The next wave of farming intelligence arrives in North America

Robotics, artificial intelligence, machine learning and predictive analytics promise to change agriculture yet again.

by MARK JUHASZ

Panelists at the University of Toronto's Rotman School of Management event on October 27: (left to right) Diane Wu, CEO of Trace Genomics; Lee Redden, co-founder of Blue River Technology; Katya Kudashkina, CEO of UDIO AgTech; Max Bruner, CEO of Mavrx; and moderator, Ravi Mattu from the *Financial Times*.

The impact of 21st-century information technologies on agriculture will be profound.

The interaction between applied technologies and agriculture is growing. We are at a unique moment where data, produced in many forms, is now matched with the models and algorithms to make better sense of it.

How will robotics, artificial intelligence (AI), machine learning (ML) and predictive analytics affect the production of food? What ethical questions should the decision makers who support these technologies ask?

Panelists recently discussed these issues at the University of Toronto's Rotman School of Management at an event titled Machine Learning and the Market for Intelligence. They included representatives from Trace Genomics, UDIO AgTech, Blue River Technology and Mavrx.

AI, ML and the production of food

"We take a data-driven approach, using software and ML which does not require upfront capital costs of installing sensors, (that) is very easy to use and takes five minutes per field to set up," says Katya Kudashkina of Toronto-based agricultural software company UDIO AgTech. "It is predictive and oriented to create a balance between costs and yields. (There are) so many inefficiencies in (the deployment of) resources in farming today that we believe this is where data science and ML can play a big role."

Mavrx, a California-based precision ag company, works with farm clients to provide a range of field data. Imaging and crop management applications track nutrient, irrigation, hydrology and fertility specifics.

Trace Genomics, co-founded by Diane Wu and based in California, provides predictive data analysis of soil microbiome health and ML sequencing techniques to predict yields.

"We see soil as the womb of agriculture, and its health is essential.

If you have soil issues, they might be apparent only at the end of the season. We offer genetic fingerprints of soil," Wu says.

"We are not telling farmers how to farm. We are figuring out what machine learning will do better, scaling it and providing insights to farmers (who) get the value back from all their hard work."

Blue River Technology, another California company, also emphasizes precision farming. Its "plant-by-plant" diagnosis monitors for optimal growing conditions.

How are established farming companies responding to the next generation of AI start-ups and entrepreneurs? Case IH and New Holland, for example, unveiled prototypes of autonomous field tractors in the fall. Farmers may one day operate these tractors equipped with a range of technologies such as LiDAR (laser-sensing) guidance.

Some of these "high-tech" applications in farming, such as global positioning systems (GPS) or drone imagery, are not shockingly new.

So what brings AI to the forefront now?

In 2015, nearly 500 ag-tech companies drew USD$4.6 billion in investment, double the amount from the previous year, reports AgFunder, a U.S.-based equity crowdfunding site that connects individual and institutional investors with high-growth ag-tech and food companies.

Amid the enthusiasm for these new information and technology investments, farmers should keep in perspective that applications have different uses with particular commodity types, locations and production models, and need to integrate often disparate but growing ways of information gathering. Farm management will require thinking across database applications toward a unified platform of the farm operation; mobile devices will provide the user with access to ideally coherent, complete data.

We can increasingly see data integration and information sharing improve the benefits of AI. Farm Hack, which is based in the United States, provides users with an open source, online data platform to share "appropriate technology" innovations. Members manage and discuss everything from water conservation and soil health to greenhouses.

Farm Hack worked with the United States Environmental Protection Agency to gather data across farming systems to validate information that helps inform both government policy and farmer decision-making.

In 2009, the Food and Agriculture Organization of the United Nations reported that by mid-century agricultural production will need to rise significantly to meet demand. The situation is further complicated because some intensely farmed regions where crops such as rice and wheat are produced have "yield plateaued."

Bringing AI to agricultural innovation and addressing the data gaps

These developments are on the radar of Ontario-based farm organizations. At the interface of agriculture, crop

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Depending on the type of agricultural commodity, data analytics bring attention to various missing links.

production and information management, partnerships between provincial institutions are combining efforts for greater impact.

Karen Hand, leader of the Ontario Precision Agri-Food (OPAF) project and founder of Precision Strategic Solutions, encourages the adoption of technologies that allow for real-time linkage between platforms and applications to align data with agronomic models and analytic tools.

Depending on the type of agricultural commodity, data analytics bring attention to various missing links. Max Bruner from Mavrx, for example, noted the "missing granular data related to hydrological models, especially in field drainage. We need better topography and sloping data to manage nutrients."

There are different perspectives on data use. Tyler Whale, president of Ontario Agri-Food Technologies, says "decision support tools can analyze data and contribute to effective management when stored in a system that allows the owner to manipulate and understand the algorithms used, skimming data to amplify for impact, accuracy and depth."

Karen Hand of OPAF values the "integration of all possible disparate data sources, enabling intercommunication of devices. Think of this as a digital highway, connecting data communities to develop robust informative decision support systems that our farmers need."

Dan Tukendorf, program manager for the Ontario Fruit & Vegetable Growers' Association, considers "the need for information about changing demographics and demand. Our producers want to grow what consumers want and the different fruits and vegetables that are needed. The development of some varieties, such as those from orchards and vineyards, have longer timelines, so we want the info on where demand is going and the right amount of that product."

New data analytics applications and services need to

have a clear financial benefit for the farmer. Ryan Koeslag, executive director of Ontario Bean Growers, asks: If an application makes "you do x, y and z, does it result in bottom-line increases? ... Does it have calculations that translate to advantage? With a million things on the go, it can't be another marginal input."

Policy to promote the benefits of AI and data analytics

Farm organizations see their support of a vibrant agri-food sector often driven by unique local public and private policy considerations.

Trace Genomics takes data seriously. "We generate a lot of genetic data," says Diane Wu, CEO of the company. "This could be taken by third parties, so we put a lot of thought and legal work into protecting our client's data in a way that has not been done before. We need to address this in terms of education to alleviate some of the fear that farmers might have."

Ontario must also remove barriers that get in the way of adopting these applications. "Until we have broadband optics, we don't have the capability," says Don McCabe, past president of the Ontario Federation of Agriculture.

"We need to speed up the process to do the job of broadband for these new technologies to come along to start seeing how they can immediately add value and allow Ontario farmers to remain competitive."

How will we ensure that the benefit of these applications is clear in return-on-investment value, is evidence-backed and maintains public trust?

We are now able to imagine information and computerized possibilities that did not exist before: assessing soil modifications, checking plant response rates, analyzing heat and weather image patterns, managing plant and herd robotics, and linking health and genetic diagnoses.

Managers and users who collect farm data will continue to face important discussions about security, ownership and confidentiality. Whale mentions "mitigating the risk of adoption where the new technologies need to work in harmony with the art of farming in how well the application understands the many intricacies of agriculture with so many variables and management styles."

"Information and knowledge from data can only be realized when the context of the data is truly understood," adds Hand.

"We need to use these powerful new analytic tools with our eyes wide open."

"We require clear issues of ownership of data and who has what when," says McCabe. "We want to move into this arena and represent farmers' interests."

Adapting to the evolution of data capacity and its analytics is a tall order. Further application in on-farm experience and collaboration across the research and transfer spectrum are required.

But these new technologies, as long as they are used responsibly, promise great possibilities. **BF**