

Mergers and Acquisitions Rose in the Past Three Decades

In the present seed industry structure, large private firms play a central role in developing and marketing seed for major field crops, such as corn, soybeans, cotton, and wheat. Moreover, the evolution of those firms provides insights into the dynamics of the modern seed industry (see box on evolution of the major seed companies).

In discussing market concentration in the seed industry, it should be noted first that the number of firms participating in the seed industry increases through each step of the production process. Plant breeding is a concentrated stage of the industry, while the production and distribution of certified seed is carried out by hundreds of companies operating in different volumes and markets. A larger number of firms are involved in the production and distribution of public varieties: the absence of exclusive property rights means that, in these cases, any individual or firm may produce the seed without permission and may distribute it without licenses (Butler and Marion, 1985, pp. 16-17). Market concentration is usually measured using the four- or eight-firm concentration ratio (CR4 or CR8), which is the share of total industry sales of the four or eight largest firms. Alternatively, market concentration may be measured by the Herfindahl-Hirschmann Index (HHI), which is the sum of squared market shares (in percentage terms) of each firm in the industry. Although it is difficult to precisely determine market size and concentration for the overall seed industry, estimates can be made of individual seed markets for major field crops.

Corn. Since its inception, the corn seed industry has included many small firms—105 of the original 190 companies operating in the 1930s were still in existence in the 1990s—together with larger market leaders, such as Hi-Bred Corn Company (which later became Pioneer), Funk Brothers Seed Company, DeKalb Agricultural Association, and Pfister Hybrid Corn (Duvick, 1998, p. 198). The size and success of the corn seed market is reflected by the fact that nearly all acreage planted in 1997 used seed purchased from the private sector.

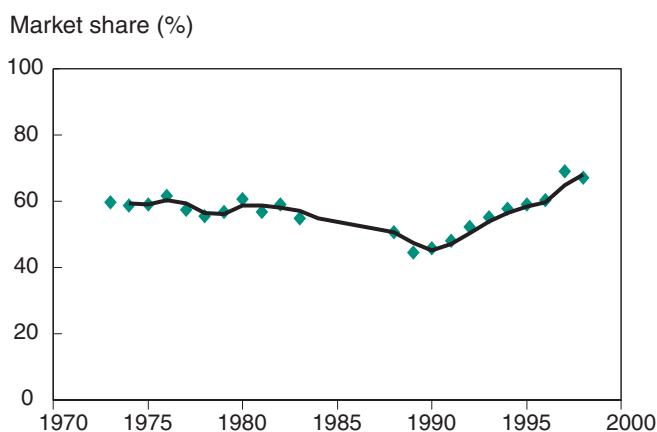
Until the 1970s, the corn seed market was characterized by small firms controlling approximately 30 percent of the industry and larger market leaders controlling 70 percent. Between 1973 and 1983, the four largest firms in the U.S. corn seed industry are

estimated to have held (CR4) between 50 and 60 percent of the market (fig. 11, table 15).

By the mid-1980s, Pioneer had expanded its market share to 38 percent while most other large firms, including Pioneer's largest competitor, DeKalb, experienced sharp declines in their market shares. The decline of other large firms, and the concurrent expansion of market share held by smaller firms, is reflected in a decrease in the CR4 ratio between 1973 and 1983 from 60 to 55 percent. In the 1990s, market concentration in corn seed had grown with the strategic entry into the industry of multinational firms. By 1997, the CR4 ratio had risen to 69 percent, as Pioneer continued to control 42 percent of the market, followed by Monsanto with 14 percent and Novartis/Syngenta with 9 percent (table 16). Smaller firms still control over 20 percent of the market.⁹

⁹ For comparison, the market structure of the seed industry is much more concentrated than the market for pesticides, another key agricultural input (Ollinger and Fernandez-Cornejo, 1995). In the seed and pesticide markets for corn and cotton, where both inputs are primarily purchased from the private sector, the CR4 ratio is higher in seed markets than in pesticide markets. From 1972 to 1989, the estimated CR4 ratio for the pesticide market averaged 45 percent, compared with 60 percent for the cotton seed market and 58 percent in the corn seed market, both of which have increased in recent periods. Recent data for corn, soybeans, and cotton, which represent a large share of the market, suggest that the seed industry is more concentrated than the pesticide industry.

Figure 11
**Market shares of four largest firms,
U.S. corn seed industry**



Source: Data sources provided in tables 15 and 16.

Table 15—U.S. market shares of corn seed by company¹

Company	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
<i>Percent</i>											
Pioneer	23.8	25.5	24.6	27.3	30.9	26.2	32.9	36.9	34.8	38.8	38.1
DeKalb ²	21.0	18.8	18.8	19.5	15.8	17.9	13.3	13.0	15.9	12.2	10.3
Asgrow	0	0	0	0	0	0	0	0	0	0	0
Funk ³	8.8	9.4	8.9	9.2	6.4	8.1	6.7	5.7	5.4	5.2	3.9
Trojan ⁴	5.9	5.1	6.8	5.6	4.2	5.4	3.8	2.0	0	0	0
Northrup-King ⁵	6.1	4.5	4.7	3.4	3.8	3.3	3.8	4.9	3.4	2.6	2.5
Zeneca/ICI	0	0	0	0	0	0	0	0	0	0	0
Cargill/PAG ⁶	4.8	6.8	3.9	3.5	4.1	4.6	3.3	4.7	5.6	5.4	4.2
Golden Harvest	0	0	1.8	2.4	2.5	3.1	2.9	1.3	3.2	2.3	2.6
Dow/Mycogen	0	0	0	0	0	0	0	0	0	0	0
Jacques/Agrigenetics ⁷	0	1.3	1.7	2	1.9	2.1	2.7	2.2	0	0	0
Other	29.6	28.6	29.8	27.1	30.4	29.3	30.6	29.3	31.7	33.6	38.4
Largest 8 firms	72.5	70.7	69.8	71.2	68.1	67.0	69.7	69.4	70.0	68.3	64.0
Largest 4 firms	59.7	58.8	59.1	61.6	57.3	55.6	56.7	60.5	59.5	59.1	54.9
Herfindahl index	0.1171	0.1159	0.112	0.1269	0.1049	0.1138	0.1354	0.1609	0.1501	0.1723	0.1604

Note: Due to the sample size of the surveys, the shares are estimates that may vary plus or minus two percentage points.

¹ Market shares are based on percentage of acres sown with respective firm's seed.

² Merged with Pfizer in 1982.

³ Acquired by Ciba-Geigy in 1974.

⁴ Acquired by Pfizer in 1975.

⁵ Acquired by Sandoz in 1976.

⁶ Acquired by Cargill in 1971.

⁷ Acquired by Agrigenetics in 1980.

Sources: 1973-80: Butler & Marion (1985), p. 90; 1981-83: McMullen (1987), p. 96.

Table 16—U.S. market shares of corn seed by company

Company	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
<i>Percent</i>											
Dupont/ Pioneer Hi-Bred	34.5	32.0	33.4	35.8	39.6	42.7	44.9	45.0	41.0	42.0	39.0
Monsanto ¹										14.0	15.0
DeKalb	9.0	8.5	9.0	8.0	8.2	8.2	8.6	9.8	10.1	10.0	11.0
Asgrow									2.0	4.0	4.0
Novartis ²										9.0	9.0
Northrup-King / Sandoz ³	4.0	4.0	3.5	4.4	4.6	4.3	4.2	4.1	5.0		
Dow Agro/Mycogen ⁴									4.3	4.0	4.0
AgrEvo/Cargill ⁵	3.0	3.0	3.0	3.5	3.7	3.8	3.9	4.0	3.3	4.0	4.0
Ciba									3.1		
ICI/Zeneca/Advanta ⁶									2.9	3.0	3.0
Golden Harvest	2.0	2.0	2.0	2.9	3.0	3.0	3.0	3.3	2.3	4.0	3.0
Others	39.7	42.7	41.7	36.7	33.1	31.3	28.6	28.4	25.6	20.0	23.0 ⁸
Largest 8 firms ⁷	52.5	49.5	50.9	54.6	59.1	62.0	64.6	66.2	72.0	80.0	77.0
Largest 4 firms	50.5	44.5	45.9	48.2	52.4	55.2	57.7	58.9	60.4	69.0	67.0
Herfindahl index	0.1300	0.1125	0.1222	0.1386	0.1679	0.1932	0.2132	0.2165	0.1864	0.2098	0.1877

¹ Monsanto acquired DeKalb in 1997 and Asgrow in 1998.

² Result of the merger between Ciba and Sandoz in 1996.

³ Northrup-King is Sandoz's American seed subsidiary.

⁴ Mycogen was bought by Dow Agrosciences in 1998.

⁵ AgrEvo acquired Cargill's domestic seed business in 1998.

⁶ ICI split in 1993 and Zeneca, the pharmaceutical spinoff, was left in control of the company's seed operations. Later in 1996, Zeneca became a part of the Advanta Seed Group.

⁷ In 1997 and 1998, market shares of only seven companies were available.

⁸ Market share amount adjusted from reported figure in Kalaitzandonakes and Hayenga to make the market add up to one.

Source: 1988-95: Merrill Lynch (various years); 1996: Kalaitzandonakes (1997); 1997: Hayenga (1998); 1998: Kalaitzandonakes and Hayenga (1999).

The Evolution of the Major Seed Companies

The evolutionary paths of four major seed companies—Pioneer/Dupont, Novartis/Syngenta, Monsanto, and Advanta Seed Group—provide some insight into the modern structure of the seed industry (figs. A-1-A-4). In each figure, the horizontal arrows pointing to a company indicate an acquisition, vertical arrows pointing down represent a merger, and a line with arrowheads at both ends indicates a joint venture.

Where possible, the nationality of the company is given in parentheses next to the company's name, along with the cost and date of acquisition.

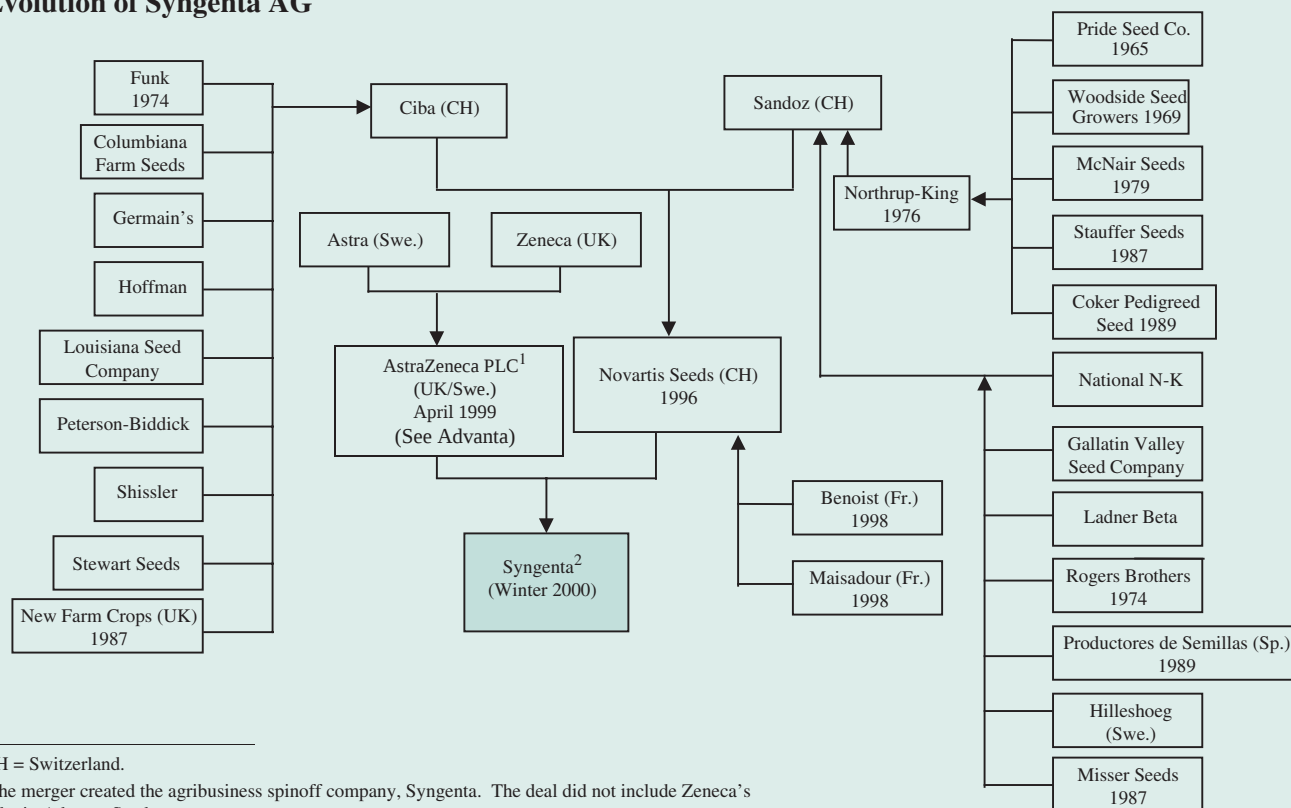
Novartis/Syngenta. Novartis was formed in 1996 by the merger of two Swiss life science giants, Ciba-Geigy and Sandoz. Sandoz brought to the merger Northrup-King, a brand name company acquired in 1976 that was well established in field crops, especially hybrid corn and sorghum. Northrup-King's own position in the market was the result of its past acquisitions of field seed companies, including Pride Seed Company, Stauffer Seeds, and Coker Pedigreed Seed. Ciba-Geigy also contributed to the merger with a long list of previously acquired seed companies, including

Funk Brothers Seeds and its extensive U.S. distribution network. The 1996 merger gave rise to a new seed division called Novartis Seeds, which controlled 7 percent of the seed market for major crops in 1997. In 1999, after operating as a complete life sciences company for only 3.5 years, Novartis announced plans to merge its agricultural business with the Swedish/English pharmaceutical giant AstraZeneca which had been formed only 6 months earlier. The agricultural spinoff, Syngenta, became a global leader in both seed and pesticide sales. According to the most recent sales figures from Merrill Lynch, Syngenta is only second to Pioneer with \$1.2 billion in annual seed sales, and first in pesticide sales with more than \$7.0 billion in annual sales (fig. A-1).

Pioneer/Dupont. Pioneer was one of the first four firms active in the emerging corn seed market in the early 1930s. Its modern achievements can be partly attributed to its success as the largest player in the corn seed market for about 40 years (Pioneer, 2001). Between 1973 and 1980, Pioneer made a series of acquisitions that further strengthened its

Figure A-1

Evolution of Syngenta AG



CH = Switzerland.

¹The merger created the agribusiness spinoff company, Syngenta. The deal did not include Zeneca's stake in Advanta Seed group.

²Merger of Novartis's crop protection and seed businesses with AstraZeneca PLC's agrochemicals business.

Sources: Fox, 1990, p. 39-40; Joly and Lemarie, 1999; Leibenluft, 1981, p. 115-116; Northrup-King Co., 2000; Schor, 1984; and Shields, 1999.

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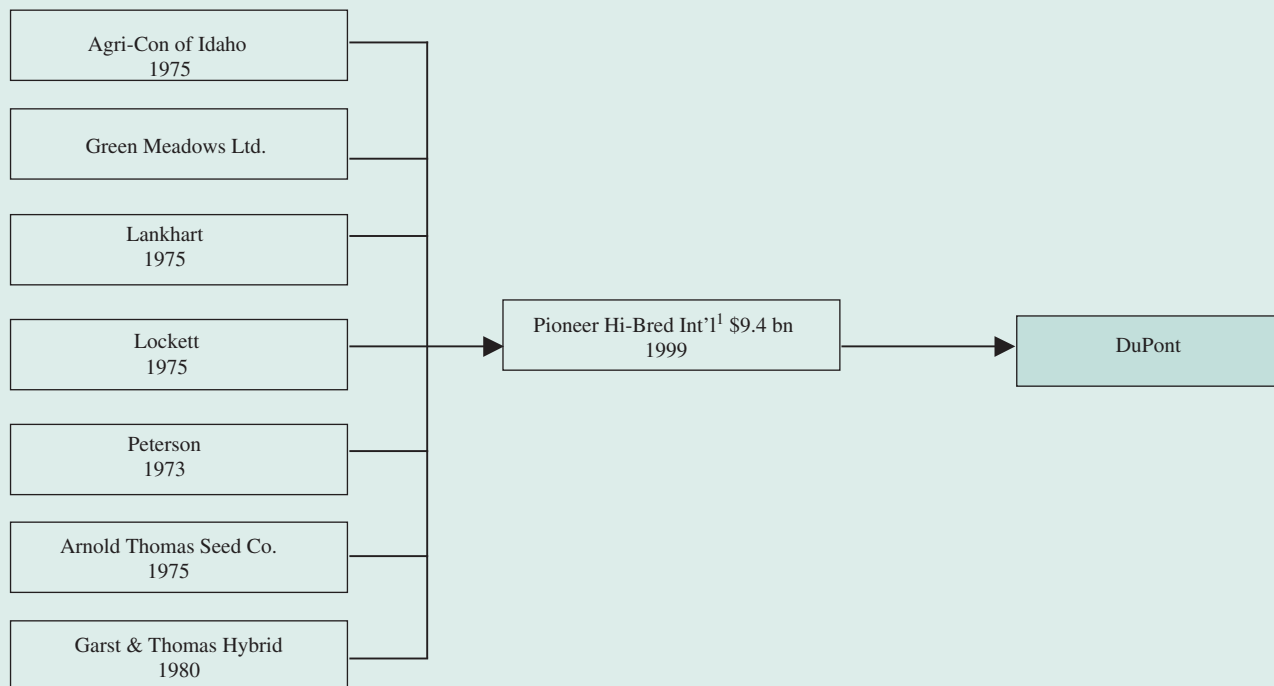
overall position in the seed market: The purchase of Lankhart and Lockett in 1975 allowed Pioneer to expand its activities in the cotton seed (used for planting and not cotton seed sold for oil or other uses) market, while its 1973 purchase of Peterson seeds gave it a larger presence in a soybean market otherwise dominated by public varieties. Bought by the chemicals giant DuPont in 1999, Pioneer continues to operate from its headquarters in Des Moines, Iowa, under the well-established Pioneer name as a part of the DuPont conglomerate. Dupont is the world's leader in production of low-use-rate herbicides, and its acquisition of Pioneer is an important element of its life sciences strategy focusing on the commercialization of a new generation of food, feed, and nutrition products developed with new biotechnology applications (fig. A-2)

Monsanto. Barely active in the seed industry until the mid-1990s, Monsanto, originally considered a chemical, then a pharmaceutical, company, acquired major players in the seed industry in a short period. In 1997, Monsanto bought Asgrow from a Mexican firm, ELM, and Calgene; in 1998,

it bought out DeKalb and Cargill's international seed business. Through the acquisition of biotechnology research companies, including Ecogen, Agracetus, and the Plant Breeding Institute, Monsanto also acquired the rights to recently developed seed technologies (fig. A-3). Monsanto also attempted to acquire more than 70 percent of the U.S. cotton seed industry with the acquisition of Delta & Pine Land in 1998. Although Monsanto sold its other cotton subsidiary, Stoneville Pedigreed, to make way for the Delta & Pine Land acquisition, the deal was called off in 1999, ultimately leaving Monsanto with no market share in cotton seed. In March 2000, Monsanto merged with Pharmacia & Upjohn, a multinational pharmaceuticals giant. The agricultural side of the merger retained the Monsanto name while the pharmaceutical and related side operates under the name of Pharmacia Corporation. After a partial initial public offering of Monsanto was launched in October 2000, Pharmacia retained 84 percent ownership. Then, on August 13, 2002, Pharmacia Corporation distributed its 84-percent stake in Monsanto Company to Pharmacia shareowners via a special stock dividend. This distribution completed Phar-

Figure A-2

Evolution of Pioneer/Dupont



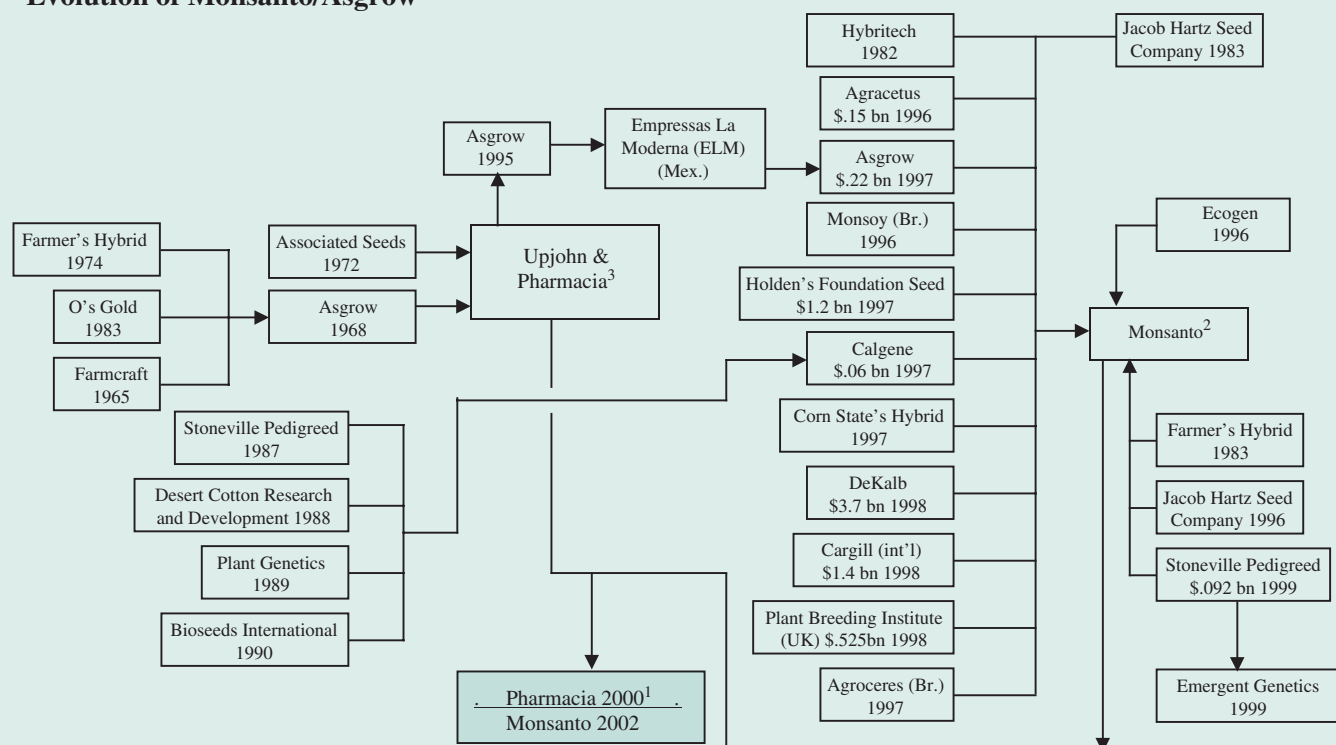
bn = billion.

¹Dupont bought 20 percent of Pioneer in August 1997 and bought the remaining 80 percent in October 1999. As a DuPont company, Pioneer continues to operate under the Pioneer name from its headquarters in Des Moines, Iowa.

Sources: Butler and Marion, 1985, p. 87; Joly and Lemarie, 1999; Leibenluft, 1981, p. 116; and Seedquest, 1999.

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Figure A-3

Evolution of Monsanto/Asgrow

bn = billion. Br. = Brazil.

¹ Monsanto Company became an agricultural subsidiary of Pharmacia Corporation in April 2000. Monsanto became completely separate and independent from Pharmacia on August 13, 2002.

² In late December 1999, Monsanto called off its \$1.9-bn deal with Delta & Pine Land (D&P). With D&P Land, Monsanto would have acquired more than a 70 percent market share in the cotton seed market since it sold Stoneville Pedigreed in mid-1999 to make way for its acquisition of D&P Land.

³ Formed in November 1995 by the merger of Pharmacia Aktiebolag and the Upjohn Company, prior to this point, Upjohn had owned Asgrow solely since 1968.

Sources: Asgrow, 2000; Fox, 1999, p. 39; Joly and Lemarie, 1999; Merrill Lynch; Monsanto website; Pharmacia, 2000; PR Newswire, 1999; Schor, 59; Seedquest, 1998; Shimoda, 1999; Wall Street Journal Interactive, 1998.

macia's spinoff of Monsanto and established Monsanto as a 100-percent publicly traded company (PR Newswire, 2002).

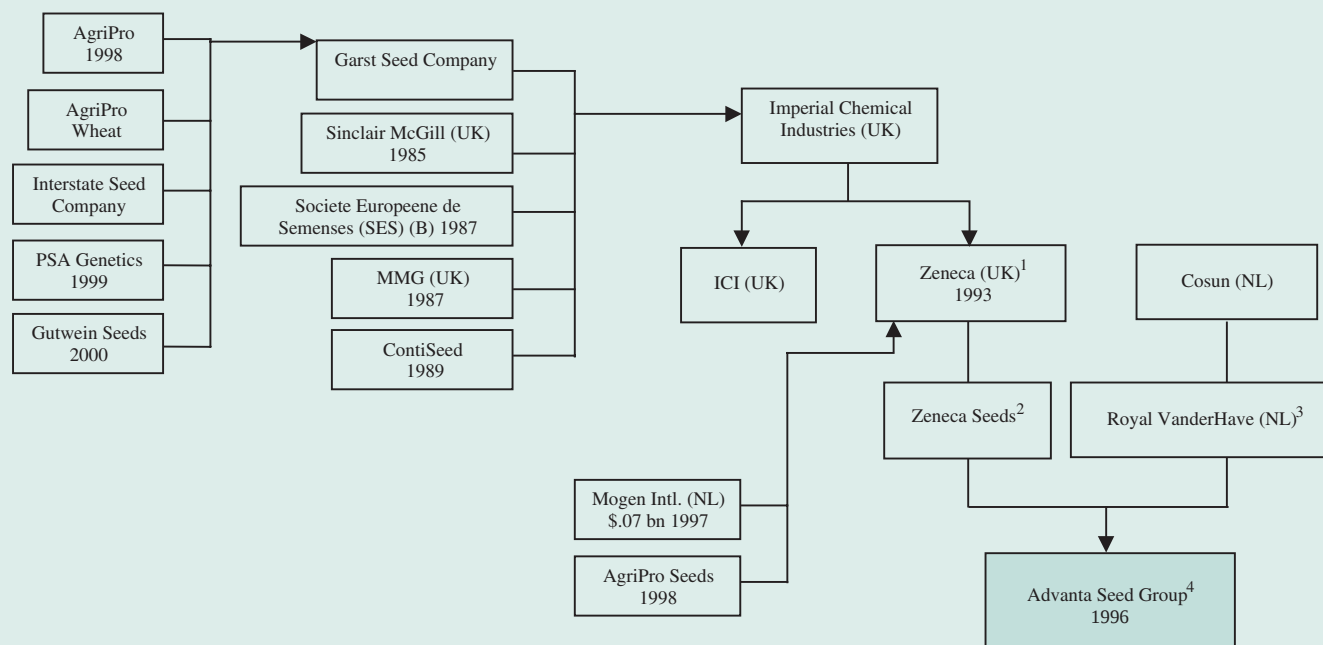
In terms of sales, Monsanto is thus the third largest player in the seed industry worldwide and the fourth largest player in the pesticide market (Monsanto, 2000). However, in terms of agricultural biotech products, Monsanto has the largest market share.

Advanta Seed Group. Advanta Seed Group similarly emerged from numerous acquisitions and joint ventures. In

1993, Imperial Chemical Industries (ICI), a British chemical manufacturing giant, split its company into ICI and Zeneca. Zeneca took over ICI's production of agrochemicals and seeds. In the deal, the ownership of Garst Seed Company, an American seed firm bought by ICI in 1985, was transferred over to Zeneca, thereby securing Zeneca's position in the U.S. market. In 1996, Zeneca merged its seed business with Royal VanderHave, the international seeds business of Dutch food manufacturer Cosun. Together with Royal VanderHave, Zeneca Seeds forms the backbone of the international seed group Advanta (box fig. A-4).

Figure A-4

Evolution of Advanta Seed Group



bn = billion. B = Belgium. NL = Netherlands.

¹On June 1, 1993, ICI split, creating a separately quoted company called Zeneca. Zeneca's industrial pursuits encompass ICI's drugs, agrochemicals and seeds, and specialties businesses.

²Zeneca Seeds is a part of Zeneca Agrochemicals. In 1999, Astra (Swe) merged with Zeneca (UK) to form AstraZeneca PLC. The agribusiness merger of Novartis AG and AstraZeneca, called Syngenta, will not change the ownership of Garst Seed Company and its subsidiaries because Advanta was not included in the deal.

³Royal VanderHave group is Cosun's international seeds business.

⁴50:50 joint venture between Zeneca Seeds and Cosun.

Sources: Abrahams, 1993; Clark, 1997; Garst Seed Co., 2000; Zeneca, 2000; Shields, 1998; Fox, 1990, p.40, 85; and Seedquest, 1999.

Soybeans. The development of soybean seed varieties was dominated by the public sector until the 1980s (table 17). However, the transformation from public to private was fairly rapid, relative to the transformation in the corn sector. In 1980, over 70 percent of soybean acres harvested in the United States were planted with publicly developed varieties, but by the mid-1990s, the public share had decreased to as low as 10 percent of the market. The increasing role of the private sector appears to have been largely due to the strengthening of intellectual property rights. The private sector's expansion into soybean seed led to a fairly concentrated industry: In the late 1980s, the four largest firms controlled about 40 percent of the soybean seed market, a relatively smaller share than in the corn seed market (table 18) (Knudson and Hansen, 1991).

However, it is difficult to discern a clear leader among these large firms in the soybean seed market. Pioneer may have held a strong position in this market, but with Monsanto's acquisitions of Asgrow and DeKalb, and with the expansion of Novartis into the market, no single firm seems to consistently outsell the others. In fact, figures may indicate that the soybean market is becoming less concentrated over time: The absence of a clear market leader, the presence of a large number of small firms, and a decrease in the HHI between 1994 and 1998 from 0.1115 to 0.0915 all point to decreasing market concentration. Such conclusions, however, depend on the number of small firms categorized as "Others" in tables 18 and 19.

Cotton. Until the early 1980s, private firms and some public institutions maintained a strong presence in the development of cotton seed varieties (table 20). The two largest private firms, Delta & Pine Land and

Table 17—U.S. shares of soybean varieties, public versus private

Year	Public sector varieties	Private sector varieties	Unknown varieties	Varieties from leading four private firms
<i>Percent of area planted</i>				
1980	70	8	22	7
1997*	10-30	70-90	--	37-47

-- = not applicable.

* Estimated figures. Smaller figure for public sector (and larger figure for private sector) assumes planted areas are roughly proportional to seed sales. Larger figure for public sector (and smaller figure for private sector) assumes most farmer-saved seed is from public sector varieties. About 25 percent of soybean seed in 1997 was estimated to be farmer saved.

Source: Heisey (1999a).

Stoneville, together controlled roughly 40 percent of the varieties planted. Smaller public and private breeders, such as Coker Pedigreed, Lankart, and University of New Mexico AES, each held between 5 and 15 percent.

In the 1980s, the cotton seed market expanded as new developments in cotton breeding brought improved seed varieties to producers, and producers recognized that the traditional practice of cleaning and separating out saved seed was less economical than purchasing seed. Between 1982 and 1997, the use of purchased seed increased from 50 to 75 percent, and large private firms rapidly replaced smaller firms and public institutions as suppliers of seed varieties. Delta & Pine Land continued

Table 18—U.S. market shares of soybean seed varieties

Institution/Company	1980	1988
	Share of acreage harvested with varieties from given breeder	Share of market sales
<i>Percent</i>		
<i>Major public breeders:</i>		
University of Illinois	20.5	NA
Mississippi AES	16.6	NA
Iowa State University	8.4	NA
University of Florida	6.2	NA
Purdue AES	4.9	NA
Arkansas AES	4.3	NA
Virginia AES	3.4	NA
Minnesota AES	3.2	NA
North Carolina State AES	2.7	NA
Total major public	70.2	30.5
<i>Major private breeders:</i>		
Northrup-King (Sandoz)	2.0	7.6
Asgrow (Upjohn)	1.8	14.9
Pioneer/Peterson	1.4	13.7
Monsanto	0.0	3.4
DeKalb	0.0	5.5
FS	0.0	2.2
Stine	0.0	3.4
North American Plant Breeders (Shell/Olin)	1.4	0.0
Ring Around Products (Occidental Petroleum)	1.0	0.0
Others	22.2	18.8
Total private and public	100.0	100.0
Largest 4 firms	6.6	42.0
Herfindahl index	0.1216	0.0526

NA = not available.

AES = Agricultural Experiment Station.

Sources: 1980: Butler and Marion (1985), p. 91; 1988: Kimle and Hayenga (1992).

Table 19—U.S. market shares of soybean seed, by company

Company	1994	1997	1998
	<i>Percent</i>		
Dupont/Pioneer Hi-Bred ¹	22.0	19.0	17.0
Monsanto ²		19.0	24.0
Asgrow	15.0	11.0	16.0
DeKalb	19.0	8.0	8.0
Novartis		5.0	5.0
Dow Agrosiences/Mycogen ³	3.7	4.0	3.0
Stine	4.0	4.0	4.0
FS	3.9		
Jacques			
Others	41.2	39.0	39.0
Public	3.2	10.0	10.0
Largest 8 firms ⁴	NA	NA	NA
Largest 4 firms	60.0	47.0	50.0
Herfindahl index ⁵	0.1115	0.0779	0.0915

NA = not available.

¹ Pioneer Hi-Bred was fully bought by Dupont in 1999.

² Monsanto acquired Asgrow in 1997 and DeKalb in 1998.

³ Mycogen was acquired by Dow Agro in 1998.

⁴ The market shares of only six companies were available in 1994, and only five in 1997/8.

⁵ The "others" category was not included in calculation of the Herfindahl index because the category is very large and the number of companies in the others category is also unknown. Public varieties were also not included in this figure.

Sources: 1994: Kalaitzandonakes (1997); Hayenga (1998); 1998: Kalaitzandonakes and Hayenga (1999).

to lead the market, a position that was strengthened by its acquisition of Paymaster in 1994 and Sure-Grow in 1996, resulting in a 76-percent share of the market by 1999. The second largest firm in the market, Stoneville, controlled only 13 percent of the market in 1999. Of the 19 small breeders (public and private) operating in 1990 with at least a 1-percent share of the market, only 7 still exist. In effect, the cotton market has become highly concentrated, a fact reflected by a CR4 ratio in 1999 of 96 percent (table 20) (fig. 12).

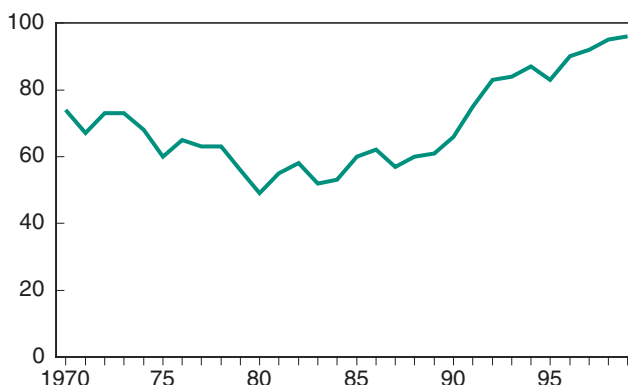
Wheat. Most U.S. wheat is cultivated from saved seed, implying that the incentives to private firm entry, research and development, and strategic behavior in the wheat seed industry are fairly limited (table 21). Furthermore, limited development of viable hybrid alternatives to self-pollinated varieties during the 1970s further constrained private sector interest in the market (Fuglie et al., 1996, p. 54-55). See also Knudson (1990) and Hansen and Knudson (1996).

As late as 1997, purchased seed accounted for only 37 percent of all acreage planted with wheat. Moreover, the public sector still plays a central role in the wheat seed market, despite more recent increases in private sector

Figure 12

Market shares of four largest firms, U.S. cotton seed industry

Market share of cotton varieties (%)



Source: Data source provided in table 20.

participation (table 22) (Heisey et al., 2001). In 1980, public breeders accounted for 72 percent of sales of hard red spring wheat seed, 80 percent for soft red winter wheat, and 85 percent for hard red winter wheat. Within the public sector, several key institutions were particularly active in providing wheat seed varieties: together the University of Minnesota and University of California at Davis provided 56 percent of the seed varieties for hard red spring wheat in 1980; Purdue University provided 65 percent of the seed varieties for soft red winter wheat; and Kansas State University and University of Nebraska provided a combined 60 percent of the seed varieties for hard red winter wheat. In the private sector, Northrup-King provided 14 percent of the seed varieties for hard red spring wheat in 1980. The total share for the private firms was 18 percent. Coker provided 7 percent of the market for soft red winter wheat, and North American Plant Breeders supplied 5 percent of the market for hard red winter wheat, with smaller firms providing the rest (Butler and Marion, 1985, p. 93).

The Effects of Concentration

The increase in seed industry concentration has raised concerns about its potential impact on market power.¹⁰ However, concentration may result in trade-

¹⁰ For example, it was reported that in 1999, after learning that the U.S. Department of Justice intended to sue over concerns about the anticompetitive effects in the cotton seed market, Monsanto abandoned its proposed acquisition of Delta & Pine Land Co., which could have combined the Nation's two largest cotton-seed firms (Ross, 2001).

Table 20—Share of cotton varieties planted in the United States, by firm or institution

Firm / Institution	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	<i>Percent</i>														
<i>Public:</i>															
Arkansas AES (Rex variety)	1	1	2	1	--	--	--	--	--	--	--	*	*	*	*
Mississippi FAES ¹ (Dixie King & DES varieties)	2	2	2	1	1	1	1	1	--	1	1	--	1	1	1
Oklahoma AES (Westburn variety)	--	--	--	--	--	--	--	1	2	1	1	1	1	--	--
Texas AES (Blightmaster & Tamcot varieties)	1	1	--	2	2	2	6	6	7	8	8	10	9	10	8
University of New Mexico AES (Acala variety)	15	11	11	15	14	10	10	10	13	13	10	13	14	13	11
<i>Private:</i>															
All-Tex	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Brownfield Seed & Delinting (Quapaw variety)	*	*	*	*	*	*	1	1	1	2	1	2	1	1	1
California Planting Cotton Seed Distributors (CPCSD)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Coker Pedigreed Seed	6	8	8	6	8	5	6	4	3	4	3	3	3	3	3
Custom Agricultural Service (Cascot variety)	*	*	*	*	*	*	*	*	1	2	2	2	2	4	3
Delta & Pine Land ² (DES, Lankart, Paymaster & Sure-Grow varieties)	28	26	29	24	23	17	20	18	18	15	14	16	16	13	16
Dunn Seed Farms	1	1	--	--	2	2	1	1	2	2	2	3	2	4	4
G & P Seed Company	*	*	*	*	*	*	*	*	*	1	1	1	2	1	2
Germain's (Acala variety)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Growers Seed Association (GSA)	*	*	*	*	*	1	3	4	7	7	7	7	2	5	6
Hyperformer	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Lankart	10	9	8	10	12	14	12	12	14	13	10	10	10	9	6
Lockett	2	2	2	2	3	4	2	1	2	2	2	2	1	1	--
McNair	1	1	--	1	--	1	1	1	1	1	1	1	2	1	3
Monsanto Company ³	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Paymaster	6	5	2	5	6	8	8	9	7	8	7	9	8	9	10
Pioneer (PR 80, Rosebud 80 varieties)	*	*	*	*	*	*	*	*	*	*	*	*	*	1	
Rilcot Seed Company (Stripper & Rilcot varieties)	2	4	3	2	5	6	4	4	2	2	2	1	1	--	--
Stoneville Pedigreed ⁴ (Stoneville, Coker & McNair varieties)	21	21	25	24	19	19	23	23	18	15	15	16	18	16	16
Summit (Deltapine variety)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sure-Grow ⁵	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
All other	4	8	8	7	5	10	2	4	2	4	13	3	7	8	10
Largest 8 firms ⁶	90	86	88	88	90	83	89	86	87	83	74	84	80	79	77
Largest 4 firms	74	67	73	73	68	60	65	63	63	56	49	55	58	52	53
Herfindahl Index	0.1648	0.1474	0.1778	0.158	0.139	0.1152	0.1345	0.1278	0.1197	0.1014	0.0982	0.105	0.11040	0.0992	0.0762

See footnotes at end of table.

--Continued

Table 20—Share of cotton varieties planted in the United States, by firm or institution—Continued

Firm / Institution	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
<i>Percent</i>															
<i>Public:</i>															
Arkansas AES (Rex variety)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Mississippi AFES ¹ (Dixie King & DES varieties)	--	1	1	2	3	3	--	--	--	--	--	--	--	--	--
Oklahoma AES (Westburn variety)	--	--	*	*	*	*	*	*	*	*	*	*	*	*	*
Texas AES (Blightmaster & Tamcot varieties)	9	7	6	5	7	3	4	1	1	1	1	1	1	1	1
University of New Mexico AES (Acala variety)	10	8	7	5	6	5	3	--	--	--	--	--	--	--	--
<i>Private:</i>															
All-Tex	--	--	1	1	3	1	2	1	1	2	2	3	2	2	2
Brownfield Seed & Delinting (Quapaw variety)	1	1	--	--	*	*	*	*	*	*	*	*	*	*	*
California Planting Cotton Seed Distributors (CPCSD)	*	*	*	*	*	*	*	5	7	6	5	7	6	5	5
Coker Pedigreed Seed	5	3	1	2	1	1	--	--	--	--	--	--	--	--	--
Custom Agricultural Service (Cascot variety)	2	2	3	2	1	1	--	1	--	--	--	--	--	--	--
Delta & Pine Land ² (DES, Lankart, Paymaster & Sure-Grow varieties)	23	27	24	30	33	38	43	54	40	71	61	71	73	72	76
Dunn Seed Farms	4	2	2	1	1	1	--	--	--	--	--	--	--	--	--
G & P Seed Company	2	1	2	1	1	1	--	--	--	--	--	--	--	--	--
Germain's (Acala variety)	2	4	4	5	5	5	4	3	1	1	1	1	--	--	--
Growers Seed Association (GSA)	4	4	3	3	1	1	1	*	*	*	*	*	*	*	*
Hyperformer	*	*	*	*	*	*	1	2	2	2	2	2	1	--	--
Lankart	7	8	4	4	4	3	--	--	--	--	--	--	--	--	--
Lockett	--	*	*	*	*	*	*	*	*	*	*	*	*	*	*
McNair	3	2	1	1	1	1	*	*	*	*	*	*	*	*	*
Monsanto Company ³	*	*	*	*	*	*	*	*	*	*	*	*	11	16	*
Paymaster	9	11	13	14	12	16	22	16	29	**	**	**	**	**	**
Pioneer (PR 80, Rosebud 80 varieties)	1	1	1	2	1	1	1	1	1	--	1	*	*	*	*
Rilcot Seed Company (Stripper & Rilcot varieties)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Stoneville Pedigreed ⁴ (Stoneville, Coker & McNair varieties)	18	16	13	11	9	7	6	8	8	8	9	9	**	**	13
Summit (Delta Pine & Land variety)	*	*	4	3	3	2	*	*	*	*	*	*	*	*	*
Sure-Grow ⁵	*	*	*	*	*	--	--	--	1	2	8	**	**	**	**
All other	1	2	10	8	8	10	13	8	9	7	10	6	6	4	3
Largest 8 firms ⁶	85	85	74	77	79	80	86	90	89	93	89	95	96	98	100
Largest 4 firms	60	62	57	60	61	66	75	83	84	87	83	90	92	95	96
Herfindahl Index	0.1244	0.1342	0.1272	0.141	0.1538	0.192	0.2564	0.3328	0.2628	0.5288	0.3984	0.5212	0.5510	0.5476	0.5978

* indicates that a company left the cotton seed industry or prior to that had presumably not been involved in the industry.

** indicates company was acquired by another company.

-- indicates less than a 0.5-percent market share.

AES Stands for Agricultural Experiment Station. These are public research facilities that also release seed varieties.

¹ Mississippi Agricultural and Forestry Experiment Station.

² Delta Pine & Land acquired Paymaster varieties in 1994.

³ Monsanto's bid for Delta Pine & Land in 1998 fell through in December 1999 when Monsanto called off the merger.

⁴ Stoneville was acquired by Monsanto in 1997 when Monsanto purchased Stoneville's parent company, Calgene. However, Stoneville was then sold by Monsanto in 1999.

⁵ Sure-Grow varieties were purchased by Delta & Pine Land in 1996.

⁶ For 1994, 1998, and 1999, there were only seven companies listed with more than 0.5-percent share of the cotton seed market.

Sources: USDA, AMS (2000); USDA, ARS (2000).

Table 21—Share of wheat seed sales by principal private and public breeders in the United States, 1980-81

Sector, institution/ company	Hard red spring	Soft red winter	Hard red winter
<i>Percentage of total sales</i>			
<i>Public sector:</i>			
University of Minnesota	34		
University of California (Davis)	22		
North Dakota University	16		
Purdue University		65	
Ohio State University		5	
University of Missouri		5	
University of Arkansas		5	
Kansas State University			35
University of Nebraska			25
Texas A&M University			10
Colorado University			10
Oklahoma State University			5
Subtotal	72	80	85
<i>Private sector:</i>			
Northrup-King/McNair (Sandoz)	14	2	
North American Plant Breeders (Shell/Olin)		4	5
Pioneer Hi-Bred		3	1
Coker (KWS)		7	
Agrigenetics			1
Western Plant Breeders	1		
World Seeds	2		
Subtotal	18	16	7
Other seeds	10	4	8
Total	100	100	100

Source: Butler and Marion (1985), p. 93.

offs between increased market power and the economies resulting from the increased concentration (arising from mergers or other combinations) (Williamson, 1968). In the case of the seed industry, if market power dominates, concentration may raise industry profits and margins, and farmers may pay

Table 22—U.S. wheat market shares, public and private varieties, 1981 and 1997

	Unknown	Public sector varieties	Private sector varieties
<i>Percent of area planted</i>			
<i>Hard red winter wheat:</i>			
1981	36	58	6
1997		85	15
<i>Hard red spring wheat:</i>			
1981	37	57	7
1997		85	15
<i>Soft red spring wheat:</i>			
1981	37	63	
1997		35	65

Source: Heisey (1999a).

higher-than-competitive prices for seeds. On the other hand, if the efficiency (or cost-reducing) effects outweigh the market power effects, concentration may be beneficial to society.

A growing body of literature presents model-based estimates of the degree of noncompetitive behavior in other industries (Appelbaum, 1979, 1982; Iwata, 1974; Gollop and Roberts, 1979; Azzam and Schroeter, 1995; Azzam, 1997). ERS examined the effects of industry concentration on market power and costs (including R&D) in the U.S. cottonseed and corn seed industries, using an econometric model to measure the relative strengths of these effects over the past 30 years (Fernandez-Cornejo et al., 2002; Fernandez-Cornejo and Spielman, 2002). The model assumes that the profit-maximizing seed firm buys its inputs, including the material input—seed purchased from contract growers—in a competitive market, and sells the seed to cotton (or corn) growers in a noncompetitive market. Most data were collected from USDA and other government sources for the period covering 1970-98. Preliminary empirical results for U.S. cotton and corn seed industries over the past 30 years suggest that increased concentration resulted in a cost-reducing effect that prevailed over the effect of enhanced market power.