Agricultural Big Data Overview

Investing in Agriculture Symposium

New York City

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The Hale Group

LSC

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Mapping Success in the Food System

Discover. Analyze. Strategize. Implement. Execute.

Issues Addressed

1. Definition
2. Why now?
3. Potential
4. Competitive Set
5. Global Potential
6. Reasonableness of Estimates
7. Potential Hurdles
8. Investment Opportunities
9. Implications for Global Agriculture

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Big Data Definition

No single standard definition . . .

"***BIG Data***" is data whose scale, diversity, and complexity require new architecture, techniques, algorithms, and analytics to manage it and extract value and hidden knowledge from it…

Source: Professor M. Eltabakh: Worcester Polytechnic Institute

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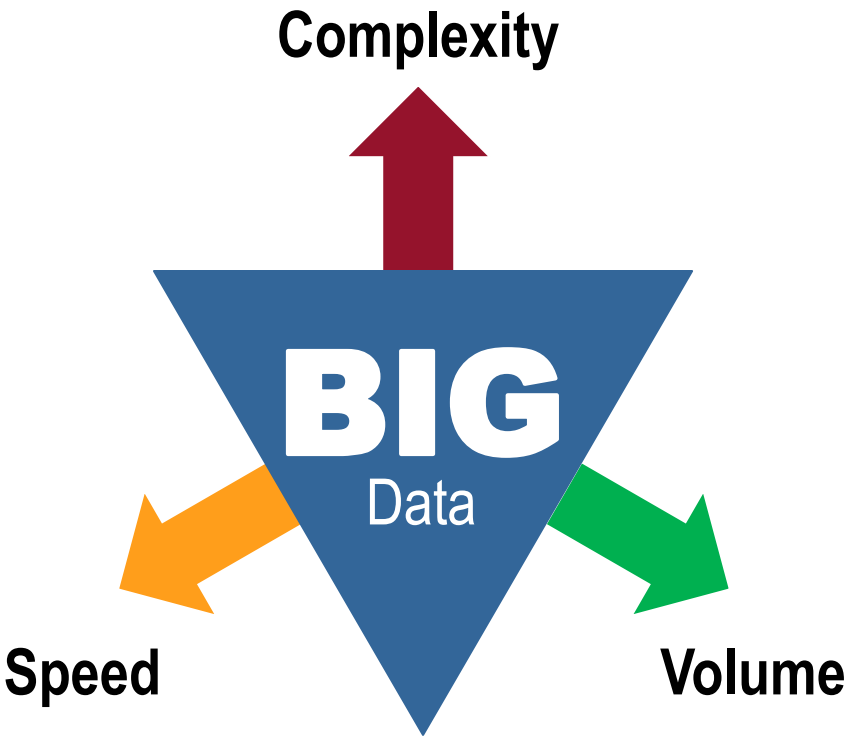
Big Data: 3V's

BIG
Data?

VOLUME
Large amounts of data

VELOCITY
Needs to be analyzed quickly

VARIETY
Different types of structures and unstructured data



Source: Professor M. Eltabakh: Worcester Polytechnic Institute

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What is Generating Big Data?

Scientific Instruments
(collecting all sorts of data)

Sensor Technology and Networks
(measuring all kinds of data)

Mobile Devices
(tracking all objects all the time)

Source: Professor M. Eltabakh: Worcester Polytechnic Institute

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Big Data in Agriculture

Big data starts with precision ag, but is much larger than on-farm data alone.

On-Farm Precision Ag
e.g. fertilizer, planting, crop protection, harvest / yield data

3rd Party Data
e.g. weather, satellite / aerial imagery, soil fertility, topographic data

Research & Development
e.g. Academic / Land grant data, biotech and equipment company publications, software and analytics

Commodity Markets
e.g. local, regional, global

x 1000s of farms

x 1000s of geographies

x 1000s of time periods

= Ag Big Data

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The Importance of This Issue

Why is Big Data in agriculture emerging now?

- *Components of Precision Agriculture have been used for years with modest benefit*
- *Computer capacity has now expanded to process vast volumes of data*

Why is Big Data an important issue?

- *Enables the promise of Precision Agriculture to be realized*
- *Makes critical agronomic decisions on small areas within each field*
- *The most important change for row crop farming since the 1940s*

What is the level of urgency?

- *Several major ag companies have just launched or soon will launch Big Data Service offerings that will define the market.*

What is the timing of this technology?

- *Crop year 2014 will be critical in competitor positioning.*

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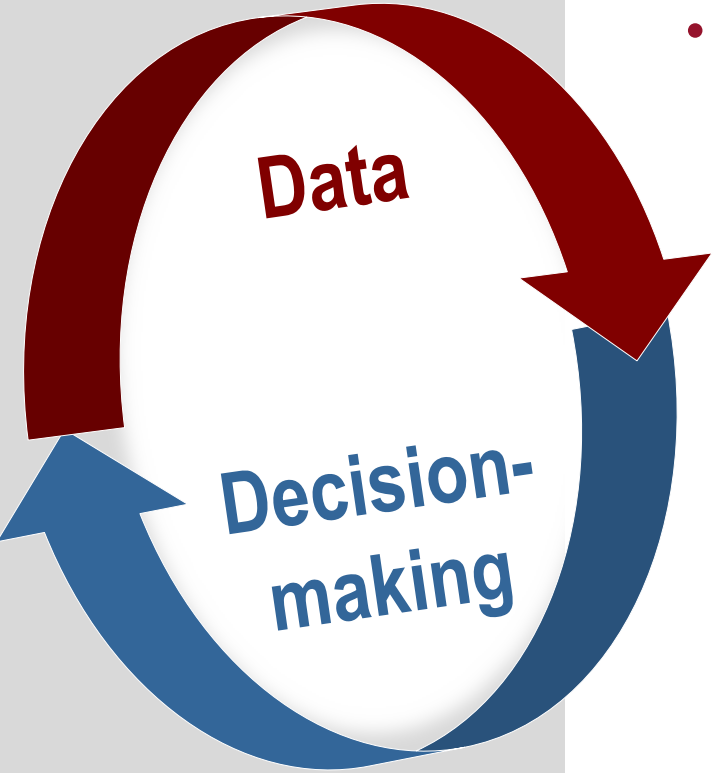
Value Generated by Ag Big Data

Making the link between



- **On-Farm Optimization**
  - Data-based decision-making for many more decisions
  - Early problem identification for management response
  - Custom solutions to minimize inputs and maximize yields
- **Input Product Innovation for Unique Conditions**
  - Biotech / seed research
  - Equipment R&D
  - Other input supplies
- **Market Linkage**
  - Improves transparency and predictability of markets

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Enabling Farmers to Make 40 Critical Decisions

Critical Decision Sets:

Planning Data
- Seed Selection
- Weed-Control Program
- Insect-Control Program

Pre-Planting Data
- Fertility Program
- Tillage Program

Planting Data
- Plant Population Dynamics
- Seed Depth

In-Season Data
- Post-Emergence Pest Control
- Crop Diagnostics

Harvest Data
- Equipment
- Crop Marketing

Goal: Maximize Net Return Per Acre

Productivity Tools:

Seed Factors
- Seed is lynchpin decision – key to establishing yield potential

Planting Factors
- Focus on best field configuration, preparation and planting elements

Pest-Control Factors
- Focus on insect and weed control regimes

In-Season Decisions
- Diseases, nutrient, etc. approaches based on in-field environment

Source: Monsanto Investor Presentation, October 2, 2013

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Reaction in the Farmer Community

"There's no question the **data generated by my equipment can be hugely beneficial to the ag companies."**

"I personally **never read the terms of use agreements."**

"Big problem is not hardware, it is software. The tools are out there to take the data and generate intelligence but most of it is really crappy."

"I would **never pass on data** to seed companies **without being paid for it."**

"How private are they going keep this information? … if I could see my neighbors information, does that somehow turn into a way to rent ground away from one another? That concerns me."

"I find it **hard to believe our data isn't being accessed** and observed."

"Do we pay **attention to the privacy agreements? Not as much as we should."**

Source: Interviews with farmers

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Farmer Perspectives

Early-adopter operators tend to be characterized by:

- Large investments in the latest equipment and technology
- Increasing consumption of 3rd party data
  - *e.g. aerial / satellite imagery has become more cost-effective*
- Limited intentional data sharing
  - *Most data "remains on farm"*
- Limited attention to Terms of Use and Privacy Policies
- Concern about the ownership and control of individual farmer data

Source: Interviews with farmers

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Monsanto's Estimate of Potential Size of the Market

- Potential is more than 1 Billion acres globally
- Initial target crops:
  - *Corn*
  - *Soybeans*
  - *Cotton*
- Current service fee is $10 per acre
- Expect service fee to increase to $20 or $25 as additional services become available
- Therefore, industry revenue potential of $20 to $25 Billion per year

Source: Monsanto Investor Presentation, October 2, 2013

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Potential Players in Agricultural Big Data

Major Players

- Monsanto
- Pioneer
- John Deere

Public Sector

- Purdue University
- Iowa State
- University of Illinois

Startup Companies

- Farmeron
- My Farms
- Yield Pop
- 640 Labs
- Farmlogs
- Solum Inc

Farmer Organizations

- Iowa Corn
- Iowa Soybean

IT Companies

- IBM
- Hitachi

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Vendor-Driven or Farmer-Driven Big Data

Who owns and controls the data?

Vendor-Driven

- Services provided to farmers by Ag Input or Equipment company. E.g., Monsanto or Deere
- Vendor obtains full control over farmers' data via the user / license agreement
- Sells a range of services to the farmer based on the data collected

Farmer-Driven

- Big Data services are provided to farmers by a independent IT company, e.g. IBM or Hitachi
- Farmers retain control over the data and allow the IT companies to develop specific services based on the data
- Farmers retain right to monetize the use of their data

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Monsanto Roll-Out

2012 Crop Year

- On-farm locations at 56 locations
- 5 to 10 bushel per acre performance advantage

2013 Crop Year

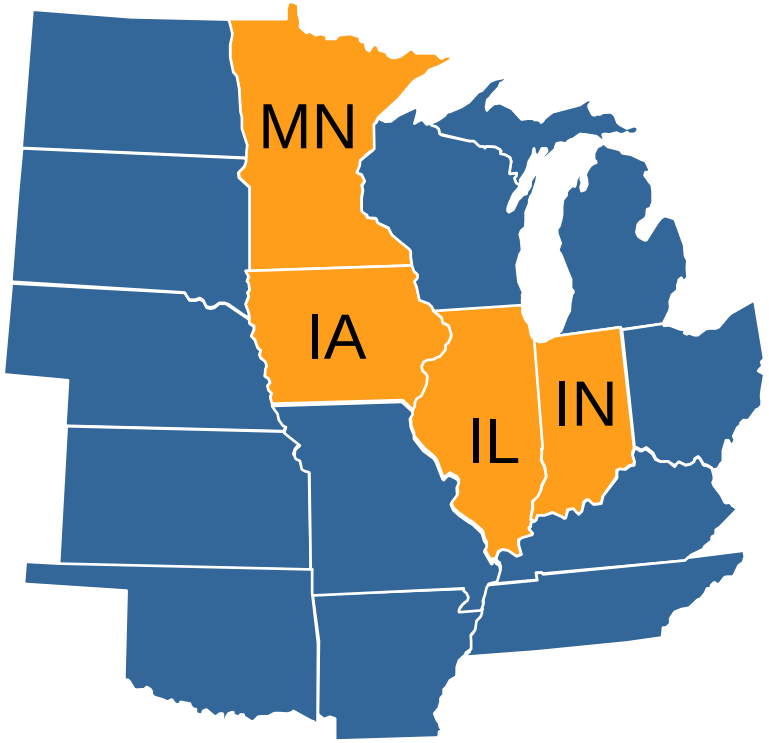
- 150 farmers on 40,000+ acres

2014 Plans

- 4 states
- Hundreds of thousands of acres

Fees

- Currently $10 per acre
- Fee will increase as value grows



Source: Monsanto Investor Presentation, October 2, 2013

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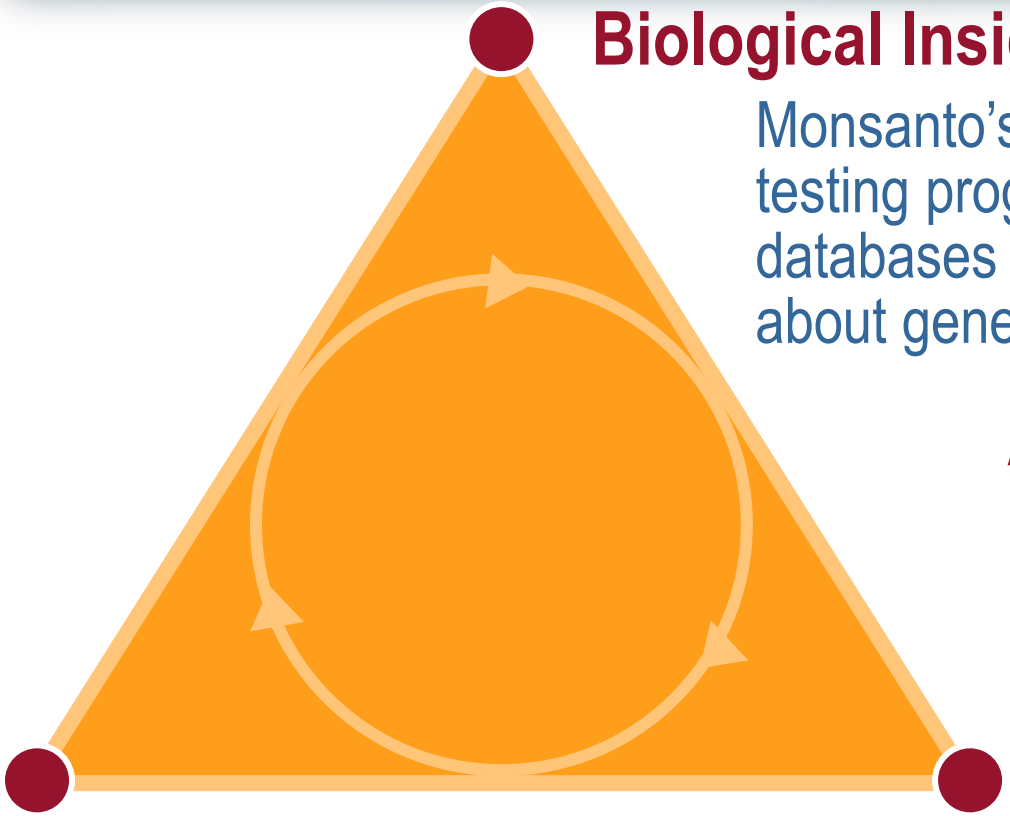
Unique Fit of Monsanto and The Climate Corporation



Biological Insight

Monsanto's R&D engine and global field testing program generates massive databases of structured information about genetics and performance.

Analytical Engine

Best-in-Class Capability. The Climate Corporation uses deep experience in science of analytics, building a unique approach leveraging predictive analytics not found elsewhere in agriculture.

Delivery to Field

Partnerships with leaders in the equipment industry and Precision Planting business allow data insight to be transmitted to the field level.

Source: Monsanto Investor Presentation, October 2, 2013

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Monsanto Purchase of The Climate Corporation: $930 Million

What does Monsanto gain from *The Climate Corporation*?

- Predictive modeling capabilities, experience, and know-how
- A differentiated, end-to-end applied information sciences platform
- Long-term growth prospect of more than $20B in revenue (Monsanto estimate)
- Early-mover advantage
- 2014 roll-out of Climate Pro, a suite of in-season decision support tools, costing $15 per acre
- Climate Corp has hyper local weather data on 29 million U.S. fields

Source: Monsanto Investor Presentations on October 2 and November 14, 2013

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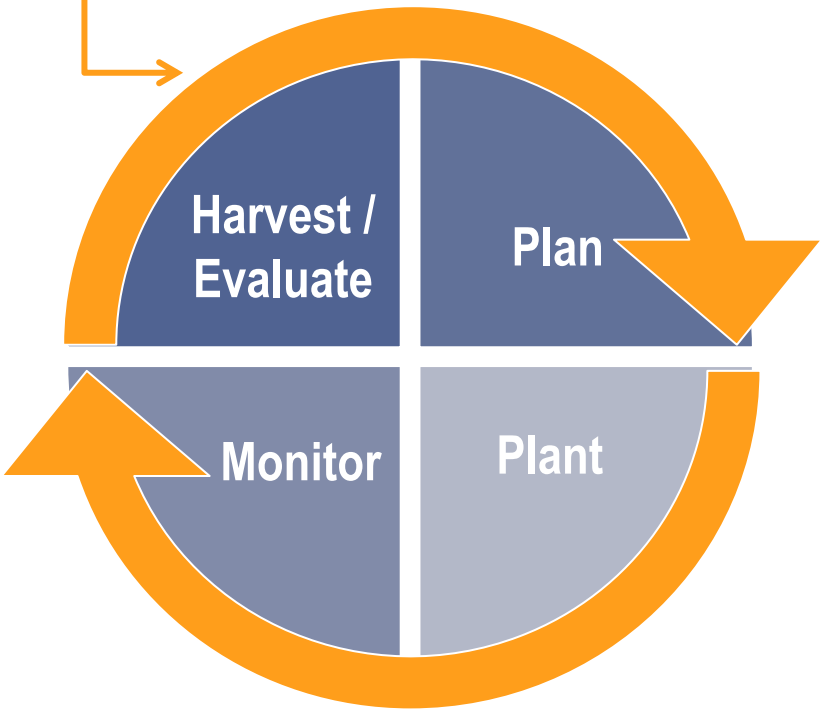
Pioneer Farmer Profitability Strategy

Whole Farm Profitability Services

Current Services Offering

- Field-by-field crop plans
- Planting maps
- Harvest maps
- Crop insurance
- Financial services
- Grain marketing



Tools to deliver additional insights for advanced farmer profitability.

Source: DuPont Investor Presentation: 2013

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John Deere Overview

Integrated wireless technology linking the equipment, managers, operators, dealers and agricultural consultants to provide more productivity and efficiency to a farm or business.

Machine Optimizations

- *Solutions that get the most out of machinery*
- *Use of automation and machine sensors*

Logistics Optimization

- *Coordination of field activities and resources*
- *Machine-to-machine communication for in-field logistics*

Ag Decision Support

- *Easy data flow between machines and trusted advisors*
- *Enable proactive management decisions through insights*

John Deere FarmSight™

Source: John Deere Investor Presentation July 2013

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Joint Decision Services – Pioneer and John Deere

- Provide near real-time field level data to growers
- Links Pioneer and Deere software and farmer services
- To be widely available to growers in 2014
- Each company markets through its local distribution channels
- The *MyJohnDeere* platform is non-exclusive and now open to:
  - *Input suppliers*
  - *Local agronomists*
  - *Software companies*

Source: Press Release by Pioneer and Deere and Co. on November 8, 2013

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Purdue University: ISOBlue Project

In an effort to free farmers from vendor-controlled data:

- Modern farming equipment generally communicates via a standard ISOBUS network to a proprietary monitor in the tractor or harvester.
- Farmers, agronomists and consultants cannot easily access the data generated by farming equipment because of the *proprietary data collection systems* of equipment vendors.
- Purdue has launched **ISOBlue,** an open-source project:
  - *Provide farmers with easy access to agricultural data gathered via smartphone*
  - *Using industry-standard ISOBUS port located on equipment*

Source: Press Release by Purdue University. on June 26, 2013

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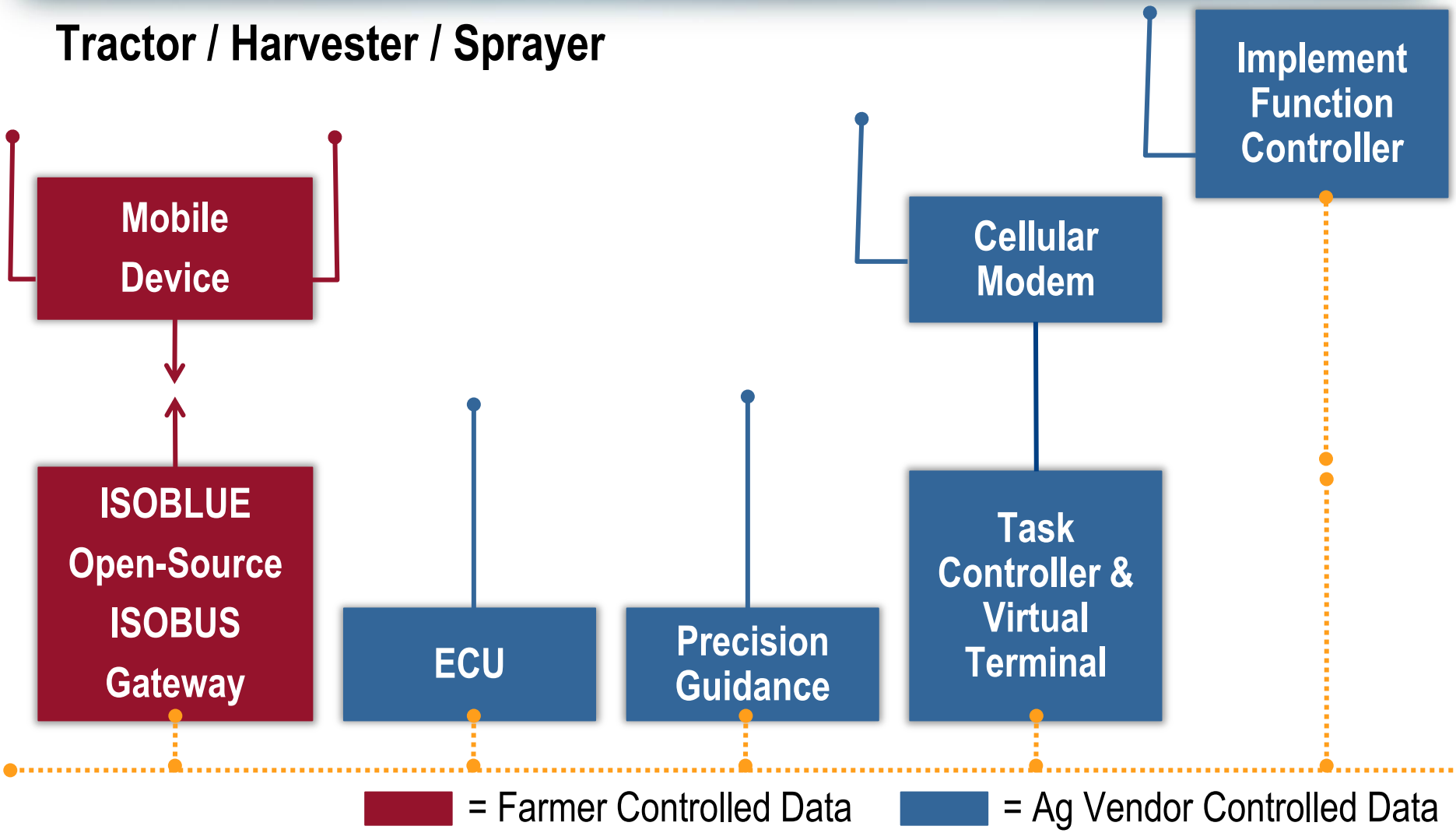
ISOBlue Project: Open Source Data Access



Source: ISOBlue.org, accessed July 16, 2013

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Greatest Potential Markets

Crops

- Corn
- Soybeans
- Cotton
- Wheat

Target crops have:

- Major input costs
- Large global acreages

Countries

- United States
- Brazil
- Argentina
- Canada
- Australia
- Parts of China

Target countries have:

- Large crop acreage
- Large farmers
- Receptivity to sophisticated technology

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High Target U.S. Field Crops

Average for 2008-2012

	Area Planted, 5 Year Ave.	Estimated Farm Gate Value
	Million Acres	*$ Billion*
Corn	92	$79
Soybeans	77	$43
Wheat	57	$18
Cotton	11	$6
Total	**237**	**$146**

Source: USDA, NASS Crop Production and Crop Value Annual Reports, National Corn Growers Association, United Soybean Board, Cotton, Inc.

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Size of the U.S. Opportunity

Assuming Fee of $10 / Acre

Average for 2008-2012

	Est. Market Opportunity at 25% Penetration	Est. Market Opportunity at 50% Penetration	Est. Market Opportunity at 90% Penetration
	$ Million	*$ Million*	*$ Million*
Corn	$242	$485	$873
Soybeans	$192	$385	$693
Wheat	$140	$280	$504
Cotton	$30	$60	$108
Total	**$624**	**$1,250**	**$2,250**

Source: USDA, NASS Crop Production and Crop Value Annual Reports, National Corn Growers Association, United Soybean Board, Cotton, Inc.

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Area of Target Crops in Key Countries

In Millions of Harvested Acres

Average for 2008-2012

	Corn	Soybeans	Wheat	Cotton	Total 4 Crops
U.S.	87	75	50	9	221
Brazil	34	57	5	3	99
Argentina	8	44	10		62
Canada	3	3	23		29
Australia			34		34
Total above 5	**132**	**179**	**122**	**12**	**445**
World Total	**398**	**251**	**544**	**80**	**1,293**

Source: http://faostat.fao.org/

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Size of the Opportunity – Major US Livestock Populations

Big Data may be applied to livestock before it is applied to smaller crops.

	No. Head, 5 Year Average	Value of Commodity at Farmgate, $ Bil.
Beef Cattle	92 mil.	$63
Hogs	65 mil.	$20
Dairy Cattle	9 mil.	$37*
Broilers	8.5 bil.	$24
Total		**$154**

Source: USDA, NASS, Livestock and Dairy Reports, U.S. Chicken Council, National Pork Board
* Est. Value of Milk Produced

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Thoughts on the Business Model

- The number of acres for which Big Data could be utilized is huge.
- Monsanto's estimate of industry revenue is based on $20 - $25 per acre.
- A per acre business model for a service to farmers, similar to chemicals or seed, might not be readily accepted:
  - *Can Big Data improve yields 5 – 10 bushel per acre year after year?*
  - *Can Big Data improve comparable yields on ALL acres?*
  - *Won't larger operators insist on a lower fee for "volume?"*
  - *Will the value of Big Data be comparable on crops with lower cost inputs than corn?*
- Integrating all of the pieces of precision agriculture data to support farmer decision-making will take time.

The roll-out of Big Data in agriculture will occur gradually.

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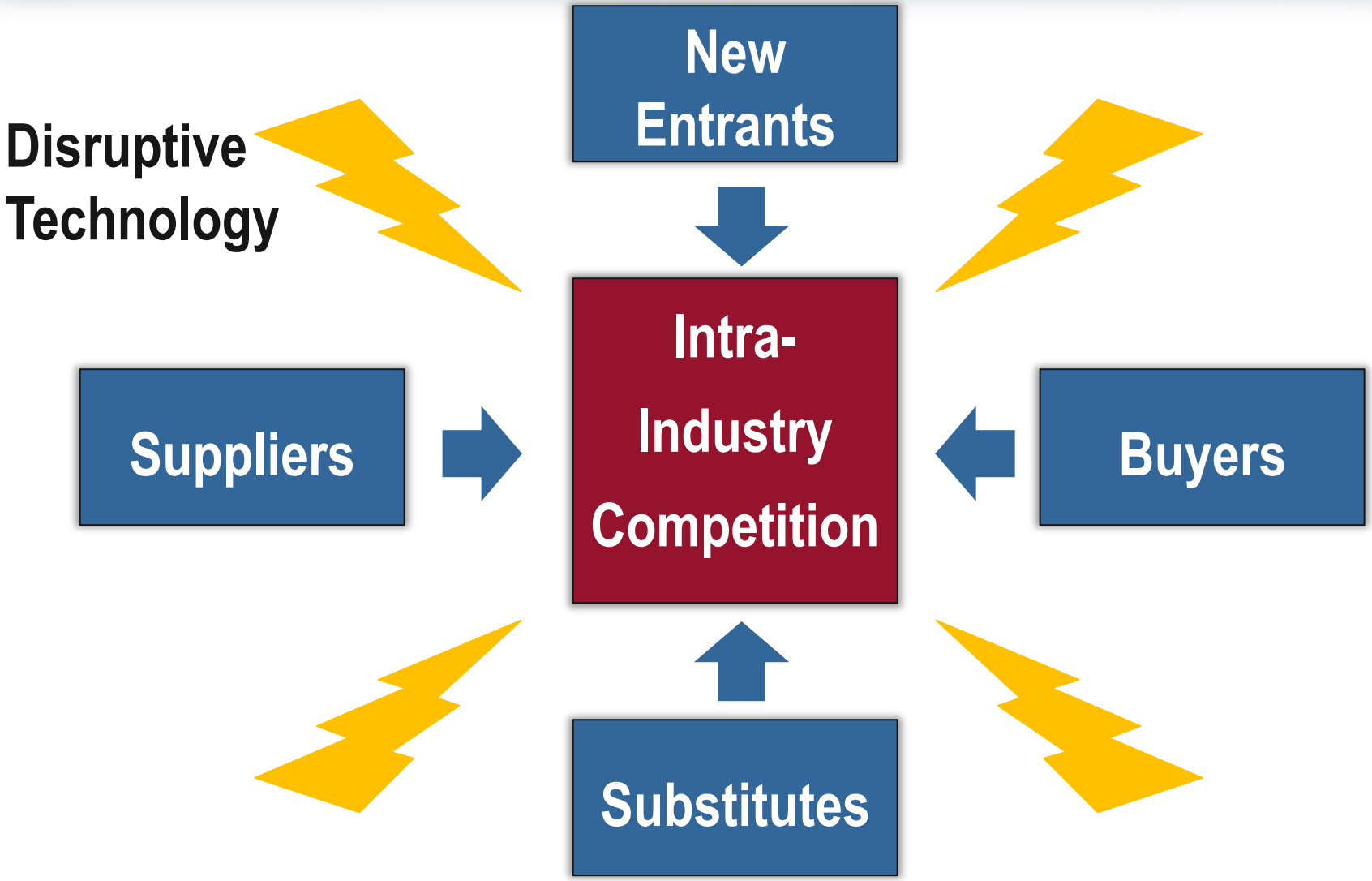
Will Big Data Shift the Competitive Balance?



Source: Michael E. Porter, the Five Forces of Competition

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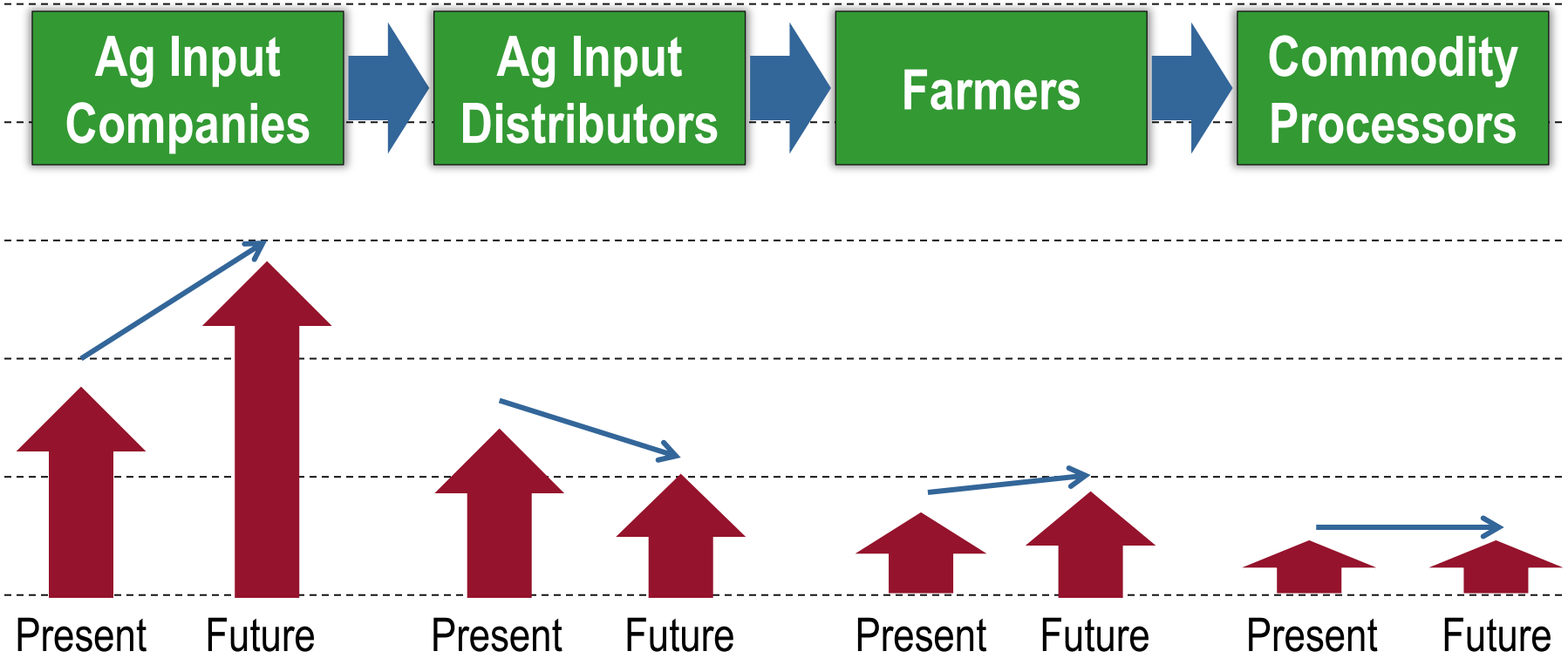
Where Will Value-Creation Occur in Vendor-Driven Big Data?



Source: The Hale Group and LSC International

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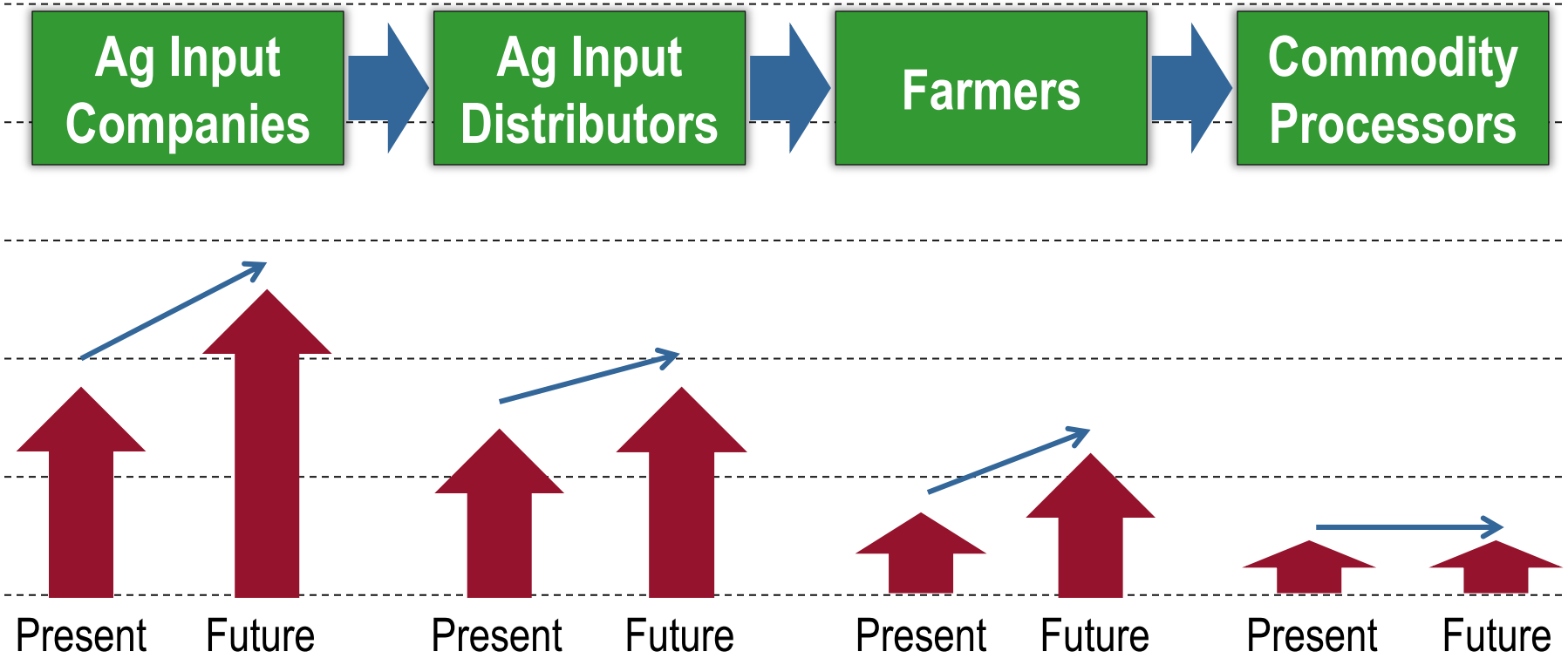
Where Will Value-Creation Occur in Farmer-Driven Big Data?



Source: The Hale Group and LSC International

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Alternative Models

Vendor-Driven

- Ag input firms become dominant Big Data service providers
- Farmers pay subscription for Big Data services
- Farmers relinquish data control through vendor license
- Farmer decision-making is limited and **prescription agriculture** becomes reality
- The value spilt will be more favorable for the input companies

Farmer-Driven

- An independent Big Data service is provided to farmers by a major IT company
- Farmers pay a subscription for the Big Data services provided based on value generated
- Farmers retain control over the data generated
- The value split will be more favorable to the farmers

Source: The Hale Group and LSC International

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Big Data Risks and Benefits: Farmers

Key Benefits

- Significant yield increases with reduced costs
- Management of complex decisions
- Scale of farming operations can increase
- Farm generated-data has significant value and **might** become new revenue stream

Key Risks

- Ag input suppliers have effective control of farming decisions
- Complex systems will make it difficult for a farmer to switch input suppliers
- Complexity will make it difficult to compare offers from competitors
- Increased competitiveness among farmers

Source: The Hale Group and LSC International

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Big Data Risks and Benefits: Agricultural Input Companies

Key Benefits

- Opportunity to bundle product and services with higher revenue per acre
- Monsanto estimates revenue opportunity in the range of $20-25 billion
- Switching costs for farmers will be increased due to complexity and access to data
- Input companies will capture more value from new technology. e.g., move the split to 70/30

Key Risks

- Reputational risk from failure to master a complex new business area
- Push back from farmers who do not wish to share data
- Farmers provide incorrect data as a way to protect their independence
- More investment required to develop the promised Big Data services

Source: The Hale Group and LSC International

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Big Data Risks and Benefits: Input Distributors

Key Benefits

- Improved efficiency and logistics to reduce costs and inventory levels
- New agronomic services that can be offered using Big Analytics
- New service opportunities such as the operation of drones for crop inspection.
- Farmer customers are larger and stronger financially

Key Risks

- The dis-intermediation of the supply chain leads to reduced margins putting the business at risk
- The input companies serve the larger farmers directly
- Customers concentration
- Loss of the advisory business which squeezes margins

Source: The Hale Group and LSC International

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Key Implementation Hurdles

- **Access to data from 10,000s** of farmers
- Data **ownership and privacy issues**
- **Convincing farmers** the benefits are real this time
- Fast broadband / **wireless access in rural areas**
- **Confusing complex options** for farmer choice
- Uncertainty over **new technology roll-out**
- Some farmers **not comfortable with IT technology**
- Others

Source: The Hale Group and LSC International

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Key Investment Opportunities

- **Ag Input companies** that offer Big Data services
- **Major IT companies** which enter agricultural Big Data
- **New start-up firms** with better "pieces" of the technology
- **New service companies** that provide data, e.g., drones for field scouting
- **Farm Management** firms
- **Large farming** operations

Source: The Hale Group and LSC International

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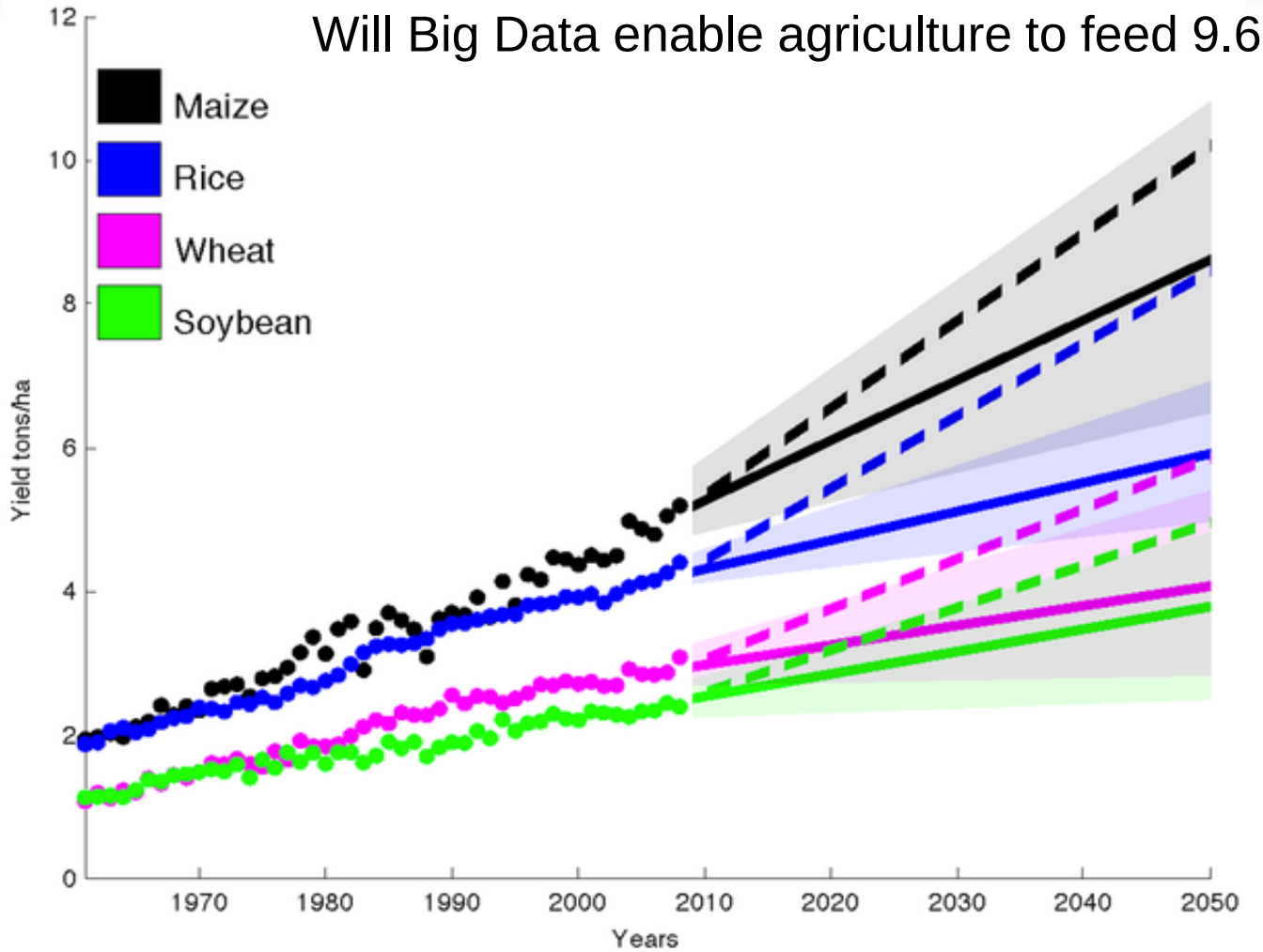
Implications for Global Agriculture

Will Big Data enable agriculture to feed 9.6 Billion?



Ray DK, Mueller ND, West PC, Foley JA (2013) Yield Trends Are Insufficient to Double Global Crop Production by 2050. PLoS ONE 8(6): e66428. doi:10.1371/journal.pone.0066428
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0066428

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Summary

- The introduction of Big Data is likely to be “bumpy” and uneven.
- However, Big Data will create the next major technological “sea change” in agriculture.
- It ranks with other sea changes such as the tractor, CPCs, and biotech.
- It should not be assumed that the business model for selling seed and chemicals will work for Big Data services.
- The technology will change the “balance of power” in the agri-food value chain.
- There will be “winners” and “losers” with the new technology.
- Farmers are concerned about the ownership and control of Big Data.
- All participants in the current agri-food chain should assess how the technology will affect their future business.

Source: The Hale Group and LSC International

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Thank You

Which Kind of Future . . .

. . . for Row Crop Farmers?

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