Enter the Agribots

Higher seed and chemical prices, the prospect of labor shortages, and growing world demand for food will drive the growth of robots on the farm.

By Emmet Cole

Robotic technologies now contribute to almost every sector of the global economy, from medical through manufacturing and space exploration. Yet one sector consistently lags behind—agriculture.

This is slightly mystifying, because farmers have used tools for millennia and complex, heavy machinery for a century or more. Further, by embracing genetically modified foods and the latest generation of fertilizers and pesticides, farmers have shown that they are relatively early adopters of technological advances.

Some factors that have impeded the adoption of robots in the agricultural sector include: the historical availability of cheap agricultural labor, the complicated processes involved in farming (which make robotic duplication of those processes a significant technological challenge), lack of research funding, low seed prices, and the somewhat complicated relationship with risk that exists within the farming community.

Notwithstanding, there is cautious optimism among agricultural robotics experts, because all of these factors are currently in transition.

Agricultural robotics projects are attracting government funding. Venture capitalist money is starting to flow. Labor is becoming less available and more expensive. Seed and chemical prices are rising, too, creating the need for their more efficient use. And thanks to the higher prices they’re receiving for their crops, farmers now have the disposable income required to invest in new technology. Finally, amid all this, agribot technologies are advancing rapidly.

Growing Opportunities

If these trends continue over the coming years, say experts, agribots of all shapes and sizes will become more attractive to farmers, and the opportunity for widespread
growth within the agricultural robotics market (in both the United States and overseas) could increase significantly.

So, what are the key indicators for future growth, and where can robotics developers find opportunities in the agricultural sector?

One area of opportunity can be found through partnerships with established agricultural equipment manufacturers. Cambridge, Mass.-based Jaybridge Robotics (specialists in systems integration for autonomous vehicles), for example, collaborated with agricultural equipment manufacturer Kinze Manufacturing Inc. on the Kinze Autonomy Project, which resulted in the development of an autonomous tractor for row crops. The robotic tractor is expected to become commercially available next year.

The ability to plant seeds with precision (and without any waste) is more important than ever, with seed prices increasing rapidly over recent years, explains Luc van Herle, global sales manager, Kinze. “The cost of the input has increased dramatically. Not that long ago, a bag of corn seed was costing somewhere between, say, $20 and $40 a bag. That same bag of seed now costs between $300 and $400. That has created the need to be 100 percent precise and accurate with how much you plant and where you plant it,” explains van Herle.

“Everybody can plant in a straight row for eight hours. Real hardy souls can plant in a straight row for 16 hours. Nobody can plant in a straight row for 24 hours. Robots can. So it’s a timing issue, as much as efficiency and speed,” he adds.

As seed prices have risen, so have values for crops like soybeans, sugar beets, and edible beans—further encouragement for robotics developers.

An international assessment of research and development in robotics sponsored by the National Science Foundation, NASA, and the National Institute of Biomedical Imaging and Bioengineering of the U.S. Government, published in 2006, estimated that a total of 885 service robots (with a value of $117 million) were in use across the U.S. agriculture, forestry, and mining industries.

More recent figures regarding the size of the agricultural robotics sector are hard to come by; unfortunately. “We don’t know the size and value of the U.S. agricultural robotics market. It’s a bit like asking, ‘What’s the market for VCRs?’ before there were such things. We’re at the leading edge of this technology with no real understanding at this stage of just how deep this will penetrate the market segment,” explains van Herle.

One of the key indicators for likely adoption of agricultural robotics is reduced availability of cheap, qualified labor. Seeding and harvesting take place within strict time frames—up to 10 days in most cases—with large farms in particular requiring a lot of labor within that short period.

In 1991, some 1.1 million farm workers were hired in the United States, according to the U.S. Department of Agriculture’s (USDA) National Agricultural Statistics Service. By 2011, that figure had fallen to around 700,000, reflecting a trend toward increased mechanization of farming. But that mechanization also requires highly developed skills on the part of the equipment operators. Thus, as qualified farm labor becomes more difficult to find, robotics solutions become more attractive.

“When a large farmer plants in the third week of April, every other farmer within a 500-mile radius is also planting at the same time. So, when the farmer is looking for labor, everybody else is looking for labor, too. It’s not as much a cost issue as it is an availability issue,” explains van Herle.

Wouter Saeys, assistant professor at the Department of Mechatronics, Biostatistics,
and Sensors at Belgium’s Katholieke Universiteit Leuven (KUL), agrees. “We hear it not only within Europe, but also from people in Latin America and the U.S.—that getting seasonal workers is becoming harder and harder, especially reliable ones,” says Saeys, who worked on a collaboration involving researchers from Flanders’ Mechatronics Technology Center (FMTC) and KUL, to develop a prototype self-steering, automated tractor.

Ten years ago, most Belgian fruit growers used students and retirees to pick the fruit, explains Saeys. Following European Union expansion (a move that enabled Polish workers to work legally in the EU region), they started employing a lot of Polish labor. Today, Polish farm workers are harder to find.

“The whole logistics of getting the seasonal workers is becoming more and more tricky. So you feel that the mindset is starting to get right to invest in robots for that work,” says Saeys.

**Trusted Helpers**

Although the conversation about agricultural robotics often centers around the availability of labor, it’s worth noting that farm workers and agribots are not necessarily mutually exclusive. In fact, opportunities exist in robots specially designed to assist farm workers.

In Japan, for example, where half of farm workers are age 65 or older, the Toyama Lab in Tokyo University of Agriculture and Technology is working on the Wearable Agri Robot, an exoskeleton being developed to assist Japan’s aging farm workers with manual labor. The device is expected to go on sale in Japan in 2012, with a price tag of approximately $10,000.
To fully exploit opportunities in the sector, companies need to understand the demographic and farmers’ complicated relationship with risk.

Forty percent of U.S. farmers are age 55 or older—not exactly the optimum age for adopting new technologies. Further, some 90 percent of the 2 million total U.S. farms are family owned.

At the same time, farms are getting larger, as the sector consolidates. In 1992, for example, 62,000 U.S. farms accounted for 50 percent of sales of agricultural products. By 1997, 46,000 farms accounted for 50 percent of sales—a positive indicator for adoption of new technologies, since large-scale agriculture requires machines to seed, irrigate, cultivate, and harvest very large areas of terrain.

Companies need to understand that farmers are some of the “biggest gamblers on the planet,” says Kinze’s van Herle, but having already invested heavily in a risky and unforgiving business, they seek to minimize their exposure at every opportunity, whether through hedging their crops on the commodities market or sticking with already proven providers of equipment, chemicals, and seeds.

“Farmers are enormous risk takers,” says van Herle. “The risk is always going to be the weather: how much sunshine, how much rain, how many storms at the wrong time of the year, and so on.”

Understandably, farmers fear the unknown effects of new devices. “Farmers plant once a year and they don’t get a second chance. If the planting operation didn’t work for whatever reason, you have just zeroed out their income for that year,” says van Herle.

So if robotics companies can prove that their equipment can provide extra reliability in the midst of agriculture’s inherent uncertainty, then farmers’ fear of new technology may be overcome. “Farmers like to control as much as possible of the risk if they can. So what they will do is try and control the facts that they can control, which is mechanization, automation, and autonomy.”

There’s a social and cultural aspect to the adoption of any kind of technology, particularly robotics, says Daniel Schmoldt, national program leader at the National Institute of Food and Agriculture (NIFA), an agency of the USDA. “Whatever you introduce in terms of technology has to fit in with the rest of the existing practices that the producer is using. If it doesn’t mesh well, it’s not going to help them or save them money; it’s just going to be counterproductive,” says Schmoldt.

“In many cases,” he continues, “even though they [farmers] might like to adopt newer technology like robotics, if their sons and daughters are not going to take over the business, maybe they won’t see the investment as worth it, because they’ll be getting out of the business. Many non-economic factors come into play that are somewhat unique to agriculture.”

Farmers may appear conservative, Schmoldt concludes, but if you can show them that robotics works to their advantage, it’s possible to get past their aversion to risky new technologies.

Big Money for Big Ag

Another positive sign indicating the likelihood of increased adoption of agricultural robotics in the future is growing investment from governments and venture capitalists.

Comprehensive Automation for Specialty Crops (CASC), for example, is a $12 million research project funded by the USDA Specialty Crop Research Initiative with 100 percent matching funds from industry and university partners. Established by
the 2008 Farm Bill, CASC is dedicated to developing comprehensive automation strategies and technologies for the $18 billion U.S. deciduous tree fruit industry and the $17 billion U.S. nursery and landscape industry. Project participants are working on technologies from autonomous vehicles through digital insect traps and robotic calipers.

Meanwhile, NIFA has a budget of approximately $5 million to invest in robotics-related projects as part of the U.S. government’s National Robotics Initiative, says Schmoldt.

A call for agricultural robotics proposals closed late this year, and submissions are currently being reviewed by experts at the National Science Foundation (NSF). And while officials won’t yet comment on the specifics of these confidential proposals, as a final decision has not yet been reached, they will say that the submissions cover a wide range of areas, from forestry through food production processing and crop production.

U.S. government investment in agricultural robotics doesn’t begin and end with the USDA, however. “My expectation is not all the agricultural projects will be funded by the USDA. I hope that the NSF will want to fund agriculture-related projects ... because it’s good science and engineering. So, the amount [of funding] that we have available isn’t really necessarily all that’s available for agricultural robotics under this solicitation,” says Schmoldt.

Schmoldt expects his agency to fund between three to seven projects “depending on how much money they ask for,” with NASA and the NSF funding other, larger projects with potential agricultural applications.

Private Funding and International Efforts

Venture capital money is beginning to flow toward robotic farming start-ups as well—at least in the case of Boston-area start-up Harvest Automation Inc. The company has raised more than $12 million in venture capital funding over the past two years, including investment from Joe Jones (co-inventor of iRobot’s vacuum-cleaning Roomba bot) and the Massachusetts Technology Development Corp.

Its flagship product is a lightweight, knee-high, mobile agribot designed to assist workers in nurseries and other agricultural settings. Aimed at the North American ornamental plant market (estimated to be worth somewhere in the region of $11.7 billion according to the USDA) the agribot is expected to launch in 2012.

These efforts to foster the development of agribots aren’t limited to the United States and Europe. In Australia, a team led by Professor Peter Corke at the Queensland University of Technology in Brisbane was recently awarded roughly $400,000 by the Australian Research Council to develop teams of lightweight agribots.

If successful, the three-year project will see the creation of agribots with advanced navigation capabilities and the ability to work cooperatively in swarms. Onboard cameras and image-recognition software will enable the agribots to work out precisely where herbicide needs to be sprayed—bringing an end to the costly, largely inaccurate, and potentially environmentally unfriendly methods currently employed by farmers worldwide.

Large swathes of Australia are not particularly hospitable environments for agriculture. Thus, the extreme shortage of arable land acts as a positive inducement for agribot adoption in that country and in other countries where arable land is at a premium—simply because it becomes critical to adopt techniques able to maximize the yield of that land.

Elsewhere, in late December, the Taiwanese government’s Council of Agriculture (COA) launched an initiative to help agricultural technology companies gain access to
capital markets. To qualify, companies are required to have spent at least 3 percent of net revenues (or 5 percent of paid-in capital) on R&D.

**The Agricultural Robotics Food Chain**

There are also opportunities for developers to create hardware and software packages such as computer vision and obstacle detection systems that can be used on existing machinery and devices. In October 2011, for example, researchers at the U.K.’s National Physical Laboratory announced the development of an imaging technology that can identify whether strawberry crops meet specific predefined criteria for ripeness. Systems like this could be implemented on fruit-picking robots to improve productivity and ensure that fruit is picked at just the right moment in time.

The most exciting trend—for both his agency and agricultural robotics in general—that NIFA’s Schmoldt has noticed over recent years is heightened interest in agricultural robotics among prestigious universities that have a proven track record in successful robotics development.

“Our primary R&D partners up to now have been colleges of agriculture and land-grant universities, but now we’re getting other people involved—Georgia Tech Research Institute, Carnegie Mellon, MIT, Stanford—that normally before wouldn’t pay any, or at least very little, attention to agriculture,” says Schmoldt.

“The National Robotics Initiative, and some of the other things that we’ve been able to do recently in our agency, [have] really brought a whole new mix of partners with different ideas and different ways of approaching problems. We’re very excited about these new partners.”

For Saeys, the most important trend is increased use of robotics for high-value crops, such as fruit and vegetables. “There has been some interesting research, but they always stayed pretty much on the academic side. Some companies have tried to get a hold, but typically they have had trouble competing with humans. The time seems to be right for these things really to get into practice in the next five to 10 years,” says Saeys.

Once these advancements provide demonstrable proof that they can provide farmers with real benefits that enhance both their bottom lines and their quality of life, it seems certain that robotic tractors and other autonomous equipment will someday become as common a sight in the world’s farming regions as manually operated equipment is today.

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