

# Big data can foster the next wave of agricultural innovation

[blogs.lse.ac.uk/businessreview/2016/06/10/big-data-can-foster-the-next-wave-of-agricultural-innovation/](http://blogs.lse.ac.uk/businessreview/2016/06/10/big-data-can-foster-the-next-wave-of-agricultural-innovation/)

6/10/2016



Production agriculture, farming, is an important sector affecting the global economy, societal well-being, and the vitality of natural ecosystems. Access to safe, nutritious, and affordable food is a goal for the citizens of all nations. In many developing countries, agricultural production employs the majority of the labour force. In more developed nations, an effective food and agricultural sector typically is a substantial economic activity.

Innovation over the last 150 years has been an important means by which [agricultural systems](#) have increased productivity and fed an ever-increasing global population. Mechanization of tillage practices fueled expansion of the land available for production while reducing human drudgery and labour needs. Biological science applied to crop breeding, mitigation of pests, and more effective preservation of agricultural produce after harvest expanded food availability for much of the world's population. More recently, advances through application of biotechnology have been successfully employed (albeit not without controversy).

The phenomenon now known as [Big Data](#) has been effectively employed in numerous sectors and offers the promise to advance innovation in agriculture as well. Just a few of the examples being tested and implemented include drone- and/or satellite-based monitoring of the growing crop to guide crop protection and harvest decisions, analysis of GPS-based information of actual field conditions and yields to determine best practices for the following seasons, and equipment monitoring capabilities to optimize machine productivity. While adoption of such technologies is further advanced in developed countries, the potential for positive impact is at least as great in developing nations. Achieving these desirable outcomes, however, will require overcoming key impediments arising from the distinctive nature of agriculture.

Let's consider this now overly familiar term, Big Data. Generally it is thought of as a singular entity. It is not! In reality, Big Data is much more a capability than it is a thing. It is the capability to extract information and insights where previously it was economically, if not technically, not possible to do so. Advances across several technologies are fueling the growing Big Data capability. These include, but are not limited to computation, data storage, communications, and sensing.

Three [dimensions](#) often are employed to describe the Big Data phenomenon: Volume, Velocity, and Variety (Figure

1). Each dimension presents both challenges for data management and opportunities to advance decision-making. These three dimensions focus on the nature of data. While each is important, we will see that variety is of particular relevance in agriculture.

Further, just having data isn't sufficient. **Analytics** is the hidden, "secret sauce" of Big Data. Analytics refers to the increasingly sophisticated means by which useful insights can be fashioned from available data.

Regarding the 3V dimensions, volume is not defined in specific quantitative terms. Rather, Big Data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. This definition is intentionally subjective; with no single standard of how big a dataset needs to be to be considered big. And that standard can vary between industries and applications.

### Fig.1 Dimensions of Big Data (Sonka, 2016)

The velocity dimension refers to the capability to acquire, understand, and respond to events *as they occur*. Sometimes it's not enough just to know what's happened; rather we want to know what is happening now. Use of cell phone signals to provide real-time traffic information illustrates the value of high-velocity data.

For agriculture, the variety dimension of Big Data is the most novel and intriguing. For many of us, and for agricultural managers, data refers to numbers meaningfully arranged in rows and columns. However, the process of producing agricultural crops and livestock generates immense amounts of potential data. With historically available technologies, however, the cost of capturing that data greatly exceeded the benefits from doing so. Innovation currently is promising to materially alter that cost/benefit ratio. Successful development of such innovations is a critical but often overlooked requirement for Big Data to provide maximum benefits in agriculture.

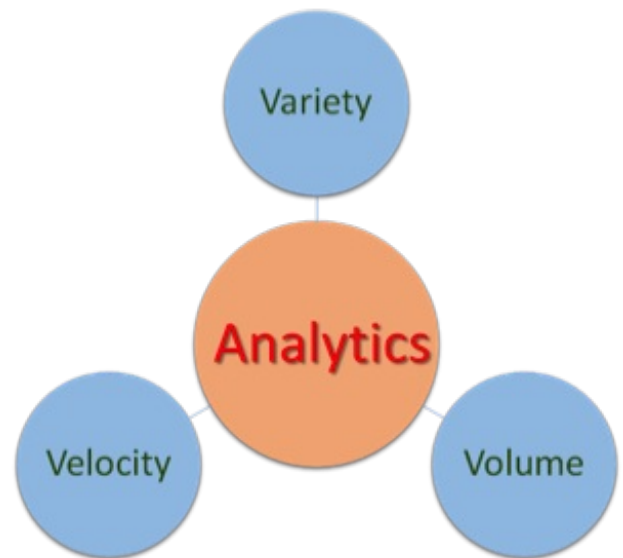
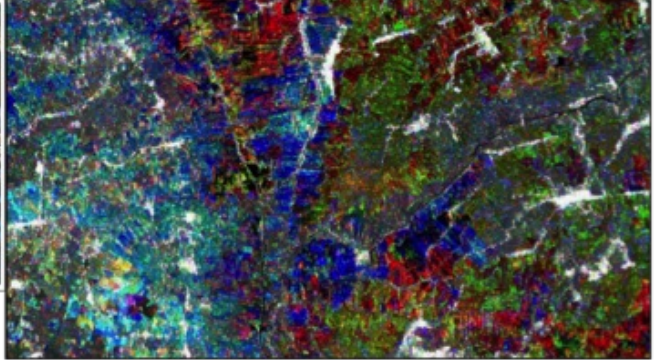


Figure 2 illustrates this change. In its upper left hand corner, we see data as we are used to it – rows and columns of nicely organized numbers. In the figure's upper right hand corner, we see a picture of a pasture in New Zealand. Pasture is the primary source of nutrition for dairy cows in that country and supplemental fertilization is a necessary economic practice. The uneven pattern of the forage in that field is measured by a sensor on the fertilizer spreader to regulate how much fertilizer is applied – as the spreader goes across the field. Now, uneven pasture growth can be data that is managerially relevant to the farmer.

The lower left hand corner of Figure 2 shows the most versatile sensor in the world – individuals using their cell phone. Particularly for agriculture in developing nations, the cell phone is a phenomenal source of potential change – because of information sent to those individuals but more importantly information they now can provide. And as illustrated in the lower right hand quadrant of Figure 2, satellite imagery can measure temporal changes in reflectivity of plants to provide estimates of growth. The picture shown is focused on rice production in Asia.

### Fig. 2. A few sources of data (Sonka, 2016)

Region	Type	Sum of Avg	PH%	Loss Amount	Consumption%	Consumption Loss Amount
Europe	Cereal	449,306,769	36%	162,871,704	25%	112,326,692
Europe	Fish & Seafood	15,940,550	27%	4,224,246	11%	1,753,460
Europe	Fruits & Veggies	273,120,717	36%	96,955,465	29%	51,930,960
Europe	Meat	56,820,963	21%	11,761,939	11%	6,250,306
Europe	Milk	254,895,073	9%	19,954,347	7%	15,182,405
Europe	Oilseeds & Pulses	72,660,866	13%	2,992,895	4%	2,906,415
Europe	Roots & Tubers	122,558,596	48%	58,824,129	17%	20,834,961
Industrialized Asia	Cereal	514,899,643	17%	192,470,617	20%	101,939,929
Industrialized Asia	Fish & Seafood	71,771,113	27%	19,378,201	8%	5,741,689
Industrialized Asia	Fruits & Veggies	1,256,874,564	33%	414,768,606	15%	188,531,183
Industrialized Asia	Meat	85,280,291	20%	16,714,937	8%	6,822,423
Industrialized Asia	Milk	50,888,097	14%	6,971,669	5%	2,544,405
Industrialized Asia	Oilseeds & Pulses	87,073,120	13%	11,919,506	4%	3,482,925
Industrialized Asia	Roots & Tubers	167,571,345	41%	68,704,251	10%	16,757,135
Latin America	Cereal	184,443,196	23%	41,500,214	10%	18,444,540
Latin America	Fish & Seafood	17,568,830	28%	4,919,276	4%	702,754
Latin America	Fruits & Veggies	393,659,366	52%	100,702,870	10%	15,965,937
Latin America	Meat	49,820,932	17%	2,806,817	6%	2,737,139
Latin America	Milk	78,359,239	20%	15,871,844	4%	3,134,369
Latin America	Oilseeds & Pulses	162,194,407	15%	24,329,161	2%	3,241,888
Latin America	Roots & Tubers	55,177,940	33%	18,274,720	4%	2,215,118
North Africa, West & Central Asia	Cereal	115,517,929	29%	32,822,610	12%	13,862,151
North Africa, West & Central Asia	Fish & Seafood	1,928,165	30%	1,099,940	4%	157,910



The potential for application of the tools and techniques of Big Data offers considerable potential to advance productivity, increase smallholder farmer well-being, contribute to food security, and to enhance the sustainability of agriculture in both developing and developed economies. While promising, the pace of adoption will be tightly linked to effective deployment of low-cost measurement capabilities. If technological and managerial advances drive effective development of those capabilities, the result will foster the next wave of innovation in the food and agricultural sector.



**Notes:**

- This post is based on the author's paper [Big Data: Fueling the Next Evolution of Agricultural Innovation](#), in *Journal of Innovation Management*. 4(2016):114-136.
- The post gives the views of its authors, not the position of LSE Business Review or the London School of Economics.
- Featured image credit: Green beds, farmlands in India, [Wikimedia Commons](#)
- Before commenting, please read our [Comment Policy](#)

**Steve Sonka** is Emeritus Chaired Professor of Agricultural Strategy at the University of Illinois and Fellow at the Ed Snider Center for Enterprise and Markets at the University of Maryland. An economist reared on a smallholder farm in the Midwest United States, his scholarship emphasizes strategic change and decision making. In 1983, he authored *Computers in Farming*, the first text devoted to computer use in the sector, and has authored or coauthored over 225 books and articles.



- Copyright © 2015 London School of Economics