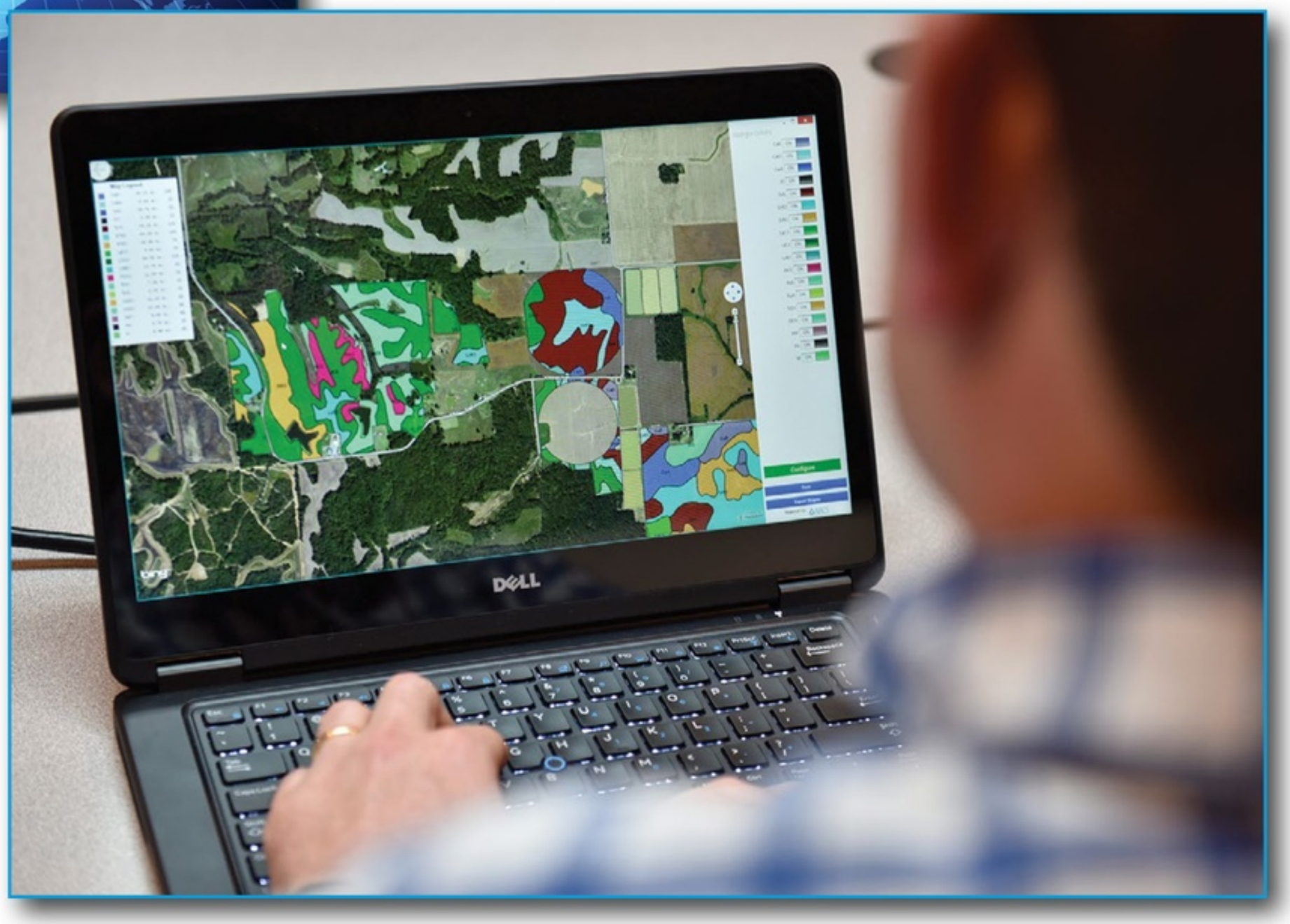

The explosion of data, cloud computing and advanced analytics is optimizing the way we grow food.

Source: Syngenta

Agriculture's need for analytics and IoT

How analytics can play a major role in ensuring a growing world population will have enough food to eat for generations to come.

By Joseph Byrum

Analytics and Internet of Things (IoT) devices promise to deliver massive returns on innovation in agriculture. When it comes to smart devices, most attention immediately turns to the home where phones and tablets communicate with lights, thermostats and other appliances to enhance the convenience of our living environments. That's certainly a welcomed advance, but analytics and IoT can achieve even more, perhaps playing a major role in ensuring a growing world population will have enough food to eat for generations to come.

Here's how that could happen.

The explosion in availability of inexpensive sensor technology, cloud computing capacity and the development of advanced operations research algorithms is coming together to optimize the way we grow food. Improving productivity isn't a luxury; it's a necessity. The world population is charging toward 9.7 billion in 2050 [1], a significant jump from just 1.6 billion at the dawn of the 20th century [2]. Naturally, the amount of arable land per person has been sliding downward ever since [3]. To guarantee that we will have enough to eat in the decades ahead, we must optimize the amount of food produced per acre.

Pre-industrial agriculture was about as far from optimized as you could imagine. It took back-breaking labor on small subsistence farms to extract enough food to feed a single person from about two acres of land. In the 20th century, the arrival of machinery, modern fertilizers and plant hybrids sent productivity soaring. An acre could feed five. Now the dawn of precision agriculture promises to harness the power of sensors and analytics to drive the next revolution in operational efficiency – one that will ensure there's enough food to go around as the population expands and the pressures on land use intensify.

Data-driven farming is more than a good business decision; it's the only truly sustainable option for the future. Growing plant crops requires soil, sunlight, water and nutrients. The amount of sun is variable and dependent on weather, but the rest is under our control. In the old days, farmers would err on the side of dumping too much fertilizer on their fields, thinking it better to go with too much than to starve the growing plant. Unfortunately, this excess of nitrogen was bad for the environment and didn't promote efficient growth. Likewise, guessing the amount of water needed tended to overuse this scarce resource.

Today, using analytic techniques to apply only as much water and fertilizer as needed to the plant so that it achieves maximum growth eliminates waste of scarce resources and protects against environmental damage. The American Farm Bureau found precision techniques cut costs by 15 percent while increasing yields by 13 percent, on average [4]. Thus, efficiency, profitability and sustainability go hand-in-hand with agriculture, thanks to the power of data analytics.

The Internet of Things to the Rescue

Data analytics are only as good as the data used to feed the algorithms, and right now agricultural data are a mess. There is no unified system for data and devices, creating a nightmare for analysis. The information collected isn't actionable.

Agriculture has lagged on the data side because, unlike the lucrative market for consumer goods, agriculture is often seen as a low-margin business with little opportunity for high-tech investment – the sort of investment needed to drive productivity to the next level. From an economic standpoint, the boost in productivity from improved data collection must be big enough to cover the cost of the new equipment. That is a hard sell, because commodity prices are variable. Farmers are inherently practical, interested not in the latest and greatest gadgets, but the devices that have a proven value.

So the sensors that create data for growers must be affordable, and IoT devices hold great promise in that respect. Small networked devices can monitor soil moisture and nutrition content, as well as environmental conditions including temperature, humidity and air quality. They can track problems with equipment, like the amount of water, pesticides and fertilizer used. Just about every relevant variable can be measured and tracked on a plant-by-plant basis. Combined with satellite imagery, drones and GPS systems, the amount of data generated can be tremendous.

The cost of rugged IoT devices has contracted in recent years, but not quite enough to encourage mass adoption. Achieving greater sensor density requires a significant up-front investment in technology that continues to evolve. Farms that were once thought to be cutting edge used 2G GSM cellular modems to upload sensor data to the cloud for later analysis. They were forced to upgrade at the beginning of the year when one of the largest wireless providers shut down this network [5].

The shrinking size and increasing power and efficiency of the equipment is making it easier to create mesh networks to move data around farms that were once severely limited by power and range constraints. This will help make mass adoption a reality. A report by BI Intelligence [6] estimates the number of data points gathered on an average farm will grow from 190,000 today to 4.1 million in 2050.

O.R. Communities to the Rescue

Having more data at one's fingertips is nice, but without proper analysis, the data lack actionable value.

Data and information are not the same thing. If the readout on the agricultural sensor is 54, that's data – but it conveys no actionable information

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Analytics will play an indispensable role in cultivating a sustainable harvest to feed a fast-growing world population.
Source: Syngenta

on its own. Knowing that the sensor is measuring in degrees Fahrenheit helps provide context. Knowing, in addition, that a soil temperature of 54 degrees is ideal for growing soybeans provides a basis for action – it's a good time to begin planting seeds.

What the INFORMS and IFORS (International Federation of Operational Research Societies) communities have in abundance is the expertise in converting data into actionable information through the tools of operations research. Agriculture traditionally has not been a data-intensive industry and has not built up the expertise to deal with the information overload that will follow mass adoption of IoT devices. There is no question that agriculture will need help from the data analytics community.

One of the big challenges that must be solved is the establishment of data standards that will replace the current array of proprietary systems with a means of cooperation and data sharing. Groups like AgGateway [7] and Open Ag Data Alliance [8] are working on the standards needed so that agriculture's IoT sensors can talk to one another, which inevitably raises difficult ownership and privacy questions about who controls the data collected.

Solving these problems, which aren't unique to agriculture, will enable farmers to place sensors in a way that gives them the granularity needed to optimize like never before. In assisting this effort, the analytics community will play an indispensable role in cultivating a sustainable harvest to feed a fast-growing world population. **ORMS**

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