

SPRING 2021

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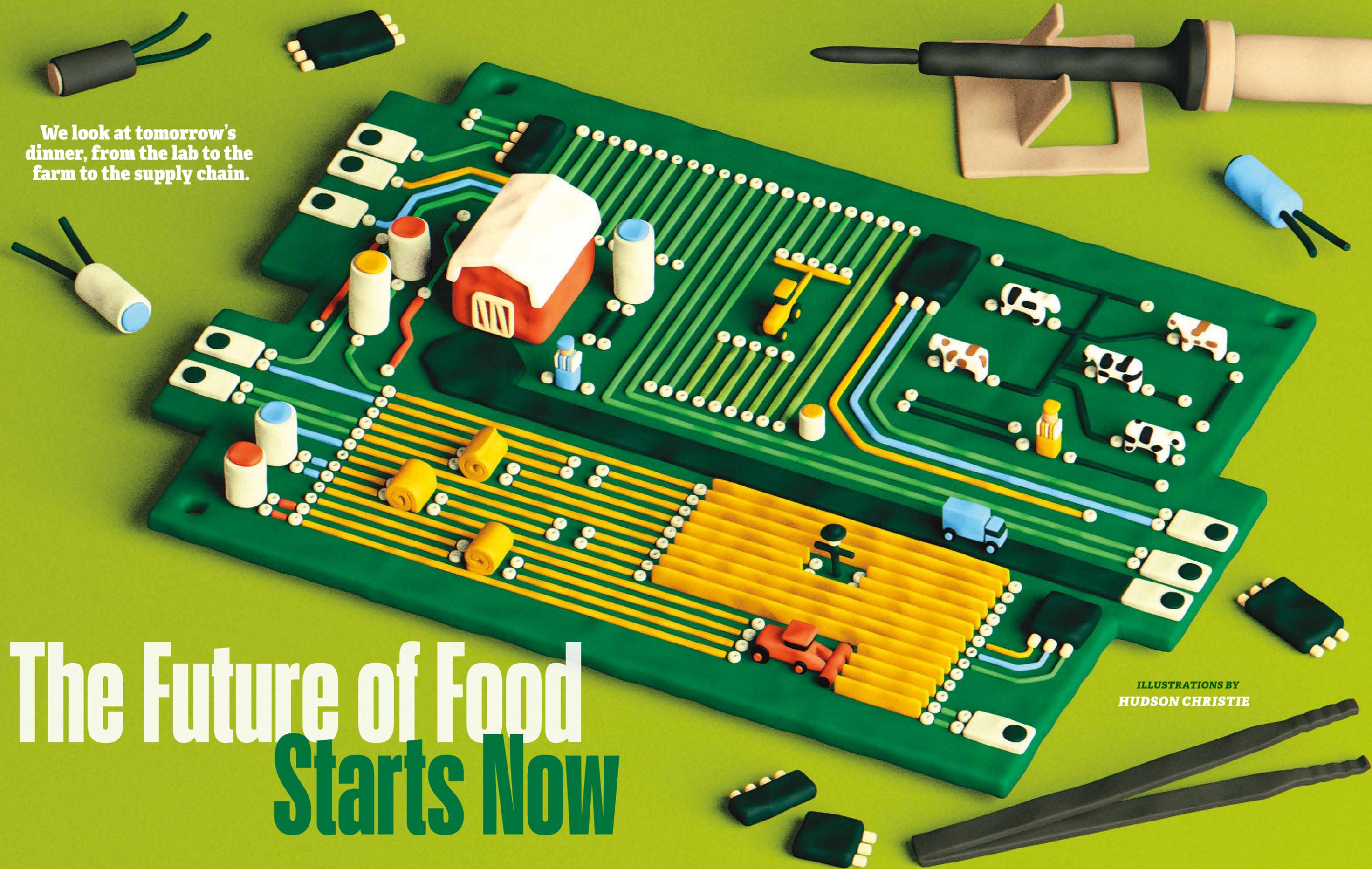
UNIVERSITY OF ALBERTA
ALUMNI MAGAZINE

THE HUNT FOR HEP C

A blood-borne illness was making millions sick, but no one could find the culprit. Inside the seven-year search to identify a mystery virus.

**And what it takes to
earn a Nobel Prize.**

We look at tomorrow's dinner, from the lab to the farm to the supply chain.



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The Future of Food Starts Now

THE FUTURE OF FARMING IS SMARTER

In the drive to become more efficient and adaptive, farms are becoming innovation incubators

By **Therese Kehler**

THE FUTURE OF FARMING MIGHT BRING TINY DRONE pollinators or a fishy foray into conserving water in greenhouses. It might bring an app that diagnoses plant disease, artificial intelligence that reduces a farmer's driving time, or robotics that lend some extra hands.

Future farming might bring some, all or none of those. What it will bring, says **Stan Blade**, '81 BSc, is change.

"This is an industry that is looking at how it can expand, how it can do things in a more informed manner, how to be more efficient, how to generate more revenue," says Blade, dean of the Faculty of Agricultural, Life & Environmental Sciences. "There's a reason why agriculture and food stories are above the fold in the business section these days."

That reason is food production, as an increasing number of mouths to feed is divided by challenges such as a shrinking and aging workforce, climate change and reduced arable land. Between 1971 and 2011, for example, Canada lost about six per cent of its agricultural land—approximately 3.9 million hectares—to the growth of cities, highways and airports, oil and gas, mining, and alternative energy projects, according to a York University policy paper. And Alberta's two largest cities grew by 52 per cent between 1984 and 2013, swallowing some of the province's top-ranked farmland, according to a University of Alberta study.

Farms and ranches take up just seven per cent of Canada's land mass but they're cornerstones of

the food production system, with more than 193,000 farms providing oilseeds and grains, fruits and vegetables, poultry, beef and other meats.

Meanwhile, a rise in small-scale farming systems is diversifying how food is produced in Canada.

Canada's greenhouse industry, for example, has been growing steadily for eight years, producing more than 660 million kilograms of fresh fruits and vegetables in 2019. Aquaculture farms, which raise fish, seafood and edible marine plants, now exist in all 10 provinces plus one territory.

There's even a fledgling industry that mashes the two together in the form of aquaponic farming systems, raising both fish and vegetables for food.

A Perfect Circle

In an engineering building not far from Blade's campus office is Rafiq Ahmad's Aquaponics 4.0 Learning Factory, nicknamed AllFactory, where traditional hydroponics will meet the fourth industrial revolution.

Call it Agriculture 4.0, with pools of tilapia fish.

"Everybody thinks that engineering is restricted to just mechanical systems ... cars, or airplanes, things like that," says Ahmad, an assistant professor of mechanical engineering.

"That was something I wanted to change here at the University of Alberta."

AllFactory is a 33-square-metre factory-in-a-lab that will see traditional methods of aquaponics practised alongside the development of machine-learning technologies for the integrated fish-and-plant system.

Aquaponics is an indoor circular system in which wastewater from the tilapia pools is circulated to plants that use the nutrients, filter the water and return it to the fish. (Crop choices would rely on consumer markets, location and local climate, pest resistance and how well the crops take up nutrients.) The system's environmental and economic advantages—nutrient recycling, minimal water loss and dual income streams—have intrigued Alberta farmers since the early 1990s.

The project received funding and approval in early 2020 by NSERC Canada. The pandemic has stalled the final setup of Ahmad's learning factory, but seeing how COVID-19 has affected on-site workforces has reinforced his confidence in the need for engineered, automated solutions.

"You need to constantly monitor the plants, the nutrients in plants. You have to monitor fish growth. You have to monitor that nothing goes wrong in the process on a daily basis, even an hourly and minute basis," he says. "If we cannot bring a lot of people to work, how can we make it

"This is an industry looking at how it can expand, do things in a more informed manner, generate more revenue."

—**Stan Blade**

completely autonomous so that people can monitor from a distance?"

The AllFactory will partner with businesses related to food production, especially those looking for engineered solutions to specific problems. In fact, one such conversation, with a U.S. company that develops aquaponics systems, inspired Ahmad's recent purchase—a small drone.

"Their problem was related to broad-based pollination," he says about the company's dilemma. How do indoor plant systems pollinate? "That is a big issue in aquaponics or hydroponics systems. Because you cannot bring in bees."

Agriculture Meets AI

The agriculture industry is no stranger to data collection. Gathering information about soil, sky, routines and yields has long been part of the farming rhythm. During an early-morning Zoom meeting in January that included academia, government agencies and agriculture industry stakeholders, **Shazan Jabbar**, '16 MSc, was pitching the benefits of turning those rhythms into algorithms.

Jabbar is a scientist who specializes in machine learning. He's hoping to drum up interest in a new program from the Alberta Machine Intelligence Institute (Amii) that aims to help the ag industry explore the potential of AI. To make his point in the Zoom meeting, Jabbar demonstrated a German-made app called Plantix, in which a farmer takes a picture of a poorly growing plant and the app identifies whether it is suffering from disease, pests or nutrient deficiencies.

"You must be wondering how this stuff gets built," Jabbar said to the group. "Mostly it's just clever algorithms and data. Data in combination with computation."

Amii's program, Reducing Emissions through Machine Intelligence (REMI), pairs AI researchers with organizations to figure out how emerging technology can be used to reduce emissions, says Nella Brodett, Amii's director of investment and partnerships. A version of the program for the energy industry, which had 20 companies participate, was completed in February 2021. This is the first time REMI has been offered to the agriculture sector.

Farms in Canada generate about eight to 10 per cent of the country's greenhouse gas emissions, and much of Amii's work will be to find ways to optimize different farm processes, Brodett says. "How many times do you run your equipment based on when you need to run it versus when you thought you needed to run it?"

The reduction in greenhouse gas emissions would be small on an individual scale but there is strength in numbers. "If every farm in Alberta, every farm in Canada, every farm in



“The farmer needs to have that aha moment of, ‘This could impact my business positively.’”

—Nella Brodett

North America was able to move that dial just slightly,” Brodett says, “that’s a big impact over time.”

She says the program has received a curious but cautious response from applicants, which range from tech startups to family farms. There are concerns about financial risk, invasion of privacy and whether farms would need to hire a data scientist. “Most of these farms are people’s homes,” she says. “This is actually personal property.”

REMI is a 16-week program structured in phases, and participants will go only as far as they need. The first phase is educational, Brodett says, “for the folks who may never use the technology or may not use it in the next five years, 10 years, but now understand what it means.” The second phase walks participants through a tangible idea. In the final phase, which only a handful of participants will reach, a proof of concept is developed.

“The farmer needs to understand what the technology means, not at a very technical level but to have that aha moment of, ‘This could impact my business positively. Now I want to know the next steps.’”

It’s Complicated

There’s a complicated relationship between agriculture and climate change, Blade says. The ongoing work to reduce agriculture’s carbon footprint — through measures such as reduced tillage or grazing strategies to maximize carbon sequestration — needs to be accompanied by research to ensure producers are set up for success.

“There will be warming in the environment. There will be challenges around moisture and transpiration,” Blade says. “Agriculture would be very much at the front of that. But we also have to be aware of what the data show us on how productivity will change in different parts of the world.” Blade adds that the sector needs to navigate the coming changes to climate without adding to the problems.

While REMI seeks to use AI to tackle emissions, crop scientists are using it to identify plant genes that use water more efficiently, fight disease more effectively and adapt more readily to the changing climate, according to an Alberta agribusiness market study from 2020.

Government and industry are investing heavily in research to drive smart innovations in agriculture.

Precision agriculture will be among the first areas addressed by the U of A’s new 5G Living Lab, the result of a \$15-million, five-year partnership between the university and Telus to explore commercial applications of new research.

In 2019, the federal government gave \$49.5 million to the Canadian Agri-Food Automation and Intelligence Network (CAAIN). As with Amii, projects that are approved for funding will see agri-food producers work directly with researchers and technology companies to find smart ways to produce more with less.

Blade is also a key player in an Alberta government program called Results Driven Agriculture Research, announced in March 2020. It has a budget of \$370 million over 10 years for agriculture research projects. Like the other programs, the Alberta one matches producers with tech experts. Unlike the others, this program is led by producers.

Blade agrees that producers are pragmatic about taking on investment risk, but they’re keen to embrace innovation, whether it’s a new way to manage crops or a GPS technology to auto-steer tractors.

“Over the last 10 years, our faculty has received tens of millions of dollars out of the pockets of farmers, through their commodity groups, because they are just rock-solid on investments in research,” Blade says.

“There always has to be a reason. It has to make things easier, faster, better — producers have seen that new approaches are going to pay off.”

The Next Generation

The future of farming is about new ideas, but it’s also about new blood.

There’s the generational factor — the average age of a Canadian farmer in 2016 was 55, a situation Blade says is untenable. But there’s also the need for new experts: students who might otherwise go into computing, sciences or engineering.

“Whenever you’re dealing in biological systems, it’s never a flat line. You’re always on the escalator going down because you have to fight insects and disease and weather and all the rest of it,” Blade says. “But the very complexity of those problems seems to be attracting the most creative individuals.”

Aidan Heaman is a good example of one of those creative types. He grew up on a seed farm near Virten, Man., and followed his dreams of an engineering career to the U of A.

Purely by accident, Heaman stumbled upon an article about aquaponics and was hooked by the system’s efficiency. That led him to start a student club on campus, the University of Alberta Permaculture Group and, in turn, the club led him to Ahmad and the AllFactory. The student club will help run the aquaponics system.

Along the way, Heaman discovered that you can take the boy off the farm but he can still work in the food industry.

“Food is something that’s kind of close to me,” says Heaman, who finished his degree in December and is now working as a building systems co-ordinator for PCL Construction. “I know that I want to someday find myself contributing to food security ... helping create some of the infrastructure that we can use to have a really good, sustainable food future.”



THE FUTURE OF BEEF IS RESILIENT

For this industry, sustainability is more than a buzzword. And it’s coming to our farms and dinner plates

By Lisa Szabo, '16 BA

SOME THINGS HAVEN'T CHANGED FOR BEEF PRODUCERS SINCE KARIN SCHMID, '04 BSc(Ag), '07 MSc, grew up on her family’s farm in Alberta. Kids still chase farm cats around the barn, spend summers working in the fields and learn to drive a little earlier than the law says they should. Cattle producers continue to keep meticulous records — though the calving book that once sat on the kitchen counter, filled with breeding and health information for the herd, has been replaced by an app. And cattle producers still have a profound understanding of their connection to the land and to the food they produce.

Alberta remains the largest beef cattle producer in the country, home to 40 per cent of Canada’s cattle herd. Research and technology still drive agricultural practices. What has changed is people’s perception of cattle farming.

In recent years the beef industry has come under fire for heavy use of resources, including land and water, and its contribution to greenhouse gas emissions. In 2013, the Food and Agriculture Organization of the United Nations reported that the world’s livestock sector was responsible for 14.5 per cent of human-induced greenhouse gas emissions — most from enteric fermentation (better known as cow burps) and the production and processing of feed.

People are also more aware of big-picture items like sustainability and animal welfare, says Schmid, who works on behalf of the province’s 18,000 beef cattle producers as lead, beef research and extension, with Alberta Beef Producers. A hundred years ago, many people would have had a parent or grandparent who farmed. But with most Albertans now three generations removed from farming, Schmid says, “there’s an increased drive from customers to have a connection to food and how it’s produced and wanting to know why we do the things we do.”

That shift in perspective has caused a change in the industry, from advancements in pain control during procedures like castration to reducing environmental impact. (Since 1981, Schmid says, Canadian beef farmers have reduced their greenhouse gas emissions by 15 per cent.) A sustainable beef industry has to have a small carbon footprint. It also has to support viable businesses for farmers, healthier animals and a resilient food supply. And U of A grads and researchers are coming at it from all angles.

Isha Datar, '09 BSc, is one such grad. In 2012, when she gave a TED Talk on in-vitro meat, the world of cultured animal products — known now as cellular agriculture — was fringe. Datar is the executive director of New Harvest, a non-profit organization supporting cellular agriculture research.

Most people had no idea that by removing a few muscle cells from a cow and soaking them in a liquid rich with

amino acids, carbohydrates and other nutrients, the cells would grow and divide. But Datar did. She was championing change in the beef industry well before the world's first lab-grown burger made headlines in 2013.

By developing the field of cellular agriculture, Datar says we would use far less land and water. She wants to reduce greenhouse gas emissions by growing only the parts of the animal used for food.

Her goal isn't to end cattle production or have everyone eat cultured meat. She expects cellular agriculture will someday be more akin to microbreweries than factory farming. Given global growing population and reliance on animals for protein, the answer isn't to cancel beef, she says. It's to feed the world in a sustainable way. "We want sellers to increase the diversity of protein production methods, because diversity is resilience."

Alberta has been a centre of research in the beef industry since 1955 when U of A researcher **Roy Berg**, '50 BSc(Ag), challenged the belief that purebred cattle were superior to crossbreeds. It took 10 years but his research proving that hybrid lines were 30 to 40 per cent more productive than purebred made Alberta a world leader in beef production and research — and made crossbreeding cattle a new global norm.

Today, innovation and research in the beef industry continue to converge at the U of A. With funding from the university's new BCRC-Hays Chair in Beef Production Systems, Gleise M. Silva is helping translate her colleagues' work into practical industry advice. She's building on decades of research. (Read more on page 7)

John Basarab, '76 BSc(Ag), '81 PhD, is working toward the same goal. He hopes to reach it by building a better cow.

As a senior beef research scientist with the Department of Agricultural, Food & Nutritional Science, Basarab studies the relationship between genetics and a host of characteristics in cattle. By identifying regions of an animal's DNA that are responsible for traits such as meat quality, fertility and disease resistance, genomics researchers like Basarab are helping ranchers build more efficient, sustainable herds. One of the ways he's doing this is through feed efficiency.

"We found that some animals consume a lot of feed but they don't do anything with it," he says. "They're just eating for fun." One heifer could eat as much as 20 kilograms of food per day, while another ate much less for its size — as little as 14 kilograms per day — but would grow and gain as much weight as a big eater without any adverse health effects.

Through his research, Basarab and co-workers determined the regions in the genome that contribute to making an efficient eater. By bringing a sample of hair from a breeding bull or heifer into

one of the province's testing sites, ranchers can use this research. Breeding for feed-efficient cattle promises to save ranchers money on the cost of feed and help reduce greenhouse gas emissions from feed production — reducing methane emissions to boot.

Working with researcher Thomas Flesch, Basarab and his co-workers measured the methane output of a group of feed-efficient cattle. They emitted around six per cent less methane than a control group. Over time, as efficient animals breed and bear efficient offspring, Basarab says the changes will add up. "Genetic selection is permanent and cumulative," he says. "We're not talking about one animal. We're talking hundreds of thousands."

Feed efficiency is one part of building a better herd. The Global Roundtable for Sustainable Beef defines sustainability as a socially responsible, environmentally sound and economically viable production that prioritizes the planet, people, animals and progress. "Sustainability means safe food. It means the welfare of animals. It means the use of technology in a responsible way to make things better," Basarab says. Reducing greenhouse gas emissions is just one part of that. Long-term sustainability means developing an industry that can withstand disaster and bounce back from global threats.

"Sustainability means that we're more robust to changes in climate, economics, health," he says. "Our grasslands are healthier, our animals more efficient and resilient to disease." It adds up to agricultural systems that can better adapt to change.

Now, nine years after her TED Talk, Datar hopes cellular agriculture can be part of that resilience. "I'd love to see a world in which you have animal meat, plant-based versions, cell-based versions and combinations," she says. "Look at how the dairy aisle has changed over the past few years." Where cow's milk was once the only option, nut and grain versions have slipped effortlessly into people's buying habits. If a blip in the dairy supply chain causes a shortage, people can turn to almond or soy. Datar sees investing in cellular agriculture as another strand in the beef industry's safety net — another way to produce protein, particularly in times of need.

We need to diversify, Schmid agrees. "We're going to have nine billion people in the next decade or so, we need to explore options to ensure there's protein for everyone who needs it." She's hopeful. We've never had a safer food supply, she says, and advances in research continue to shape the foundation of a sustainable industry. "Research forms the backbone of how we improve our sustainability, competitiveness and profitability," Schmid says, by applying the advances of science and technology in a cost-effective manner. "We don't do things because that's the way they've always been done."

But change takes time, and cultured meat is a long way from your dinner plate. Companies will need regulatory approval to sell their products in stores as well as investment to scale up. Plus, Datar says, they'll have to mind their own environmental impact. In the meantime, increasingly sustainable cows are born every day.

The burger of the future will be backed by research and steady innovation. But mostly, it will be delicious.



THE FUTURE OF FOOD DELIVERS

COVID-19 changed how we process, ship and shop for food. What supply chain changes will stay into the future?

By Alexis Kienlen

NO ONE WILL FORGET GOING TO THE GROCERY STORE AT THE BEGINNING OF COVID-19 and seeing empty shelves. It revealed flaws in the Canadian food supply chain. "The food supply chain has become a prominent topic through the COVID-19 crisis," says Sven Anders, a professor in the U of A's Department of Resource Economics and Environmental Sociology. "It's bringing something into the public discourse that hasn't been there."

Before the pandemic, food just showed up at the grocery store — people didn't have to think about it. What changes can we expect to play out in stores and kitchens in the wake of the pandemic?

The pandemic created shortages and delays in global and local supply systems, which caused people to wonder just how robust our food supply chains really are. Going backward along that chain from the grocery store to the producers, we find a system of intricate logistics. Every commodity has a different supply chain. It's exceedingly complicated.

"There's producers, there are aggregators, or buyers, who can be distributors. The aggregator can also be a packer, like in the meat industry," Anders says. "A processor aggregates meat from several packers, it arrives in a packing house, where it's weighed, packaged and shipped to grocery stores." Sometimes food goes right to the store. Sometimes it goes to a logistics company, such as a trucking company that takes, say, a container of avocados from Mexico to the U.S. border, and then another company takes them to Calgary. Then the avocados might be repackaged or sent to stores directly.

"The products that are the most vulnerable are foods that are delicate by their nature. Anything that has to be handled with care, that can be dented or bruised, would expedite deterioration," Anders says. Think tomatoes or spinach.

COVID-19 disrupted the food supply chain at every point. People got sick and weren't able to get the product off the field, and truckers weren't able

to move product to the market. Processing plants for meat are labour-intensive and encompass both slaughtering and cutting; staff at these facilities were sickened across the continent.

“Those facilities have people coming together. That’s why these supply chains are more vulnerable to disruptions,” Anders says.

Some meat-packing plants closed for a couple of weeks last spring, disrupting slaughter capacity and leading to a backlog of fat cattle that lasted for months. Anders says that as employees were affected, so were logistics. Highly detailed and computerized grocery logistics weren’t enough to handle the initial crisis because, as you move backward along the supply chain, each link presents potential problems.

When the food supply chain has to react to a global crisis again, Anders predicts, protective measures will be put in place more quickly. “Some protocols are already in place now. Everybody has learned a lesson, so next time the shocks will be less severe,” he says. Companies overcame some hurdles by providing workers with personal protective equipment, dividers between workstations, and staggered breaks and start times. New policies allowed seasonal farm workers to quarantine in hotels after crossing a border.

And in April, the Government of Alberta announced it would vaccinate workers in meat-packing plants, regardless of where individual employees found themselves on other priority lists. It’s a step that, taken early next time, could see food processing facilities open sooner or avoid closures altogether, depending on the crisis.

The pandemic showed us that our sophisticated systems are vulnerable to systemic disruptions. Many consumers turned to support their local producers. “If we were to pay more attention to what’s close by and local, it would insulate us a bit from global shocks,” Anders says. “This isn’t the first time people have promoted ‘buy local.’” This time the message resounds, and consumers understand the hardships small producers face.

Ellen Goddard researches consumer behaviour. She tracked news stories and Google trends about local food and found there were significantly more in 2020, trending highest during severe restrictions. “There’s a shift to local, but I’m afraid there isn’t much data yet,” says Goddard, Co-operative Chair in Agricultural Marketing and Business. “The shift was a risk response.” When consumers couldn’t find in-store products, they looked to local producers. As grocery stores’ stocks have improved, demand for local products has tailed off, she says. Also, the pandemic has accelerated Canadians’ desire for online options and the stores’ capacity to make it happen — a trend she predicts will continue, citing consumer research reports.

“It doesn’t mean that everybody who’s buying online is going to continue having their groceries delivered all the time. But people want the option, and they want the option of being able to run into a shop,” she says.

Goddard predicts that most consumers, shaken by the empty shelves, will maintain a larger stockpile of food in their homes than they used to. “People started to carve out a place in their house to stock up on staples. I don’t think that’s going away.”

Further, she says cooking has become a family activity. “There are other benefits to getting your kids involved in cooking. I think we will see more of an interest in basic ingredients.”

People have become more interested in their food, and it’s a reasonable bet that we’ll pay more attention in the future. Some of us are keen to find out where our meat is coming from, even

“Grocery stores are looking at better ways of making sure they can satisfy sudden demands. Empty shelves were stressful for them, too.”

– Ellen Goddard

buying direct from farmers. And there’s increased attention to plant-based meat substitutes. “People are interested in cooking and in variety,” Goddard says. “That’s a permanent change.”

Changes in consumer behaviour precipitate in-store changes. “Grocery stores will probably never go back to being dedicated 100 per cent to a just-in-time purchasing pattern,” she says. Just-in-time describes the level of inventory a store keeps. Prior to the pandemic, stores didn’t keep big inventories. Why would they? A phone call could bring more.

“Grocery stores are looking at ways of making sure they have more food in more-distributed places so they can satisfy sudden demands,” Goddard says. “Empty shelves were stressful for them, too.”

The pandemic also revealed problems with intense specialization in our food system. Specializing allows producers to operate on scales of efficiency, producing mass amounts for certain markets. “But the second specialization goes wrong, it comes to haunt you,” Anders says. “I learned about a cucumber producer who used to serve the American market. When COVID-19 closed the border, they had to throw out semi-truckloads full of English cucumbers.

“Because we’ve been specializing to such a high degree, we are dependent on large, long international supply chains, which are prone to all sorts of issues,” he says. While there’s no crystal ball, Anders says the supply chain should move into the post-pandemic world with increased flexibility to pivot between markets and not stick to highly planned systems that fall apart in a crisis.

Anders hopes the pandemic will encourage shoppers to look for local agriculture rather than relying on international markets. But that’s not the only answer. “Here in Alberta, we need these other markets. Otherwise we will eat cabbage, carrots and potatoes all winter.”

Goddard predicts stores will accelerate their quest for reliable distribution systems that can help them through crisis. “Stores will need distribution systems that guarantee them access to more goods,” she says. Those goods include packaged foods with a long shelf life and the typical non-food items you find in a grocery store. She says some chains are already looking at automated warehouses for these products.

Loblaws, for example, has been worked with a tech company that specializes in automated trucks that could deliver groceries locally. Other companies are building automated warehouses. These facilities will be built where the population warrants it, Goddard explains, and automated robots could assemble grocery orders and restock shelves.

Regardless of how it takes shape, the pandemic has inspired and hastened changes to the contents of our dinner plates and how the food gets there. ■