Beyond Precision Ag: If Big Data's the Answer, What's the Question? Executive Summary

This case study explores the potential for Big Data in Midwest agriculture. The overall content, therefore, has to be somewhat speculative — we won't know what the future impact of Big Data will be, if any, until the future occurs. However, we can use what we've learned through the application of Big Data in other sectors and the use of information and communication technology (ICT) in agribusiness to hopefully better anticipate the nature of potential change. The case study's components are described below:

- Precision Agriculture, Its Effects and Emerging Applications of ICT: Over the last 20 years, Midwest agribusiness managers have had experience with precision agriculture and should recognize both that it has had significant impact and that, at times, the hype has exceeded reality. Available data does suggest that adoption of precision agriculture continues to grow. The capabilities associated with ICT use (autonomous steering, machine-based sensors) also has expanded. Future innovations, such as in remote sensing and communications, likely will have impact in developing countries as well as application in the Midwest.

- ICT Application and Industry Transformation: While popular media tends to focus on the technology "gee whiz" factor in its reporting of ICT adoption, key economic factors typically determine success or failure. In particular, low-cost data acquisition invariably is a key determinant and analytics has transformed the process of creating value through aggregation.

- Big Data and Its Business Application: Three dimensions are typically used to describe the Big Data phenomenon: volume, velocity, and variety. Volume typically does not have a specific numeric value but rather refers to amounts of data that significantly exceed currently software and hardware capabilities. The velocity dimension refers to the capability to acquire, understand and interpret events as they occur. Variety may be the most novel and intriguing of these three characteristics as the concept of "what is data" is widely expanded. Numerous examples and potentials for Big Data applications exist; however, the conventional wisdom is that each firm's business needs and capabilities, rather than technology, must drive Big Data implementation.

- Big Data and Midwest Agriculture: Vision and/or Hallucination? Big Data capabilities in areas such as manufacturing and logistics are being tested and improved across the economy. As providers become more proficient in applying these tools, application costs will decrease. Even if, today, implementation in agribusiness is not economically attractive, future cost decreases will change those calculations. Large branded food manufacturers and retailers are striving to employ Big Data techniques to improve their customer offerings. Product and service offerings that employ Big Data concepts within them increasingly will be offered to agribusiness managers.

One means by which Big Data could alter the basis of agribusiness competition would be to foster new linkages across traditional boundaries in the sector. This could involve multiple farming units as well as suppliers and customers of the farming operation. In addition, the science and research knowledge base that currently fuels the sector likely has a vital role, even if large amounts of operational data are accessible. While technical challenges in accomplishing these efforts are significant, the organizational and business model adaptations that will be necessary could be even more profound.

Discussion Questions

1. Sometimes media can be a bit "breathless" in their description of the impact of technology. Below is a recent description of precision agriculture.[1] At least the topic, barley production for beer, is of critical societal importance.

> **A New Kind of Agriculture Replaces Intuition with Precision**
>
> Precision farming — using sensors, automatic sprayers, and even drones and satellites — are letting farmers manage each plant in their fields perfectly, leading to farms that are much less resource intensive. Record-setting drought across the United States in recent years has pushed everyone to look for new ways to save water. So while nature and beer don't always go together, it was natural for The Nature Conservancy (TNC) to join forces with America's beer brewers to change how farmer irrigate their crops. For the non-profit, conserving America's rivers meant growing America's barley, one of the primary ingredients in one of our favorite cold beverages, with less water.
>
> The key is precision farming: the convergence of digital technology that allows farmers to apply just the right amount of fertilizer and water on their fields. Humans have practiced a rather crude form of agriculture for millennia: we douse fields to give them as much water and fertilizer as we think they need. Yet field conditions may differ drastically within a few feet.

Let's consider the application of precision agriculture in Midwest corn and soybean production.

   a. Would we assert that Midwest farmers can manage each plant "perfectly"? What arguments would the group use to support or refute that claim?

   b. Instead of perfectly, would we assert that precision agriculture enables Midwestern farmers to operate at significantly higher levels of economic productivity? What arguments would the group use to support or refute that claim? In particular, what specific practices have been found to contribute the most to economic productivity?

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[1] http://www.fastcoexist.com/1682029/a-new-kind-of-agriculture-replaces-intuition-with-precision

2. Increasingly, some consumer segments seem to want to know more about "how" their food and the agricultural output in that food have been produced. The text below is from a recent Wall Street Journal article indicating that new measurement techniques can link meat products to the soil where the lamb or beef grazed.[2]

How to Ensure You Have No Beef With Your Lamb

Producers Work to 'Fingerprint' Products as Mislabeled and Tainted Food Eat Into Customer Confidence

WELLINGTON, New Zealand — Beef and lamb producers are at the forefront of a global push to try to verify scientifically the provenance of the meat that people buy, as a series of scandals over mislabeled and tainted food eats into consumer confidence.

Farm groups from the highlands of Scotland to the pastures of New Zealand are investing in technology that tries to "fingerprint" meat by looking for chemical traces of the soil, grass, water and air where the animals once roamed.

Let's assume these same measurement techniques could be applied to Midwestern production of corn, soybeans, beef and dairy. Further, let's assume consumers of the future demand this level of accountability, to the extent that agricultural outputs that couldn't be linked to its farm of origin would be severely discounted in the market. (Here we need to suspend our disbelief regarding how this would be done.)

a. What changes in our commodity markets might we expect if this level of production traceability was the norm?

b. Given that consumer segments are never satisfied, what other production characteristics might consumer segments be willing to pay for — in addition to knowing the farm of origin?

c. As information about farms of origin and other attributes start to accumulate, how might the tools and approaches of Big Data be employed to further advance productivity and effectiveness?

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[2] A version of this article appeared July 31, 2013, on page A9 in the U.S. edition of The Wall Street Journal, with the headline: New Zealand Pushes Technology To Head Off Mislabeling of Meat.

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3. Many, if not most, of the Big Data episodes we hear about focus on capturing "what" happened, examining it in detail and then creating the capability to respond to what is happening in the future as it happens. Below is a little anecdote that illustrates the danger of only focusing on "what" (correlation) rather than understanding "why" events occur (causality). [3]

The Truth about Nutrition

Here is the final word on nutrition and health. It's a relief to know the truth after all those conflicting medical studies.

- The Japanese eat very little fat and suffer fewer heart attacks than do the British or Americans.

- The French eat a lot of fat and also suffer fewer heart attacks than the British or Americans.

- The Japanese drink very little red wine and suffer fewer heart attacks than the British or Americans.

- The Italians drink excessive amounts of red wine and also suffer fewer heart attacks than the British or Americans.

- The Germans drink a lot of beer and eat lots of sausages and fats and suffer fewer heart attacks than the British or Americans.

Conclusion: Eat and drink what you like. Speaking English is apparently what kills you.

A key to the current effectiveness of Midwestern agriculture is its historic and current capability to employ science-based knowledge (Small Data) to advance the productivity of crop and livestock production.

a. Is all this science and causality stuff really needed? If we can track exactly what's happening in actual crop and/or livestock production systems, do we really need the science-based knowledge?

b. Let's pretend that the group thinks it would be beneficial to link science-based and Big Data information. (Don't worry about the computational issues of doing this; it can be done.) What organizational and business challenges would need to be overcome? What suggestions would the group make to overcome those challenges?

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[3] Ellsworth, T. (2013, August 1-7). The truth about nutrition. The News-Gazette, pp. 16.

4. Figure 16 of the case study illustrates how telematics could be employed to link together the various sources of information across a farm firm. But, conceptually, that framework could be employed to link together a market region. For example:

After harvest, a major portion of the corn crop resides within distributed storage facilities across the Midwest. And before planting, fertilizer inputs are poised for use in another distributed set of facilities. Today, the process by which those goods are brought to market is done in a highly efficient manner, based upon the decisions of thousands of decision makers considering only their independent economic needs.

The current system is efficient and the gold standard for much of the rest of the world. However, improvement still might be possible.

a. Given that individual farmers would still have decision power on when to price grain and what inputs to apply, how might the system operate if the logistics could be optimally allocated as the marketing year or the planting seasons progresses? Note: Such a system would incorporate information (rainy weather, for example) as it occurs and adjust the optimal plan based upon these real time events.

b. Are there potential economic benefits (for the entire market) that could be achieved from operations of such a system? Are there potential costs?
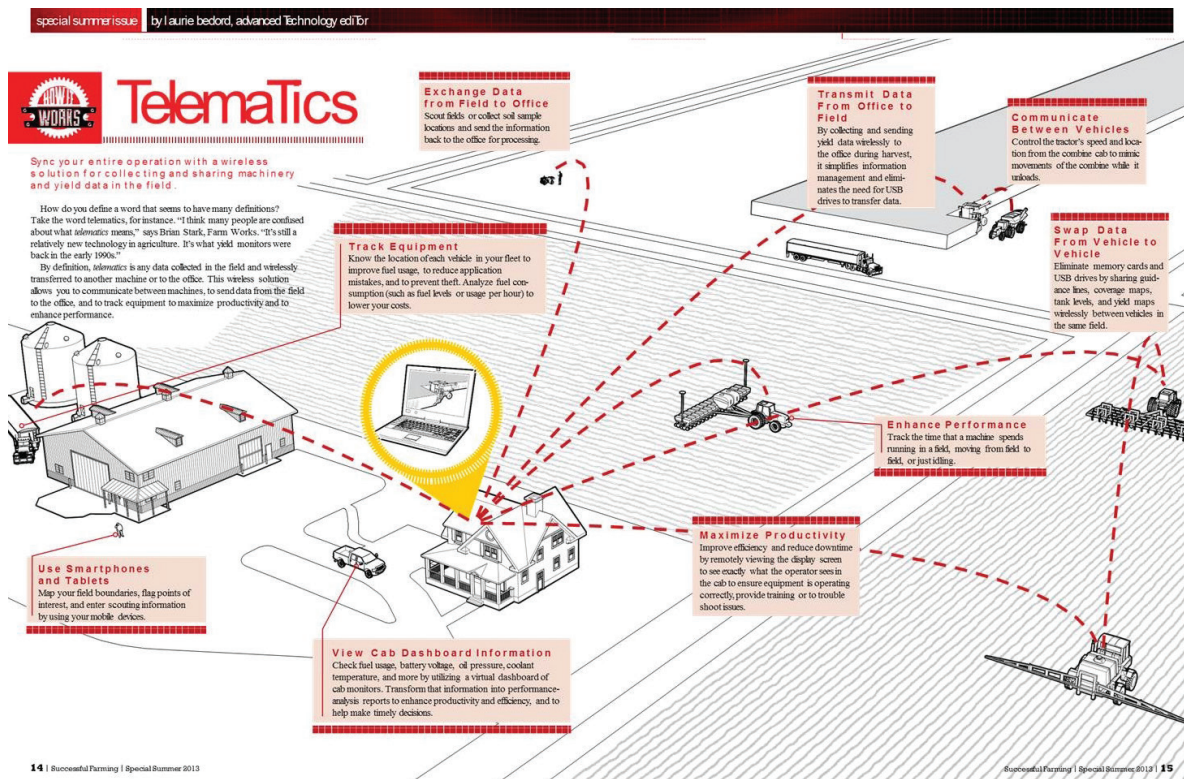

Figure 16. Telematics connects the farm firm

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5. As noted in the text box below, a recent study identified five game changers for the U.S. economy.[4] What a surprise, application of Big Data technologies is one of them!

Game changers: Five opportunities for U.S. growth and renewal

The U.S. economy is struggling to find a new formula for vigorous growth. But all growth opportunities are not created equal. New McKinsey research pinpoints five catalysts — in energy, trade, technology, infrastructure, and talent development — that can quickly create jobs and deliver a substantial boost to GDP by 2020.

One of those categories is Big Data analytics as a productivity tool. Sectors across the economy can harness the deluge of data generated by transactions, medical and legal records, videos, and social technologies — not to mention the sensors, cameras, bar codes, and transmitters embedded in the world around us. Advances in computing and analytics can transform this sea of data into insights that create operational efficiencies. By 2020, the wider adoption of big-data analytics could increase annual GDP in retailing and manufacturing by up to $325 billion and save as much as $285 billion in the cost of health care and government services.

a. Assume it's now the year 2020 and you're being paid to contribute ideas to an article entitled, "Halleluiah! Midwest agriculture has led the way in the successful implementation of Big Data techniques, contributing to the nation's economic growth." Please identify and describe the three most important developments that you would expect to be featured in that article?

On the other hand:

b. Assume it's now the year 2020 and you're being paid to contribute ideas to an article entitled, "Oh, woe is us! Despite early optimism, Big Data techniques have failed to achieve effective traction in Midwest agriculture, thereby restraining the nation's economic growth." Please identify and describe the three most important non-technological factors that impeded successful implementation that you would expect to be featured in that article?

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[4] http://www.mckinsey.com/insights/americas/us_game_changers