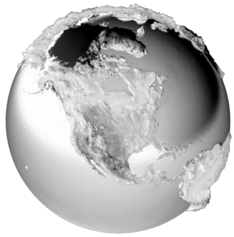
FORESIGHT

A FUTURIST EXPLORES THE
TRENDS TRANSFORMING TOMORROW

JACK ULDRICH
WITH
SIMON ANDERSON



6

GROWING UP EVERYWHERE: THE FUTURE OF FARMING

On a 7,000-acre farm in California, a large combine drives itself with sub-meter accuracy and lays down fertilizer only in areas predetermined by the device's yield mapping software to need additional nutrients. Half a world away, on a rooftop in Berlin, Germany, sits an aquaponic farm that produces both vegetables and fish. It uses the fish waste to fertilize the plants, and the plants to purify the water. Both trends, in their separate ways, foreshadow how the agriculture industry will feed the 500 million new people expected to be added to the world's population by the end of the decade. What follows is a glimpse into the world of farming circa 2020.

FUTURE SCENARIO

Using data supplied from the latest private Chinese satellite, as well as information provided from a low-cost unmanned aerial vehicle (UAV), a businessman working for a Russian agricultural conglomerate in Moscow monitors a self-driven combine a thousand miles away on a farm in the Krasnodar region of Russia. The combine steers itself with sub-millimeter accuracy in the middle of the night and disperses tightly controlled amounts of the latest variety of genetically modified corn and soybean seeds in perfectly aligned rows.

So accurate is the GPS and UAV data that the combine retraces its previous trips over the soil with near-perfect accuracy and no land is unnecessarily lost due to soil compaction. The increased accuracy (from sub-meter to sub-millimeter levels) has allowed the conglomerate to squeeze an additional twenty acres of land production for every thousand acres it farms. Comparable yield increases have been experienced elsewhere around the world as many of the precision agricultural tools and prescriptive planting methodologies have become so affordable that even the few remaining midsized farms have incorporated them into their regular farming practices.

Because the conglomerate can access the latest weather forecasting models as well as operate around the clock, it is able to plant its crops at a time optimized for both reducing water usage and ensuring the maximum growth potential of the half-inch of rain expected to begin falling in a few hours. Furthermore, because the precision agriculture technology can be used to plant and space corn and soybeans at an optimal distance from one another, it is able to minimize the use of fertilizers. (This is because the nitrogen from the soybeans benefited the corn.) Planting the two crops together also prevents soil erosion and reduces runoff. It is estimated that five percent of all farmland now employs elements of intercropping or "companion planting."

As significant as the advances in precision farming and prescriptive planting techniques are, they pale in comparison to the continued advances in genomics that pushed the yield of soybeans to 200 bushels per acres and corn to 410 bushels per acre. As farmers around the world reaped similar advances, concerns over feeding the world's surging population dissipated (poverty and starvation still exist, but are caused mainly by ineffective and corrupt political regimes, not food scarcity) and were replaced by concerns over plunging prices caused by supply exceeding demand.

The most significant yield increases were seen in the crops of sugar cane, wheat, corn, soybeans, rice, barley, potatoes, and sorghum. Advances in genetics were not only credited with feeding the additional half-billion new people on the planet, they were also making people around the world healthier. In the United States, certain crops were modified to add Omega-3 to peoples' diets in an effort to reduce the prevalence of heart disease. In India and China, iron was added to certain types of rice to fight against iron-deficiency, and in northern climates of North America and Europe, Vitamin D was added to wheat to counter the negative consequences of a natural lack of sunlight.

So noteworthy were the advances in genomics that by 2019, a number of leading environmental groups had reversed their longstanding opposition to genetically modified organisms (GMO).

"To do otherwise," said Renee LaChappelle, executive director of World Sustainable Land Institute, "would be to relegate millions of the world's poorest citizens to a continued existence of poverty, starvation, and death." LaChapelle went on to add, "The world simply can't afford the luxury of only producing and consuming organically grown crops. They're too water-intensive and spoil too quickly."

A handful of sustainable/organic-related organizations still opposed the policy shift, but they were now a minority and no longer argued that the newer GMO crops didn't use less water or fewer chemical inputs but, rather, were bad because they ceded too much power to the large corporations that produced the seeds.

Officials at the largest ag-bio companies, plus a handful of smaller private genetic start-ups, countered that their technology was necessary if they were to continue to build upon the extraordinary advances achieved in the past decade. Advances, they argued, that were equal to, and in some cases greater than, the improvements witnessed during the "Green Revolution" of the 1960s and 1970s.

Perhaps the greatest of these achievements was the creation of new types of perennial wheat and corn. This advance alone effectively doubled farmers' yields by allowing them to harvest two crops a year, whereas before only one was possible. In a handful of African countries, this breakthrough virtually eliminated the food crisis and was credited with bringing political stability for the first time in decades. As an added benefit, the deep roots of the perennial crops allowed the crops to access the water deeper in the land, thus holding the soil intact and preventing erosion.

Ironically, as more land was being cultivated and growing periods were becoming more pronounced, the amounts of chemical inputs, fertilizers, pesticides, and fungicides, were decreasing. Part of the decrease was due to the creation of genetically modified crops that offered better "natural" protection against certain diseases, funguses, and insects; part could be attributed to the exponential growth of microsensors farmers deployed across their fields to better monitor when and where they needed the chemicals; part due to new nanofiltration systems capable of effectively capturing nitrogen run-off and then recycling the nitrogen into fertilizer, part was the result of continued advances in UAV-assisted field management and other precision farming tools that allowed fertilizers to be prescribed in precisely measured amounts.

Only slightly less significant than the creation of new perennial types of crops in terms of increasing agricultural output was the creation of new types of drought-resistant seeds that could grow in conditions previously not conducive to farming. These advances were especially beneficial to farmers in the increasingly arid regions in California, Australia, northwest China, and sub-Saharan Africa where the effects of climate change were being felt most intensely.

Concerns over insects' and fungi's ability to become resistant to genetically modified crops was still a serious concern, but scientist's ability to employ powerful gene sequencing machines and supercomputers allowed them to create new versions of seeds at a faster pace than Mother Nature could adapt to them. The concern was also being mitigated by the extraordinary advances researchers were making in understanding microbes and then applying that research into effective bio-pesticides.

In a limited number of cases, the combination of the aforementioned advances allowed some farmers to switch from growing crops for food to growing crops for biofuels. In the American southwest, land previously used for fruits and vegetables was transitioned to large algae farms and was now responsible for producing hundreds of millions of gallons of jet fuel. In Brazil, large bioreactors, using only genetically modified organisms, carbon dioxide and sunlight, were producing record amounts of biodiesel on lands previously used to grow sugar cane.

Another consequence of the unexpected increase in agricultural yield was that commodities such as corn and grain that had previously gone directly to the market for individual consumption were redirected toward the cattle and poultry industries as feedstock. This, in turn, allowed the meat and poultry industries to keep pace with the millions of new middle class citizens in Brazil, China, and certain regions in India who were seeking the more protein-rich diets that red meat and chicken provided.

So heavy was the demand that in certain regions a niche market for "in vitro"—or lab-grown—meat had materialized. Scientific and biotechnology advances had reached the point where the taste and texture of many in-vitro meats was now indistinguishable from naturally produced meats. The former was still expensive, but some consumers were willing to pay the higher price because they viewed lab-grown meat as more humane (no animals were slaughtered in its creation) and more environmentally friendly (unlike a cow that must consume an average of 10,000 pounds of feedstock to produce 1,000 pounds of meat, in-vitro meat is created with almost zero waste). A growing number of companies were even beginning to roll out large-scale advertising campaigns to convince people that lab-grown meat was healthier, more flavorful, and better for the environment. In addition to in-vitro meat, another less expensive meat-alternative made from plant proteins was quickly gaining popularity for its affordability, near-meat taste and meat-like "mouth-feel" or texture.

In spite of this extraordinary progress, the world's food situation was far from perfect. One downside of all the additional land being farmed was that, in spite of the creation of a variety of drought-resistant crops, the demand for water continued to increase. Advances in nanotechnology had yielded significant improvements in desalination technology, and continued improvements in solar and tidal power were able to meet the power requirements of the growing number of desalination plants, but, the net effect was that the salinity of the world's oceans continued to rise and this issue was gaining the serious attention of marine biologists and politicians around the world—especially in the Persian Gulf where vast quantities of the brine created by the desalination plants was being dumped back into the sea.

Also, advances in aquatic farming were slow to develop and, in 2018, officials at the United Nations called upon the governments of Japan, Indonesia, and the Philippines to severely restrict both the number of fishing licenses granted and the areas those fishermen could operate. So severe was the state of the world's fisheries that the number of endangered species had quadrupled in the past decade. In a handful of cases, the navies of Japan, China, and the United States had been called upon to police the world's ocean against rogue fisherman who either refused to have their fishing vessels outfitted with the latest tracking technology, used banned methods, or continued to fish in restricted areas. In one testy standoff, the Chinese navy fired upon a small fleet of North Korean ships and set off a dangerous international incident that caused the militaries in both countries to go on their highest alert and wreaked havoc on global supply chains as the world's busiest shipping lane was disrupted for the better part of two weeks.

It was concern over growing water shortages—more so than the "acidification" of the world's ocean—that fueled the growth of agriculture's second big trend: urban farming. As the price of water skyrocketed during the previous decade, farmers, retailers, and consumers reacted to the change. Farmers responded by planting genetically modified and perennial crops designed to use less water. They employed more sensors, the latest satellite data, and drip irrigation systems to accurately gauge exactly where and when to use water.

Retailers got into the act by demanding suppliers employ more hydroponic farming techniques in locations closer to major metropolitan areas. In America, this resulted in underutilized land in the suburbs being re-devoted to farming. In one of the more innovative cases, a 100-acre mall outside of Kansas City was torn down and repurposed to hydroponic agriculture. Through the innovative use of mineral nutrient solutions and water recycling techniques, the new farm had doubled the yield of a conventional farm. In post-bankruptcy Detroit, the transition was more pronounced because of city and state government leader's willingness to try anything that could help begin to restore the city. Significant amounts of acreage were re-allocated for farming and the Michigan Department of Agriculture began marketing Detroit as "Grow-Town—The New Leader in Urban Agriculture."

In Asia and across the Middle East, a growing number of high-rise apartment and office buildings were dedicating as much as 10 percent of their space to innovative hydroponic farming solutions that required no soil. Advances in water filtration technology and LED lighting made it possible for a surprising number of crops to be grown effectively inside these complexes.

Individual households also began adjusting to the new realities of a water-constrained world. Beset by long-term structural unemployment due to the growth of robotics, additive manufacturing, ever more advanced software and artificial intelligence, as well as innovative open-sourced teaching methods that had decimated the ranks of high school teachers and university professors, more people took to growing food as a way to supplement their shrinking incomes. The University of Michigan started an experimental new degree program targeted at individuals interested in pursuing a career in urban agriculture, while scores of technical colleges offered courses for those people just interested in learning the fundamentals of growing their own food.

In other cases, urban residents, in an effort to cut down on their food bills, utilized new networks to establish more direct relationships with rural farmers that effectively cut out the middleman and allowed farmers to supply consumers with fresh produce and meat directly. Other urban residents repurposed their rooftops, balconies, and small yards into makeshift plots, while suburban residents refashioned their larger yards into mini-farms. In response to continued budget cuts, one major city transformed four of its city parks into community farms and rented out small plots on an annual basis. (To guard against theft, low-cost cameras with motion detectors were positioned around each plot.)

One curious side effect of the transition to urban farming was that a boutique market in the insurance industry was created to offer small urban farmers protection against the vagaries of Mother Nature. Hard hit by the rapid advancements in self-driving cars and the related drops in revenue, insurance companies were eager to find new ways to offset those losses. Depending upon the location of the farm and the types of crops being grown, policies could be purchased for as little as five dollars, which allowed just about anyone with an urban farm to purchase a policy.

In ways small and big, the agriculture industry and hundreds of thousands of new "urban farmers" rose to the challenge of feeding the world's surging population with a healthier and more protein-rich diet in a way that was also more sustainable than past practices. The big question was whether farmers, citizens and agri-business could repeat their accomplishments in the coming decade and feed the 600 million new mouths expected to arrive by 2030.

— BONUS QUESTIONS —

In the US, the percentage of the population working in agriculture has dropped from over 40 percent in 1900 to below 2 percent in 2002. Will we ever reach a point when food production becomes fully automated and requires no human labor?

Do you believe the terms “precision agriculture” and “prescriptive planting” will still be in use by 2020, or will all farmers just be assumed to be using “precision” and “prescriptive” techniques and those terms will fade from use?

What are the benefits of genetically modified crops? What are the negative aspects?

In August 2013, lab-grown meat was used to make a hamburger which was cooked and eaten in front of an audience in London. It took a decade of trial and error to create this burger, and at a cost of several hundred thousand dollars. Once the price drops to consumer-level affordability, what will it take for most people to accept this new process of meat production?

It’s been often said that the next world war will be fought not over oil or land, but over water. Do you think we can develop technologies to produce enough drinking water before the lack of it starts a serious global conflict?

Climate change is already affecting agriculture and crops around the world. In 2020, do you think we will have a found a way to largely reverse—or, at least, begin to counter—its effects?

Do you think it will ever be economical and convenient enough to grow all of your own food at home—or at least locally?

Would you be interested in living in a building that had indoor gardens and allowed residents to purchase fresh vegetables and other produce at an affordable price and with a greatly reduced environmental impact?