Down on the Smart Farm

PRECISION AGRICULTURE

Berry-picking robots. Tablet-controlled tractors. Weed-sensing drones. How farms are going high-tech to produce more food and a healthier environment.

By Michael Behar

PHOTOGRAPH BY NAYAN STHANKIYA

Trevor Scherman *(right)* has nine weather stations like this one on his farm. They send all sorts of data—rainfall, temperature, humidity, wind and weather forecasts—straight to his iPad. "Weather is such a huge factor in farming," he says. "This way, I'm not just guessing."

Trevor Scherman is getting more rest these days, thanks to his iPad. Scherman is a farmer who grows wheat, peas, canola and lentils near Battleford, Saskatchewan. Like legions of farmers in both Canada and the United States, he uses precision agriculture technology—cutting-edge tools like drones and satellite imagery—to keep a careful watch on his crops. The sensors positioned around Scherman's farm provide instant feedback on all sorts of conditions that could impact his crops, such as heavy rain or a sudden frost. He also gets digital satellite images of his fields delivered by email. A company called Farmers Edge analyzes the data with sophisticated mathematical algorithms and artificial intelligence (AI). In addition to identifying major issues, the software can even pinpoint a minor weed outbreak or a few acres where plants are withering, problems that large-scale farmers like Scherman likely would have never discovered on their own until they were rampant.

Not only has precision ag made Scherman's 6,500-acre farm more efficient and profitable, he also no longer has to get up at 3 a.m. when it rains and spend hours driving around his property in the predawn darkness to assess soil conditions so he knows whether or not to seed. (If the ground is too soggy, the seeds won't germinate.) Scherman used to have to check his rain gauges manually, but now a network of wireless sensors continuously monitors precipitation, transmitting the readings to an app on his iPad, which he checks in bed. "If it's too wet," he says, "I go back to sleep."

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Because farmers equipped with precision ag know exactly where problems exist, they can also use less water and limit their application of pesticides, herbicides, fungicides and fertilizers to the plants that need them most, subsequently reducing their reliance on these chemicals. And it translates to less time and mileage crisscrossing fields in a diesel-fueled tractor that's spewing carbon emissions from its tailpipe. A recent USDA report estimates that this technology can reduce the application of pesticides and other chemicals by up to 80%, shrink water usage by between 20% and 50% and burn 40% less fuel. Precision ag also reduces crop losses by up to 80%, in part by locating weed-infested areas or diseased plants with 99% accuracy.

"If farmers don't catch problems in time, they can lose crops. And margins are tight, so one wrong decision can significantly impact their bottom line," says Marina Barnes, chief marketing officer for Farmers Edge. With so many farmers adopting the technology (according to a 2017 survey, up to 93% of farms larger than 1,000 acres are using some form of precision ag) it's also a big win for the environment. Smaller operations—including organic farms—have begun turning to precision ag, too, to keep an eye on weather patterns, weeds and yield. And farmers report a real benefit to using these practices. "I have seen an increase year over year for my return on investment," says Scherman. Turn the page for more ways tech is already shaping the future of farming.

GROWING TECHNOLOGY

Take a look at the innovations that growers, dairy farmers and ranchers are using to be more productive and lighten their environmental footprint. This future is now; imagine what cool gadgetry we'll dream up next.

ILLUSTRATION BY JING ZHANG

Robotics Robots are the newest technology to debut in precision ag, though many designs are still being tested or prototyped. Even so, they're slowly replacing humans on farms that cultivate labor-intensive crops, especially those that require a delicate touch, such as strawberries and grapes. There are currently huge labor shortages on American farms, and robots could mean the difference between a farmer's produce being picked or going to waste in the fields. (A) Harvest CROO Robotics, a tech company in Tampa, Florida, is engineering what will be perhaps the most advanced agricultural system available. Its strawberry picker, named "Berry 5," is about the size of a school bus and has taken five years and $10 million to develop. On its underside are 16 robotic pickers, each with a camera that snaps 400 images per second. Special processing software then determines whether the berries are ripe. The robotic pickers can pluck the fruits from a single plant in just 10 seconds—allowing the machine to selectively harvest 8 acres a day, a feat that would take about 30 human workers to accomplish.

On dairy farms, robots are also being used to milk cows and increase production. (B) The cows enter special stalls that dispense just the right amount of food for them to nibble on while they're being milked. The equipment is also designed to sanitize before each milking, and if something goes awry, it sends text alerts to the farmer. Automated milkers can check the health of the cow's udder and other measures of well-being, too.

GPS A constellation of 32 orbiting satellites forms the Global Positioning System (GPS), a location-tracking technology that tells Uber how to find you and navigates airplanes, among countless other tasks. In the mid-1990s, GPS ignited the precision ag movement when farm equipment manufacturers began installing it on tractors to automate steering and navigation. Today, GPS-guided equipment like tractors and combines (C) is nearly ubiquitous in agriculture. It helps farmers avoid overlap—so they don't seed, spray pesticides and fertilizers or water an area twice, which often leads to excessive waste and environmental harm. And thanks to self-driving machinery (D), farmers can work in dense fog or at night, when visibility is limited but winds are typically lighter, reducing pesticide drift and overseeding.

Drones Unmanned aerial vehicles, aka drones (E), furnish farmers with an immediate, up-close view of their fields. Drones are relatively inexpensive, self-operational (with many, a trained farmer can preprogram a flight plan through a tablet and the drone pilots itself) and easy to outfit with a variety of sensors, cameras and hardware that tell the farmer just about anything he or she wants to know. There are sensors that measure chlorophyll, pertinent to a plant's overall health and vigor. Other drone-mounted cameras use color-sensitive filters—multispectral, hyperspectral and thermal—that act like bionic eyes in the sky. They can "see" ground temperature, assess the water content in the soil, tally the number of plants within a specified area, confirm seeds are germinating, estimate crop yields and spot weed outbreaks. Drones are also used on livestock and dairy farms to monitor and herd the animals (F) and track any that get lost.

Weather Forecasting Your local weather forecast helps you decide if you should carry an umbrella to work. But its predictions are too generalized for farmers, who need extreme specificity. For that, they look to companies like the Climate Corporation, aWhere or Aeris to craft customized hyperlocal forecasts (G) that can tell them—down to a mile or two—if it'll be too windy to fertilize or too wet to plant. Urgent warnings for hail, lightning or frost arrive via text alerts. Meanwhile, on-farm weather stations dispatch real-time conditions and record historical data. This came in handy when a hard freeze destroyed Scherman's recently germinated crop of canola. Although he had insurance, the adjuster wouldn't cover the loss because the nearest official weather station never recorded subfreezing temperatures. "But that was 30 miles away," he says. "I had them come out and see my weather stations; I had data that proved it froze on my farm." The insurer promptly paid up, enabling Scherman to buy new seed and replant quickly before he missed the brief springtime window.

Satellite Imagery It can take several years and thousands of orbits for a conventional satellite to survey our entire planet. Now more than a dozen companies are operating fleets of tiny, shoebox-size satellites called "CubeSats" (H) that produce daily satellite imagery in unprecedented detail. For example, Planet, based in San Francisco, currently has more than 150 CubeSats in orbit—enough to capture every square inch of Earth in a single day. Its satellites snap thousands of high-definition images, often employing a NASA-developed remote-sensing technology called Wide Dynamic Range Vegetation Index, which can distinguish between different plant species and convey their health status. Software scans the images for anomalies, like drooping crops or plants darkening in color (perhaps from a nutrient deficiency or drainage issue). Says Scherman: "I use it to track pests, like beetles." From the ground, farmers might not notice the problem until rows of crops are damaged or destroyed.

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