Climate change, dwindling acres to grow crops, lack of labor, and demand for even greater protection of the environment are forcing the agriculture industry to reassess its business model.

“As the global population reaches 9 billion by 2050, agricultural production must double,” says Susan Eustis, president of WinterGreen Research LLC. “Given existing land, water, and labor resources, the efficiency of agricultural productivity must increase by 25% to meet that goal. Robotics and automation can play a significant role.”

According to the 2014 report by the Massachusetts-based research firm, the ag robot market is projected to grow from $817 million in 2013 to $16.3 billion by 2020.

“Robots are being used more widely than expected in a variety of sectors. The trend is likely to continue, with robotics becoming as ubiquitous as computer technology over the next 15 years,” says Eustis.

The new farmhand
Harvesting is the most labor-intensive chore for many crops. Finding Americans to do the arduous tasks is a struggle. Yet, many believe high unemployment is linked to hiring illegal immigrants. We are in denial about how our food moves from field to fork.

“To entice unemployed Americans to the farm, the United Farm Workers Take Our Jobs campaign offered to help connect unemployed Americans with farm employers,” she says. “In its first three months last year, the initiative placed only seven workers.”

Counting on interim labor has also become more difficult.

“A migrant worker can arrive one season but go elsewhere the next, leaving tons of fruits and vegetables to wither,” Eustis says. “Georgia’s crackdown on undocumented workers this year was so effective the state lost millions of dollars in unharvested crops. Relying on illegal immigrants can be a legal liability.”

Employing robots will stabilize the bottom line. Yet, advocates of robotics say no one has built a machine that comes close to matching the sensory motor skills of humans.

“That is about to change, as sensors and software become cheaper and more advanced,” she says. “In the next five years, robots are poised to go out into the field and become just another tractor with no one in the cab.”

On dairy farms, robots are becoming increasingly common, essentially allowing cows to milk themselves. “We don’t milk cows. We manage cows now,” says Galen Nolt, who recently added three robotic milkers.

Even though the Peach Bottom, Pennsylvanian, along with sons Darwin and Mike, is milking three times more cows than before the robots, not having to physically milk every animal has provided the flexibility that generations before him weren’t afforded.

“I remember my father telling me that he didn’t miss a milking for 35 years,” says Nolt. “My children wouldn’t be satisfied doing that.”

As robots continue to move into ag at an ever-increasing pace, they will bring new levels of efficiency and safety, create better working environments, and fill positions most cannot, should not, or will not do.

Following are seven concepts that could be coming to a farm near you.

- See what each concept may look like
Prospero
Man has always been at the center of food production and has become the limiting factor, says David Dorhout, Dorhout R&D LLC. “For 10,000 years, the primary focus of technology has been increasing the productivity and safety of the operator. The exponential population growth we are experiencing will soon outpace these incremental improvements. In the near future, the population will exceed our ability to produce enough food for everyone.”

While the industry has developed technology like automatic steering and yield monitors, these add-ons are built around a person controlling the machine.

Equipment also grew to offset the high cost of an employee while maximizing productivity. However, Dorhout feels this, too, has its drawbacks because soil nutrients and moisture can change from foot to foot in a single field. He believes what is needed is a paradigm shift.

“Small robots, like Prospero, would make farming decisions inch by inch. They would examine the soil before planting each seed and choose the best variety for that spot based on generalized instructions given by the farmer,” he explains. “This would maximize the productivity of each acre, allow less land to be converted to farm ground, feed more people, and allow farmers to focus on the business and science of farming.”

Developed by Dorhout, Prospero is a working prototype of an autonomous microplanter that combines swarm and game theories. Sensors let the robot know if a seed has been planted in an area at optimal spacing and depth.

“Prospero can dig a hole, plant a seed, cover the seed with soil, and apply pre-emergence fertilizers and herbicides,” he says. “It then talks to other robots in the area and lets them know whether it needs help planting or if they can move on.”

It is the first of four steps. “The second and third steps involve autonomous robots that tend and harvest crops,” he notes. “Phase four integrates the first three steps – planting, tending, and harvesting – into one autonomous intelligent robot that can operate all season long, performing any task as necessary.”

Grizzly
Clearpath Robotics
Grizzly RUV is an all-terrain, autonomous utility vehicle.

Part tractor and part robot, the 80-hp. machine is an all-electric, 1-ton vehicle with a maximum payload of 1,320 pounds. It has a maximum speed of 12 mph. Cruising run time is 12 hours; towing run time is three hours.

With an entry price above $50,000, the main focus right now is research. The company realizes there is great potential at the farm level.

“We’ve had interest from quite a few agricultural companies – mostly people who make equipment and are looking for new product ideas,” says Clearpath’s Robin Albrecht. “It’s at least two years away from the end-use applications in farming, That’s because we need to include the user interface that allows you to tell it what to do to make it an effective piece of equipment.”

Rosphere
About the size of a hamster ball, an experimental robot called Rosphere may one day be rolling into fields to monitor crops.

Developed by the Robotics and Cybernetics Research Group at the Universidad Politécnica de Madrid, its spherical shape gives it the ability to move over uneven terrain and through a crop without damaging it.

“The Rosphere moves forward by manipulating its center of gravity with a system of small weighted pendulums,” says Jorge Barrientos, a student and researcher at the university.

The group also spent a great deal of time refining the mechatronics, which involve the robot’s mechanics and control electronics, communications, and programming.

Researchers first used the robot to check crop conditions in a cornfield. The information gathered was used to monitor precision farming techniques. Rosphere has also been tested around people to ensure it interacts safely.

Bin bot
South Dakota farmer and inventor Jerome Mack developed Bin Bot to replace farmers and workers in grain bins.

Operated by wireless remote control, the Bin Bot weighs about 550 pounds, will lift over 400 pounds, and can push a full-size pickup truck around a parking lot.

“The machine is small enough to fit into nearly any size bin door, yet, it’s large enough to do a number of tasks inside the bin,” says Mack. “From outside, you can use the Bin Bot to assist the power sweep auger found in many bins.”

Bin Bot ranges from $20,000 to $25,000, depending on options and attachments.
Rowbot
Rowbot, by Minneapolis-based Rowbot Systems LLC, is an articulated robot intended to apply nitrogen fertilizer in sync with corn needs, interseed cover crops into tall corn, and collect data to make informed in-season decisions as well as plan for future seasons.

At 2 feet wide by 7 feet long, this diesel-powered machine is slender enough to fit nimbly between corn rows.

During the 2014 season, the company test marketed in-season nitrogen (sidedressing) and cover crop seeding services. It expects to offer its services to more farmers in 2015.

“Generally, rates will be $10 to $15 per acre,” notes Kent Cavender-Bares, Rowbot Systems LLC.

Rover
Robotic Rover is the vision of University of Sydney researchers looking to provide farmers with an alternative to monotonous chores.

“We want to use the unmanned ground vehicle as a platform to conduct repetitive tasks such as monitoring pasture cover, herding cows, and monitoring cows through the night for calving and detecting lameness,” says Cameron Clark, University of Sydney.

The robot is battery powered and has a computer on board, which processes algorithms implemented by the user. It can travel at a pace of around 6 to 8 km/h, which Clark says is sufficient, given that a cow generally moves between 3 and 4 km/h. “We have time to do any function since we have 24 hours a day with a robot,” he notes.

Clark says research is on-going, and Rover likely won’t be ready for farmers for a number of years yet.

Spirit tractor
Removing the operator from the tractor seat is a concept companies such as Kinze Manufacturing (see story below) and Minnesota-based Autonomous Tractor Corporation have been exploring recently.

At 102 inches wide, 152 inches long, and 96 inches high, Autonomous Tractor Corporation's Spirit tractor has four core technologies.

- The patent-pending wheel motor technology eliminates the need for axles, transmissions, and differentials. Designed for a service life of 25,000 hours and 500-hour service intervals, the maintenance, repair, and labor costs are significantly reduced.
- Artificial intelligence re-creates everything a driver does. “The vehicle will be trained by the farmer to do simple tasks with supervision, but it will not require hands-on use of a farmer’s time,” says Terry Anderson, Autonomous Tractor Corporation.
- Central to the vehicle is its safe operation. It has 360° perimeter safety sensors and can identify objects up to 30 meters away.
- The company’s proprietary and patent-pending land-based navigation system includes several technologies: inertial measurement units, wheel motor encoders, GPS, digital compass, and sonar and radar navigation.

It expects the price to be about $500 per horsepower.

Initially, the company plans to introduce a mower.

“Because mowers are a relatively simple implement, as is the software, we are working to have an autonomous mower available before a tractor or other implement,” Anderson says. “We hope to have the first commercialized mower available in 2016.”

Kinze Manufacturing Autonomous System
Originally developed in a lab setting using computer simulation, Kinze Manufacturing partnered with Jaybridge Robotics to bring autonomous technology to farm fields for testing and refinement.

The project married three existing technologies – GPS, automation, and sensing – to create a system designed to reduce the need for skilled labor by taking the human element out of the tractor cab.

Since its introduction nearly four years ago, significant enhancements have been made to the real-time path planning software, which allows it to dynamically determine the optimal path and avoid obstacles. All hardware has been updated. A tablet computer has also been added in the combine and features a new user interface for complete control of the system.

“We have a multiyear rollout plan and are right on schedule,” says Luc van Herle, who was involved in the project since its inception for Kinze. “After next year, we might be ready to release it. This is very advanced technology, so we have to take it one step at a time.”