FEEDING CHINA

The nation's booming appetite is reshaping its agriculture—and the world's.

In spring, farmers plant seedlings in terraced fields in the traditional Longning rice terraces, some still prepared by hand. Most of China, however, has turned more to industrialized agriculture. But small farmers still play a crucial role.
A couple enjoys afternoon tea at a luxury hotel in Shanghai with a view of the city's financial district. As the Chinese become wealthier, their diets increasingly include Western foods. The country is consuming more meat, dairy, and processed foods.
This chicken-processing factory, nestled in Shanghai, one of China’s largest cities, employs about 1,000 workers and processes more than 30,000 birds per hour. Operated by CP Group, it employs 2,500 people, on top of the plant’s own staff and local Chinese workers.
Watching Jiang Wannian and Ping Cuixiang harvest a stalk of an acre of dalton seed in the north-central province of Gansu feels a little like traveling back in time.

In a dry valley ringed by dusty mountains, on a brick-paved lot, Jiang drives a rusted tractor over a high mound of dried plants. As they crush down, Ping, Jiang's wife, plunges a homemade pitchfork into the straw and arranges it for another pass. Eventually, Jiang and Ping work side by side, wiry figures with tawny skin. It's hot, but they are swaddled in clothes to protect themselves from the dust and the sun. They have handsome faces, taut and lined from years of laboring outdoors, and they turn them skyward as they throw fine chaff up and watch ruddy seed rain down. This rhythm continues for hours. In a singong voice Ping encourages the wind, murmuring, "Blow, blow!" Machines can do this work in minutes, but they are too expensive for Jiang and Ping. Instead they still thresh the dalson by hand, just as farmers did centuries ago.

Jiang and Ping represent one story of China and its farms. More than 90 percent of all farms in China are less than 2.5 acres, and the average farm size is among the smallest in the world. But this is not the only story. Over the past four decades China has caught up to the agricultural development that took the Western world 150 years to achieve—and reimagined it to boot. Every kind of agriculture is now happening all at once: tiny family farms, gleaming industrial factories and dairies, sustainably minded high-tech farms, even organic urban ones.

China is grappling with a daunting conundrum: how to feed nearly one-fifth of the world's population with less than one-tenth of its farmland, while adapting to changing tastes. Thirty years ago about a quarter of the country's people lived in cities, but by 2016, 57 percent of the population was urban. Living in a China that is wealthier and more technologically advanced, with a diet that increasingly resembles that of the West, the Chinese eat nearly three times as much meat as in 1990. Consumption of milk and dairy quadrupled from 1995 to 2010 among urban residents and nearly sextupled among rural ones.

And China now buys far more processed foods, increasing about two-thirds from 2008 to 2016. Because China's agricultural resources are so modest, supplying this new diet means heading abroad, leading the government to encourage—and help—Chinese companies to acquire farmland and food companies to place like the United States, Ukraine, Tanzania, and Chile. But China has long prided self-sufficiency in staple grains, as an ideology and a response to political isolation, and this has implications for fields at home too.

In 2013 President Xi Jinping, discussing food policy with rural officials, told them, "Our rice bowl should be mainly loaded with Chinese food." This raises a tricky question: If the Chinese are going to feed themselves and eat more like Americans, what does that mean for the way they farm?

THE MISMATCH BETWEEN agricultural supply and demand in China can seem insurmountable. There are 334 million acres of arable land, of which roughly 37 million are polluted or set aside for restoration. There are 1.4 billion people to feed, but the giant farms that fuel Western diets are nearly impossible to replicate here. That is partly because much of China's terrain is mountains or desert but also because the
farmland is split among about 200 million farms. China's agricultural landscape looks less like a blanket of green than a patchwork quilt.

Jiang and Ping's patches adjoin their village—mud-walled houses arrayed in clusters along paved streets that dead-end in cornfields. Their area is known as Team Seven, a remnant of the collective period under Mao Zedong, when the state told farmers what to farm and took most of what they produced. Jiang and Ping lived through the great famine in the late 1950s and early 1960s; Jiang can recall eating boiled bark and leather bits when food ran out. After the collective system ended in 1981, the state kept ownership of the land but distributed the rights to cultivate it equally among villagers.

That process gave Jiang and Ping less than three acres divided among four sites. They dismayed their daughter, a 36-year-old tour company worker visiting her parents from Kunming.

The small fragmented nature of Chinese farms is the crucial difference from Western ones, and it's antithetical to the way much of the industrialized world produces food. If China is to meet its changing appetites with domestic crops, "there are a number of changes that we need," says Huang Jian, an agricultural economist at Peking University. Irrigation must be upgraded, he says, and technology and mechanization need to expand. But the first thing that feeding China from home requires, he says, is enlarging the country's small farms.

The solution might seem simple: replace the patchwork quilt with a vast blanket that can be moved down in one fell swoop. But Huang caution that big isn't always best. China's staple crops of corn, rice, and wheat all yield the most food per acre at modest scales. One study suggested the sweet spot is between five and 17 acres. "If you've got a very small farm, a farmer

WALKING THE LENGTH OF A COW BARN and processing plant at modern farming's Berg- bu Farm in Anhui Province, the largest dairy farm in China, I took me almost five minutes. It was dim and cool, and there was a sweet smell, half animal and half decay, that wasn't quite unpleasant. The cows, black-and-white motiled Holsteins, were quiet. They poked their heads through slotted metal fencing to reach feed along the concrete walkway and eyed me, a white-clad interloper in sterile coveralls, galoshes, bonnet, and face mask, with mild interest. The farm, nearly 600 acres, has eight enormous barns built to hold 1,800 milking cows each. Other barns and sheds hold calves and pregnant cows, putting the farm's maximum bovine population at 40,000, among the largest in the world. Part of industrial agriculture's allure is the sheer scale of it, and China has succumbed to this as it has expanded its meat and dairy production. China has always

1,200 miles away, to show me their farm. Under hot, clear skies Jiang Yuping, wearing white jeans, knockoff vans, and a melon-colored off-shoulder blouse, leads me to the end of the structure. I see a tiny, mud-walled building adjacent to an irrigation canal and ask why an outhouse is placed so close to water. She shrinks. It's like a temple for worship," she says, eyes wide, skeptically. As I apologize, she turns to point out her family's sties fields, an acre patch of short, matted-heard plants bound for slaughter. We walk farther, and she shows me the family's half acre of bauxecad, planted beneath a factory's spindly chimneys. A couple kilometers down the road, an Asian-American line, "Look at China: Most land is difficult to manage," she tells me. "There is a waste of human labor and resources."

is out there weeding and working very intensely," notes Fred Gale, a senior economist at the U.S. Department of Agriculture, and crop yields per acre will reflect that, often being higher than if a large machine is used. China's plan is not to merge the holdings of small farmers like Jiang and Ping into Kansas-style farms. That would be nearly impossible logistically and would also spur social disruption by uprooting millions of farmers. For now, at least, the idea is to cluster adjoining fields into farms about the size of a Walmart Supercenter parking lot.

 Spend a few days with Jiang and Ping, and it can be hard to fathom that China also has some of the most sophisticated industrial farms in the world. The epitome of that is in the meat and poultry processing plants. I occasionally overstate the importance of food safety to Chinese consumers. Besides fatal levels of melamine in baby formulas, scandals have included long beans treated with a banned pesticide and adulterated fox meat passed off as donkey. A 2010 McKinsey & Company study found that nearly three-quarters of Chinese customers worry that the food they eat is harmful to their health. The vast number of small farms makes China's food system "almost completely unmanageable in terms of food safety," says Scott Rozelle, an expert on rural China at Stanford University. Industrial dairies and slaughterhouses make traceability and accountability (for quality possible, and this is something Chinese consumers want. Indeed, a colloquial phrase traditionally used to describe being at ease. "Put your heart down," has been repurposed. Farmers repeatedly assured me that I could put my heart down with their food; it was, in other words, safe to enjoy.

At Modern Farming's dairy, officials introduced me to an employee, Zhang Yunjun, whose family home had been where the offices now stand. The Bengbu farm displaced about a hundred villagers, and the government moved them a little way down the road. People in the village cooperated willingly when officials promised jobs at the dairy, new housing, and regular increases to the rental fee for their land. Before the dairy Zhang had worked about six acres with two relatives, growing peanuts and wheat. Now, he tends to bedding in the barns and earns more than twice what he did farming. "People are very happy," he says. "It was really hard working as a farmer. Now I can make much more."

Nearly every proponent of large-scale farms told me modernization was one version of this story, saying that big farms are effective solutions to poverty in rural areas. Farmers, the thinking goes, can work for the large farm and rent out their land, earning two incomes at once. But the reality doesn't always match the sales pitch. "They do employ people, but it's very limited," says Yu Zhonghong, a rural sociologist at China Agricultural University in Beijing. "If they want to make a profit, the first thing they want to cut is the labor employment. And they can only employ a very limited amount of people, mostly of low-paid farmworkers."

As the sun began to set, I visited the displaced villagers and their employee for the dairy much thinner than Zhang's. They live in a gridded
Side by side with suburban housing just south of Kunming in Yunnan Province, these greenhouses grow high-value crops such as fruits and vegetables. In the relatively mild climate, crops are raised year-round.
At an annual festival in Xupi County, northwest of Shanghai, 10,000 people dine on the area's specialty, crayfish. The fishing industry raises an estimated 100,000 tons of the shellfish a year in local lakes.
AN APPETITE FOR MORE

Sweeping reforms starting in the late 1970s have transformed China from an isolated, centrally controlled economy into an increasingly marker-oriented juggernaut. Agricultural and industrial modernization has fueled continuing migration to cities, rising incomes, and a growing appetite for a more westernized diet among China's 1.4 billion people.

More people and food
Economic and food production reforms have helped China's growing population increase its scope of daily calories.

Craving protein
China has overtaken the United States in chicken, pork, poultry, seafood, and fish.

Limited lands
Combined areas indicate where people (green) and animals (red) are in close proximity.

High growth
Growth in urban areas with a population of five million or higher in 2015.

Urban migration
China's cities have grown by roughly 600 million people since 1980. Most are filling rental units and wages in the industrial sector.

Rising incomes
A fifth of China's population has entered the global middle class, and hundreds of millions have moved out of poverty.

Economic boom
China has emerged among the world's fastest growing economies for nearly four decades.

PER CAPITA GDP IN DOLLARS
cluster of flat-roofed, two-story apartment buildings painted yellow, surrounded on three sides by peanut and corn fields. Across the road, the dairy’s alfalfa fields roll into the distance. A woman hanging laundry in her small concrete yard told me the water now smelled funny. Several people told me the dairy didn’t hire many workers, their homes were crumbling, and rental income had not budged in four years. Everyone complained about an incessant stench from manure sprayed on the fields. Nobody I talked with seemed happy about having moved, but hardly anyone seemed all that upset either. The overarching sentiment was simply resignation.

For most rural Chinese these agricultural projects are at best double-edged swords, just as they are elsewhere in the world. Big animal farms can offer some Chinese an escape from the grinding toil of peasant life, but they also bring significant environmental and health risks. A 2010 census of pollution by the Chinese government found agriculture to be the largest polluter of water, greater even than manufacturing. And with all of China’s pollution challenges, it’s hard to see how large-scale animal production will escape the polluting and public health problems attributed to, say, dairies in California—which are smaller than the mega-farms in China.

The government says it recognizes the dangers and emphasizes addressing animal waste in a sustainable way. These concerns are shared by many of the agriculturists in China, including Modern Farming. In Henan the company installed a biogas digester to turn manure into enough energy to meet one-third of its needs there and uses the by-products to fertilize its fields. “Almost no waste,” says Liu Qiang, the mild-mannered, bespectacled guide who took me around the farm. “The whole thing, from the fields to the barns, the milking parlor to the bottling plant, he says, is “a demonstration for this country.”

Across Hangzhou Bay from Shanghai, at the edge of a shimmering expanse of mudflats, a Thai animal-feed conglomerate is building a megafarm with a sustainable bent. In exchange for a break on the rent and a 20-year contract, Charoen Pokphand, or CP Group, is converting 6.425 acres of filled-in mudflats outside of the city of Cixi to food production. The goal is “to create value for society in all directions,” says Wang Qingjun, senior vice president dressed in loose darks and shirtless.

This is what China’s agricultural future looks like too: a transnational corporation sinking billions of yuan into an agrifood complex comprising fields, farms, factories, corporate offices, and even, eventually, employee housing ranging from apartments to waterfront villas. Last summer, rice paddies covered 3,600 acres. Of those, 15 acres were grown organically and stocked with crabs that are sold for food. There are produce greenhouses, broccoli fields, drones to distribute chemicals, a near-finished dumpling factory, and a one-million-hen egg factory slated to triple in size—large enough to justify a temperature-sensitive robot to automatically cull dead birds. CP Group also expects to harvest enough chicken manure annually to produce 22,000 tons of organic fertilizer. Last year the company built a vertical farm, an airy, translucent box housing six 30-foot towers with rotating shelves of plant beds, akin to Ferris wheels. When I visited, they held ok choy, amaranth, and garlic chives. The controlled environment allows for targeted fertilizer application, eliminates the need for most pesticides, and produces quadruple the yield of a field with the same footprint, Wang says. This is remarkably promising for a country with too little farmland, particularly when farmers hand over the country’s pollution woes by using three times as much fertilizer as needed. It also sets up CP Group to comply with the government’s goal, announced in 2015, of capping fertilizer and pesticide use by 2020.

The complex is largely an exercise in applying manufacturing logic to food, and Wang, who struck me as part pragmatist, part dreamer, envisions At an automated farm owned by CP Group, three million hens lay about 2.4 million eggs a day. Robots detect and remove dead birds, enabling a single worker to tend 90,000 chickens. Northeast of Beijing, it’s the largest such facility in Asia.
Miniers in Rongcheng, on the Yellow Sea, harvest seaweed by dry on rotary racks. A common food in the Chinese diet, it is usually added to soup or used in a cold vegetable dish. Different kinds of seaweed are also harvested to feed to animals.
it as a paragon of vertical integration. "The relationship of human and land should be in harmony," he says. He sees the food-manufacturing system that CP Group is building as a way to accomplish that. For eggs that means growing grain for poultry feed, breeding chickens, then slaughtering and processing them once they are spent. Dumpling dough will be made from CP Group wheat and filled with the company's meat and produce. To sell its products, the company has its own grocery stores. It's an impressive vision, if nothing goes awry. But, if say, Listeria were to end up in its fruits, contamination could spread far more widely and rapidly than in a decentralized system—as Americans have learned.

Nearly all the large-scale farms in China are run by the government, cooperatives, and businesses, but I also met Liu Lui, a farmer in Inner Mongolia who has become well-off by growing alfalfa for industrial dairies. As a teenager Liu heard a radio broadcast about American farming and its use of machines to till the land. This sounded better than breaking up soil by hand with a hoe, and he became obsessed. Over time Liu persuaded local governments to rent him about 2,470 acres. He bought sophisticated agricultural machines from the U.S. and Europe that, in four hours, could finish what had taken 30 workers 20 days to do.

By the time I met Liu last summer, his farm had several giant barns, barracks for workers, a set of offices and carpentry, and a two-story villa overlooking a pond. I watched, impressed, as a French sludge baler rumbled across a field. In 90 seconds it vacuumed up mowed alfalfa, compressed it into a 1,700-pound cylinder, encased it in plastic, and discharged it onto the field.

Later Liu took his car, a Lexus SUV, to town to get it washed; his daughter-in-law drove me to meet him in her husband's Lexus sedan, playing Amy Winehouse on the stereo. In the din of the car wash, I asked how much he earns. More than 10,000 yuan—5,000—a month? I couldn't bear the response, but saw him smile. Later my interpreter told me he had emphatically said, yes, he made more than that—a lot more.

I thought of Liu during my visit to CP Group's park and corporate offices, where it's easy to intuit another less discussed selling point of giant farms: money. Experts may debate what size farm will produce the most food per acre, but industrial farms still generate profit far more readily than small ones. CP Group is working to ensure that the group has hired leading American business academics, as well as consultants such as McKinsey & Company, to help it succeed. When I visited the Cili park in August, it was sweltering and humid, and Wang whisked me into a highly air-conditioned boardroom for a PowerPoint presentation. We moved on to lunch in an executive dining room with a wall of windows overlooking the grounds, about a dozen of us seated at a heavy wooden table with a rotating center. I was given the seat of honor, at Wang's right, and we grazed on the 27 dishes arrayed on the lazy Susan, including grapes and dragon fruit from the park's greenhouses. Wang offered me red wine and, in keeping with Chinese custom, praised me warmly. It was the most lavish meal I ate in China.

Even as China strives to scale up its agriculture, many affluent urbanites have leapfrogged ahead to a distrust of industrial farming. A compelling example of this can be found north of Beijing, where Jiang Zhenghao, the son of Jiang and Ping, is helping build the latest addition to China's agricultural future. Behind two squat concrete buildings next to a roaring freeway, he tends five acres that make up his patch of China's agricultural quilt.

Jiang grows nearly a hundred crops—watermelon, eggplant, taro, and sweet corn among them. He takes some to wholesale markets, but his primary business is persuading middle-class Beijingers to pay him in six-month installments for weekly delivery of safe, farm-fresh food to their door. He also rents plots to people who want to grow food, and for an extra fee, he will tend...
In Quite, in southern Guangdong Province, children eat a hearty breakfast of noodles, eggs, and meat outside their school. Many families now have two working parents, leaving less time to make meals at home the traditional way.

Jiang Zengchao, who runs a small farm, says he has no time for traditional meals. "We have this emotional bond with farming," he says. "I cannot afford to be a luxury life." He says, and he's OK with that.

Jiang is part of a phenomenon of rural-born, college-educated Chinese going back to the fields. Though small in scale, it is still common enough that there's a phrase for it: "returning【】

Countryside【】—young people returning to the countryside. They now have a new organization dedicated to supporting their interests, the Sustainable Agriculture Development Center, and a magazine catering to them called Sustainable Farming. China's organic sector has boomed, with sales growing at least 30-fold since 2006, according to a recent industry analysis. Researchers say that at least 12 community-supported agriculture (CSA) projects, with farmers following the same model as Jiang, have sprung up, but the movement claims there are hundreds.

National【】a few Western-style farmers markets are operating, all in large cities.

For consumers the appeal of small farms is twofold. It's partly about trusting the farm to supply safe food. But smaller farms also reflect China's agricultural traditions, says Wen Tiejun, a leading【】scholar of rural China, and that appeals to rural and urban Chinese alike. "In Asia you have 40 centuries of agriculture," Wen says. "You not only get enough food for this big population but have a very good environment." People know and remember this, he says. In 2008 Wen helped found Little Dookey, a model organic farm in Beijing. The next year it became a CSA after one of his graduate students returned from Minnesota, where she'd studied with food activists.

This kind of food remains a minuscule share of China's market. But it suggests that many Chinese aren't completely sold on a future of industrial meals. Jiang Zengchao understands why his parents would love to leave their farm behind, and he has no wish to repeat their hardships. But he's also skeptical that industrialized farms are necessary.

When I visited him, Jiang took me to a barbecue dinner at a barbecue restaurant. We sat outside at a plastic table, watching a plump woman in a tight apron tend a narrow metal grill atop sausages legs. An industrial fan roared above it, spinning tendrils of smoke into the evening air. The woman brought us caramelized nuggets of pork and skewered chicken hearts, fibrous enoki mushrooms dosed with sauce and black sesame, grilled garlic cloves, eggplant slice with oil and vinegar, boiled peanuts tossed with soy sauce. It was more meat than Jiang had eaten as a child but far less than is typical for Americans. As the light faded into dusk, elderly farmers loitered on a corner, selling off surplus scallions. Jiang told me he lusted his life and later quoted poetry to illustrate what Americans tend to call living simply: an old but comfortable house, nothing too fancy, a beautiful space in the woods.

"I don't think it's a bad thing in the old days that the people could support themselves from their own land," he says. "In China if you are a farmer, then people look down on you, but I just love it. Life is short, so I do what I like."

Jiang has seen the benefits of the changes that China's farms have undergone in the past four decades. Our meal with enoki pork and chicken was part of that for him. So was the way his life encompassed a kind of time travel, looping between rural Gansu Province and hypermodern Beijing. But he wasn't sure he'd stick it out with the CSA. It paid so little and took so much work. Maybe, he told me, he'd go back to Gansu and try to start a big farm.

Tracie McMillan, author of The American Way of Eating, wrote about hunger in the United States for the August 2014 issue of National Geographic. George Steinmetz, who has photographed assignments for the magazine for 30 years, is working on a long-term project about the global food supply.