

The Digital Transformation of Row Crop Agriculture

A “Big Data” Project Report
for the
Iowa AgState Group

December 2014

The **Hale** Group

LSC

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Mapping Success in the Food System
Discover. Analyze. Strategize. Implement. Execute.

Sections of this Presentation

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What is Iowa AgState?

VISION STATEMENT

Empower Iowans to lead the world in responsibly-produced food and agricultural products to not only meet, but exceed, the demands of customers.

MISSION STATEMENT

Dedicated to identifying challenges and opportunities in Iowa agriculture and recommending changes to help the entire state achieve the greatest possible benefit from Iowa's food, materials, and products industry.

MEMBER ORGANIZATIONS

- Agribusiness Association of Iowa
- Dairy Iowa
- Iowa Cattlemen's Association
- Iowa Corn Growers Association
- Iowa Corn Promotion Board
- Iowa Department of Agriculture and Land Stewardship
- Iowa Department of Economic Development
- Iowa Farm Bureau Federation
- Iowa Institute for Cooperatives
- Iowa Pork Producers Association
- Iowa Poultry Association
- Iowa Soybean Association
- Iowa State University College of Agriculture and Life Sciences
- Iowa Turkey Federation
- Midwest Dairy Association

Task Force

The consulting team was guided by a six member Task Force that devoted major amounts of time and invaluable insights to the project. Task Force members included:

- Dr. Ed Anderson, Chair, Iowa Soybean Association
- Dr. Matt Darr, Iowa State University
- Kim Heckert, Iowa Institute for Cooperatives
- Brian Jones, Iowa Corn
- Dean Lemke, Agribusiness Association of Iowa
- Dave Miller, Iowa Farm Bureau Federation

This report is much stronger because of the many conversations, discussions, and debates with the Task Force.

Motivation for this Project

- Iowa farmers have always been innovators in adopting new technology.
- During the last two decades, precision agriculture tools have been adopted by Iowa farmers with somewhat mixed success: –
 - *Some tools being highly regarded as very useful;*
 - *Other tools providing minimal value to farmers..*
- During 2013-14, concern began to grow within farmer organizations about the use and potential misuse of farm data.
- The promise of Big Data in agriculture was alluring, but there was also concern about the potential adoption challenges of the technology.
- Several farmer organizations in Iowa decided to ask Iowa AgState, as an umbrella organization for state-wide agriculture, to investigate the implications of Big Data for farmers.

Purpose of this Project

To develop the most appropriate strategy and tactics for row crop farmers to utilize Agricultural ***BIG Data*** to enhance the productivity, efficiency, and choices of American farmers while also protecting their farm data and intellectual property.

Definitions

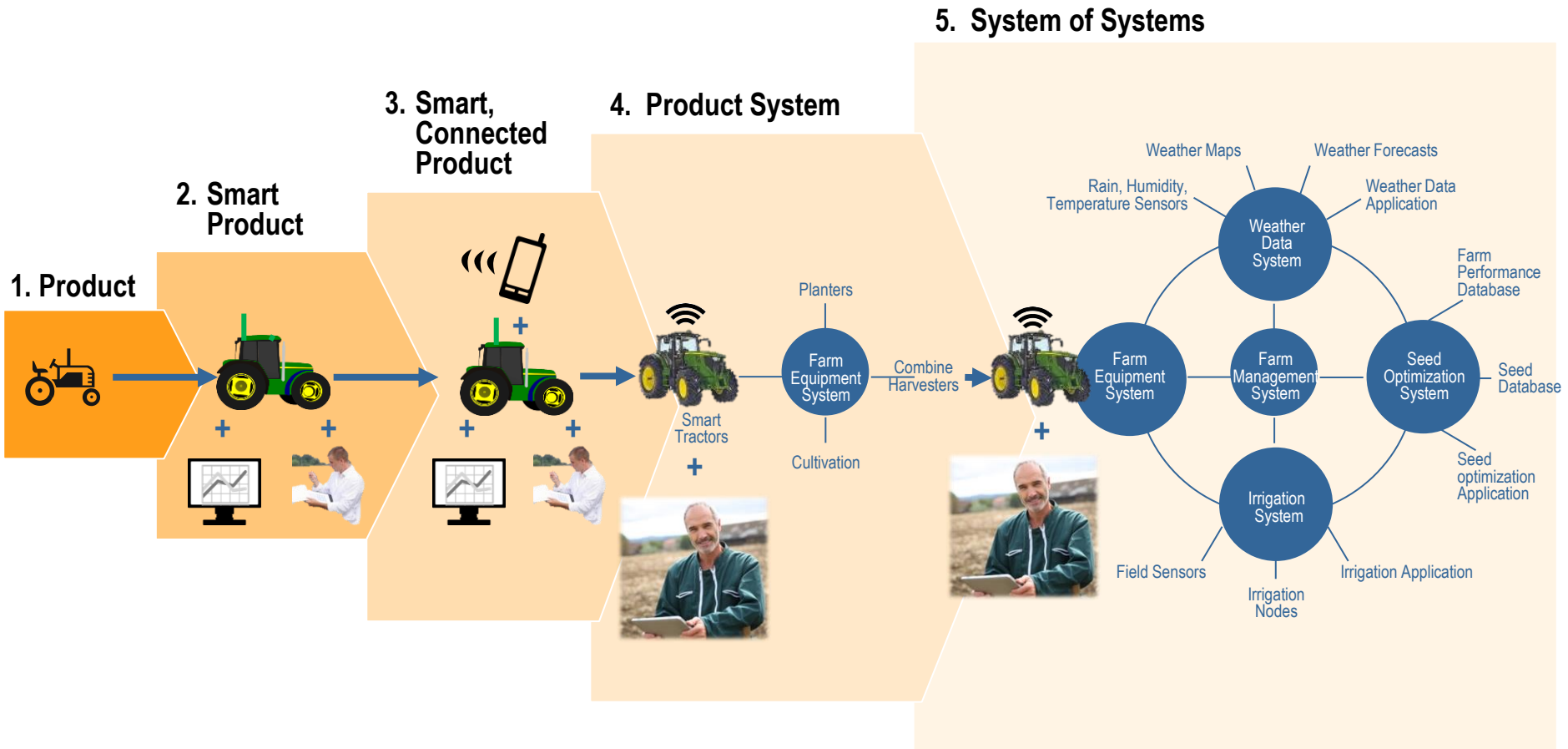
- **Big Data**: Data whose scale, diversity, and complexity require new architecture, techniques, algorithms, and analytics to manage it and extract value and hidden knowledge from it.
- **Enterprise Agriculture**: An integrated computer platform that includes: planning; agronomy; human resource management; work orders; purchasing systems; risk management; inventory management; logistics control; machinery maintenance; marketing; profit per acre.
- **Digital Agriculture**: A family of activities related to farming that includes Precision Agriculture, Prescription Agriculture, Enterprise Agriculture and depends on the collection, analysis and use of data from a multiplicity of sources with the goal of optimizing productivity, profitability and sustainability of farming operations.
- **Advanced Farming**: The research activities that are designed to advance Digital Agriculture to achieve improved productivity and sustainability over the long-term future, e.g., predictive phenomics.

The Situation Analysis

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Digital Transformation of Agriculture Past-Present-Future



Source: Harvard Business Review, Michael E. Porter and James E. Heppelmann, November 2014

Key Data Challenges to be Resolved

Tom Vilsack: “There are 3x farmers over 65 as under 35 today.”

- **Human Capital:** Farmers need to be **Tech-Savvy** and to have access to **IT skills** for use of data in decision making.
- **Quality Data:** The majority of Data generated currently is not useable due to poor quality, e.g., lack of calibration.
- **Data Access:** Much of the Data is on cards, sticks, hard drives or in binders of printed documents, and is very hard to access.
- **Better Analytics** are required to automate the analysis of imagery and maps.
- **Agronomic Data held by Ag Retailers** is not easily available for farmer use and aggregation in a broad manner.

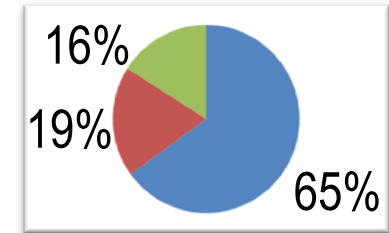
The Adoption of Digital Agriculture: Enablers

- **More Embedded Knowledge** in the equipment, devices or systems required. Easy to use, intuitive, meeting expectations, e.g., iPhone.
- **More Standardization** across the vast range of products, services and systems being offered.
- **Validation Processes** for services offered and business models.
- **Effective Security** for data held both on-farm and off-farm.
- **Technology Pull** process that empowers farmers to define problems and influence innovation.
- **User Training** that works for the broad population of farmers.
- Attracting **Data Scientists**, Software Engineers and Computer Scientists to the sector.

Summary of Write-In Comments from Electronic Survey

Skeptical and/or Fearful of the New Technology – 65%

- The biggest concern is misuse of farm data by:
 - *The ATPs*
 - *Activist groups*
 - *Grain traders*
 - *The government*
 - *Computer hackers*
- Fear that it favors the large farmers.
- Prescriptions will recommend only some products, i.e., are biased.
- It doesn't work. Agriculture is a complex biological system.



N = 95

Neutral or Nuanced in Attitudes – 19%

- It has potential, but must be implemented carefully.

Embracing the New Technology – 16%

- The technology is here to stay. Let's embrace it and make it work for us.
- No one that is highly profitable today is doing it with only their own ideas and crop data.

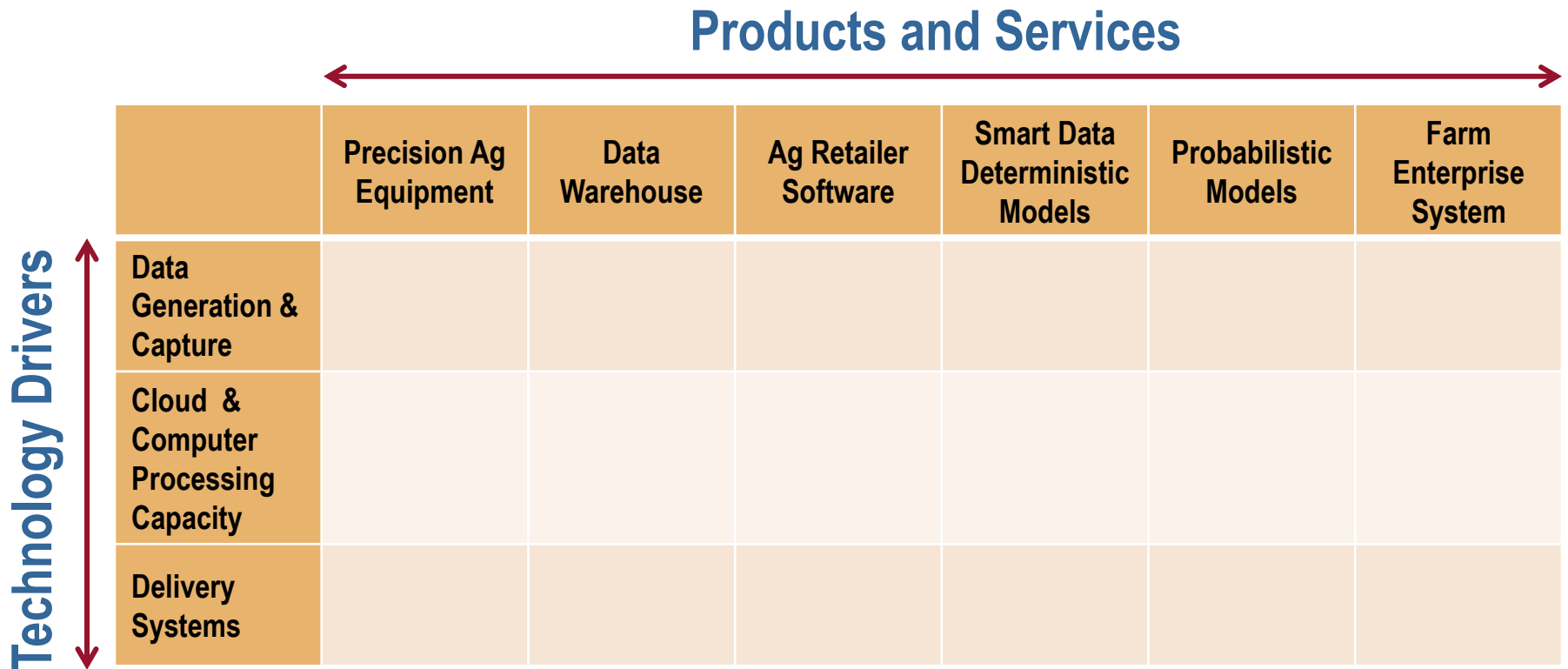
Company Positioning

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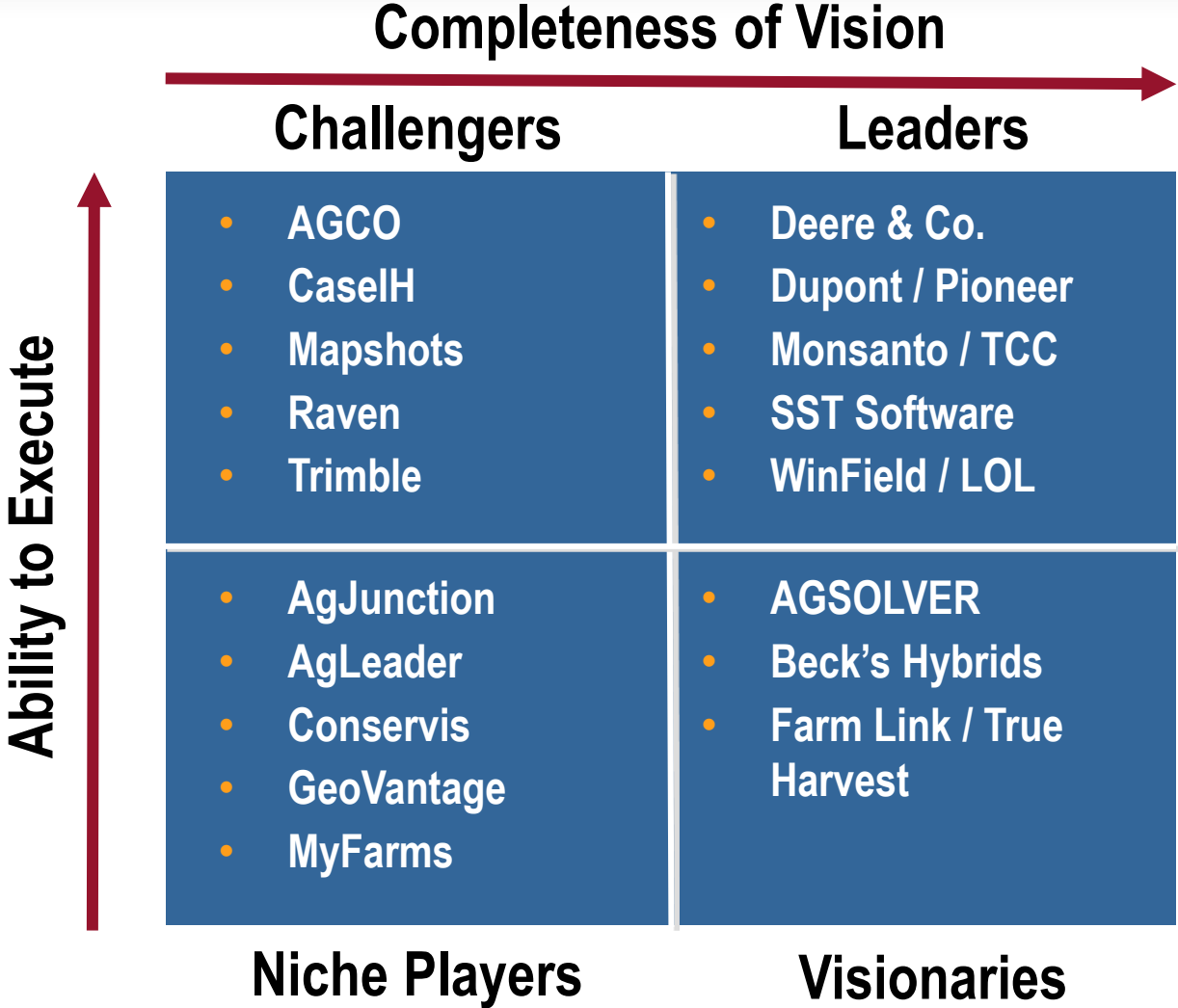
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Technology Map

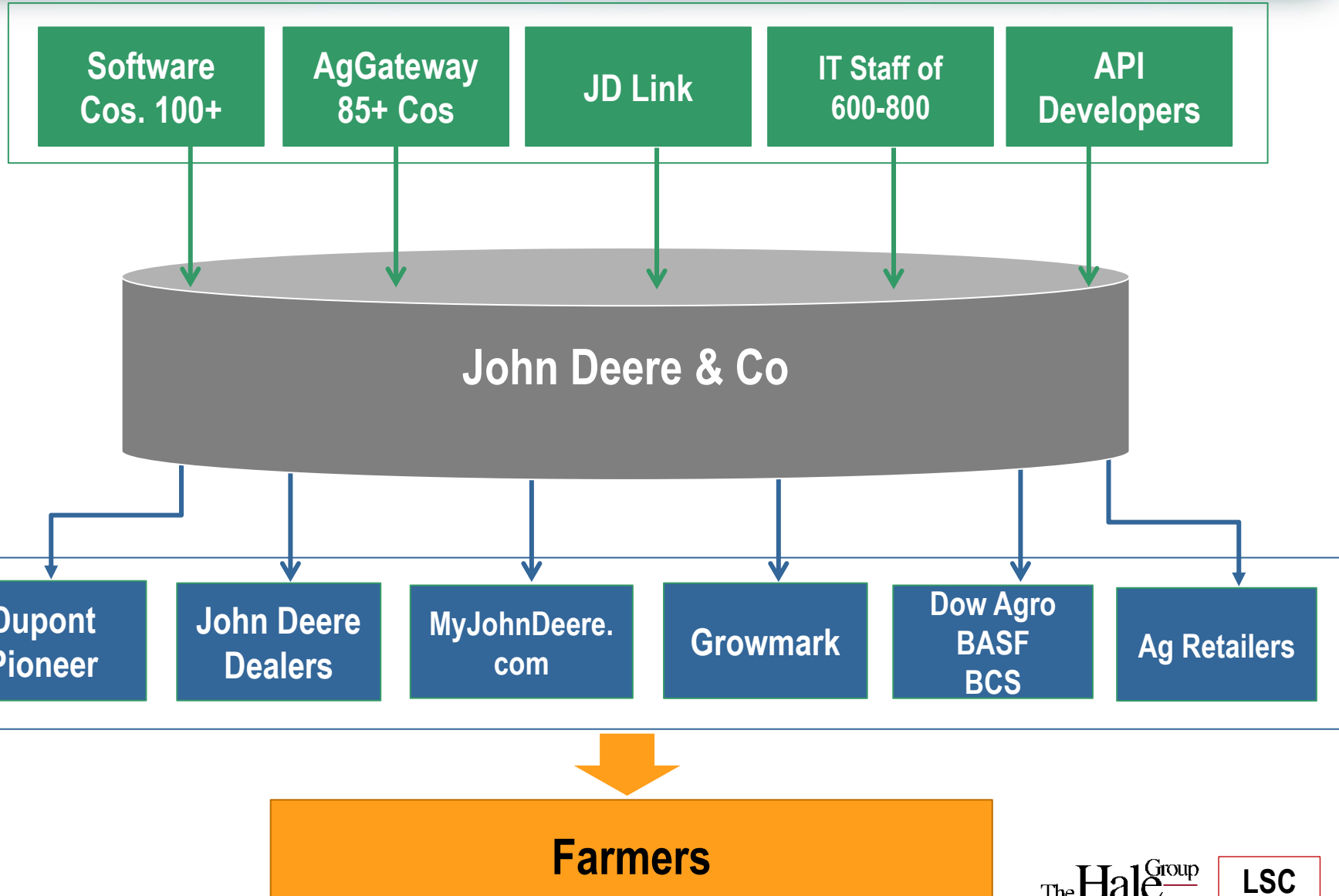
The Technology Map is designed to present companies in the appropriate cells based on their offerings and position in the market.



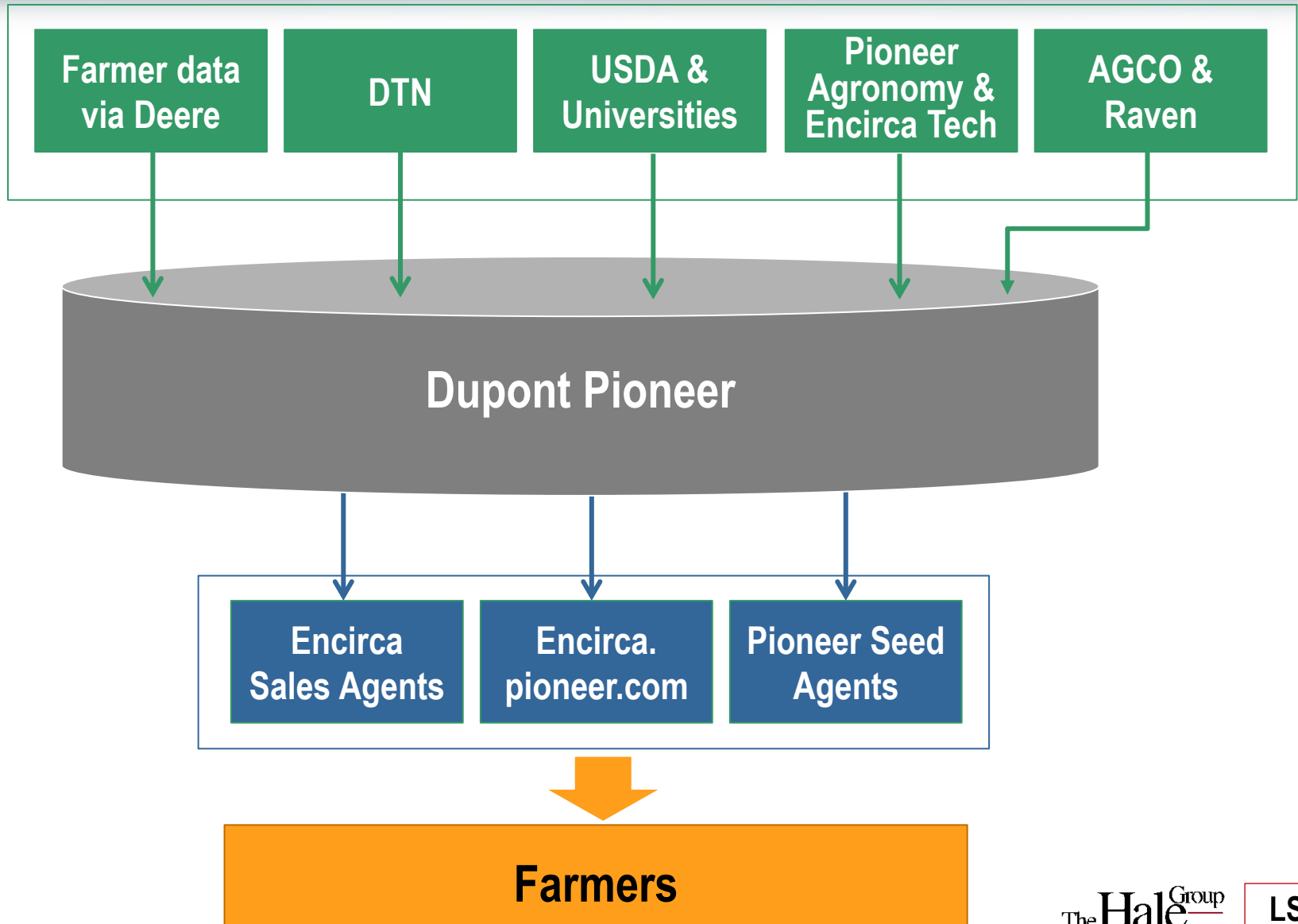
Assessment of Key Players



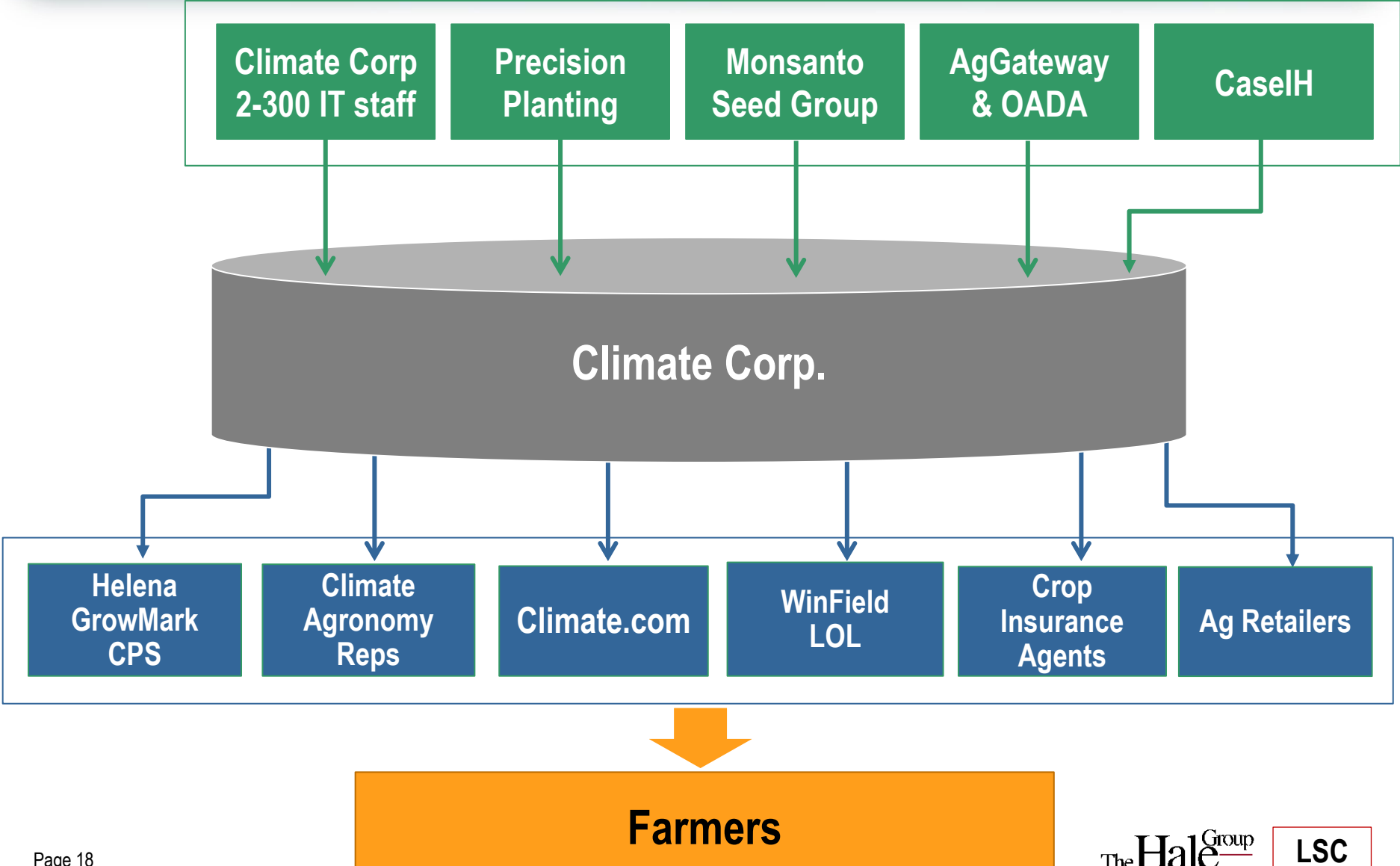
Deere & Company: Backend and Frontend



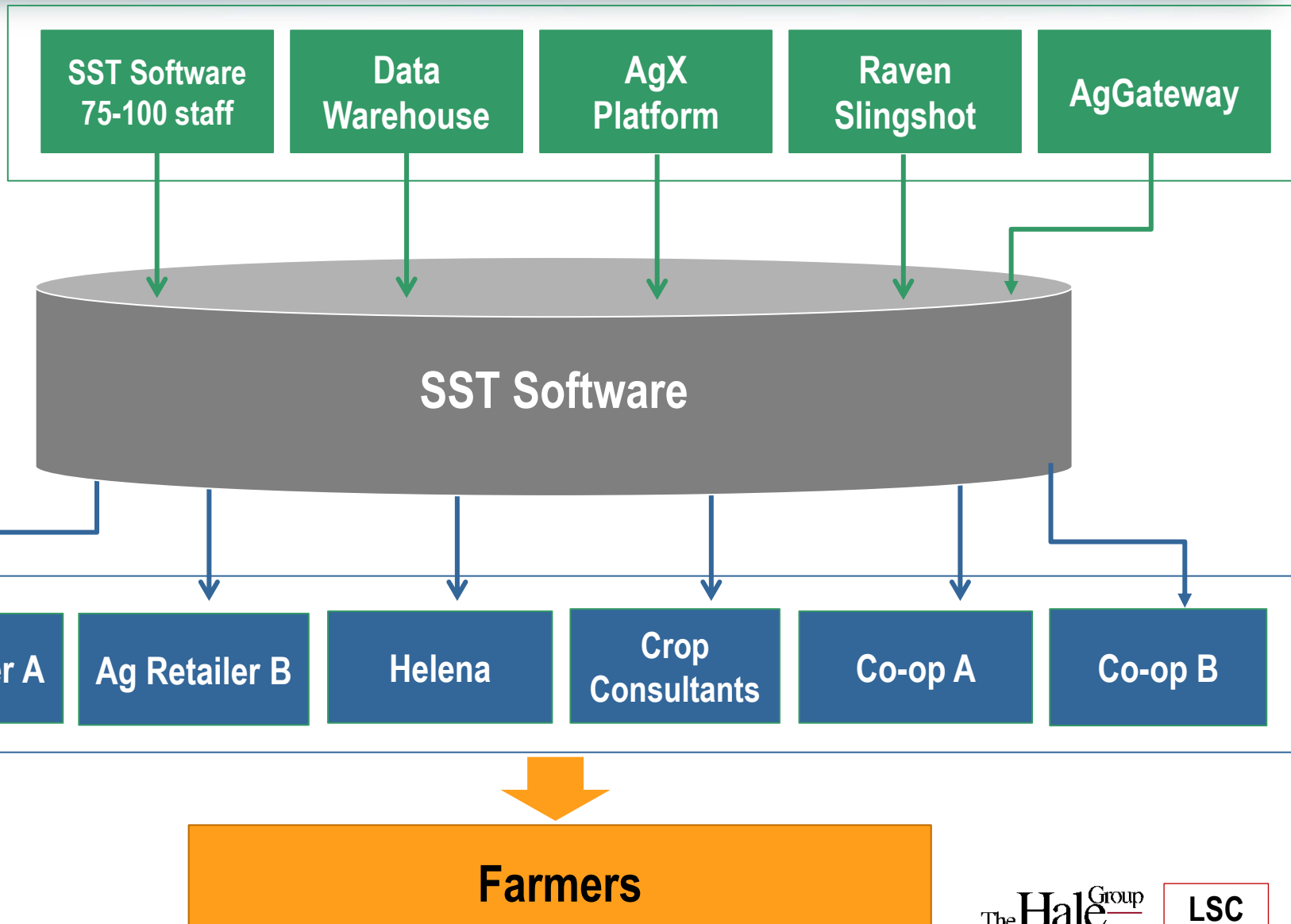
Dupont Pioneer: Backend and Frontend



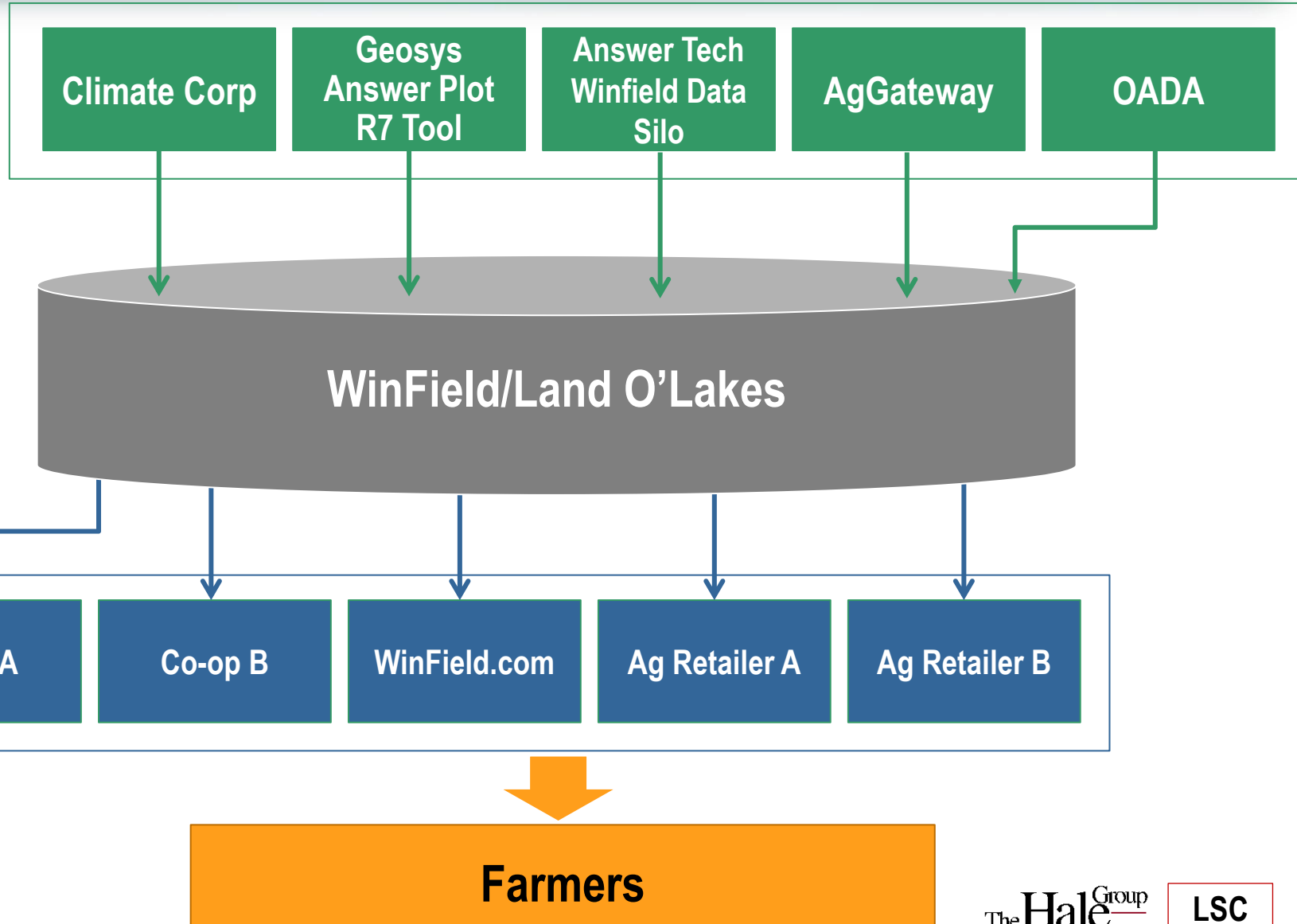
Monsanto-Climate: Backend and Frontend



SST Software: Backend and Frontend



WinField : Backend and Frontend



Establishing Value is a Challenge

Farmers need solutions with clear value.

	Tools	Solutions
Clear Value	<ul style="list-style-type: none">• Auto steer• Variable rate seeding/fertilizer• Aerial imagery• Telematics	
Unclear Value	<ul style="list-style-type: none">• Yield maps• UAVs• Local weather• Scouting apps• Multi-hybrid planting	<ul style="list-style-type: none">• Current prescription models• Nitrogen management• Farm Enterprise System• Benchmarking

High Level Summary – Business Model

- The companies are attempting to use established business models for the type of service provided and/or models that are well established for other products in the ag sector.
- There is a great deal of experimentation currently and a common response is that “our business model is in a state of flux.”
- At the farmer level it is difficult to establish the value of the services being offered. Potential sources of value:
 - *Agronomic Value*
 - *Operational Management*
 - *Logistics*
 - *Regulatory Compliance*
 - *Information Sharing*
 - *Crop Budgeting at sub-field level*
- It is necessary to define value before sustainable business models can be established.

Criteria to Evaluate Business Models

Criterion	Evaluation Methodology
<ul style="list-style-type: none"> Economic Value Generated 	<ul style="list-style-type: none"> Yield increase Reduction of input costs Other cost savings
<ul style="list-style-type: none"> Cost of the Product or Service 	<ul style="list-style-type: none"> Subscription & software fees Cost per acre with a minimum. Share of value generated Share of yield per acre Investment amount
<ul style="list-style-type: none"> ROI for Products and Services 	<ul style="list-style-type: none"> DCF or economic payback
<ul style="list-style-type: none"> Transparency of Pricing 	<ul style="list-style-type: none"> No hidden fees or costs
<ul style="list-style-type: none"> Standalone or Tied Product / Service Offer 	<ul style="list-style-type: none"> Bundled / unbundled with other products or services.
<ul style="list-style-type: none"> Data Ownership, Use and Control 	<ul style="list-style-type: none"> Farm data: Permission to share Aggregated data: Farmer access
<ul style="list-style-type: none"> Vendor Independence 	<ul style="list-style-type: none"> Product / service agnostic
<ul style="list-style-type: none"> Software approach by ATP 	<ul style="list-style-type: none"> Closed proprietary or open source

High Level Summary – Potential Economic Impact

- The “Innovators” indicate that using the best available Digital Technology in combination with high quality data it is possible to achieve a yield gain of 5-10 bushels of corn per acre.
 - *At \$3.50/bushel: Potential of \$18-\$35 per acre gross*
 - *Nitrogen Efficiency: Potential of \$25-30/acre per beta testers.*
 - *Yield + input savings: Potential of \$43-\$65 per acre.*
 - *Less \$3-10 per acre for ATP services:*
 - ***Potential gain with current Digital Technology: \$33-\$62 per acre***
 - *These gains are in addition to savings from use of precision planting and application equipment.*

Considerations for Strategy Development

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Overall Assessment

- This technology will continue to improve rapidly.
- Tech savvy farmers are already adopting it with enthusiasm.
- There is likely to be a major turnover in farm operators due to:
 - *The current age of farmers.*
 - *The prospect of low crop prices for the next several years.*
- The farmers that adopt this technology may have an advantage in renting land and will expand.
- There is a significant gap between those farmers who are prepared to adopt this technology and those who are skeptical and/or fearful.

The farmer organizations and the ag retailers should assist their constituents in closing the gap.

The Problems to be Addressed in the Strategy

Unequal Market Power

- Farmers do not have equal negotiating power with major ATPs
- Information asymmetry puts farmers at a major disadvantage
- There are few places a farmer can turn for detailed information

Complexity

- Farmers find the hardware, software, and business models hard to understand
- Hardware and software is not fully compatible across ATPs
- Many companies are marketing “tools” rather than “solutions”

Legal Obstacles

- Some user agreements limit farmers' choices
- Some legal documents are hard to understand

Unclear Benefits

- There is a mixture of fact and hype in the marketplace
- The economic benefit of some products is not quantified

Four Strategic Questions

1. Will all of the components of Digital Agriculture combine to create a major “inflection point” similar to the introduction of hybrid corn many decades ago?
2. Will Digital Agriculture Technology cause the row crop sector to become integrated, i.e., coordinated through contracts with farm operators by:
 - *a few large ATPs, or*
 - *a handful of large corn and soybean customers?*
3. How rapidly will consolidation occur within the row crop sector?
4. Will the sophisticated agronomy models allow computers to provide agronomic advice with little local agronomic input?

**All four questions are difficult to answer.
We provide our opinions on the following slides.**

1

Incremental Change *or* Inflection Point

Inflection Point

- Not likely at this time since the value gain has not been established.

- **Given rapid changes in Digital Technology and the age profile of farmers an inflection is likely in the 2019-2023 period.**

Incremental Change

- **Most likely for the next 4 years since neither a dramatic breakthrough nor clear value have been developed as yet.**

- Most likely if the value created is at the current modest level of +/- 5%.



The Case for Integration by Major ATPs

Likely

- Major ATPs could help farmers use the new technology.
- Major ATPs already have a substantial integrated seed production system.
- The exit of older farmers will create opportunity for integration.

Not Likely

- Improving pork quality was part of the motivation for swine industry integration. ATPs do not have this motivation.
- The asset base for row crop production is much greater than for hog production.
- Volatility of crop prices would create huge risks for ATPs.

At this time we believe full-scale integration by large ATPs providing agronomic prescriptions is not likely in the next 8 to 10 years.

Likely

- Some farmers may need help using the new technology. Large corn and soybean users might fill the gap.
- The exit of older farmers will create opportunity for integration.
- Large feed, ethanol, soy processors, and other industrial users could control genetics and quality for greater product consistency and quality.

Not Likely

- Large independent farmers will resist such arrangements.
- Weather and the volatility of crop prices creates huge risks for integrators.
- If Prescription Agriculture produces only modest benefit.

Integration by large customers cannot be ruled out if Prescription Agriculture is proven to be successful.

What Will Be the Rate of Farm Consolidation?

Current Speed

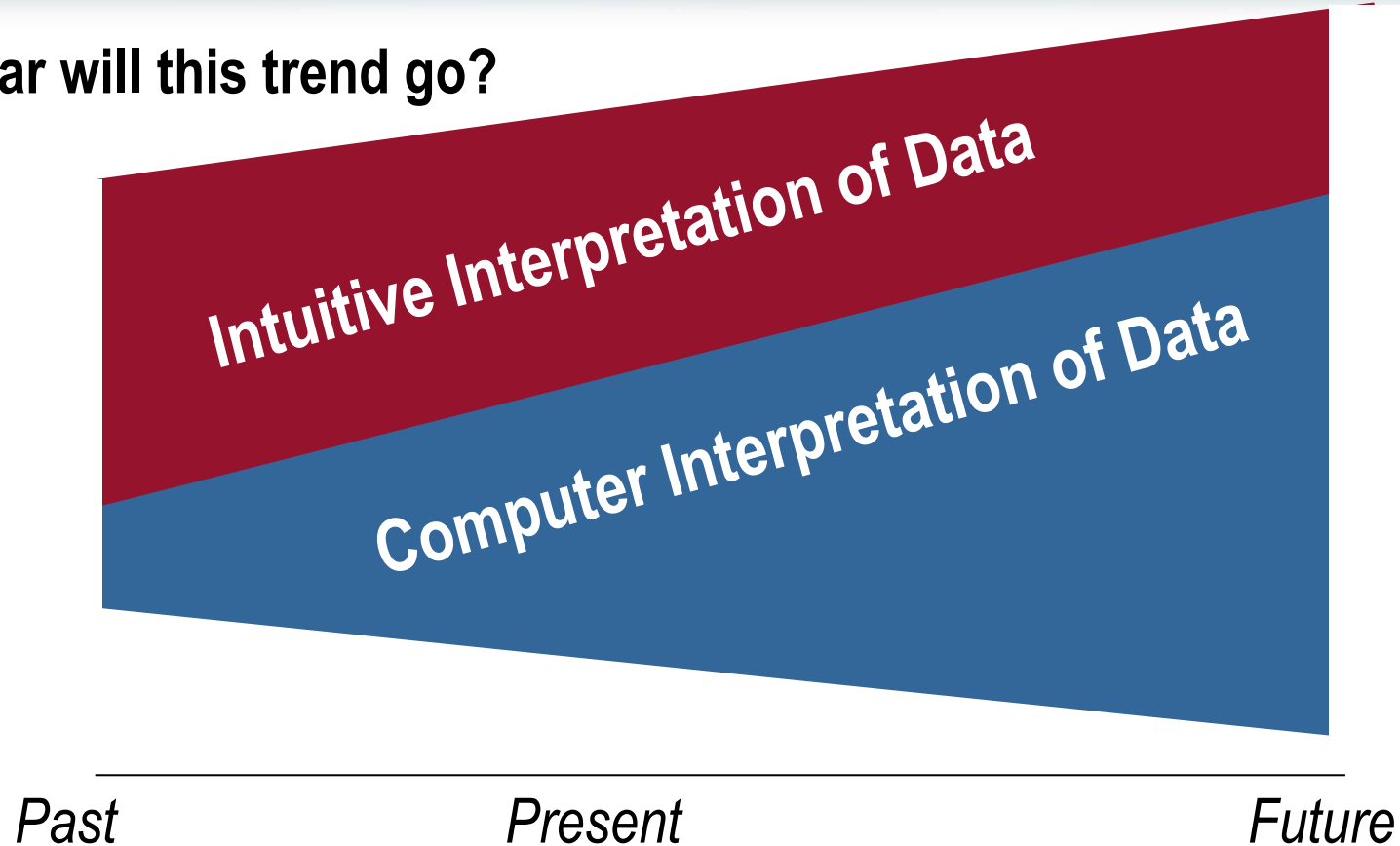
- If adoption of Digital Agriculture is slow due to complexity human constraints.
- If the ATPs can't demonstrate value.
- If the data security issues become more severe.
- Caps on total farm payments under Farm Bill may limit consolidation in low price environment.

Accelerated Speed

- The prospect of low crop prices provides incentives to leave farming.
- Aging farmers retire and high tech, low cost producers capture land rentals.
- This technology is simplifying operations for large-scale farmers.
- Large farmers can hire people with specialty skills, e.g., IT and agronomy.
- The data privacy fears and concerns are mitigated through company action and experience.

We believe that because of Moore's Law, the technology will develop quickly and farm consolidation will accelerate.

How far will this trend go?



Obviously the actual trend is not a straight line – the graphic is directional only. It's too early to tell how far this technology will go.

A Farmer-Centric Strategy

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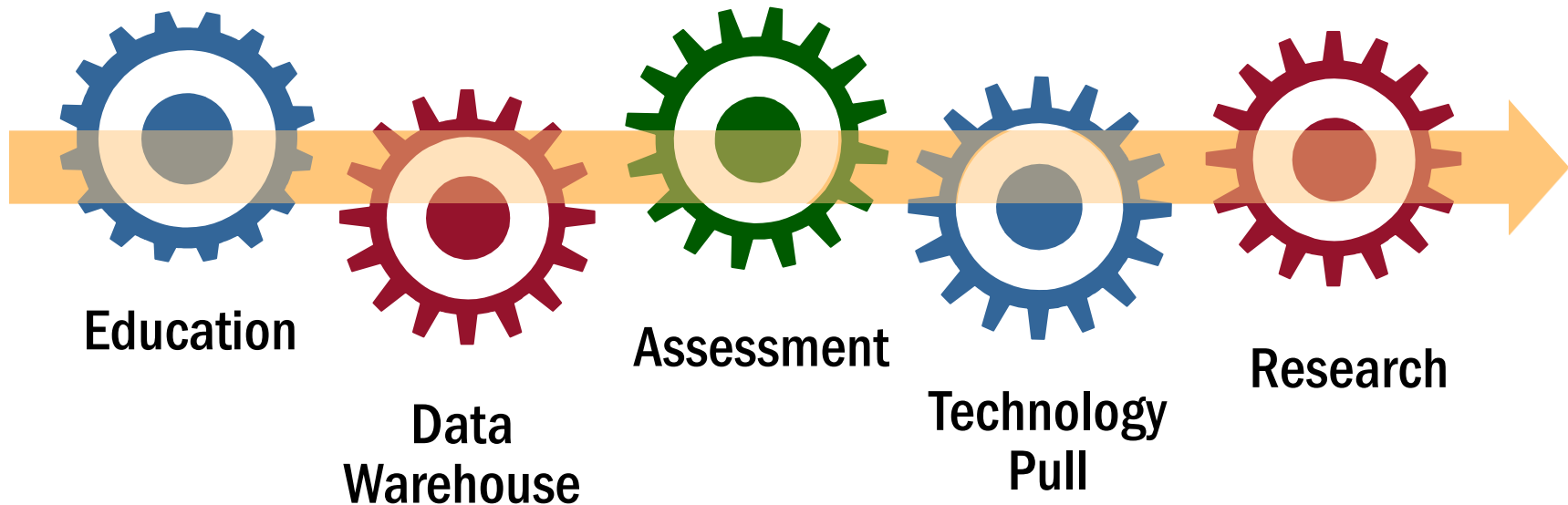
Mission of AgState Members for Digital Transformation

To assist Iowa farmers during the Digital Transformation of Agriculture while fostering a business environment that is highly competitive and provides farmers with many business options.

To assist Iowa ag retailers to: (1) capitalize on the new business opportunities; and (2) mitigate the threats to a strong rural business environment posed by Digital Transformation.

Five Components of a Farmer-Centric Strategy

A Farmer-Centric Strategy



Initiative #1 – Educate Farmers, Ag Retailers, Local Businesses, Policy Makers

Provide continuous, on-going education for farmers, ag retailers, other local businesses, and policy makers that will enable them to make informed decisions:

- a. Distribute The Hale Group report.
 - *Short and long PowerPoint presentations*
 - *Executive Summary Report*
 - *Short articles*
- b. Conduct state-wide and regional workshops and webinars for farmers, ag retailers, and other businesses on Digital Agriculture:
 - *Intensively in 2015*
 - *Addressing new topics thereafter*
- c. Provide the AgState Board with regular updates on the Digital Transformation of Agriculture developed for this project.

Initiative #1 – Educate Farmers, Ag Retailers, Local Businesses, Policy Makers

Provide continuous, on-going education for farmers, ag retailers, other local businesses, and policy makers that will enable them to make informed decisions:

- d. Create short videos on specific topics:
 - *Provide short videos on a specific topic so farmers and retailers can learn and apply the knowledge immediately.*
- e. Educate State and Federal policy makers
 - *Provide timely information about Digital Agriculture to policy makers on any issues which affect farmers and the rural economy.*

Initiative #2 – Create a Grass Roots Data Warehouse

Create an independent, farmer-controlled data warehouse for farm level data and aggregated agronomic data which can be used to better serve farmer participants.

- a. Develop guidelines for the ownership and use of data among land owners, farm operators, ag retailers and local businesses.
- b. Define the scope and scale of the agronomic data sets currently held by farmers, ag retailers and their software providers.
- c. Define the costs and capital requirements for the establishment of a cloud based data warehouse for farmers that is coordinated with ag retailers. Potential options include SST and Amazon Web Services.
- d. Evaluate business structures that would enable both farmers and ag retailers to collaborate in an independent data warehouse entity.

Initiative #2 – Create a Grass Roots Data Warehouse

Create an independent, farmer-controlled data warehouse for farm level data and aggregated agronomic data which can be used to better serve farmer participants.

- e. Develop a set of Privacy, Use and Control policies that fully protect the interests of the farmer while providing a high level of security.
- f. Establish the required API's to facilitate access on a permission basis for trusted advisors and ATPs.
- g. Prepare a pilot program that could be tested in 2016 with at least several hundred farmers.
- h. Develop a strategy to optimize the value of local data if the results of the pilot project are positive and establish feasibility.

Initiative #3 – Evaluate Products, Services, Business Models

Create mechanisms to provide an assessment of the many products, services, and business models in the market while promoting uniform, agreed-upon industry standards and guidelines.

- a. Create a website where farmers share their assessment of specific Digital Agriculture tools similar to Amazon's book evaluation.
- b. Create a mechanism for timely technical assessment for complex products and services similar to the Nebraska Tractor Test, Profi in Germany or Underwriters Laboratory.
- c. Engage with companies at early development stages so that the products launched receive early, practical feedback and reflect farmer priorities.
- d. Create a mechanism for estimating the economic value of products and services to farmers.

Initiative #3 – Evaluate Products, Services, Business Models

Create mechanisms to provide an assessment of the many products, services, and business models in the market while promoting uniform, agreed-upon industry standards and guidelines.

- e. Evaluate alternative business models used by industry participants in terms of clarity, benefits provided, and fee structure.
- f. Simplify the technology through collaboration with standards organizations such as AgGateway and OADA.
- g. Provide an assessment of the farmer-friendliness of legal documents used by manufacturers and service providers, by collecting, analyzing, and scoring the documents.

Initiative #4 – Development of Farmer-Friendly Products and Services

Drive a “technology pull” strategy focused on products and services that provide solutions to farmer problems rather than just complicated tools.

- a. Conduct focus groups and surveys to identify the key “pain points” for farmers which are not being addressed by the ATPs.
 - *Farmers decide by electronic ballot what is most needed*
 - *Define categories of products and services of most interest for farmers.*
- b. Conduct outreach to the Tech Community and ATPs so that the needs of farmers are understood and can be taken into account during the design and development phase for new products and services.
- c. Evaluate the potential for a “Challenge Award” process as a way to influence the direction of new technology development.

Initiative #5 – Create an Institute for Advanced Farming

Create a center for inter-disciplinary research that will position Iowa farmers to be at the cutting edge of digital technology for generations to come.

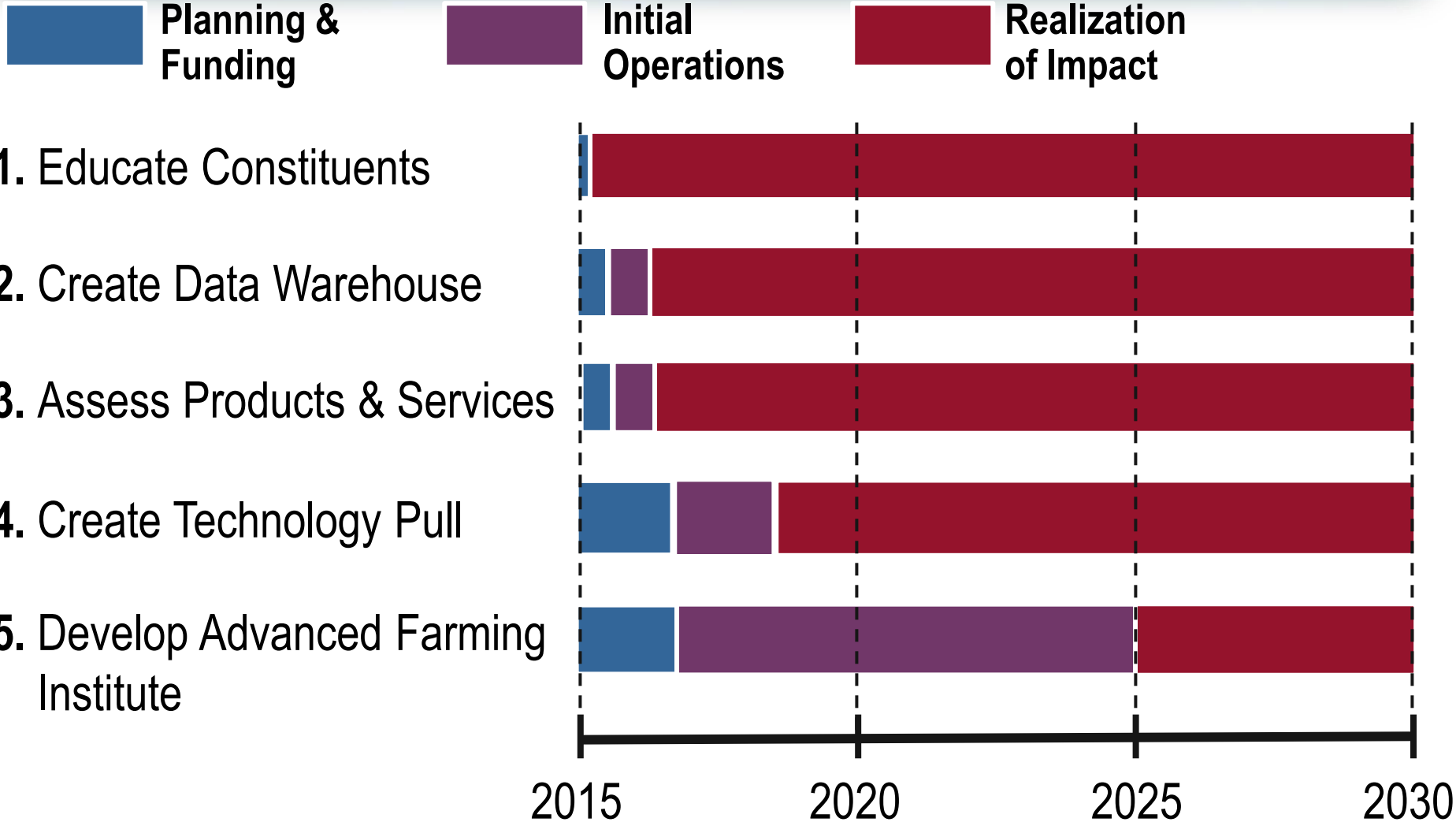
- a. Commence the Development of an Institute for Advanced Farming that would be based on the White House Policy to create six large Innovation Institutes in the Agriculture Sector using the public-private partnership model. Leadership by ISU.
- b. Define an inter-disciplinary research platform that includes Digital Agriculture, computer engineering, sensors, robotics, chemistry, genetics, genetic engineering, genomics, phenomics, and other non-traditional disciplines, supported by advanced simulation and predictive computer models.
- c. Conduct an Advanced Farming Workshop at ISU that would bring together all of the interested stakeholders from within the University and across the State of Iowa under the sponsorship of Dr. Steven Leath, President of ISU, Dean Wendy Wintersteen, and Secretary Bill Northey.

Initiative #5 – Create an Institute for Advanced Farming

Create a center for inter-disciplinary research that will position Iowa farmers to be at the cutting edge of digital technology for generations to come.

- d. Position the Advanced Farming Institute as the equivalent of the US Advanced Manufacturing Institutes which focus on the development of new opportunities in that sector.
- e. Obtain the support of the USDA and the active support of Secretary Vilsack for this initiative. This will require an updating of the PCAST study done in 2012 before the importance of the Digital Transformation of Agriculture became apparent.
- f. The Ag State members adopt a coordinated approach for this initiative and raise specific funding to support the development of an Institute at ISU.
- g. Obtain the support of the National Farm Organizations since the research conducted at the Institute will be applicable across the Midwest Region.

Expected Timeframe to Realize Impact of Initiatives



Annual Conceptual Budget Estimated Costs

Initiative	Launch Period	Establishment	Critical Mass Long-Term
#1: Education	<ul style="list-style-type: none"> • 2 FTE • \$400K 	<ul style="list-style-type: none"> • 2 FTE • \$500K 	<ul style="list-style-type: none"> • 2 FTE • \$750K
#2: Data Warehouse	<ul style="list-style-type: none"> • 5 FTE • \$1.25 MM 	<ul style="list-style-type: none"> • 10 FTE • \$2.5 MM 	<ul style="list-style-type: none"> • 20 FTE • \$5.0 MM
#3: Technical Evaluation	<ul style="list-style-type: none"> • 3 FTE • \$750 K 	<ul style="list-style-type: none"> • 5 FTE • \$1.25 MM 	<ul style="list-style-type: none"> • 5 FTE • \$1.5 MM
#4: Technology Pull Program	<ul style="list-style-type: none"> • 1 FTE • \$250 K 	<ul style="list-style-type: none"> • 2 FTE • \$500 K 	<ul style="list-style-type: none"> • 2 FTE • \$750 K
#5: Advanced Farming Institute	<ul style="list-style-type: none"> • 2 FTE-Core • \$500K 	<ul style="list-style-type: none"> • 10 FTE-Core • \$2.5 MM • \$7.5 MM-R&D-Contract 	<ul style="list-style-type: none"> • 10 FTE-Core • \$2.5 MM • \$22.5 MM-R&D-Contract
TOTAL: \$/year	\$3.15 MM	\$14.75 MM	\$33 MM
TOTAL: FTE	13 FTE	29 FTE	41 FTE

Major Take-Aways

- Digital Transformation will create structural change in American agriculture.
- We're in the 2nd inning.
- Farmers are still able to help shape the outcome.
- This project must now “pivot quickly” to include national organizations and other state organizations.
- The period between today and the hiring of full-time personnel to execute these initiatives is “the valley of death.”
- This is not the end. It is the end of the beginning.

Thank you

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