RESEARCH AND INNOVATION POLICIES FOR
SUSTAINABLE PRODUCTIVITY GROWTH IN AGRICULTURE


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Texas A&M University
U.S. Corn Yield in Bushels per Acre from 1866 to 2016

- **Darwin** 1876: First genetic maps 1986
- **H. Wallace first hybrid seed sale** 1924: DNA major discoveries
- **Shull and East 1908/9**: DNA major discoveries
- **1924**: “Synthetic fertilizer” Haber-Bosch process
- **<1908**: “Hybrid vigor”
- **1924**: ‘B73’ developed 1973
- **1930 - 1975**: Public breeding
- **1996**: Period of industry consolidation
- **2013**: Heavily adopted by industry by 2013
- **2007**: Genomic selection developed in 2007
- **2012**: Drought
- **2016**: Now a $12 billion dollar private corn seed industry
Pace of Change is Slow in Plant Breeding

Nokia 2330
http://www.mymobiles.com/

Samsung S6
http://www.mymobiles.com/

7 years

1 new variety
<table>
<thead>
<tr>
<th>Agricultural Research</th>
<th>Role (naïve)</th>
<th>Metrics of Success (naïve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private (basic)</td>
<td>Discover new technologies</td>
<td>Patents, stock value</td>
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<tr>
<td>Private (startup)</td>
<td>Translate new technologies to sellable product. Sell product to established company.</td>
<td>Growth, market share, “buzz”</td>
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<tr>
<td>Private (established applied)</td>
<td>Sell product to end user (farmers); well funded incremental research</td>
<td>Product sold, market share, stock value</td>
</tr>
<tr>
<td>Non-profit / Private Research Institute</td>
<td>Conduct novel research (mostly basic)</td>
<td>Depends: publications, grant $</td>
</tr>
<tr>
<td>University Researcher</td>
<td>Conduct novel research (basic through applied), train students</td>
<td>Many: Publications, patents, varieties; students trained, classes taught; international recognition, presentations; grant $</td>
</tr>
<tr>
<td>University Extension</td>
<td>Assist farmer, conduct farmer relevant applied research</td>
<td>Number of contact hours, extension publications, $ brought in, training</td>
</tr>
<tr>
<td>ARS / ERS government research</td>
<td>Provide long-term big-picture research on agriculture and ag. economics</td>
<td>Many: research products used (industry, congress, etc.), publications</td>
</tr>
<tr>
<td>NASS government research</td>
<td>Provide unbiased and operational data routinely</td>
<td>Trusted, on-time data publications of facts</td>
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Basic Scientific Discovery ➔ Validation and Translational Research ➔ Applied Product ➔ Commercialization ➔ Sell to End User
<table>
<thead>
<tr>
<th>Agricultural Research</th>
<th>Time horizon (naïve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private (basic)</td>
<td>Short; 1-3 years</td>
</tr>
<tr>
<td>Private (startup)</td>
<td>Until VC runs out</td>
</tr>
<tr>
<td></td>
<td>Very short; 1-3 years</td>
</tr>
<tr>
<td>Private (established applied)</td>
<td>Short; 1-3 years</td>
</tr>
<tr>
<td></td>
<td>Some longer, most &lt; 5-7 years</td>
</tr>
<tr>
<td>Non-profit / Private Research Institute</td>
<td>Medium; 3-5 years</td>
</tr>
<tr>
<td>University Researcher</td>
<td>Varies: 1-7 years</td>
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<tr>
<td>University Extension</td>
<td>Very short: 1-2 years</td>
</tr>
<tr>
<td>ARS / ERS government research</td>
<td>Varies: typically 5 year cycles</td>
</tr>
<tr>
<td>NASS government research</td>
<td>Constant: Short yearly deadlines Readjust year to year</td>
</tr>
</tbody>
</table>

**Realities that make agriculture different:**
- Biology
- Outdoors
- Complex and unpredictable
- Regionally specific

Can not scale up immediately or beyond appropriate regions.

Thus...Timescale
Agricultural research progress often requires a much longer time horizon than other industries

Makes speeding things up very attractive
Justification: Increase yield, food stability and sustainability

Gains in maize yield ~50% due to genetic improvement, ~50% due to agronomy

– Duvick 1995

Agronomy includes site specific management & precision agriculture

Industry consolidation research in just the best environments

Data from USDA-NASS
Zea mays (Corn)
Commercial Hybrid

Wild species Zea
Corn X Wild species hybrid

New lines selected from crosses
March 2, 2017 listening session “Visioning of United States Agricultural Systems for Sustainable Production”

• Discuss strengths, weaknesses, opportunities and threats in the long-term future (to 50 years) of U.S. agricultural production systems; especially focusing on how to leverage new technologies and scientific knowledge.

• 86 in person participants, 58 by phone, and 50 by Web

Relevant Big-Picture Topics

• Major systematic issues are not being addressed due to a lack of integration across agricultural species and disciplines (i.e. silos, and not holistic systems);

• Missing opportunities because research lacks longer-term (>7 years) funding and longer-term performance metrics (e.g. breeding perennial grain crops)