# Data Farms

## Robots and artificial intelligence are being designed to take decision-making and labor out of farmers' hands.

**BY DEBORAH R. HUSO**

Research is under way to build a cotton-harvesting robot that would constantly patrol the field and pick the bolls as they open.
PHOTO: COURTESY OF CLEMSON UNIVERSITY

Scientists predict the world's population will exceed 10 billion by 2050 (it's 7.6 billion now). That's going to mean a lot of food, and artificial intelligence is going to play a large role in producing it.

Artificial intelligence (AI) describes the ability of machines to learn from experience and to make adjustments in a process based on new inputs. In agriculture, AI will—it already has in some instances—allow robots to harvest crops, monitor crop and animal systems, and make actionable predictions.

Robots will be key, explains Stavros Vougioukas, associate professor, biological and agricultural engineering, University of California-Davis. He expects farmers will use ground robots to assist with planting, harvesting and processing.

Vougioukas believes robotic harvesting aids will be a major tool in addressing labor shortages in agriculture, referencing this as "technologies that let people pick more quickly and more safely," he says. "Picking is a physically demanding task and takes a lot of skill. You need to be able to find the ripe strawberries and then carefully and quickly pick them."

Harvesting aids are being designed for citrus and fruit crops to increase production efficiency and reduce labor downtime.
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Vougioukas estimates pickers spend 10 to 25% of their time just walking back and forth—time not spent picking. Even with strawberry machine harvesters moving in front of pickers, time is lost whenever the machine turns to enter a new set of rows. That can take 10 to 15 minutes, during which time workers are idle.

**SMALL REPLACES BIG.** To address these inefficiencies, Vougioukas is working on a robotic aid for strawberry harvesting with the help of a grant from the USDA National Institute of Food and Agriculture. "Our idea is to change the paradigm and replace the existing multiple-row [harvesters] with a larger number of smaller machines," he says. Four to six robots will carry the trays, and when a laborer has finished picking, a robot will appear with a new tray and take the full one.

Plus, that robot will have the ability to monitor how fast individual pickers harvest and the weight of the fruit they harvest, and will then proactively come to workers with new trays the moment they need them, no summoning required.

Vougioukas says his team has several prototypes in the works. He began full-scale testing of a harvest aid fleet last fall. He is also working on a larger harvest aid for orchards that would reduce walking and ladder climbing for orchard workers, increasing both efficiency and safety.

While harvest platforms already exist, Vougioukas's team is developing more advanced technologies for platforms that will "learn" the speed and yield of individual pickers, and adjust heights and movements to match.

They are also looking at developing robotic pickers with multiple arms. "Robotic

fruit harvesting was proven feasible in 1985," Vougioukas points out. "The problem was that trees were very large, and you could only see (and consequently pick) 75% of the fruit." However, through biological engineering, scientists have developed tree architecture that is more friendly to robotic harvesting, where almost all the fruit is visible and accessible to a robot for picking. Vougioukas believes these robotic harvesters will be commercially available within the next few years.

**DAIRY ANALYTICS.** The dairy industry already benefits from robotic milking machines. But, researchers at the University of Kentucky want to extract new data from the more than a dozen sensors used to analyze production.

Robotic milking machines collect data on a series of biological functions, ranging from the animal's body temperature to her stomach pH.

"Some of these milking machines [collect data on] color of milk, clotting, number of times a cow has been milked, length of time she was milked and milk flow rates," says Tyler Mark, assistant professor, agricultural economics at the University of Kentucky.

One technology would use cameras to identify individual cows, detect lameness and monitor body condition and a host of other concerns.

"It is like facial recognition on your iPhone. A cow's spots can be unique identifiers," Mark says. Body condition can be scored using 3-D cameras and algorithms that read the photographs.

"We're trying to figure out how to take all this information and integrate it with activity monitors," he explains. "It would be like a Fitbit for cows to allow farmers to make real-time management decisions."

Mark says that integration of data and analytics is one of the more interesting spaces in ag research right now. But, he adds, "we're not prepared to deal with the volume of data that's available; there is so much information coming at us."

He expects artificial intelligence will eventually be able to comb through all the data and create predictive models. "Labor shortages and availability are driving the technology," Mark says. "There just aren't enough people out there to milk cows for $10 to $15 per hour. We're going to have to continue to automate."

**COTTON-PICKING AI.** Food production isn't the only area where researchers are employing ever more advanced AI to increase efficiencies and yields. Cotton Inc. is trying to find ways to speed cotton harvest.

But, this is no easy task for a plant that flowers gradually throughout the season. The bolls mature from the bottom of the plant to the top. The result is that bolls at the bottom are often victim to wind, weather and pests, while producers wait for the rest of the plant to mature.

"We would like to develop a robotic harvester that could constantly patrol the field and pick bolls as they open," says Edward Barnes, senior director, agricultural and environmental research, Cotton Inc. Additionally, researchers are working on a concept in which the robot would also contain a roller gin to separate seed from fiber.

Cotton Inc. has also been working with USDA in Arizona on high throughput phenotyping. It would establish 3-D images of a cotton plant and automatically identify where the bolls are, and the distance to those bolls in 3-D space, so the robot could accurately grab those bolls. They hope to work with Clemson University to develop the robot based on an already commercially available autonomous platform that cultivates fields.

**ROBOT SWARMS.** Barnes sees these up-and-coming robots as "very scalable." He explains, "You buy as many robots as you need."

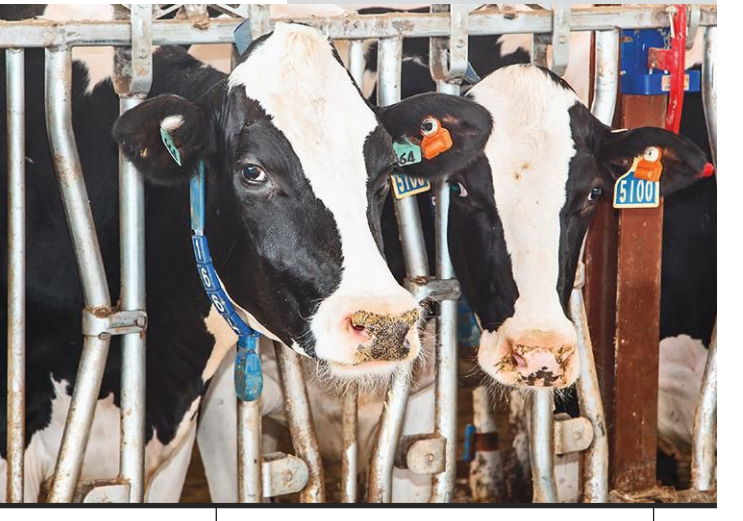
So-called robot swarms could be life-altering for young and beginning farmers who struggle with the capital investment required to buy tractors, combines and harvesters. "The new John Deere cotton pickers are pretty awesome," Barnes says, "but also pretty expensive, at $700,000 per machine."

He envisions the robotic cotton harvesters at roughly $4,000 per robot. "Imagine," he marvels, "you wouldn't have to have 2,000 acres to afford a cotton harvester."

Mark agrees, pointing out how animal scientists are working to breed dairy cows that are more comfortable going into milking machines. "I'm looking forward to the day," he says, "where we can merge the precision [side of] dairy with data coming off the crop[s]. We have to be able to get those pieces integrated if we're going to make real advances in ag."

"Biological and technical engineering go hand in hand," Vougioukas says. "We need an interdisciplinary approach."

All this, Barnes says, "is leading up to having a completely robotic farm." ●




**3-D cameras may soon collect data on the condition of dairy cows. Merged with data collected by milking machines, producers will be able to make real-time management decisions to improve production.**

PHOTO: STEVE PATTON