The Structure of U.S. Agricultural and Food Research, with an Emphasis on Seed/Biotechnology Research

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The views expressed are those of the author(s) and should not be attributed to the Economic Research Service or USDA.
Public agricultural research investments are spread across a broader array of topics, but both public and private sectors invest significant amounts in crop related research.

### Allocation of research expenditures by topic area in 2009

<table>
<thead>
<tr>
<th>Topic Area</th>
<th>Private sector</th>
<th>Public sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food &amp; feed manufacturing</td>
<td>$4.50</td>
<td>$0.00</td>
</tr>
<tr>
<td>Plant systems &amp; crop protection</td>
<td>$3.00</td>
<td>$1.00</td>
</tr>
<tr>
<td>Animal systems &amp; animal health</td>
<td>$1.00</td>
<td>$0.50</td>
</tr>
<tr>
<td>Farm machinery &amp; engineering</td>
<td>$0.50</td>
<td>$0.00</td>
</tr>
<tr>
<td>Environment &amp; natural resources</td>
<td>$1.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Human nutrition &amp; food safety</td>
<td>$0.50</td>
<td>$0.00</td>
</tr>
<tr>
<td>Economics, statistics &amp; policy</td>
<td>$0.50</td>
<td>$0.00</td>
</tr>
<tr>
<td>Social &amp; community development</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

Source: ERS based on Current Research Information System and Fuglie et al. (2011)
Across all crops, plant breeding activity allocation differs between the public and the private sector (National Plant Breeding Study, 1994)

Source: Calculated from Frey (1996)
Public and private corn research the U.S. has co-evolved, as has crops research in general

- 1930s—beginning of the diffusion of hybrid corn
- Early 1960s—hybrid corn approaches 100% of the U.S. corn area
- About 1970—half the U.S. corn area is still planted to hybrids with at least one public sector inbred parent
- About 1980—all of the U.S. corn area is now planted to hybrids with no public sector parents
- 1994—Frey (National Plant Breeding Study) finds about 35 scientist years in public sector plant breeding activities in corn; about 510 scientist years in the private sector
- Today (informal information)—four plant breeders for field corn still at the State Agricultural Experiment Stations?
  - North Dakota—new environment, about ready to hand over to the private sector
  - Wisconsin and New York—breeders focused on dairy silage
  - North Carolina—program focused on germplasm development through the introduction of exotic genetic material
Seed/biotechnology research has been the growth component of all U.S. private sector agricultural research.

Source: Fuglie et al. (2011)
Market concentration is rising in the global crop seed and biotechnology industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Four-firm concentration ratio</th>
<th>Eight-firm concentration ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Share of global market (percent)</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>21.1</td>
<td>29.0</td>
</tr>
<tr>
<td>2000</td>
<td>32.5</td>
<td>43.1</td>
</tr>
<tr>
<td>2009</td>
<td>53.9</td>
<td>63.4</td>
</tr>
</tbody>
</table>

Source: ERS based on Fuglie et al. (2011)
Different measures of research output or new product commercialization reflect high concentration ratios in the seed-biotechnology industry

<table>
<thead>
<tr>
<th>Measure of research output or new product commercialization</th>
<th>Share held by “Big 6” companies (including subsidiaries and acquisitions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. patents issued for all crop cultivars, 1982-2007</td>
<td>76</td>
</tr>
<tr>
<td>U.S. patents issued for agricultural biotechnology, 1976-2000</td>
<td>64</td>
</tr>
<tr>
<td>Field trials of genetically modified (GM) plants in the U.S., 1985 to mid-2008</td>
<td>62</td>
</tr>
<tr>
<td>GM crop approvals for planting or environmental release globally, 1985 to 2007</td>
<td>87</td>
</tr>
<tr>
<td>Market share for U.S. corn seed, 2007</td>
<td>70</td>
</tr>
<tr>
<td>Market share for U.S. soybean seed, 2007</td>
<td>55</td>
</tr>
<tr>
<td>Market share for U.S. cotton seed, 2007</td>
<td>92</td>
</tr>
<tr>
<td>Market share of trait-acres* for GM corn, soybeans, cotton, and canola worldwide in 2007</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Market share of trait-acres* for GM corn, soybeans, and cotton in the U.S. in 2009</td>
<td>&gt;95 (90% held by top firm)</td>
</tr>
</tbody>
</table>

*A “trait-acre” is the area sown to GM crops, where stacked GM traits are counted as multiple acres, depending on the number of traits stacked in a single seed.

Source: ERS, using Fuglie et al. (2011) and Moschini (2010)
In recent years startups and total firms in the small and medium agricultural biotechnology sector appear to have declined.

Source: Fuglie et al. (2011)
Thank you!

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Additional slides
Funders and performers of U.S. agricultural and food research, 2009

Federal
$3,060 million

States
$1,413 million

Private sector
$9,698 million

USDA intramural
$1,654 million

LGU-SAES
and cooperating institutions
$3,667 million

Industry
$8,850 million
(48% by ag input sectors, 52% by food sector)

USDA
$2,330 million

NSF, NIH, etc.
$730 million

$20 million

$1,597 million

$44 million

$686 million

$1,413 million

$855 million

$8,830 million

$13 million

$2,330 million

$730 million
Formation of the “Big 6” seed-biotechnology-chemical companies

Source: Fuglie et al. (2011)

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Petitions to USDA for deregulation of GM crops were highest in the mid-1990s, more variable since

Source: Calculated from Information Systems for Biotechnology (ISB) database, Virginia Tech