THE U.S. SEED INDUSTRY: AN EXPLORATION OF STATISTICS HIGHLIGHTING THE ECONOMIC ACTIVITY OF THE U.S. ROW CROP SEED INDUSTRY

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Abstract

This report presents relevant statistics that highlight the economic activity of the U.S. seed industry. The focus of this report is on the four main U.S. crops: corn, soybean, wheat, and cotton. The report contains three sections. The first is related to the U.S. seed market's size based on seed sales and expenditures. The second section examines industry investment in research and development (R&D) activity in terms of both budget and human resources. The final section illustrates the impact of the seed industry in terms of intellectual property development, improved productivity, and other benefits. This report focuses on using publicly available data to examine these three areas. In addition, the report presents the results of a survey conducted among American Seed Trade Association (ASTA) members that helped fill some gaps in publicly available information. The report ends with identification of deficiencies in the industry data that could be improved with more study and/or reporting from the industry.

Keywords: Seed industry, field crops, biotechnology, herbicide-tolerant crops, Bt crops, corn, soybeans, cotton, wheat.

JEL Codes: L11, L16, L65, o33, o34, q16

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Introduction

The U.S. seed industry is an estimated $12 billion industry serving the needs of agricultural producers in field crops, fruits, vegetables, forage, and flowers. The industry is a leading provider of new technology that is advancing the productivity of food and fiber production through heavy investment in research and development (R&D).

The purpose of this report is to explore data sources that highlight the economic activity of the U.S. seed industry. This report focuses on the four primary U.S. cash grain crops: corn, soybean, wheat, and cotton. Information on other crops will be presented where the data allow.

This report contains three sections. The first section examines the level of seed sales in the United States from a historical, commodity-type, and regional perspective. The second section attempts to highlight the seed sector's productivity by focusing on yield improvements for the primary crops. The third section explores inputs to the seed process, namely employment and R&D activity, respectively.

In additon to examining available data on the seed industry, this report identifies potential gaps in the data to be used as the focus of future research. The closing section describes these gaps and outlines future steps that could be taken to fill them.

Seed Market Information

1. Economic Indicators of the Size of the Seed Market

The seed industry's size can be summarized by determining the overall value of sales in the marketplace. This data is difficult to identify because the seed industry is not classified as an industry by the North American Industry Classification System (NAICS). Seed is instead classified under either the Farm Services or Agricultural Chemicals categories, depending upon the company producing the seed. This makes a number of industry measures difficult to estimate, including industry sales, employment, and research and development investments.

In this section of the report, we use publicly available data from a variety of sources to paint a picture of both the global and U.S. seed industry sales. These estimates will be attributed to the group that has published them; however, we cannot verify the accuracy of these numbers. The estimates we will provide on the size of the industry are felt to be somewhat reliable as they are derived from credible sources. However, no concrete reporting structure exists for this industry.

We will start by exploring global and U.S. seed market size as reported by various consulting groups that attempt to estimate these markets. Our focus will then turn to estimating the size of the U.S. market.

1.1. Global Seed Market

In 2000, the global commercial seed market was estimated to be $24.4 billion, with the top 10 seed firms controlling 30% of the market (ETC Group, 2001). In 2002, the ETC Group estimated worldwide commercial seed sales to be about $23 billion, with the top 10 firms accounting for almost 31% of this market (ETC Group, 2003). In 2004, the commercial seed market was evaluated to be around $21 billion, which is relatively small compared to the global pesticide market ($35.4 billion) or to the pharmaceutical market ($466 billion). The top 10 seed firms represent about 49% of world seed sales (ETC Group, 2005).

According to estimates provided by industry analysts at ETC Group, the value of the overall commercial seed market was $22.9 billion in 2007 (ETC Group, 2007). Context Network also summarized parts of the industry as follows (ETC Group, 2007):

- The global proprietary seed market was worth $19.6 billion in 2006.
- In 2006, the top 10 companies account for $12.6 billion, or 64%, of the total proprietary seed market.
- The top 4 companies account for $9.6 billion, or 49%, of the total proprietary seed market.
- The top 3 companies account for $8.6 billion, or 44%, of the total proprietary seed market.

According to the Global Industry Analysts' January 2006 report, the U.S. seed market represented almost a quarter of the world market in 2005. The group anticipated that the U.S. would maintain this share of global sales through 2010 (see Table 1). The $34 billion estimate of the global seed industry represents a relatively wide discrepancy from the estimates provided by the ETC Group above. This discrepancy can most likely be attributed to differences in methodology and the types of sales included in the estimates.

Table 1: Worldwide Seed Sales

Country	2005	2010
World	$34 B	$42 B
U.S.	$7.08 B	$8.7 B
U.S. % of World Seed Sales	20.8%	20.7%

Source: Global Industry Analysts, Inc. SEEDS-A GLOBAL STRATEGIC BUSINESS REPORT. Jan 2006

In June 2008, the International Seed Federation (ISF) estimated the U.S. seed market value at $8.5 billion and global seed market value at $36.5 billion (Table 2). The Global Industry Analysts report uses ISF data, so it is our belief that the more recent estimates from the ISF are in line with the Global Industry Analysts report. The ISF states on its Web site that these estimates by country are not always updated annually because of the lack of availability to reliable data. They also accept no responsibility for the use of this information, likely because of the lack of reliability. Nonetheless, we have found no better publicly available source for estimating the U.S. commercial seed market value than the ISF estimate.

Table 2: International Seed Federation Estimate of the Domestic Seed Market in Selected Countries

Estimated Value of the Domestic Seed Market in Selected Countries (USD million)
(updated June 2008)

Note: A Euro/USD conversion rate of 1.4 has been used for these estimates

USA	8,500	Morocco	140
China	4,000	Egypt	140
France	2,150	Bulgaria	120
Brazil	2,000	Chile	120
India	1,500	Serbia	120
Japan	1,500	Nigeria	120
Germany	1,500	Slovakia	110
Italy	1,000	New Zealand	100
Argentina	950	Switzerland	90
Canada	550	Paraguay	80
Russian Federation	500	Portugal	80
Spain	450	Ireland	80
Australia	400	Algeria	70
Korea	400	Uruguay	70
United Kingdom	400	Kenya	60
Mexico	350	Iran	55
Poland	350	Israel	50
Turkey	350	Tunisia	45
Taiwan	300	Colombia	40
South Africa	300	Bolivia	40
Hungary	300	Slovenia	40
Netherlands	300	Zimbabwe	30
Czech Republic	300	Peru	30
Denmark	250	Libya	25
Bangladesh	250	Saudia Arabia	20
Greece	240	Zambia	20
Sweden	240	Ecuador	15
Romania	220	Tanzania	15
Belgium	190	Malawi	10
Finland	160	Uganda	10
Austria	150	Dominican Republic	7

Total = 32,002*

*The commercial world seed market is assessed at approx. USD 36.5 billion

Source: International Seed Federation (2008)

1.2. Estimating U.S. Seed Market Value Using Expenditure Data

An alternative method for computing total seed sales in the U.S. market would be to use farm-level expenditures for seed. Table 3 presents U.S. farm nominal seed expenditures from 1985 to 2007. Based on this information, we estimate the size of the U.S. seed industry in nominal dollars to be $11.9 billion in 2007. This estimate is well above the estimates provided by the sources listed above. There could be a number of reasons for this discrepancy, but we believe the primary difference to be that the ISF report of $8.5 billion represents commercial value of seed, while the additional $3 billion represents non-commercial seed expenditures by farmers.

Since methodologies are not explained within the ISF report, there may be other explanations for the discrepancy, such as definition of the market in terms of wholesale versus retail value or inclusion of seed treatments and other enhancements. The benefit of using expenditure data is that it reflects the demand-driven (farmer) estimate of the marketplace's value.

Real seed prices have remained relatively flat since 2003, with seed expenditures rising at the same pace or slightly slower than other farm production expenses. Seed expenditures are compared to total purchased farm inputs, illustrating the rise in importance of seed purchases as a share of the farm's total expenditures from 4.36% in 1985 to 7.2% in 2007, a rising but still relatively small amount of total purchased inputs for agriculture. Table 4 also uses the producer price index to determine the inflation adjusted (real) expenditures for seed in 1991 dollars. Seed expenditures have doubled from 1985 to 2007, which likely reflects improved performance, as will be shown in later sections of the report.

Table 3: U.S. Farm Seed Expenditures and Farm Seed Price Index

Year	Expenditure on seed	Total farm production expenditure	Share of total farm production expenditure	Producer Price Index 1991 = 1	Real expenditures on seed
	Million Dollars		Percent		Million 1991 Dollars
1985	3,128	71,671	4.36%	0.87	3,595
1986	3,188	69,956	4.56%	0.85	3,751
1987	3,259	74,234	4.39%	0.87	3,746
1988	4,060	81,696	4.97%	0.92	4,413
1989	4,397	86,121	5.11%	0.97	4,533
1990	4,518	90,097	5.01%	0.99	4,564
1991	5,113	92,071	5.55%	1.00	5,113
1992	4,913	90,400	5.43%	1.01	4,864
1993	5,163	97,743	5.28%	1.02	5,062
1994	5,373	101,578	5.29%	1.05	5,117
1995	5,462	106,310	5.14%	1.09	5,011
1996	6,212	109,205	5.69%	1.14	5,449
1997	6,711	116,534	5.76%	1.18	5,687
1998	7,214	114,544	6.30%	1.14	6,328
1999	7,217	115,225	6.26%	1.13	6,387
2000	7,519	118,136	6.36%	1.18	6,372
2001	8,222	121,577	6.76%	1.21	6,795
2002	8,925	119,548	7.47%	1.21	7,376
2003	9,425	125,789	7.49%	1.25	7,540
2004	9,625	132,841	7.25%	1.33	7,237
2005	10,426	139,253	7.49%	1.42	7,342
2006	11,026	149,113	7.39%	1.51	7,302
2007	11,927	166,327	7.17%	1.62	7,362

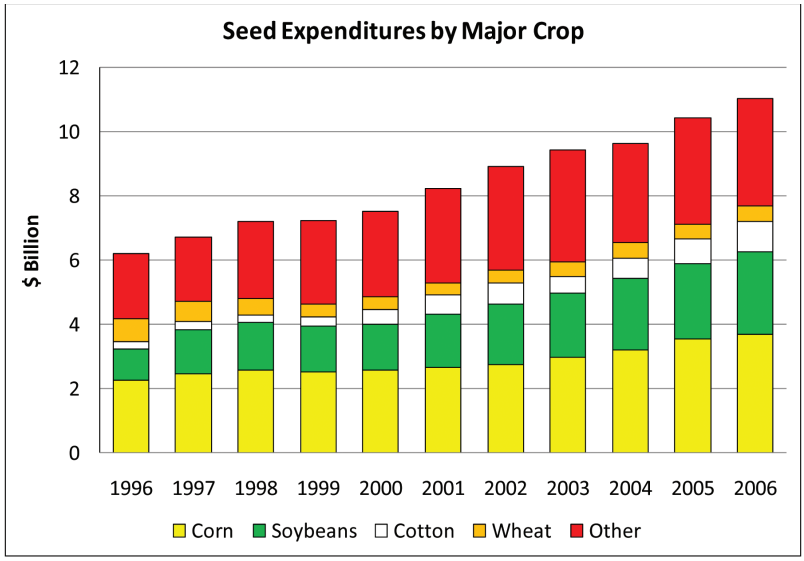
Source: United States Department of Agriculture: National Agricultural Statistics Service, various years.

1.3. Seed Expenditures by Individual Crop

Figure 1 summarizes total seed expenditures from 1996 through 2006 for the four major crops studied in this report, plus all other seeds and plants purchased by U.S. producers. Two-thirds of seed expenditures are accounted for by the expenditures for corn, soybean, cotton, and wheat seed. Corn and soybeans account for an average of 55% of seed expenditures. Corn seed expenditures have declined slightly as a percent of total expenditures during this 11-year period, while soybeans have increased from 15% to 23% of total expenditures. Cotton expenditures have also risen from 4% of seed expenditures to 8.5%, while wheat has declined from 11% to 4% over the same period.

The change in seed expenditure shares for each crop can be partially explained by shifts in planted acres of each crop. Another part of the change in share can be explained by changes in the prices of the various seed products. Prices for individual products are not readily available, but the USDA collects data on costs of production for various crops, including cost per acre for seed. We can use the cost per acre as a proxy for changes in pricing[1].

Figure 1: Seed Expenditures by Crop Type (1996–2006)

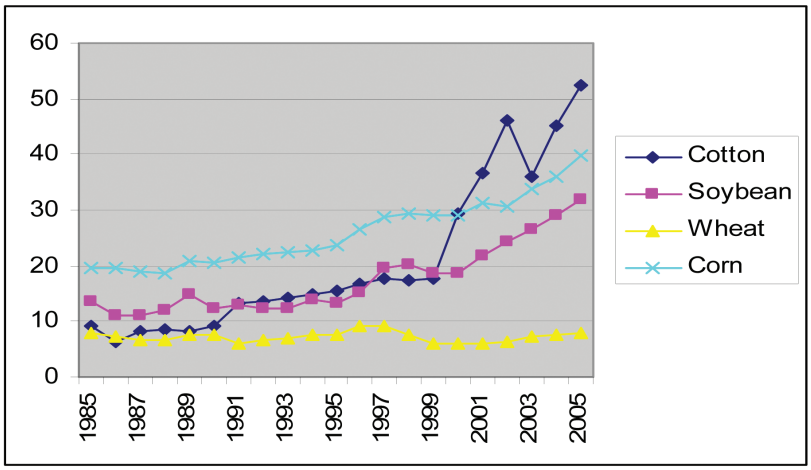


Source: Center for Food and Agricultural Business using data from ERS, USDA 2008 (http://www.ers.usda.gov/Data/ARMS/app/Farm.aspx)

[1]Changes in plant population per acre are also a part of the changes in costs per acre. Thus, this proxy for pricing likely overstates the true change in prices for the various products.

Figure 2 illustrates the change in real seed expenditures for the four main crops studied in this report: corn, wheat, soybeans, and cotton. From 1985 to 2005, wheat real seed expenditures per acre have been declining. Real seed costs per acre for corn, soybean, and cotton have steadily increased, with significant increases since 2000. This increase is likely due to new seed innovations that provided desirable crop protection traits, such as Bt and glyphosate resistance. The rapid rise in cottonseed expenditures is partially a reflection of producers shifting from saved seed from the previous year's crop to purchasing seed every year to obtain new varieties with crop protection traits.

Figure 2: Real Seed Expenses per Acre (index 1991=1) from 1985 to 2005 by Crop



Source: Center for Food and Agricultural Business using data from ERS, USDA 2007

1.4. Estimates of Seed Sub-Industry Sales

In fall 2008, Purdue University's Center for Food and Agricultural Business and the American Seed Trade Association (ASTA) conducted a survey of the ASTA membership. The purpose of the survey was to better understand the value of the seed industry broken down by major sub-industry activities. The major activities identified for this survey were trait production, seed production, wholesale activities, and retail activities. No conclusion can be drawn from the survey responses because of the limited response rate, but in the interest of full disclosure, the survey and its analysis are presented in the appendix.

Investements in Innovation and Productivity Enhancement

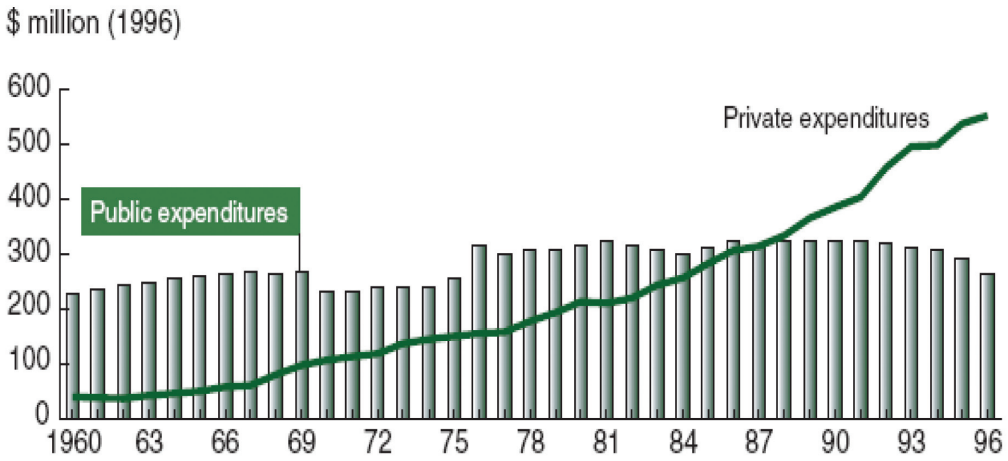
2. Measures of Investment by the Industry in Innovation and Productivity Enhancement

The purpose of this section is to explore the conduct of the seed industry with respect to investments in innovation and productivity enhancements. Exploring this particular conduct will provide some insight into the industry's willingness to contribute to the need for enhanced agricultural productivity to feed the world's growing population. One can look at innovation either from an input standpoint (R&D expenditures, human resources invested) or from an output standpoint (number of patents, yield productivity). In this section, we are interested in the inputs to the innovation process. The following section will explore some of the possible outcomes of the innovation process.

2.1. Publicly Available Measures of R&D Investments by the Seed Industry

Figure 3 summarizes the level of R&D expenditures by the public and private sector from 1960 through 1996 (Fernandez-Cornejo, 2004). This data clearly shows that investment in R&D for seed research has been stagnant to declining in the public sector since 1976, while the level of R&D investment by the private sector has continued to rise. Unfortunately, publicly available data on R&D investment in the seed industry since 1996 is quite sparse and highly variable. For instance, a study by McDougal in 2006 estimated R&D investment by the six major U.S. seed companies at around $1.6 billion. However, this estimate ignores investments from other parts of the industry including smaller companies, production companies, and retail-only companies. A study conducted by Spielman and Von Grebmer (2004) estimated expenditures in 2002 of leading multinational firms at approximately $2.8 billion, or about 10% of sales with U.S.-headquartered companies closer to 14% of sales.

Figure 3: Public and Private R&D Expenditures from 1960 to 1996



Source: Fernandez-Cornejo and Schimmelpfennig, 2004

2.2. Estimate of Current R&D Investments by the U.S. Seed Industry

To address the wide disparity in estimates of R&D investment by the U.S. seed industry, we asked ASTA members to answer the following question:

> On average, what percent of your company's U.S. seed sales are invested in R&D activities at the various stages of the production process?

As mentioned earlier in this report, no conclusion can be drawn from the survey responses because of the limited response rate. However, the survey and its analysis are presented in the appendix.

2.3. Publicly Available Estimates of Human Resources Devoted to Innovation and Productivity Enhancement by the U.S. Seed Industry

Another measure of investment in innovation for the seed industry consists of examining the amount of human resources dedicated to the process of innovating and enhancing seed. A classic measurement of the human resource investment is the number of scientist years devoted to various aspects of seed improvement. Scientist years are a measure of the time scientists spend on the various aspects of research. Table 4 summarizes the number of scientist years dedicated to seed development activities and to biotechnology enhancements. The years are broken down by university research (SAES), government research (USDA), and private research. From 1994 to 2001, there was a substantial reduction in the scientist hours dedicated to germplasm enhancement and cultivar development probably due to the profit of research in biotechnology. In addition, private investment exceeds public investment of human resources by more than a 2-to-1 margin.

Table 4: Number of Scientist Years Devoted to Plant Breeding Research, Germplasm Enhancement, Cultivar Development, and Biotechnology

	SAES		USDA		Private		Total	
	1994	2001	1994	2001	1994	2001	1994	2001
Basic plant breeding	159	85	70	54	70	210	372	349
Germplasm enhancement	153	71	85	33	85	96	403	200
Cultivar development	217	144	22	22	22	673	1,430	839
Total	529	300	177	109	177	979	2,205	1,388
Biotechnology	NA	124	NA	80	NA	566	NA	770

Source: CSREES

Productivity in the Seed Industry

3. Measures of Productivity Improvements for the Sector

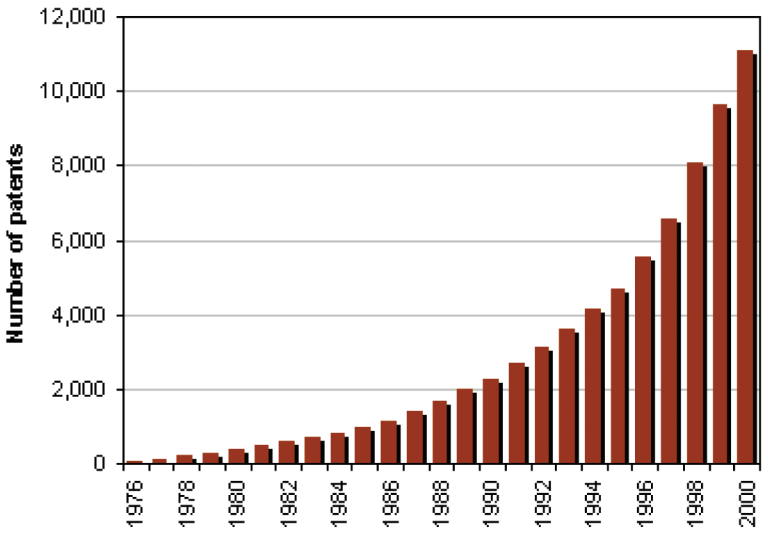
There are numerous ways one might measure the productivity of the seed industry. One way is to measure the activity or output associated with R&D investments through patent and intellectual property development activity. Another way is to measure the impact on yield productivity. Finally, there are other benefits that come from investments in improved seed technology, such as changes in farming practices that have energy saving and environmental benefits that are highlighted in this study.

3.1. Publicly Available Estimates of Intellectual Property Development

Since 1976, the number of patents has increased exponentially (see Figure 4) in technology categories, such as genetic transformation and plant technologies (see Figure 5), with the private sector (see Figure 6) issuing most of the patents. This increase in activity is likely a function of the level of R&D expenditures by the public and private sector, as well as stricter enforcement of intellectual property rights laws, such as the Plant Variety Protection Act (PVPA). Unfortunately, this data has only been collected through 2000.

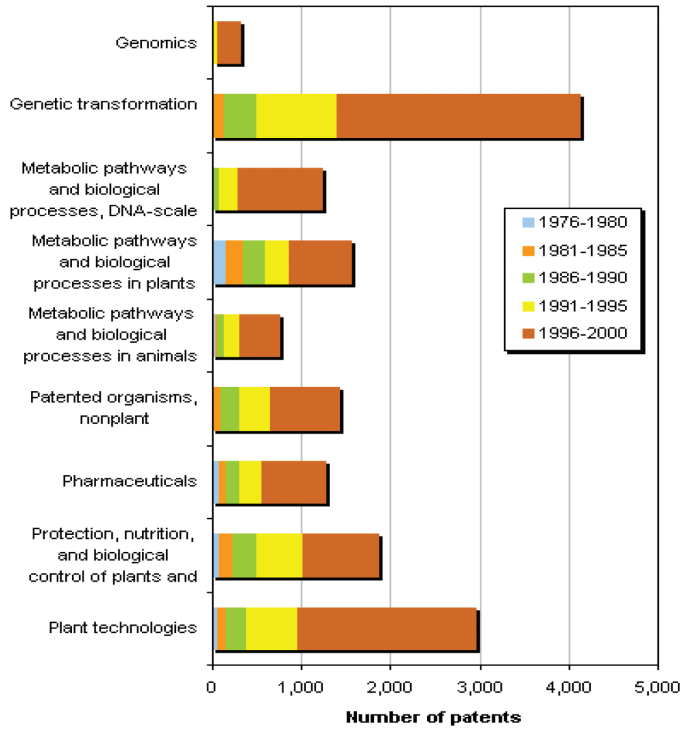
In a study conducted at Purdue University, researchers found the average number of days to obtain a permit from the Animal and Plant Health Inspection Service had gone from approximately 150 days from 1993 to 1998 to more than 400 days during the 1999 to 2004 period (APHIS database). Given this increase in the delay of receiving petitions, we might speculate that rate of increase in patents has likely slowed since 2000, if not actually declined.

Figure 4: Number of Patents Granted by Date of Application (Public and Private)



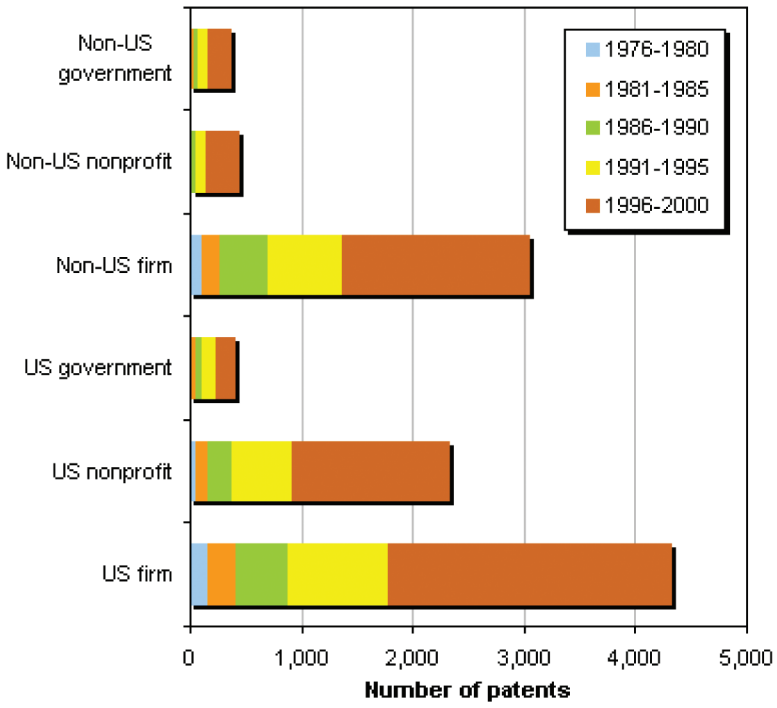
Source: Pray, Oehmke, Naseem (2005)

Figure 5: Number of Plant Biotechnology Patents by Technology Category (1976–2000)



Source: Pray, Oehmke, Naseem (2005)

Figure 6: Biotech Patents by Institutional Type

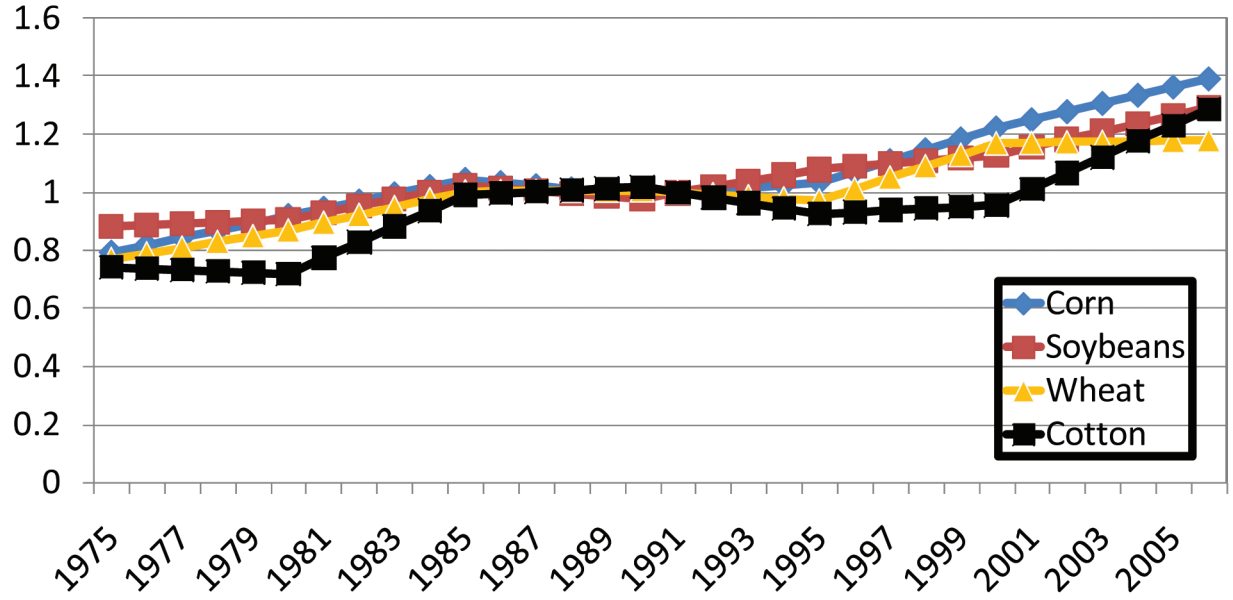


Source: Pray, Oehmke, Naseem (2005)

3.2. Publicly Available Estimates of Yield Productivity Enhancements

The last century has yielded significant improvements in agricultural productivity. Much of the increase in the early 1900s was due to agricultural mechanization, but advancements in genetic seed technology caused more recent improvements. (Fernandez-Cornejo, 2004). Figure 7 shows the steadily increasing yields for cotton, soybeans, wheat, and corn. The contribution of seed technology improvements to increased yields justifies the substantial increase in seed expenditures over time.

Figure 7: Trend Yields for Corn, Cotton, Soybeans, and Wheat Adjusted Every 5 Years (1991=1)



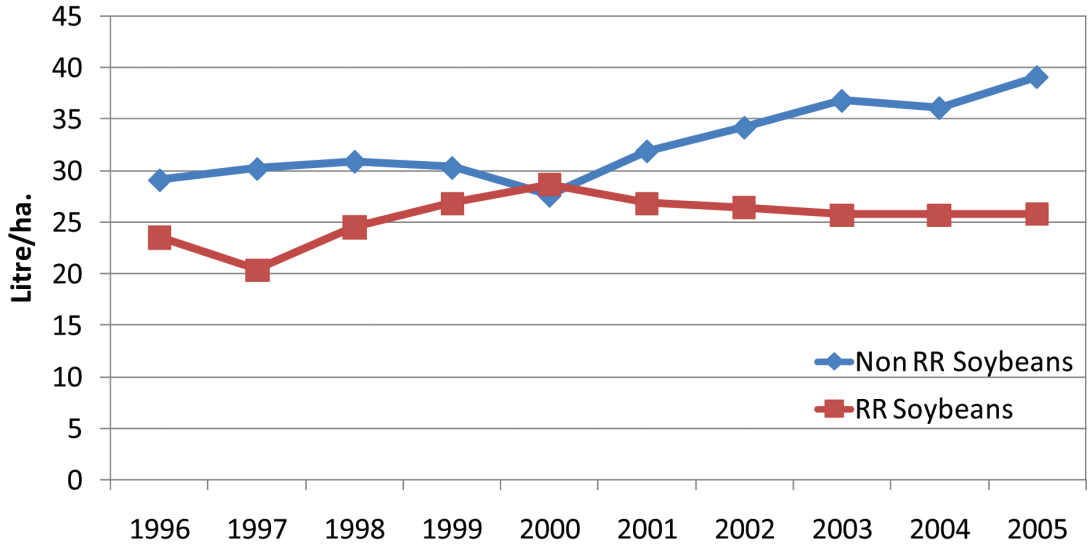
Source: Quick Stats: Agricultural Statistics Database

3.3. Publicly Available Estimates of Other Benefits from Seed Industry Advancements

Survey results have reported that using transgenic seed has reduced tillage (Marra et al, 2004;) (see Figures 8 and 9). Marra et al. (2004) reports that Roundup Ready growers make 25% fewer tillage passes over the field than growers of traditional soybean varieties. Tillage is used to control weeds, prepare the soil for planting, and incorporate herbicides. According to the Canola Council of Canada (2001), excessive tillage can change soil structure, reduce soil moisture, and increase susceptibility to erosion. Reducing tillage therefore presents obvious advantages.

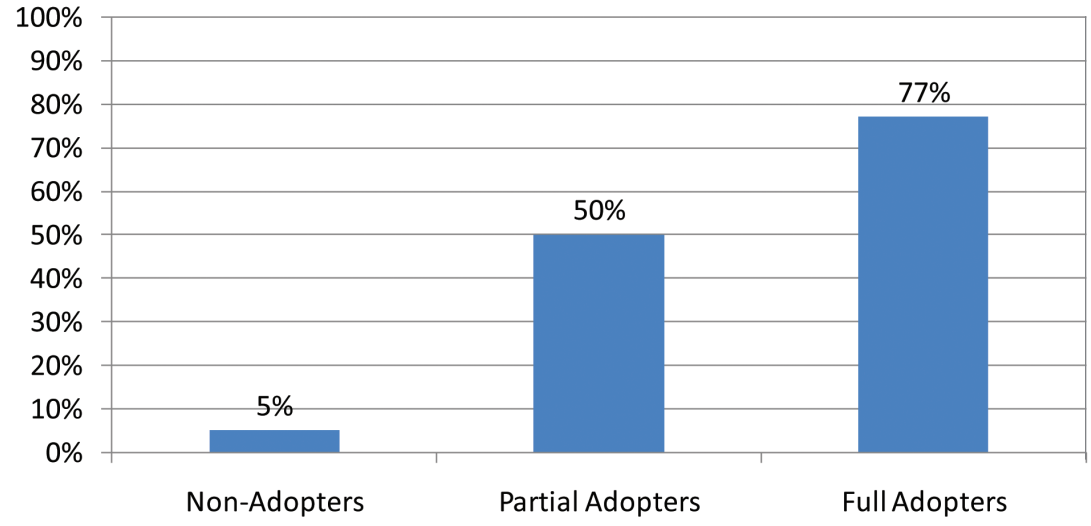
The use of transgenic seed reduces the number of pesticide applications—requiring fewer field passes, which results in less soil compaction, lowered labor costs, and reduced fuel consumption. (Thompson et al., 2007).

Figure 8: U.S. Soybean Consumption of Tractor Fuel Used for Tillage (1996–2005)



Adapted from Brookes and Barfoot (2006)

Figure 9: Change in Reduced Tillage Use as the Proportion of RR Soybean Acres Increases



Adapted from Marra et al. (2004)

Conclusion

In June 2008, the International Seed Federation (ISF) estimated the U.S. seed market value of commercial seeds at $8.5 billion and the global seed market value at $36.5 billion. Using farm-level expenditures for seed, we estimate the total size of the U.S. seed industry in nominal dollars to be $11.9 billion for 2007. Farm-level data suggests that this number has been steadily increasing, since seed expenditures have doubled from 1985 to 2007 and seed purchases as a share of the farm's total expenditures have increased, as well. This is the reflection of intense investment in research and development (R&D).

The report clearly shows that investment in R&D for seed research has been stagnant to declining in the public sector since 1976, while the level of R&D investment by the private sector has continued to rise. The number of scientist years devoted to various aspects of seed improvement shows a substantial reduction in the scientist hours dedicated to germplasm enhancement and cultivar development, probably to the profit of research in biotechnology.

Since 1976, the number of patents has increased exponentially, with the private sector issuing most of the patents. The growing number of patents is likely a result of increased R&D expenditures. The steadily increasing yields for cotton, soybeans, wheat, and corn over time are also a great tribute to the advances in seed. Survey results have also reported that using transgenic seed has reduced tillage. The use of transgenic seed has also reduced the number of pesticide applications. This requires fewer field passes, which causes less soil compaction and also lowers fuel consumption and labor costs.

While this report provides an extensive summary of available and relevant statistics about the economic activity of the U.S. seed industry, there are still gaps that need to be addressed in order to paint a complete picture of the industry. First, because the seed industry does not have its own classification as an industry in the North American Industry Classification System (NAICS), available public data on this sector is harder to extract. Second, publicly available information on seed sales and R&D investment and employment for the industry is sparse, disjointed, and often outdated. To fill this gap, we recommend direct research with seed companies. The research should focus on determining current, accurate measures of the true U.S. commercial seed market value (for the overall industry and by sub-industry), as well as measures of R&D investment in the seed industry, including the budget and the number of scientists, overall and by technology category.

Our attempt to survey seed companies was unsuccessful due to a lack of responses. The survey questionnaire may still be used as a starting point and may be implemented directly by a seed organization, which may elicit a better response rate.

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Appendix: ASTA Membership Survey

Recruitment E-mail

Survey of ASTA membership for total industry employment and total industry investment in research and development

Purpose: To provide estimates of the resources that the seed industry invests to deliver state-of-the-art seed and technology to U.S. producers.

Background: ASTA and Purdue University are engaged in a study to gather statistics of economic activity of the seed industry. We are requesting your assistance in estimating two of the key inputs (employment and investment in R&D) to the process of providing the marketplace with state-of-the art seed. This information will be combined with total industry sales (a proxy for industry size and output), as well as productivity measures such as yield trends to create a picture of the investment and benefits provided by the seed industry. This information will be used by ASTA to help communicate the importance and impact of the seed industry on the U.S. agricultural economy to policymakers and other critical constituencies.

In all cases, individual company responses will be held in strictest confidence. ASTA and Purdue have no interest in reporting individual company numbers. Our focus is solely on industry-level measurements, but we need individual company assistance to calculate industry estimates. The survey instrument is Web-based and no information regarding the specific identity of any respondent is requested. Purdue University will be the sole recipient of the raw data provided by the ASTA membership and no connection between individual responses and the companies that information represents will be included in the dataset received by Purdue University. By following this procedure, all responses will be anonymous. It is critically important to ASTA and Purdue University that trust between ASTA members, ASTA, and Purdue be maintained in this process.

This is a short survey with only four questions. Thank you for your participation in this important activity.

Please click the link to start the survey.

Web Survey

Survey of ASTA membership for total industry employment and total industry investment in research and development

1. Our estimates indicate that the U.S. seed industry was an $11.9 Billion industry in 2007. This is based on the amount of money spent by farmers on seed in the U.S. Unfortunately, public available data does not allow this aggregate sales number to be split into the sub-industries of the seed industry. To get estimated employment and R&D investments for the sub-industries we need your best estimate of the proportion of the total industry sales accounted for by each of the following sub-industry activities: (percentages should sum to 100%)?

a.	Genetic trait development/production	_____%
b.	Seed development/production/finishing	_____%
c.	Wholesale distribution and sales activities	_____%
d.	Retail distribution and sales activities	_____%

2. What proportions of your company's 2007 seed industry sales, in the U.S., were associated with the following activities: (percentages should sum to 100 across the stages. Please consider both intercompany transfers as well as sales to other companies in the various stages).

a.	Sales of genetic traits/licenses	_____%
b.	Seed development/production/finishing	_____%
c.	Wholesale distribution and sales activities	_____%
d.	Retail distribution and sales activities	_____%

3. How many full-time equivalent employees (FTE) did your company employ in 2007 that were directly involved in the following seed industry activities?

a.	Genetic trait development, production, marketing, and sales	_____%
b.	Seed production related activities	_____%
c.	Wholesale distribution and sales activities	_____%
d.	Retail distribution and sales activities	_____%

4. On average, what percent of **your company's** U.S. seed sales are invested in R&D activities at the various stages of the production process?

a.	Genetic trait development, production, marketing, and sales	_____%
b.	Seed production related activities	_____%
c.	Wholesale distribution and sales activities	_____%
d.	Retail distribution and sales activities	_____%

Survey Analysis

Publicly available information on seed sales and R&D investment and employment for the seed industry is sparse, disjointed, and often outdated. For that reason, this report also presents the results of a survey conducted among ASTA members to help fill in the gaps in publicly available information. This survey was initiated for the first time in this study and provides a first approximation of seed industry sales levels by sub-level, as well as an estimate of R&D activity for the industry. The survey results consist of 36 usable responses from seed industry representatives in the ASTA membership database. The survey respondents estimate employing 1,581 people within the seed-related areas of their business. This survey was administered via the Web and distributed in August/September 2008.

Estimates of Seed Sub-Industry Sales

Table 5 summarizes the number of firms by major function and the number of employees hired by the firms in each category. It is interesting to note that while the firms that are considered primarily wholesale represent 32% of the firms in the survey, they only account for 19% of the employment and retail firms, which account for 16% of the total firms, represent 46% of the employment.

Table 5: Number of Firms and Number of Employees Represented in the Survey

	# of Firms	Employees
Total	37	1,581
Primarily Traits	3	55
Primarily Production	7	220
Primarily Wholesale	12	298
Primarily Retail	6	733
Combination	9	275

To help understand how seed-industry value is broken down among the four major functions, survey respondents were asked the following question:

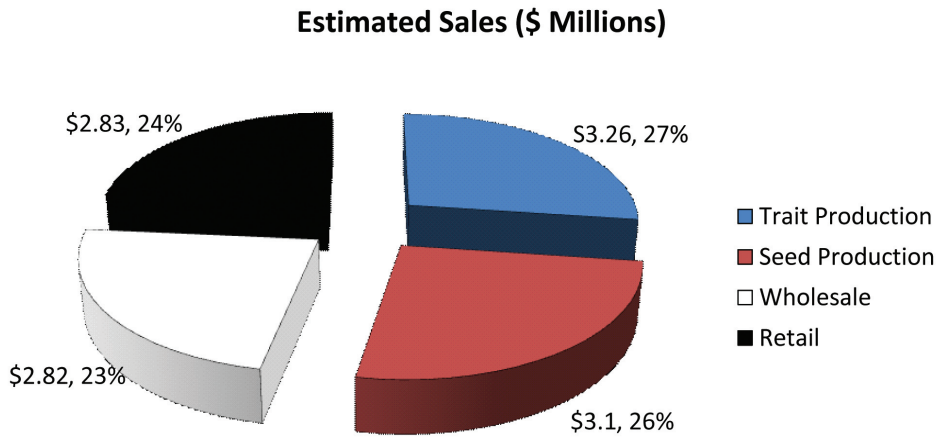
> Our estimates indicate that the U.S. seed industry was an $11.9 billion industry in 2007. This is based on the amount of money spent by farmers on seed in the U.S. Unfortunately, publicly available data does not allow this aggregate sales number to be split into the sub-industries of the seed industry. To get estimated employment and R&D investments for the sub-industries, please enter an estimate of the proportion of the total industry sales accounted for by each of the following sub-industry activities. The sum of all percentages should equal 100%.

The question asks respondents to focus on their assessment of industry breakdown and the breakdown of sales for their own business. Only 29 of the 37 companies answered this question.

Figure 10 summarizes the estimated breakdown of seed industry market value by major sub-industry activity. The values are calculated using the $11.9 billion estimated farm expenditures for seed and the average of the answers provided by the survey participants. It could be argued that the $8.5 billion estimate of commercial market value from the ISF should be used. If the ISF estimate were used, the dollar values in Figure 3 would change proportionally, but the percentage breakdown across the major sub-industry activities would not change.

Based on the results, trait production accounts for the largest share of the industry, at 27%, while wholesale activity is the lowest, at 23%. Thus, participants in the survey believe that the value of the industry is fairly evenly divided among the primary activities identified.

Figure 10: Estimated Sub-Industry Market Values Based on Farm Seed Expenditures and Seed Industry Survey Responses



Estimates based on a survey of ASTA membership with 29 firms responding. The margin of error is +/-4%.

Estimate of Current R&D Investments by the U.S. Seed Industry

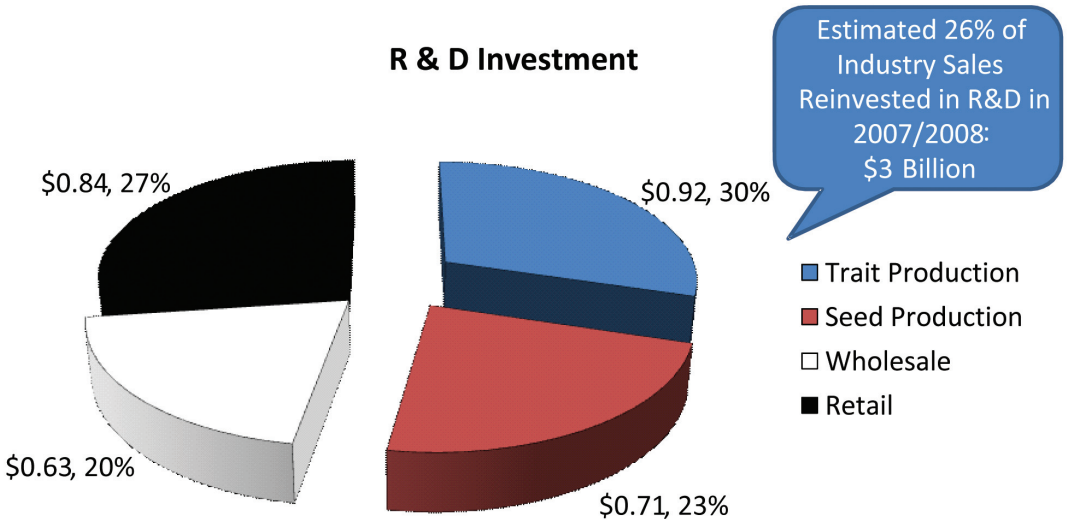
To address the wide disparity in estimates of R&D investment by the U.S. seed industry, we asked ASTA members to answer the following question:

> On average, what percent of your company's U.S. seed sales are invested in R&D activities at the various stages of the production process?

We took the average of those responses for each stage of the seed production process (genetic trait development, production, marketing, and sales; seed development/production related activities; wholesale distribution and sales activities; and retail distribution and sales activities) and multiplied by the sales estimate to arrive at an estimate of R&D expenditures for each stage of the seed production process. The results are summarized in Figure 11.

In total, the survey suggests that the industry invested $3 billion, approximately 26% of industry sales, in R&D activities. Trait production leads the way with approximately $920 million in expenditures (30% of the total), followed by the retail sector with approximately $840 million. The large investment by the retail sector is indicative of the nature of this survey's definition of R&D activity likely being broader than that of other studies. Here, R&D at the retail level likely involves field trials and on-farm trials of different seed varieties. It is likely that this level of R&D is not measured in other data. So, in one sense, the estimate of the total industry investment may be inflated compared to other statistics. However, the two more likely areas for traditional measurement of R&D, trait and seed production, add up to $1.6 billion in investment or 13.5% of industry sales, similar to other estimates of R&D expenditures.

Figure 11: Estimated Sub-Industry R&D Investment Based on Farm Seed Expenditures and Seed Industry Survey Responses



Estimates based on a survey of ASTA membership with 33 firms responding. The margin of error is +/-5%.