Pressures and Challenges for Improving Technologies in Crops

The Fifth Annual Daryl F. Kraft Lecture

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Topics

- Macro/dramatic Changes in Agriculture
- Technology development in Agriculture
- **Major theme:** Agriculture is changing very rapidly, impacting exports and ultimately investing opportunities, research and risk, more than ever before.

- **Implications:** Ag research, technology, private/public partnerships
Macro Drivers to Changes in Agricultural Markets

- Global supply and demand
  - Demand growth exceeds productivity growth
- Escalation in Investment in Ag—cost reducing: Reducing costs (increasing profits) for US Growers
- Biotechnology—change in trend, geography, future traits, wheat, US vs.... ROW
- Change in geography of production and trade
  - Partly in response to biotechnology
  - More cropping alternatives
- Biofuels—35% of corn area in US is now supporting ethanol
- Volatility---more risky---

Major Themes

- Growth in exports driven by demand growth exceeding productivity growth (bullish—8-10 years)
  - Greater competition from FSU and S. America
- Increase investment in ag and ag infrastructure
Summary of the Problem: 9 billion people

- Change in demand
  - Accelerating population growth
  - Growing incomes
  - Urbanization
  - Dominance by China in many commodities

- Growth in ag productivity is slowing…
  - 1960’s 3.5%/yr
  - 2010 1.5%
  - Fertilizer use increased from
    - 1961 2 t/sq km
    - 2010 11 t/sq km

- Declining area planted in many countries/regions of the world

- Paradigm shift in commodity prices
  - 1900-2000 declining prices
  - 2000 to current..rapid real appreciation in all commodity prices
Diminishing Agricultural Productivity

**a** Yields never improved
- Maize: Morocco
- Rice: North Korea
- Wheat: Glacier County, Montana, USA
- Soybean: Lubbock County, Texas, USA

**b** Yields stagnating
- Maize: Harvey County, Kansas, USA
- Rice: Hokkaido, Japan
- Wheat: Basse-Normandie, France
- Soybean: Anoka County, Minnesota, USA

**c** Yields collapsed
- Maize: Moldova
- Rice: Enugu, Nigeria
- Wheat: Central west, New South Wales, Australia
- Soybean: Dem. Rep. of Congo

**d** Yields still increasing
- Maize: Clay County, Minnesota, USA
- Rice: Faulkner County, Arkansas, USA
- Wheat: Big Stone County, Minnesota, USA
- Soybean: Baradero Municipio, Buenos Aires, Argentina
Cereals Productivity

Demand: Where Does the Growth Come From (e.g., Soybean)?

- **Source of Demand Growth** driven by:
  - Population, income growth, urbanization, women in work force and demographics

- **Income growth**: impacts of large income elasticities (% ΔD/% ΔI)
  - China: .47 vs.... US <.15
  - NAfrica, SE Asia, S Africa also have relatively large income elasticities of demand for soybeans,
  - Africa…very high elasticity, but, no income

- **Urbanization, women in the work force and population demographics!**
  - Results in irreversible changes in diets
  - Similar impacts in corn, higher-protein wheats

Chen Xiwen, deputy director of the Leading Group on Rural Work under the Central Committee of Communist Party of China

“If the country’s grain output will not speed up, possible food shortage will threaten the development of urbanization….,” In order to underpin the development of urban expansion, China has to make efforts to secure a stable supply of grain …
China Soybean Supply Demand

- The fastest growth market in the world is China Soybean Imports
- This has induced
  - Huge investments in port (PNW)
  - Infrastructure and expansion in rail/handling capacity
- Longer term:
  - Projections to 2021 by USB (Informa): 106 mmt (vs. current ≈ 58mmt)
  - USDA 2013: increase to 103 mmt in 2022/23
  - PROExporter (July 2012) China imports to increase at 2 mmt/yr
**Facts: China to become major importer of wheat**

- Chinese wheat prices have hit record peaks due to dwindling high-quality supplies and growing expectations state purchase prices will rise before the planting season begins next month.
- "If the price gap widens further, China could step up imports from Australia, Canada and may also be interested in U.S. HRS.

**JCI Interpretation**

- China May Boost Wheat Imports to Curb Prices, Shanghai JC Says
  - Sept. 25 (Bloomberg) -- China, the world’s biggest wheat consumer, may increase imports to boost stockpiles and help curb record gains in local prices, Shanghai JC Intelligence Co. said.
  - Wheat traded in central Henan province, the biggest growing region, rose 3.4 percent this month to 2,760 yuan ($451) a metric ton, according to data by China National Grain & Oils Information Center. The government may sell from stockpiles and ask state-owned companies to import additional supply, Shanghai JC analyst Shi Wei said by phone today.
  - A smaller harvest this year and rising demand during the mid-autumn holidays last week helped boost prices, according to Shi. Imports may total 7.5 million tons in the year that started June 1, Grain.gov.cn said on Sept. 23. That compares with 9.5 million tons estimated by the U.S. Department of Agriculture.
  - Last year’s purchases were 3 million tons.
  - "China’s wheat is more expensive, so there is always strong motivation to import," Shi said. "Only the government can decide whether to sell domestic stockpiles to curb prices and when to buy imports."
China Corn Supply Demand

Past:
- Periodic exporter (from North to South)
- Draw down in stocks is a significant change in policy in early 2000

Recent suggestions of like acceleration in corn imports
- Hanver Li (JCI Intelligence) anticipates that China will import as much as 15mmt in 2014-2015.
- Basse (November 2011) at 8-12 mmt by 2014
- Rabobank 10 mmt (Nov 2011) by 2014 (down from 25 mmt est in Dec 2011):

Chinese apparent strategic efforts on corn acquisition (buy at CME<600)
China to Invest in Ukraine Farms  Sept 2013

- Reuters) - China is to buy 3 million hectares (7.4 million acres) of Ukrainian farmland,
- China's official Xinjiang Production and Construction Corps has signed an agreement with Ukrainian agricultural firm KSG Agro, which would see Ukraine provide 100,000 hectares to China. That would eventually rise to 3 million hectares.
- China must expand its overseas farming to ensure sufficient food supplies because of its limited land and low productivity.
- China's overseas expansion in agriculture has raised some concern.
  - In June, Australian politicians called for greater scrutiny over farm purchases by foreign buyers. Chinese investors bought up Australia's biggest cotton farm in 2012.
- China, has aims to be 95 percent self-sufficient in food,
Genetic Modification in Grain Crops—Game Changer

• Changing geography on production and displacing other crops, notably small grains

• Changing technology growth rates

• Impacts
  ◦ First mover advantages to countries/regions/states targeted by agbiotech firms---4-5 year advantage
  ◦ Greatest appreciation in land values
    • those regions transforming from non-GM technology; to more GM technology.
    • i.e., technology efficiency is partly capitalized into value of technology and value of land for which the technology is applied.
Corn Belt Moves North!

*BusinessWeek, Nov 12*

The Corn Diaspora
A warming climate means more hospitable growing conditions for Canadian corn, and the farmland market is responding.

**Change in farmland price, 2001 to 2011**
- Alberta: +157%
- Saskatchewan: +112%
- Manitoba: +115%
- Montana: +59%
- North Dakota: +87%

**+78%**
Change in corn grown in the Canadian prairie provinces, 2002 to 2012

Climate Change
Canada’s Corn Belt Attracts the Hot Money

...is likely to climb by as much as 3C (6F) in the region by 2050, according to Canadian researchers. A temperate climate and longer growing season are ideal for corn. An...
Monsanto to spend $100 mln on W. Canada corn over 10 years
Mon Jun 24, 2013 11:49am EDT
By Rod Nickel

- (Reuters) - Seed developer Monsanto Co said on Monday that it would spend $100 million over the next 10 years on breeding corn for Western Canada, a move it said might change the crop makeup in a fertile region that produces big harvests of spring wheat and canola.
- Monsanto said it would focus on producing corn that matures earlier than current varieties, making it a seeding option for an area of Western Canada spanning 26 million acres (10.5 million hectares).
- Factoring in farmers' crop rotations, corn may annually occupy 8 million to 10 million acres of Western Canada by 2025, Monsanto said.
- Corn prices are attractive to Canadian farmers, but the relatively short growing season in parts of Western Canada, particularly in the top grain-growing province of Saskatchewan, has led to a focus on wheat, canola, barley, oats and a host of niche crops like mustard and lentils.
- Monsanto will aim to breed corn varieties that mature in 70 to 85 days. Currently, the earliest maturing variety in Monsanto's Dekalb brand needs 76 days.
- Monsanto's rival DuPont Pioneer also sees a bright future for corn in Western Canada, likely at the expense of other feed grains like barley and wheat.
- Monsanto's increased budget for breeding corn suitable for Western Canada places it in the company's top three Canadian spending priorities, behind canola and soybeans.
HRS Area: Has retained area relative to rest of wheat sector due to demand growth, competitive pressures and niche market characteristics— acres decline from peak <20% (vs. rest of wheat which has declined 40%)
North Dakota Crop Planted Area

Planted Acres (Millions)

- Barley
- Corn
- Soybeans
- Durum
- HRS

Net Return Per Acre and 2013: Jamestown ND

ND Farm Mgmt Records
Ag Technology:

- Massive resources and Money being spent on numerous technologies to improve productivity of agriculture
- The world will see massive changes in the coming decades as a result of these efforts
- Seeds, biotechnology, machinery, water, informatics, logistics, processing, food-safety
- Returns to research in agriculture is important, valuable and in many cases undervalued
ND Annual Growth Rate in Productivity

Table 1: Annual growth rate (percent per year) in agricultural productivity

<table>
<thead>
<tr>
<th>Decade</th>
<th>Total farm</th>
<th>Livestock</th>
<th>Crops</th>
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<tbody>
<tr>
<td>1980 - 1990</td>
<td>3.46</td>
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<tr>
<td>1990 - 2000</td>
<td>1.90</td>
<td>0.92</td>
<td>2.10</td>
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<tr>
<td>2000 - 2010</td>
<td>2.29</td>
<td>0.13</td>
<td>2.62</td>
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</table>

Longer Term Productivity Growth in North Dakota Agriculture: Crops and Livestock

ND Ag Research Expenditures, and Growth in Ag Productivity
Estimated Cumulative Distribution for Return on Investment in North Dakota

- **25%**: ROI to agriculture research in ND over the period 1960-2011
- Agriculture research in ND is attractive and exceeds that of most of the rest of the country.
Value of HRS Varieties in ND
(Elements of Value: Glenn top, Faller Lower Panel)

Table S3: Value of Varieties using Ex Post Analysis ($million)

<table>
<thead>
<tr>
<th></th>
<th>Glenn</th>
<th>Faller</th>
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<tbody>
<tr>
<td></td>
<td>Peak Year 2008 PV vs. Best 3 NDAES Varieties</td>
<td>Peak Year 2009 PV vs. Best 3 NDAES Varieties</td>
</tr>
<tr>
<td>Total Value</td>
<td>44 137</td>
<td>-51 -127</td>
</tr>
<tr>
<td>Attribute</td>
<td>Value attributed to</td>
<td>Value attributed to</td>
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<tr>
<td>Yield</td>
<td>40 -78</td>
<td>2 16</td>
</tr>
<tr>
<td>Protein</td>
<td>4 224</td>
<td>301 -73</td>
</tr>
<tr>
<td>Flour Extraction</td>
<td>-1 -19</td>
<td>-29 10</td>
</tr>
<tr>
<td>Flour Absorption</td>
<td>0 9</td>
<td>8 -4</td>
</tr>
<tr>
<td>DON</td>
<td>1 2 2</td>
<td>0 -0.3</td>
</tr>
</tbody>
</table>

Total Value

Yield
Protein
Flour Ext
Absorp
DON
Total

Graph showing planted acres and value attributed to different attributes.

Graph showing the value of varieties using ex post analysis in million dollars.
Crop Improvement Technology:  
GM Tech and “Seeds and Traits”

- Competing crop technologies have embraced
  - Marker-Assisted Breeding
  - GM technology

- Emergence of “Seeds and Traits” as business

**Seeds & Traits Platform:** combining novel genetic traits with elite germplasm to develop crops that thrive while expressing the desired trait.

- Discovering novel genes.
- Transforming them into the cells of plants.
- Optimizing the expression of the genetic trait in plants in the correct plant tissues, at the appropriate time and in sufficient levels.
- Incorporating, through breeding, the genetic trait into commercially viable varieties or hybrids.

- Business strategy e.g., From Dow
  - Introduction of genetic traits via biotechnology does not reduce the importance of superior germplasm in the host plant, nor does it replace the need for plant science and plant breeding.

- Fundamental *Paradigm Shift* on Technology Distribution
Research Expenditures: Seeds and Traits

SOURCE: Context Research

- Following 1996 Monsanto’s R&D on Seeds and Traits increased drastically from about $200 million/year to $600 million in 1998 and another peak in 2008 at over $1.2 billion.

- Other agbiotechnology companies increased spending on seeds and traits but did not do so until about the early 2000s.

- By 2006 each of the agbiotechnology companies has further accelerated their spending on seeds and traits.

- Monsanto has a lead on its rivals by about 5-6 years.

SOURCE: Context Research
Hi-Throughput Seed Chipper (Monsanto)
Ex of new technology to accelerate breeding and lower costs

- Ex of new technology accelerating breeding and lowering cost
- Patented (other companies are adopting like technologies; and recent patent dispute w/DuPont)
- Determine the genetics of a seed without destroying the seed itself.
- Breeder can plant the seed in a field test and use it in the breeding process to create more seeds of its kind.
- Identifies the best-of-the-best germplasm (genetics)
- Doubles the rate of improvement in genetic characteristics.

Source: C. Paterson, Monsanto's Innovation, AgAdvance, Jan 2013, pp. 36-
Public-Private partnerships in advanced plant/animal development

Budget: $5 million to $800 million/yr

All projects are public/private partnerships

Likely leading rest of industry by 4-5 years and clearly leader in wheat, dairy, high-energy grasses
Chinese Response: BGI

- Converted Shoe Factory In Shenzhen
- Largest genome mapping company in the world,
- Largest facility, a former shoe factory,
- Two gray buildings, the factory and the dorm
- Salary: $451/m for graduate trained professionals in bioinformatics
Yield Trends in Corn: USDA View
(embodies tremendous technological innovation)

- Transgenic (Bt) insect resistance
- Reduced N fertilizer & irrigation?
- Soil testing, balanced NPK fertilization, conservation tillage
- Double-X to single-X hybrids
- Expansion of irrigated area, increased N fertilizer rates
- Integrated pest management

\[ y = 112.4 \text{ kg/ha-yr} \]
\[ 1.79 \text{ bu/ ac- yr} \]
\[ R^2 = 0.80 \]

Monsanto (and most other agbiotech companies) on Doubling of Corn Yields:

Source: Monsanto Biennial Investor Event, Nov 10, 2011

**Doubling Yield with Technology: U.S. Corn Example**

- **Historic Yield Gain**
- **Agronomic Practice Improvements**
- **Breeding Improvements**
- **Biotech Improvements**

**Technology to Double Yields**

- **Boosting yield to double output will come from the integration of tools to boost productivity including biotechnology, breeding and agronomic practices.**

**Biotechnology**

- Yield & Stress Pipeline
- Third-Generation Agronomic Traits Pipeline

**Breeding**

- Molecular Breeding for Disease Resistance
- Molecular Breeding for Yield Improvement

**Agronomic Practices**

- Optimize Farming Practices
- Improved On-Farm Data Systems
- Improved Equipment
**Industry Corn Portfolio**

A Steady Pipeline of Events

*Estimated commercialization pipeline of corn biotech events prepared by the U.S. Grains Council*

Commercialization dependent on many factors, including successful conclusion of regulatory process.
Corn trait efficiency: **Drought Resistance**

- Potentially improve yields by 8-22% (15% average) under drought stress that reduces yields by 50%
- Monsanto (2008) indicated
  - yield improvements of 6-10% in water stressed environments.
  - Testing of first and second generation DT corn varieties ranges from
    - 7 to 13% for first generation tests
    - 9-15% for second generation
    - 9-10% yield advantages were reported in low drought seasons and 15% in a high drought.
  - Approved in Dec 2011, and field trials in 2012
- Syngenta:
  - 15% less yield loss during dry years.
Corn: Real Option Values of ‘Drought Tolerance’
NUE Corn

- 5 companies working on NUE
- 5-10 years out
- 2 technologies
  - GM
  - MAS (does not need dereg)
- Trait efficiency
  - Produce same yield with 30% less fertilizer
  - Or, Produce greater yield w/same fertilizer
- Value: $700 million (US), $1.5 bill. worldwide
Wheat: Industry Concerns (ex) Beginning in 2008

- **ConAgra** …*I see continual declines in wheat acreage in the US, all driven by genetics for row crops and the lack of genetics for wheat.* M&BN Jan 29, 2008.

- **Sosland Editorial** *Huge price paid for opposition to biotechnology*

  - …Not only does genetic engineering offer growers vastly higher yields …, but the science has resulted in varieties that do a much better job of withstanding unfavorable weather…

  - …The absence of biotechnology from wheat has cost grain-based foods untold sums this year. Neglecting wheat is due in part to how seed is saved by farmers for replanting each year, as well as the complex genetics of the bread grain. But it also reflects the hesitancy, if not the outright opposition, of entities that are bearing the full brunt of this year’s price explosion. This is opposition based largely on unproven fears about how consumers will react to foods made from bioengineered crops.

  - …Costs and prices like those registered this year in wheat ought to awaken opponents of biotechnology to realizing how greatly their stance is costing themselves and the economy
Productivity Growth Rates

• Relevance: Wheat losing acres to competing crops, in part due to
  • **Greater productivity growth** in competing crops (1.2% in wheat, 1.8% in GM row crops)
  • **Wheat is more risky:** Price, quality, and quantity, in addition to severity of ‘post-harvest discounts’
    • More ready risk reduction mechanisms for competing crops

• Results: % Change per year

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<thead>
<tr>
<th></th>
<th>CWAD</th>
<th>CWRS</th>
<th>HAD</th>
<th>HRS</th>
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<tr>
<td>Constant</td>
<td>-47.43</td>
<td>-116.70</td>
<td>8.24</td>
<td>-160.77</td>
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<tr>
<td>Year</td>
<td>6.69</td>
<td>15.80</td>
<td>-0.64</td>
<td>21.62</td>
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<tr>
<td>R2</td>
<td>0.02</td>
<td>0.11</td>
<td>0.00</td>
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<tr>
<td>Sign</td>
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<td>&lt;0.05</td>
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Emergence of Advanced Technologies in Wheat

- RR Wheat abandoned in May 2004
- 2009 to current: All major agbiotech firms entered into wheat with advanced breeding and GM technology
  - Crop with largest area for which advanced technologies have not been developed
  - Agro-political shift to encourage developments in GM Wheat
    - End-user demands for more competitive wheat
    - Support from grower groups in N. America and Australia
  - Competitive pressures and prospective technological advances
    - Numerous public organizations beginning to expand in wheat (CSIRO, VABC, others)
- All major AgBiotech companies are/have entered into varying arrangements to facilitate development of GM Wheat
## Wheat Research Partnering

<table>
<thead>
<tr>
<th>Company</th>
<th>Acquisitions or Partners (Year, Country)</th>
<th>GM trait targets¹</th>
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<tbody>
<tr>
<td></td>
<td>Athenix (2009, US)</td>
<td>Drought</td>
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<td></td>
<td>CSIRO (2009, AU)</td>
<td>NUE</td>
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<td>Evogene (2010, IL)</td>
<td>Yield</td>
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<td>NARDI (2011, RO)</td>
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<td>RAGT (2011, FR)</td>
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<td>SORT, EUROSORT (2010, UA)</td>
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<td>South Dakota State University (2011, US)</td>
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<td></td>
<td>Texas A&amp;M (2011, US)</td>
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<td></td>
<td>University of Nebraska-Lincoln (2010, US)</td>
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<td>HRZ Wheat (2011, US)</td>
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<td>Northwest Plant Breeding (2011, US)</td>
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<td></td>
<td>Arcadia (2010, US)—they own a small share</td>
<td>Disease</td>
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<tr>
<td></td>
<td>Acquired Trident seed..</td>
<td>Drought</td>
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<tr>
<td></td>
<td>Biogemma (FR)</td>
<td>Quality</td>
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<td></td>
<td>U of Idaho</td>
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<td></td>
<td>CSIRO (2006, AU)</td>
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<td></td>
<td>BASF (2010, US)</td>
<td>Drought—stress</td>
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<td></td>
<td>Intergrain (2010, AU)</td>
<td>Herbicide tolerance</td>
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<td>Kansas State University (2010, US)</td>
<td>Yield</td>
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<td>Westbred (2009, US)</td>
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<td></td>
<td>Virginia Tech (2010, US)</td>
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<td></td>
<td>NDSU (2012)</td>
<td></td>
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<td></td>
<td>CIMMYT (2010, MX)</td>
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<tr>
<td></td>
<td>NA</td>
<td>Hybrid/biotech 2/2013</td>
</tr>
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Improving Wheat is Particularly Challenging Due to Water Scarcity and Pests (Monsanto 2012)

Wheat is Grown in Drought Area

Typical annual precipitation: 15” or less

Key Pests

- **Fungi**
  - Fusarium (scab)
  - Rusts (stripe, leaf, stem)
  - Septoria (blotch)

- **Insects**
  - Wheat stem sawfly
  - Hessian fly
  - Aphids

- **Viruses**
  - Barley yellow dwarf virus
  - Wheat mosaic virus

- **Weeds**
Wheat Yield Under Alternative Technology Assumptions

- Wheat technology
  - Marker assisted selection +1-2%/yr.
  - GM technology +20%
- Australia GM lines had yield 20 percent higher than conventional wheat varieties under conditions of drought stress
- Value of DR Wheat in N. America
  - About $350 million
### DR Wheat: Cumulative Expected Returns

(By Regions, over 15 years after release, at Technology Fee Ratio of 30-50 Percent of trait value for Biotech Company)

#### At 20 \% Efficiency Gain

<table>
<thead>
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<th>Rank</th>
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<tr>
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<td>7</td>
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<td>5</td>
<td>$36</td>
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<td>4</td>
<td>$50</td>
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#### At 25 \% Efficiency Gain

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<tr>
<td>5</td>
<td>$45</td>
</tr>
<tr>
<td>4</td>
<td>$58</td>
</tr>
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</table>

#### Regions

- Heartland
- Northern Crescent
- Northern Great Plains
- Prairie Gateway
- Mississippi Portal
- Southern Seaboard
- Fruit Rim
- B’Range
Multitude of Changes Impacting Structure of Wheat Competition: *Induce Strategy Initiatives for Variety Development*

**THE INDUSTRY IS CHANGING!**

- **New technologies and competition in wheat**
  - Ht-mas DNA (Mon) and Genome Wide (VABC)
  - GM Trait development (all majors and several research organizations)
  - Israel tech developers
    - Evogene partners w/BCS
    - Rosettsa Green (RRNA Technology) acquired by Monsanto
  - Other technologies to expedite breeding and lower costs
    - Apoximis
    - Exzact (DOW)
  - Chinese res organizations
  - Hybrid (Syngenta, DuPont; BCS)
  - *BreedWheat:* French wheat consortium among INRA and privates to expedite germplasm access/breeding-$35million
    - Foci: Yield, Disease, Drought and in the future-- *Healthful traits*

- **Changes in institutional relations**
  - Privatization of breeding occurring in most regions: Australia and Canada(?)
  - Changing breeding role for AgCanada (greater privatization)
  - Changing variety registration requirements in wheat (to attract private investment )
  - *Breeding Relations in US:* changing relations in URN

- **Non-GM evolution will necessarily evolve toward pre-planting-variety-specific Contracts**
  - Large domestic mills (bakeries)
  - Japan and other non-gm buyers.
Private/Public Partnerships are Essential in Wheat Technology

- Primary motives
- Public Orgs.
  - Germplasm largely controlled by publics
  - Limited ability to create more advanced technologies
  - Poorer marketers
- Privates:
  - Have technology, experience, money; and motivation
  - Generally lack germplasm

### Form or partnerships (spectrum of alternatives)

<table>
<thead>
<tr>
<th>Partnering Alternative</th>
<th>Strategic Implications</th>
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<tbody>
<tr>
<td>Acquisition of germplasm by technology company</td>
<td>Varies: Ranging from easy to Costly</td>
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<tr>
<td>Joint development &amp; ownership</td>
<td>Challenge coordinating public/private</td>
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<td>Licensing</td>
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<tr>
<td>No relationship</td>
<td>Very risky for both parties</td>
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Major Questions Confronting Partnerships/Univ.

- What is role of University research in rapidly changing costly technology
- Who owns the germplasm
- What is its value
- What is its future value
- What are competing sources of germplasm
- How can that value be improved w/other technologies
- How to share the value of that improvement
Implications for Public-Sector Research

- Research has (or should have) value
  - Define it, promote it, etc.
- Private-public partnerships will become more common, but, challenging
- Interdisciplinary Research is Essential in the Emerging Cropping Technologies
Summary Points: Implications
Exciting times for ag and investment opportunities in Ag

Longer-Term Driven by
- Growth in demand exceeding productivity growth
- Abnormal influence of China in soybean and corn

Geographical Shifts:
- US increase soybeans, corn and shift from small grains
- S. America increase soybeans, and corn
- FSU—more domineering in small grains and non-biotech crops

Investment in Agriculture: Worldwide---massive investment in agriculture
- broadly defined as farming, handling/trading, technology, logistics, etc.
- Most stable is land; greater returns and risk in other technology/inputs (fertilizer, seeds and technology, machinery, information technology)

Game Changers
- Biotechnology: Game changer and induce changes in productivity growth rates, and spatial geography of production
- Cost reducing investments in Ag: Increases profits and favors US Growers
- Logistics. Investment in infrastructure and efficient operations is critical to efficiently capturing market premiums (without which growers will take discounts and/or traders abnormal risks)
- Risk/Volatility: Increase in risk in all markets and marketing functions, and likely sustained. Critical to develop mechanisms for managing risks, without which growers end up absorbing risks and will seek alternatives with lesser risks

Farm Mgmt:
- Will become much more intensive in numerous dimensions (technology, diversification, marketing, finance, risk mgmt, etc)
- More professionally managed operations (including multi-unit operations).
- Sophistication will escalate to exploit these changes and compete against emerging competitors
Jim Rogers believes the finance industry is about to slip into secular decline. That's why the famed investor advises young people to pursue careers in farming rather than in finance.

"If you've got young people who don't know what to do, I'd urge them not to get MBAs, but to get agriculture degrees," Rogers told CNBC.com.