Competition in the U.S. Seed Industry and the Role of Intellectual Property

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* The author is a full-time employee of Iowa State University, the economic analysis presented here reflects his professional assessment, and the views articulated are his and his alone.
Outline and (preliminary) bottom line

- For the seed industry, R&D and innovation are crucial
- Public R&D is stagnating and private R&D is doing the heavy lifting
- Private R&D relies critically on intellectual property rights (IPRs)
- The seed business is very competitive but the seed industry is certainly not a competitive industry
  - Concentration is high and competition is constrained by IPRs on both biotechnology traits and germplasm
  - Some potential anticompetitive elements warrant scrutiny
- There is a tension between IPR objectives and antitrust concerns as they relate to competition issues in this industry
Innovation and productivity: Iowa corn yields, 1901-2009

Source: USDA

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Innovation in the seed industry

- Modern seeds provide value to farmers from two sources:
  - **Germplasm**
  - **Biotech traits** (e.g., herbicide tolerance, insect resistance)
    - Monsanto’s pioneering role

- Germplasm and biotech traits are **essential complementary assets**
  - both are needed for commercially viable genetically modified (GM) varieties
  - also: synergism between seed and agrochemical industries

- Seeds embody “**cumulative innovations**”
  - innovations have long-lasting value (durable goods)
  - innovations are the springboard for further improvements

- Biotech is more than GM traits
  - research tools (e.g., transformation methods, marker-assisted breeding ...)

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Evolution of the Seed Industry and IPRs

- Emergence of **biotechnology** and increased role of **intellectual property rights** have played (and are playing) a crucial role
  - Mergers and acquisitions (M&A) in the pursuit of essential complementary assets
    - research tools, GM traits, germplasm
  - Example: Monsanto’s remarkable transformation into the largest seed company in the world

- Germplasm, GM traits and biotech research tools are all amenable to IPR protection
  - **Germplasm**: trade secrets, PVPCs, patents
    - the type of IPRs matters
  - **GM traits** and **biotech tools**: patents
Milestones of IPRs for plants in the United States

- Plants long considered outside the statutory scope of patents ...
  - but: 1930 Plant Patent Act (PPA) for asexually reproduced plants


- 1980 - Diamond v. Chakrabarty
  Supreme Court decision allowing patenting of living organisms

- 1985 - Ex Parte Hibberd
  US PTO ruling that Chakrabarty applies to plants as well

- 2001 - J.E.M. Ag Supply v. Pioneer Hi-Bred International
  Supreme Court confirms validity of utility patent protection for plants

- Plus: Trade secret protection (State law)
Why intellectual property rights?

- Knowledge is a “public good”
  - “non-rival” and “non-excludable” (absent IPRs)
    Example: biolistic gun for DNA insertion into cells

- Quintessential “free rider” problem:
  - Lack of private incentives to produce a public good
  - “innovators” vs. “imitators”

- IPRs “solve” problem by granting an exclusivity to innovators
  - E.g., patents grant (limited) monopoly rights
  - It is a second-best solution
Economic effects of patents

- New products create value to users
  - exclusivity of patents allow owners to capture some of that value
  - Example: pricing of a new seed trait (e.g., insect resistance)

- The profit prospect is a powerful *ex ante* incentive to invest in R&D

- Patents restrict adoption of valuable products (*ex post efficiency loss*)
The ag biotech revolution: U.S. adoption of GM crops

<table>
<thead>
<tr>
<th></th>
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<td>Soybean</td>
<td>7%</td>
<td>54%</td>
<td>81%</td>
<td>89%</td>
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<tr>
<td>Corn</td>
<td>1%</td>
<td>25%</td>
<td>40%</td>
<td>61%</td>
<td>85%</td>
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<tr>
<td>Bt</td>
<td>18%</td>
<td>25%</td>
<td>25%</td>
<td>17%</td>
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<tr>
<td>Herbicide-tolerant</td>
<td>6%</td>
<td>11%</td>
<td>21%</td>
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<td>Stacked genes</td>
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<td>Cotton</td>
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<td>26%</td>
<td>32%</td>
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<tr>
<td>Stacked genes</td>
<td>20%</td>
<td>27%</td>
<td>39%</td>
<td>48%</td>
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Source: USDA, NASS Surveys (1996 data: ARMS Survey)
### GM corn hybrids in the United States, 2009 planting

**Source:** National Corn Grower Association

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>EVENT</th>
<th>PRODUCT</th>
<th>EVENT</th>
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<tbody>
<tr>
<td>Syngenta Agrisure CB/LL</td>
<td><strong>Bt11</strong></td>
<td>Syngenta Agrisure GT/CB/LL</td>
<td><strong>S YTGA21 + Bt11</strong></td>
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<tr>
<td>DowAgrosciences Pioneer Hi-Bred Herculex I</td>
<td><strong>TC1507</strong></td>
<td>MonsantoYieldGard</td>
<td><strong>MON 810 + S YTGA21</strong></td>
</tr>
<tr>
<td>MonsantoYieldGard</td>
<td><strong>MON 810</strong></td>
<td>Dow AgroSciences Pioneer Hi-Bred Herculex RW</td>
<td><strong>DAS-59122-7</strong></td>
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<tr>
<td>MonsantoYieldGard Roundup Ready 2</td>
<td><strong>MON 810 + Nk603</strong></td>
<td>Dow AgroSciences Pioneer Hi-Bred Herculex Xtra</td>
<td><strong>TC1507 + DAS 59122-7</strong></td>
</tr>
<tr>
<td>YieldGard Corn Rootworm Protection Roundup Ready 2</td>
<td><strong>MON 863 + Nk603</strong></td>
<td>Dow AgroSciences Pioneer Hi-Bred Herculex Rootworm Monsanto Roundup Ready 2</td>
<td><strong>DAS-59122-7 + Nk603</strong></td>
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<td>YieldGard Corn Rootworm Protection</td>
<td><strong>MON 863</strong></td>
<td>Dow AgroSciences Pioneer Hi-Bred Herculex Xtra Monsanto Roundup Ready 2</td>
<td><strong>TC1507 + DAS 59122-7 + Nk603</strong></td>
</tr>
<tr>
<td>Monsanto Roundup Ready 2</td>
<td><strong>Nk603</strong></td>
<td>YieldGard VT™ Rootworm/RR2</td>
<td><strong>MON 88017</strong></td>
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<tr>
<td>Bayer CropScience LibertyLink®</td>
<td><strong>T25</strong></td>
<td>YieldGard VT™ Triple</td>
<td><strong>MON 810 + MON 88017</strong></td>
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<tr>
<td>MonsantoYieldGard Plus</td>
<td><strong>MON 810 + MON 863</strong></td>
<td>Syngenta Agrisure RW</td>
<td><strong>MIR604</strong></td>
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<td>MonsantoYieldGard Plus with Roundup Ready 2</td>
<td><strong>MON 810 + MON 863 + NK603</strong></td>
<td>Syngenta Agrisure GT/RW</td>
<td><strong>MIR604 + S YTGA21</strong></td>
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<tr>
<td>Herculex I Roundup Ready 2</td>
<td><strong>TC1507 + NK603</strong></td>
<td>Syngenta Agrisure CB/LL/RW</td>
<td><strong>Bt11 + MIR604</strong></td>
</tr>
<tr>
<td>Syngenta Agrisure GT</td>
<td><strong>S YTGA21</strong></td>
<td>Syngenta Agrisure GT/CB/LL</td>
<td><strong>S YTGA21 + Bt11 + MIR604</strong></td>
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Monsanto’s domination of **GM traits**, United States

<table>
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<tr>
<th></th>
<th>2000</th>
<th>2005</th>
<th>2009</th>
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<tbody>
<tr>
<td><strong>CORN</strong></td>
<td></td>
<td></td>
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<tr>
<td>Single-Trait Acres</td>
<td>17.2</td>
<td>27.8</td>
<td>14.1</td>
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<tr>
<td>Double-Trait Acres</td>
<td>0.1</td>
<td>13</td>
<td>4.5</td>
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<tr>
<td>Triple-Trait Acres</td>
<td>0</td>
<td>1.3</td>
<td>31.2</td>
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<tr>
<td>RR w/ non-Monsanto traits</td>
<td>0</td>
<td>0.5</td>
<td>20.7</td>
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<tr>
<td>Total Monsanto trait acres</td>
<td>17.3</td>
<td>42.6</td>
<td>70.6</td>
</tr>
<tr>
<td>% of total planted acres</td>
<td>21.8%</td>
<td>52.1%</td>
<td>81.1%</td>
</tr>
<tr>
<td><strong>COTTON</strong></td>
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<td></td>
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</tr>
<tr>
<td>Single-Trait Acres</td>
<td>5.6</td>
<td>3.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Double-Trait Acres</td>
<td>4.1</td>
<td>7.7</td>
<td>5.3</td>
</tr>
<tr>
<td>RR w/ non-Monsanto traits</td>
<td>0</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>Total Monsanto trait acres</td>
<td>9.7</td>
<td>10.9</td>
<td>7.1</td>
</tr>
<tr>
<td>% of total planted acres</td>
<td>62.6%</td>
<td>76.8%</td>
<td>78.9%</td>
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<tr>
<td><strong>SOYBEAN</strong></td>
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<tr>
<td>Roundup Ready</td>
<td>45</td>
<td>66.4</td>
<td>71.7</td>
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<tr>
<td>Roundup Ready 2 Yield</td>
<td>0</td>
<td>0</td>
<td>1.5</td>
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<tr>
<td>Total Monsanto trait acres</td>
<td>45</td>
<td>66.4</td>
<td>73.2</td>
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<tr>
<td>% of total planted acres</td>
<td>60.4%</td>
<td>92.1%</td>
<td>94.5%</td>
</tr>
</tbody>
</table>

Source: Monsanto (percent values calculated based on USDA planted acres)
IPRs on corn and soybean Germplasm

U.S. PVPCs and patents, 1977-2006

Source: USDA and USPTO

PVPCs/patents counts

- PVPCs Soya
- PVPCs Maize
- Patents Soya
- Patents Maize

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IPRs on **Germplasm** — Corn, 1987-2006

**PVPCs**
- DuPont: 34.7%
- Monsanto: 47.6%
- Syngenta: 9.2%
- Dow: 3.3%
- Other private: 3.7%
- Public: 1.6%

**Patents**
- DuPont: 50.1%
- Monsanto: 25.7%
- Syngenta: 11.1%
- Dow: 2.8%
- Other private: 0.3%
- Public: 9.9%
IPRs on **Germplasm** — Soybean, 1987-2006

Source: USDA and USPTO

**PVPCs**

- DuPont: 31.6%
- Monsanto: 29.9%
- Syngenta: 21.5%
- Other private: 10.9%
- Public: 4.5%
- Stine: 0.4%

**Patents**

- DuPont: 21.0%
- Monsanto: 41.7%
- Syngenta: 12.4%
- Other private: 7.8%
- Public: 18.4%

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Global market shares, agrochemical and seed industries
(Source: ETC group)

<table>
<thead>
<tr>
<th>Year 2007</th>
<th>Agrochemicals</th>
<th>Seeds</th>
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<tbody>
<tr>
<td>Bayer</td>
<td>19.3%</td>
<td>Monsanto 22.6%</td>
</tr>
<tr>
<td>Syngenta</td>
<td>18.9%</td>
<td>DuPont 15.0%</td>
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<tr>
<td>BASF</td>
<td>11.1%</td>
<td>Syngenta 9.2%</td>
</tr>
<tr>
<td>Dow</td>
<td>9.8%</td>
<td>Limagrain 5.6%</td>
</tr>
<tr>
<td>Monsanto</td>
<td>9.3%</td>
<td>Land O'Lakes 4.2%</td>
</tr>
<tr>
<td>DuPont</td>
<td>6.1%</td>
<td>KWS 3.2%</td>
</tr>
<tr>
<td><strong>Market size (US $mil)</strong></td>
<td><strong>38,600</strong></td>
<td><strong>Market size (US $mil) 22,000</strong></td>
</tr>
</tbody>
</table>
Agrochemicals and seeds global sales, 2007

Source: Phillips McDougall

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A look at prices

- Seed prices have increased more than prices of (some) other inputs

- The farmers’ “demand” side:
  - GM varieties pack more than improved germplasm into seeds
  - expected yields and per-acre costs are the critical parameters
    - e.g., cost of Bt seed vs. cost of traditional seed + insecticide
  - trend in stacked GM traits
    - e.g., value of germplasm + herbicide tolerance + insect resistance

- The seeds “supply” side:
  - IPRs provide market power positions that seed companies exploit
  - Other anticompetitive issues?
Indices of prices paid by US farmers, 1997-2009

1990-92 = 100

Source: USDA

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US hybrid corn seed prices, 1990-2008

Source: USDA

Dec-09 G Moschini, USDA/Farm Foundation Workshop
US soybean seed prices, 1990-2008

Source: USDA

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Estimated Roundup Ready royalties, soybean and corn

Source: The Context Network

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Competition and the seed industry

- Extensive **M&A activities** have resulted in a very concentrated seed industry
  - Modern seeds require two essential complementary assets for competitiveness: Germplasm and GM traits
  - Access is a real issue for all but a few companies
  - Barriers to entry are high
    - R&D is expensive, development times are long, meeting regulatory requirements is costly, ...

- Numerous **licensing agreements** by dominant firm in GM traits have facilitated spread of GM varieties but might carry restrictive conditions that limit firms’ future R&D and commercial actions
Tension between IPR law and antitrust law

- IPR law aims at increasing welfare by promoting innovation
  - grant of *exclusivity is crucial* to provide incentives for private R&D
  - exclusive control of an innovation necessarily confers some *market power*

- Antitrust law aims at increasing welfare by promoting efficiency
  - monopolistic positions are not prohibited per se, but certain activities that lead to the acquisition or exercise of market power are banned

- Efficiency considerations in an innovation context are subtle
  - *ex ante* vs. *ex post* perspectives
    - the IPR tradeoff: static efficiency losses vs. dynamic innovation gains
Open Issues: Licensing of GM traits

- The need to combine GM traits and germplasm for commercially successful seeds has resulted in widespread licensing of GM traits
  - nonexclusive licensing generally viewed as procompetitive. But:
  - dominance of GM traits, and the do-it-alone threat made credible by early acquisitions (e.g., Dekalb, Holden), give Monsanto strongest bargaining position

- What constitutes an anticompetitive licensing restriction?
  - DOJ “Antitrust Guidelines for the Licensing of Intellectual Property”
    - owner of IPR not required to create competition in own technology. But ...
    - a number of licensing clauses might be anticompetitive, e.g.,
      - anti-stacking restrictions (vis-à-vis other companies’ GM traits)
      - exclusive arrangements that penalize licensee for dealing with competitors
      - exclusionary provisions
Other Open Issues

- Transition to “generic” GM seed varieties as GM traits go off patent
  - uncharted territory
  - role of existing licensing agreements — who controls the GM seed (germplasm + GM traits) after patents expiration?
  - role of regulation

- Research Joint Ventures (cooperation among competitors)
  - e.g., $1.5 billion R&D collaboration between Monsanto and BASF (2007)

- Vertical integration and the loss of small independent seed companies

- Price tag passed on to farmers: SmartStax or SmartsTax?
Conclusion

- The critical role played by IPRs makes competition issues in the seed industry somewhat unique vis-à-vis other agricultural industries.

- Innovation is of critical importance in this context:
  - evidence suggests that biotechnology is increasing the pace of innovation
  - IPRs are essential for biotechnology R&D investments

- Concentration and restrictive licensing practices remain real concerns:
  - need for further scrutiny and economic research

Thank you