Agriculture*. September 14. Online at: <https://www.bayer.ca/en/media/press-releases/newsdetail/?dt=TVRJ PQ==&st=1>
- Benbrook, Charles M. 2016. "Trends in Glyphosate Herbicide Use in the United States and Globally." *Environmental Sciences Europe*, 28(3): 15 pages.
- Bronson, Kelly, and Irena Knezevic. 2016. "Big Data in Food and Agriculture." *Big Data & Society*, 3(1): 5 pages.
- Brooks, Chris, Zhong Chen, and Yeqin Zeng. 2018. "Institutional Cross-Ownership and Corporate Strategy: The Case of Mergers and Acquisitions." *Journal of Corporate Finance*, 48(February): 187–216.
- Brown, Mark J.F., Lynn V. Dicks, Robert J. Paxton, Katherine C.R. Baldock, Andrew B. Barron, Marie-Pierre Chauzat, Breno M. Freitas, et al. 2016. "A Horizon Scan of Future Threats and Opportunities for Pollinators and Pollination." *PeerJ*, 4(August): 20 pages.
- Bryant, Henry, Aleksandre Maisashvili, Joe Outlaw, and James Richardson. 2016. *Effects of Proposed Mergers and Acquisitions Among Biotechnology Firms on Seed Prices*. Agricultural and Food Policy Center, and Texas A&M University. Online at: https://www.afpc.tamu.edu/pubs/0/675/WP_16-2.pdf
- Buck, Tobias. 2019a. "Bayer Keen to Shift Attention from Monsanto Woe to Tech Vision." *Financial Times*. January 24.

- Buck, Tobias. 2019b. "Bayer faces 11,200 Lawsuits over Weedkiller Cancer Allegations." *Financial Times*. February 27.
- Burwood-Taylor, Louisa. 2016. "Why Bayer Invested in 5 Agtech Funds and Big Data is So Exciting." *Agfunder News*. November 1. Online at: <https://agfundernews.com/why-bayer-invested-in-5-agtech-funds.html>
- Bush, Ray. "Food Riots: Poverty, Power and Protest." *Journal of Agrarian Change* 10(1): 119–129.
- Byerlee, Derek. 1996. "Modern Varieties, Productivity, and Sustainability: Recent Experience and Emerging Challenges." *World Development*, 24(4): 697–718.
- Canada Competition Bureau. 2011. *Merger Enforcement Guidelines*. Online at: <http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/03420.html#wb-tphp>
- Canada Competition Bureau. 2018. *Competition Bureau Statement Regarding Bayer AG's Acquisition of Monsanto Company*. May 30. Online at: <http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/04374.html>
- Chazan, Guy. 2016. "Scepticism Swirls around Bayer's Megadeal." *Financial Times*. September 15.
- Chemnitz, Christine, et al. (eds). 2017. *AgriFood Atlas*. Heinrich Böll Foundation, Rosa Luxemburg Foundation, and Friends of the Earth Europe. Online at: https://www.boell.de/sites/default/files/agrifoodatlas2017_facts-and-figures-about-the-corporations-that-control-what-we-eat.pdf?dimension1=ds_agrifoodatlas
- Clapp, Jennifer, and S. Ryan Isakson 2018. *Speculative Harvests: Financialization, Food, and Agriculture*. Halifax: Fernwood.
- Clapp, Jennifer. 2015. "ABCD and Beyond: From Grain Merchants to Agricultural Value Chain Managers." *Canadian Food Studies*, 2(2): 126–135.
- Clapp, Jennifer. 2016. *Food*. 2nd edition. Polity: Cambridge.
- Clapp, Jennifer. 2018. "Mega-Mergers on the Menu: Corporate Concentration and the Politics of Sustainability in the Global Food System." *Global Environmental Politics*, 18(2): 12–33.
- Clapp, Jennifer. 2019. "The Rise of Financial Investment and Common Ownership in Global AgriFood Firms." *Review of International Political Economy* (forthcoming).
- Cornish, Chloe. 2017. "John Deere Ploughs a New Furrow with Algorithmic Acquisition." *Financial Times*. September 11.
- Cornish, Chloe. 2018. "AgTech Fundraising Doubles as Farmers Seek Disruptive Solutions." *Financial Times*. January 8.

Crooks, Ed. 2015. “Dow and DuPont Aim to Pre-Empt Activists with Megadeal.” *Financial Times*. December 9.

Diez, Federico, Daniel Leigh, and Suchanan Tambunlertchai. 2018. “Global Market Power and its Macroeconomic Implications.” IMF Working Paper WP/18/137. Washington, D.C.: International Monetary Fund. Online at: <https://www.imf.org/en/Publications/WP/Issues/2018/06/15/Global-Market-Power-and-its-Macroeconomic-Implications-45975>

Eley, Jonathan, and Arash Massoudi. 2019. “Sainsburys Faces Tough Battle to Keep Asda Deal on Track.” *Financial Times*. January 13.

ETC Group. 2015. *Breaking Bad: Big Ag Mega-Mergers in Play: Dow + DuPont in the Pocket? Next: Demonsanto?* Communiqué #115. Online at: http://www.etcgroup.org/sites/www.etcgroup.org/files/files/etc_breakbad_23dec15.pdf

European Union (EU). 2004. *Guidelines on the Assessment of Horizontal Mergers under the Council Regulation on the Control of Concentrations between Undertakings*. Online at: [http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52004XC0205\(02\)&from=EN](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52004XC0205(02)&from=EN)

Fernandez-Cornejo, Jorge, and Richard E. Just. 2007. “Researchability of Modern Agricultural Input Markets and Growing Concentration.” *American Journal of Agricultural Economics*, 89(5): 1269–75.

Fernandez-Cornejo, Jorge. 2004. *The Seed Industry in U.S. Agriculture: An Exploration of Data and Information on Crop Seed Markets, Regulation, Industry Structure, and Research and Development*. Washington, D.C.: USDA. Online at: <http://ageconsearch.umn.edu/handle/33671>

Ferreira, Miguel, Massimo Massa, and Pedro Matos. 2009. “Shareholders at the Gate? Cross-Country Evidence on the Role of Institutional Investors in Mergers and Acquisitions.” *Review of Financial Studies*, 23(2): 601–44.

Fontanella-Khan, James, and Arash Massoudi. 2015. “Maths, Not History, Drives Mergers and Acquisitions.” *Financial Times*. June 29.

Fontanella-Khan, James, Arash Massoudi, and Scheherazade Daneshkhu. 2015a. “Heinz Swallows Kraft in Deal Engineered by Warren Buffet and 3G.” *Financial Times*. March 25.

Fontanella-Khan, James, Arash Massoudi, and Scheherazade Daneshkhu. 2015b. “Anheuser-Busch InBev Eyes Takeover of Rival SAB Miller.” *Financial Times*. September 16.

Friends of the Earth. 2017. *Sign-on Letter on Agrochemical and Seed Industry Mergers*. On file with author.

- Fuglie, Keith, Paul Heisey, John King, and David Schimmelpfennig. 2012. “Rising Concentration in Agricultural Input Industries Influences New Farm Technologies.” *Amber Waves*. December 3. Online at: <https://www.ers.usda.gov/amber-waves/2012/december/rising-concentration-in-agricultural-input-industries-influences-new-technologies/>
- Fuglie, Keith, Paul Heisey, John King, Carl Pray, Kelly Day-Rubenstein, David Schimmelpfennig, Sun Ling Wang, and Rupa Karmarkar-Deshmukh. 2011. *Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide*. USDA Economic Research Service. Online at: https://www.ers.usda.gov/webdocs/publications/err130/11777_err130_1_.pdf
- Fulton, Murray, and Konstantinos Giannakas. 2001. “Agricultural Biotechnology and Industry Structure.” *AgBioForum*, 4(2): 137–51.
- Fung, Brian, and Caitlin Dewey. 2018. “Justice Department Approves Bayer-Monsanto Merger in Landmark Settlement.” *Washington Post*. May 29.
- George, Bill, and Jay W. Lorsch. 2014. “How to Outsmart Activist Investors.” *Harvard Business Review*, 92(5): 88–95.
- Goodman, Jim, and Tiffany Finck-Haynes. 2018. “Monsanto-Bayer Merger Hurts Farmers and Consumers (Opinion).” *Des Moines Register*. September 1. Online at: <https://www.desmoinesregister.com/story/opinion/columnists/2018/09/01/monsanto-bayer-merger-hurts-farmers-and-consumers/1135005002/>
- Gullickson, Gil. 2018. “Not Everyone Buys into Bayer Buying Monsanto.” *Successful Farming*. June 1. Online at: <https://www.agriculture.com/news/business/not-everyone-buys-into-bayer-buying-monsanto>
- Hayenga, Marvin. 1998. “Structural Change in the Biotech Seed and Chemical Industrial Complex.” *AgBioForum*, 1(2): 43–55.
- Hayley, Andrea. 2016. “New Technology Spurs Consolidation in Seed Industry.” *Epoch Times*. September 27. Online at: <http://www.theepochtimes.com/n3/2162211-why-crispr-is-key-to-massive-agribusiness-consolidations/>
- Headey, Derek, and Shenggen Fan. 2008. “Anatomy of a Crisis: The Causes and Consequences of Surging Food Prices.” *Agricultural Economics* 39: 375–391.
- Heisey, Paul, and Keith Fuglie. 2011. “Private Research and Development for Crop Genetic Improvement.” In Keith Fuglie et al. *Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide* – USDA Economic Research Report #130, pp. 25-48. Online at: https://www.ers.usda.gov/webdocs/publications/44951/11777_err130_1_.pdf?v=0
- Holt-Giménez, Eric, and Miguel A. Altieri. 2013. “Agroecology, Food Sovereignty, and the New Green Revolution.” *Agroecology and Sustainable Food Systems* 37(1): 90–102.

Howard, Philip H. 2009. "Visualizing Consolidation in the Global Seed Industry: 1996–2008." *Sustainability*, 1(4): 1266–87.

Howard, Philip H. 2015. "Intellectual Property and Consolidation in the Seed Industry." *Crop Science*, 55(6): 2489–95.

Institute for Mergers, Acquisitions and Alliances (IMAA). 2018. *Number & Value of M&A Worldwide*. Online at: <https://imaa-institute.org/mergers-and-acquisitions-statistics/>

International Panel of Experts on Sustainable Food Systems (IPES Food). 2017. *Too Big to Feed: The Short Report*. Online at: <http://www.etcgroup.org/content/too-big-feed-short-report>

International Service for the Acquisition of Agri-biotech Applications (ISAAA). 2016. *Global Status of Commercialized Biotech/GM Crops: 2016*. Brief 52. Online at: <https://www.isaaa.org/resources/publications/briefs/52/download/isaaa-brief-52-2016.pdf>

Kelland, Kate. 2016. "U.N. Experts Find Weed Killer Glyphosate Unlikely to Cause Cancer." *Reuters*. May 16. Online at: <http://www.reuters.com/article/us-health-who-glyphosate-idUSKCN0Y71HR>

Khan, Lina, and Sandeep Vaheesan. 2017. "Market Power and Inequality: The Antitrust Counterrevolution and Its Discontents." *Harvard Law & Policy Review*, 11: 235–94.

Khan, Lina M. 2017. "Amazon's Antitrust Paradox." *Yale Law Journal*, 126: 710–805.

Khan, Lina. 2018. "The New Brandeis Movement: America's Antimonopoly Debate." *Journal of European Competition Law & Practice*, 9(3): 131–32.

King, John L. 2001. *Concentration and Technology in Agricultural Input Industries*. USDA Economic Research Service, Agriculture Information Bulletin Number 763. March. Online at: https://www.researchgate.net/profile/John_King15/publication/23516824_Concentration_and_Technology_in_Agricultural_Input_Industries/links/0c96051ddba4f06fa4000000.pdf

Kuyek, Devlin. 2007. "Sowing the Seeds of Corporate Agriculture: The Rise of Canada's Third Seed Regime." *Studies in Political Economy* 80(1): 31–54.

Kynge, James, Tom Mitchell, and Arash Massoudi. 2016. "M&A: China's World of Debt." *Financial Times*. February 11.

- Lesser, William. 1998. "Intellectual Property Rights and Concentration in Agricultural Biotechnology." *AgBioForum*, 1(2): 56–61.
- Lianos, Ioannis, Dmitry Katalevsky, and Alexey Ivanov. 2016. *The Global Seed Market, Competition Law and Intellectual Property Rights: Untying the Gordian Knot*. Centre for Law, Economics and Society, UCL. Online at: <https://www.ucl.ac.uk/cles/research-paper-series/research-papers/cles-2-2016>
- Lipin, Steven, Anita Raghavan, and Stephen D. Moore. 1999. "AstraZeneca, Novartis Confirm Plans to Merge, Spin Off Agrochemical Units." *Wall Street Journal*. December 2. Online at: <https://www.wsj.com/articles/SB944092897505924463>
- MacDonald, James M. 2019. "Mergers in Seeds and Agricultural Chemicals: What Happened?" Amber Waves. USDA. Online at: <https://www.ers.usda.gov/amber-waves/2019/february/mergers-in-seeds-and-agricultural-chemicals-what-happened/>
- Maisashvili, Aleksandre, Henry Bryant, J. Marc Raulston, George Knapek, Joe Outlaw, and James Richardson. 2016. "Seed Prices, Proposed Mergers and Acquisitions Among Biotech Firms." *Choices*, 31(4): 11 pages. Online at: <http://www.choicesmagazine.org/choices-magazine/submitted-articles/seed-prices-proposed-mergers-and-acquisitions-among-biotech-firms>
- Massoudi, Arash, and James Fontanella-Khan. 2018. "Coffee Group JAB Holding to buy Dr. Pepper Snapple." *Financial Times*. January 29.
- Massoudi, Arash, James Fontanella-Khan, and Guy Chazan. 2016. "Bayer Braced for Tough Scrutiny over \$66bn Monsanto Deal." *Financial Times*. September 14.
- Massoudi, Arash, Don Weinland, Ralph Atkins, Shawn Donnan, and Barney Jopson. 2016. "ChemChina Plays Down Alarm over \$44bn Syngenta Bid." *Financial Times*. February 3.
- Massoudi, Arash. 2016. "Watchdogs Weigh Up Pros and Cons of Seed Mergers." *Financial Times*. November 30.
- McLaughlin, David, Lydia Mulvany, and Naomi Kresge. 2018. "Bayer Wins U.S. Approval for Monsanto after Two Year Quest." *Bloomberg*. May 29. Online at: <https://www.bloomberg.com/news/articles/2018-05-29/bayer-wins-u-s-nod-for-monsanto-nearing-end-of-two-year-quest>
- McLaughlin, David. 2016. "Bayer, Monsanto, Face Global Review as Farmer Options Shrink." *Bloomberg*. September 14. Online at: <https://www.bloomberg.com/news/articles/2016-09-14/bayer-monsanto-confront-global-review-as-farmer-options-shrink>
- Meyer, Gregory, and James Fontanella-Khan. 2018. "Grain Powerhouse ADM Makes Bunge Takeover Approach." *Financial Times*. January 19.

Michalopolous, Sarantis. 2018. "DowDuPont Boss: Merger Will Speed Up Innovation to Face Farming Challenges 'Quickly'." *Euractive*. February 14. Online at: <https://www.euractiv.com/section/agriculture-food/news/wed-dowdupont-boss-the-merger-will-speed-up-innovation-to-face-farming-challenges-quickly/>

Monsanto. 2016. *Monsanto Company*. United States Securities and Exchange Commission (SEC) Filing. Online at: <https://www.sec.gov/Archives/edgar/data/1110783/000119312516711104/d250543ddefa14a.htm>

Monsanto. 2017. *Growing Better Together: 2017 Sustainability Report*. Monsanto. Online at: https://monsanto.com/app/uploads/2017/12/Sustainability_2017.pdf

Monsanto & Bayer. 2019. *It's Time to Grow*. Online at: <https://monsanto.com/company/time-to-grow/>

Mooney, Pat. 2018. *Blocking the Chain: Industrial Food Chain Concentration, Big Data Platforms and Food Sovereignty Solutions*. Ottawa: ETC Group. Online at: http://www.etcgroup.org/sites/www.etcgroup.org/files/files/blockingthechain_english_web.pdf

Mordock, Jeff. 2016. "A Wildly Different DuPont a Year After Peltz Defeat." *The News Journal*, Delaware Online. April 29. Online at: <http://www.delawareonline.com/story/money/2016/04/29/duponts-wild-ride/83650956/>

Moretti, Irene Musselli, and Olivier Matringe. 2006. *Tracking the Trend Towards Market Concentration: The Case of the Agricultural Input Industry*. Geneva: UNCTAD. Online at: http://www.ecolomics-international.org/iprsa_unctad_2006_gm_ag_incr_concentration_olivier_matrice_irene_musselli_moretti.pdf

Murphy, Sophia, David Burch, and Jennifer Clapp. 2012. *Cereal Secrets: The World's Largest Grain Traders and Global Agriculture*. Oxfam. Online at: <https://www.oxfam.org/sites/www.oxfam.org/files/rr-cereal-secrets-grain-traders-agriculture-30082012-en.pdf>

Myers, John Peterson, Michael N. Antoniou, Bruce Blumberg, Lynn Carroll, Theo Colborn, Lorne G. Everett, Michael Hansen, et al. 2016. "Concerns over Use of Glyphosate-Based Herbicides and Risks Associated with Exposures: A Consensus Statement." *Environmental Health*, 15(19): 13 pages.

Naldi, Maurizio, and Marta Flamini. 2014. *The CR4 Index and the Interval Estimation of the Herfindahl-Hirschman Index: An Empirical Comparison*. Online at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2448656

Nicolaou, Anna, James Fontanella-Khan, Adam Samson, and Leslie Hook. 2017. "Amazon Agrees to Buy Wholefoods for \$13.7 bn." *Financial Times*. June 16.

- Noel, Andrew Marc. 2016. "Syngenta Says U.S. Talks over ChemChina Bid 'Constructive'." *Bloomberg*. July 22. Online at: <http://www.bloomberg.com/news/articles/2016-07-22/syngenta-says-regulatory-talks-over-chemchina-bid-constructive>
- Organisation for Economic Cooperation and Development (OECD). 2007. "Competition and Barriers to Entry." *OECD Observer Policy Brief*. January. Online at: <http://www.oecd.org/competition/mergers/37921908.pdf>
- Parayil, Govindan. 2003. "Mapping Technological Trajectories of the Green Revolution and the Gene Revolution from Modernization to Globalization." *Research Policy* 32(6): 971–90.
- Scoles, Sarah. 2018. "Big Ag Wants Farmers to Buy into Satellite Imagery." *Wired*. March 20. Online at: <https://www.wired.com/story/big-ag-wants-farmers-to-buy-into-satellite-imagery/>
- Shapiro, Carl. 2002. "Competition Policy and Innovation." *OECD Science, Technology and Industry Working Papers*, 2002/11. Paris: OECD Publishing. Online at: <http://dx.doi.org/10.1787/037574528284>
- Stam, Claire. 2018. "Bayer Nearing Monsanto Deal Amid Stakeholder Concerns." *Euractiv*. May 31. Online at: <https://www.euractiv.com/section/agriculture-food/news/bayer-nearing-monsanto-deal-amid-stakeholders-concerns/>
- Stiegert, Kyle W., Guanming Shi, and Jean Paul Chavas. 2010. "Innovation, Integration, and the Biotechnology Revolution in U.S. Seed Markets." *Choices*, 25(2): 7 pages.
- Stockhammer, Engelbert. 2010. *Financialization and the Global Economy*. Political Economy Research Institute Working Paper 240. Online at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.434.2586&rep=rep1&type=pdf>
- The Economist. 2016. "Too Much of a Good Thing." *The Economist Magazine*. March 26.
- Torshizi, Mohammad, and Jennifer Clapp. 2019. "Price Effects of Common Ownership in the Seed Sector." *SSRN Online Journal*. Online at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3338485
- Turner, Matt. 2016. "We Just Got a Rare Insight into How Wall Street Dealmakers Make Their Money." *Business Insider*. September 12. Online at: <http://www.businessinsider.com/mergers-acquisitions-advice-on-wall-street-2016-9>
- U.S. Department of Justice. 2010. *Horizontal Merger Guidelines*. Online at: <https://www.justice.gov/atr/horizontal-merger-guidelines-08192010>

Varinsky, Dana. 2017. "Trump Could Approve a Giant Merger that's Scaring American Farmers." *Business Insider*. February 5. Online at: <https://www.businessinsider.com/bayer-monsanto-merger-trump-farmers-worried-2017-2>

Vestager, Margrethe. 2017. *Open Letter Regarding the Proposed Acquisition of Monsanto by Bayer in the Agro-industry*. August 22. Online at: http://ec.europa.eu/competition/mergers/cases/additional_data/m8084_4719_6.pdf

Wield, David, Joanna Chataway, and Maurice Bolo. 2010. "Issues in the Political Economy of Agricultural Biotechnology." *Journal of Agrarian Change* 10(3): 342–366.

World Health Organization (WHO). 2015. *IARC Monographs Volume 112: Evaluation of Five Organophosphate Insecticides and Herbicides*. International Agency for Research on Cancer. Online at: <http://www.iarc.fr/en/media-centre/iarcnews/pdf/MonographVolume112.pdf>

Wu, Timothy. 2018. *The Curse of Bigness: Antitrust in the New Gilded Age*. New York: Columbia Global Reports.

