

Who will feed China?

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Abstract

It will be in the booming economy of China that the inevitable collision between expanding human demand for food and the limits of some of the Earth's most basic natural systems will be seen. China's loss of the capacity to feed itself is examined.

Full text

In April of 1994, the Journal of Commerce reported that grain prices in China's 35 major cities had shot up by 41 percent during the first two months of the year. In March, driven by panic-buying and hoarding, the rise had continued unabated. In response, the government released 2.5 million tons of grain from stocks to check the runaway rise in prices. This action calmed food markets--at least temporarily.

What happened last spring may be a precursor to the much larger disruptions that will occur as three extraordinary trends converge. China's population is growing by 14 million people a year. Incomes are climbing at a record rate, which means that even as the number of people increases, their consumption of meat is increasing even faster. And while the resulting surge in demand is occurring, the country's capacity to produce food is projected to shrink, due to the massive ongoing conversion of cropland to nonfarm uses.

In neighboring Japan, the soaring demand for grain driven by prosperity and the heavy loss of cropland to industrial development since mid-century have combined to push dependence on grain imports to 77 percent of total grain consumption in 1993. These same forces are now at work in China. It is one thing for a nation of 120 million people to turn to the world market for most of its grain, but if a nation of 1.2 billion moves in this direction, it could quickly overwhelm the export capacity of the United States and other exporting countries, driving food prices upward everywhere.

Rather suddenly, China is starting to lose the capacity to feed itself. The decline comes on the heels of four decades of impressive progress, particularly since the agricultural reforms of 1978, which transferred land from production teams to individual families. The energies unleashed by these reforms boosted the country's grain production by half, from 200 million tons in 1977 to more than 300 million tons in 1984. That put China ahead of the United States as the world's leading grain producer, and boosted annual output from the subsistence level of roughly 200 kilograms per person to nearly 300 kilograms.

Though growth in output has slowed since the mid-1980s, that gain was enough to effectively eliminate the traditional threat of famine. The issue now facing Beijing is not starvation, but the prospect of a gap between the market demand for food and its production--a gap that will dwarf anything the world has ever seen.

This potential grain deficit is raising one of the most difficult questions world leaders have ever had to face: who will feed China? The only country to measure its population in billions rather than millions is moving into uncharted territory on the food front, and in an integrated world economy it will--one way or another--take the rest of the world with it.

While China's food production capacity is eroding, its demand is surging. The country is projected to add 490 million people over the four-decade span between 1990 and 2030, swelling its population to 1.6 billion--the equivalent of adding another Beijing every year for the next 40 years. Because its population is so large, even a slow rate of growth means huge absolute increases. Yet, those increases are only the beginning of the story.

Moving Up the Food Chain

Even as population expands, incomes are rising at an unprecedented rate. Economic growth of 13 percent in 1992 and again in 1993, plus an estimated growth of 10 percent in 1994, adds up to

a phenomenal 40 percent expansion of the Chinese economy in three years. Never before have incomes of so many people risen so rapidly.

As their incomes rise, one of the first things that low-income people do with their money is to diversify their diets, shifting from a monotonous fare in which a starchy staple such as rice supplies 70 percent or more of the calories, to more meat, milk, and eggs. Last year, when asked by a New York Times reporter if living conditions were improving, a Chinese villager responded, "Overall, life has gotten much better. My family eats meat maybe four or five times a week now. Ten years ago, we never had meat."

Much of China is barren desert, and in a country where there is no vast grazing land like that of the U.S. Great Plains, the rising demand for livestock products translates directly into demand for additional grain. When the economic reforms were launched in 1978, only 7 percent of the grain was being used for animal feed, but by 1990 that share had risen to some 20 percent, most of it used to produce pork. Now, demand for beef and poultry is also climbing. More meat means more grain--2 kilograms of additional grain for each kilogram of poultry, 4 for pork, and 7 for each kilogram of beef added in the feedlot. As the Chinese get richer, they will eat more meat, milk, and eggs. But if the supply of grain does not expand apace with their appetites, food prices will soar.

To put this in perspective, consider the United States, where the use of grain to produce meat has reached its historic zenith. The United States is a leader in red meat consumption. The cowboy has been its mythic figure, the steak or hamburger its classic meal. Yet, the Chinese have eclipsed Americans in total red meat consumption almost entirely on the strength of their appetite for pork. At 21 kilograms per person in 1990, China's consumption of pork is approaching the 28 kilograms (62 pounds) consumed by the average American (see table). (Table omitted) Chinese consumption of beef, poultry, and milk is still minuscule compared to that of Americans. So, what happens if the Chinese start closing the gap in these other livestock products as they have with pork?

In fact, that is beginning to happen. Poultry was once a rare luxury in China, and the average person still eats only one-tenth as much as an American, but the appetite for chicken is growing fast. Ironically, that change has been spurred by a government policy that encourages production of chickens because they convert grain into meat more efficiently than pigs or cattle do. During the 1990s, poultry consumption has expanded from its small base at double-digit rates.

It is beginning to happen with eggs, too. The official goal for egg consumption has been set at 200 per person by the year 2000--double the quantity consumed in 1990 and close to the 235 consumed per year by the average American. With the population expected to reach 1.3 billion people by then, annual egg consumption will rise to 260 billion. If Chinese hens lay 200 eggs per year (U.S. hens averaged 252 last year), China will need a flock of 1.3 billion hens to satisfy this need. Yet, reaching this goal will take an additional 24 million tons of grain, an amount equal to the grain exports of Canada.

Clearly, China's expanding demand for animal protein could overwhelm the world's grain-producing capacity unless alternatives to livestock are found.

One precedent is that of Japan, which long ago adjusted to the limitations of its land by turning to the oceans for animal protein, giving rise to the now-traditional fish and rice diet. And, indeed, China's appetite for seafood too is rising--but with a key difference.

In recent years, as fleets of other seafood-hungry countries have joined Japan in the aggressive pursuit of fish, oceanic fisheries have been pushed to their biological limits. According to the U.N.'s Food and Agriculture Organization (FAO), all 17 of the world's major fisheries are being fished at or beyond capacity. Nine are in a state of decline. The Japanese option has been eliminated for any major newcomers, which means that if China wants more fish, it will have to grow them in ponds. It is already doing so, at a rate of 6 million tons (mostly of carp) per year. But this, too, puts new demands on the country's shrinking grainfields; close to 12 million tons of grain were used in 1993 in these marine feedlots.

And the good life for newly affluent Chinese doesn't stop with meat and fish. They are also acquiring a great enthusiasm for beer. To raise individual consumption for each adult by just one bottle takes another 370,000 tons of grain.

CROPLAND DISAPPEARING

As the demand for grain spirals upward, one might assume that at least a potential solution could be found in China's vast territory--in a commensurate planting of new cropland. But, in fact, much of that huge landmass is arid and unproductive, with the food-growing capacity concentrated in a relatively small area--a band of river valleys constituting about a third of the country along the southern and eastern coasts (see map on pages 14-15). (Map omitted) This is also the area where the bulk of the population is concentrated. With the simultaneous growth of both that population and the industrial economy, there are competing demands on the land--for factories, housing, roads, and highways, as well as for crops. As a result, at a time when China most needs to expand the area of its cropland, that area is shrinking.

As this tug-of-war continues, the experience of three other countries that were densely populated before serious industrialization got underway--Japan, South Korea, and Taiwan--gives a sense of what to expect. Over the last few decades, the conversion of grainland to nonfarm uses (and, to a lesser degree, to production of the fruits and vegetables demanded by a more affluent populace) in these countries has cost Japan 52 percent of its grainland, South Korea 42 percent, and Taiwan 35 percent.

As the losses of cropland proceeded, they began to override the gains in land productivity, leading to steady declines in production. From their peaks, grain production levels have fallen by 33 percent in Japan, 31 percent in South Korea, and 19 percent in Taiwan. With the growth in population and affluence driving up the overall demand for grain, each of those countries has become heavily dependent on imports. By 1993, Japan was importing 77 percent of its grain, South Korea 64 percent, and Taiwan 67 percent.

Now the same changes are commencing in China, and for the same reasons. The transformation of China from an agricultural to an industrial society is progressing at a breakneck pace. Shifting 100 million workers from the farm labor force to the industrial sector, broadly defined, and assuming 100 employees per industrial establishment (about par for China's private sector) means building one million factories, plus warehouses and access roads. Modernization of the Chinese economy, as in Japan, South Korea, and Taiwan before it, means sacrificing cropland.

The transportation sector, too, is claiming cropland as highways and railroads are built to replace dirt roads and trails. Increasing reliance on cars and trucks, sales of which totaled 1.2 million in 1992 and are expected to approach 3 million per year by the decade's end, will cover large amounts of cropland with roads and parking lots. New houses, larger than in the past, will spring up along these roads and will take still more of this land. In each of the last three years, the loss has mounted to nearly one million hectares, or 1 percent of China's cropland per year.

Along with the continuing disappearance of its farmland, China is facing the extensive diversion of irrigation water to nonfarm uses--an acute concern in a country where half the cropland is irrigated. Between 1950 and 1978, the irrigated area increased from 12 million to 45 million hectares, or nearly 1.2 million hectares per year. But since then, as water has become scarcer, irrigated area has expanded by only 190,000 hectares per year--not nearly enough to keep pace with the country's ballooning demand.

Early growth of irrigation came mostly from the construction of dams, some large and many small. But as the number of potential sites diminished, the growth shifted to wells. Today, roughly half of China's irrigated land is watered from dams and the other half from wells. It was the drilling of millions of wells for irrigation that is today lowering water tables in much of the country.

With large areas of North China now experiencing water deficits, existing demand is being satisfied partly by depleting aquifers--and the growing scarcity is slowing growth in food production. In late 1993, the Chinese Minister of Water Resources, Niu Mao Sheng, stated that "in rural areas, over 82 million people find it difficult to procure water. In urban areas, the shortages are even worse. More than 300 Chinese cities are short of water and 100 of them are very short." Even the capital itself is threatened; the aquifer under Beijing has dropped from five meters below the surface in 1950 to 50 meters below in 1993. In this respect, too, China's road to industrialization will be far more perilous than were those of Japan, South Korea, and Taiwan, where water is still relatively abundant. As the scarcity intensifies, both industrial and residential claimants are taking water from agriculture.

THE PRODUCTIVITY SLOWDOWN

With the cultivated area declining inexorably, China's ability to feed itself now rests entirely on raising the productivity of its cropland. In assessing the potential for raising yields, once again it is instructive to look at the case of Japan, which has led the world in raising rice yields for more than a century. Japan kept improving its yields until 1984, when it reached a plateau of just under five tons per hectare. Since then, even excluding the disastrous weather-reduced 1993 harvest, yields have actually fallen slightly (see graph on page 13).(Graph omitted.)

Rice yields in China, which have been rising toward those in Japan, are starting to level off around 4 tons per hectare--suggesting that the potential for raising yields further is limited. Neither Japan nor any other country has been able to push the rice yield per hectare above five tons. In South Korea and Taiwan, too, the rise in yields slowed once they reached four tons per hectare--indicating that further dramatic boosts in China may not be possible without a major new technological breakthrough. But the prospect for that, so far, has not been encouraging. Agricultural economists Duane Chapman and Randy Barker of Cornell University point out that "The genetic yield potential of rice has not increased significantly since the release of the high-yielding varieties in 1966."

Farmers and policymakers have searched in vain for new breakthroughs, particularly from biotechnology, that could lift world food output quickly to a new level. But biotechnology has not produced any yield-raising technologies that will lead to large jumps in output, nor do many researchers expect it to. Donald Duvick, for many years the director of research at the Iowa-based Pioneer Hi-Bred Seed Company, one of the world's largest seed suppliers, offers a sobering appraisal: "No breakthroughs are in sight. Biotechnology, while essential to progress, will not produce sharp upward swings in yield potential except for isolated crops in certain situations."

With wheat, China's other food staple, the rise in yield is also slowing. In the early 1980s, China's wheat yield per hectare surged past that of the United States, and has remained well above it at roughly 3 tons per hectare. The big jump came immediately after the economic reforms of 1978, as yields climbed 83 percent from 1975-77 to 1984. During the following nine years, however, they rose only 16 percent (see graph above).(Graph omitted)

Nor is there much prospect of any large gains from further use of fertilizer--which has been one of the keys to raising yields since the agricultural reforms. After climbing from 7 million tons in 1977 to nearly 29 million tons in 1993, fertilizer use appears to be leveling off, as it did in the United States a decade earlier. The reason for the leveling is not that there's any lack of fertilizer, but that farmers have encountered diminishing returns from further applications of it. Without the development of new cereal varieties that can respond to much heavier applications of nutrients, the rise in yields can be expected to slow dramatically--and could even come to a halt as it did in Japan.

ENVIRONMENTAL DEDUCTIONS

Food production trends in China will be shaped not only by the availability of cropland and water, but by several environmental trends--including soil erosion, waterlogging and salting of irrigation systems, air pollution, and global warming. On the half of China's cropland that is not irrigated, soil erosion is common. In fact, the Huang He or Yellow River that drains much of Northern China derives its common name from the 1.6 billion tons of ocher-colored topsoil that it annually transports to the ocean. So much of China's topsoil blows away that scientists at the Mauna Loa Observatory in Hawaii, the U.S. National Oceanic and Atmospheric Administration's official site for collecting air samples to measure changes in atmospheric CO₂ levels, can detect the dust within a matter of days after spring plowing starts in North China.

Waterlogging and salting are reducing productivity on an estimated 15 percent of China's irrigated land. When river water is diverted onto the land, part of it percolates downward, sometimes raising water tables. When the water table rises to within a few feet of the surface, deep-rooted crops suffer. When it gets within inches of the surface, water evaporates through the soil into the atmosphere, leaving a layer of salt on the soil surface. Unless an underground drainage system is installed to lower the water table, the accumulating salt eventually turns fertile land into waste land, as it did with the early Middle Eastern civilizations.

Air pollution and acid rain are intensifying too, largely as a result of increased burning of coal. The result is to lower crop yields and forest productivity not only in China, but as far away as Japan and South Korea. So far, there is no direct measure of how much this reduces yields. But one hint comes from the United States. If air pollution lowers the U.S. harvest by at least 5 percent, as U.S.

Department of Agriculture figures indicate, then one has to wonder about the toll that even more severe air pollution will take on China's harvest.

Finally, there is the as-yet incalculable but potentially enormous toll of global warming. Even a modest loss of rainfall or increase in evaporation could disrupt China's finely tuned, highly productive agriculture. Climate research in the rice-growing south, for example, shows that a rise of 3 degrees Fahrenheit in average summer temperature would markedly reduce rice yields.

But among all these variables, the one that looms largest in the short run is that of shrinking cropland--the question of how much will be lost, and how fast. Rapid industrialization in recent years has already taken a large toll, as grain area has dropped from 90.8 million hectares in 1990 to an estimated 87.4 million in 1994. This annual drop of 850,000 hectares, or 1 percent--remarkably similar to the loss rates of China's three smaller Far Eastern neighbors in their industrialization heyday--is likely to endure for the foreseeable future if rapid industrialization continues.

That process will claim millions of parcels of farmland over the next four decades, not only for factories and warehouses, but for the housing of 490 million additional people. In 1994 alone, 10,000 miles of new highways are taking a toll as the construction crews pave their way across wheat and rice fields. As U.S. conservationist Rupert Cutler has noted, "Asphalt is the land's last crop."

Even if China were to launch a concerted national effort to preserve cropland, it is questionable whether it could be any more successful than Japan, which has long had some of the strongest agricultural land protection laws of any country. Even in the immediate vicinity of Tokyo, where land prices are among the world's highest, every tiny plot of rice land is fiercely protected from development. Some 13,000 families work farmland within Tokyo's city limits.

There is little prospect, then, that China can raise land productivity fast enough to offset the loss of cropland. None of the three newly industrialized countries that preceded it was able to do that--not even Japan, where the rice support price is six times the world market level. Given that Japan went to great lengths to protect its grainland, but still lost half of it over a four-decade span, it is difficult to see how China can avoid similarly heavy losses. With the plateauing production of recent years followed by a drop of 1 percent or more in 1994, the long-term decline may be starting.

THE COMING FALL

Taking all of these factors into account, and assuming that rapid industrial growth continues, it now appears likely that China's grain production will fall by at least one-fifth (or 0.5 percent a year) between 1990 and 2030. This compares with a 33 percent decline in Japan since its peak year of 1960 (a fall of roughly 1 percent a year), a 31 percent decline in South Korea since its peak in 1977 (1.9 percent a year), and a 19 percent decline in Taiwan, which also peaked in 1977 (1.2 percent a year). Seen against this backdrop, the estimated decline of one-fifth in China may, if anything, be conservative.

The resulting grain deficit will be huge, many times that of Japan--which is currently the world's largest grain importer. In 1990, China produced 329 million tons of grain and consumed 335 million tons, with the difference covered by net imports of just 6 million tons. Allowing only for the projected population increase with no rise in consumption per person, China's demand for grain would increase from 335 million tons in 1990 to 479 million tons in 2030. In other words, even if China's booming economy produced no gains in consumption of meat, eggs, and beer, a 20 percent drop in grain production to 263 million tons would leave a shortfall of 216 million tons, a level that exceeds the world's entire 1993 grain exports of 200 million tons.

But of course, China's newly affluent millions will not be content to forego further increases in consumption of livestock products. If per capita grain consumption climbs even modestly, from just under 300 kilograms at present to 350 kilograms in the year 2030, total demand will climb to 568 million tons of grain. By 2030, the deficit to be made up by imports will have risen to a staggering 305 million tons of grain. Imported grain as a share of consumption will climb to 56 percent, compared with 76 percent in the three smaller countries in 1993 (see graph on page 18). (graph omitted) In both of these scenarios, China's import deficit quickly surpasses the 28 million tons of grain imported in 1993 by Japan. If grain consumption per person were to rise to 400 kilograms, the current level in Taiwan, or one-half the U.S. level, total consumption would climb to a staggering 641 million tons and the import deficit would reach 378 million tons.

The Chinese themselves have apparently been making similar calculations. Professor Zhou Guangzhao, head of the Chinese Academy of Sciences, observes that if the nation continues to squander its farmland and water resources in a breakneck effort to industrialize, "then China will have to import 400 million tons of grain from the world market. And I am afraid, in that case, that all of the grain output of the United States could not meet China's needs."

Concern about food security runs deep in China. As a result of the 1959-61 famine following the Great Leap Forward, 30 million Chinese starved to death. Several times this number were close to death. The current generation of leaders, remembering all too clearly the Great Famine, are torn between the desire to remain largely self-sufficient in food and the desire to industrialize rapidly. But if the frenetic industrialization continues, imports of grain seem certain to escalate, reaching a level never seen before.

In confronting a deficit on the scale projected, two questions arise: will China have enough foreign exchange to import the grain it needs? And, will the grain be available? On the first count, if the premise underlying this demand is a continuation of the economic boom, there would likely be ample income from industrial exports to pay for the needed grain imports. Importing wheat or corn at 1994 prices averaging \$150 a ton would require \$15 billion to fill a 100-million-ton import deficit. In 1993, China's exports, growing by leaps and bounds, were close to \$90 billion. In contrast to Africa, which cannot afford to import much grain, China's trade surplus with the United States in 1993 totaled \$23 billion, more than enough to buy all U.S. grain exports.

Given the likely continuing growth in China's non-agricultural exports, importing 200 or even 300 million tons of grain at current prices would be within economic range if the country's leaders were willing to use a modest share of their export earnings for this purpose. Of course, this would mean cutting back on capital goods imports, which in turn would diminish the inflow of technology needed to sustain rapid economic growth.

The more difficult question is, who could supply grain on this scale? The answer: no one. Since 1980, annual world grain exports have averaged roughly 200 million tons, of which close to half comes from the United States. But the United States is also faced with losses of cropland and irrigation water to nonfarm uses. And, given the projected addition of 95 million Americans over the next four decades, including both natural increase and immigration, the U.S. exportable surplus may not increase much, if at all. With more than 100 countries already importing U.S. grain, and with their import needs projected to climb, this exportable surplus is largely spoken for. For example, between 1990 and 2030, Egypt's grain imports are projected to rise from 8 to 21 million tons and Mexico's from 6 to 19 million tons.

Among the few countries that are now grain exporters, Argentina could substantially boost its output and perhaps double its annual grain exports of 11 million tons if it adopts appropriate farm price policies. But that would do little to help China. Europe, with a remarkable stable demand and supply of grain, is likely to maintain exports at close to the current level even with the GATT-required reductions in farm subsidies. The reality is that no country, or combination of countries, has the additional export potential to fill more than a small fraction of the potential food deficit forming in China.

At the same time, huge deficits are projected for other parts of the world. Africa, notably, is expected to need 250 million tons of grain by 2030--ten times current imports. The Indian subcontinent is expected to rack up a deficit several times larger than its present one. Scores of countries with rapid population growth--among them Iran, Ethiopia, and Nigeria--will find themselves facing huge food deficits in the years ahead. In these circumstances, the vast deficit projected for China will set up a fierce competition for limited exportable supplies, driving world grain prices far above familiar levels.

China may succeed in importing much more grain than it now does, but to some degree that success would have to come at the expense of other, less affluent societies that lack the foreign exchange needed to compete in the world market. And, as U.S. consumers find themselves competing with their Chinese counterparts for U.S.-produced grain, the political fallout could lead to pressure for export restrictions or even outright embargoes.

Exactly when this competition among importing countries will develop, no one knows. But if recent trends continue, the buyer's market of recent decades could become a seller's market overnight.

The government of China may not be able to withstand the spreading public protests if there is a resumption of runaway food prices such as those experienced in the early months of this year.

At issue is how to bridge the projected gap between China's import needs and the inability of the rest of the world to supply those needs. If the chasm develops as projected, rising food prices will forcibly curb demand for food worldwide, reducing consumption among rich and poor alike. For the former, it will mean less fat-rich livestock products and less cardiovascular disease, much as happened in the early 1940s in the United Kingdom, when U-boats cut off grain shipments. But for the hundreds of millions of rural landless and urban poor who remain on the lower rungs of the global economic ladder, food consumption could well drop below the survival level.

In the face of unprecedented social stress, some national governments may attempt to ration food supplies, as some industrial countries did during World War II. Whether the government in Beijing is strong enough to reinstate a national food-rationing program is not certain. Alternatively, governments could ask those living near the top of the food chain to voluntarily move down, thus lessening the amount of grain used to produce livestock products. At least one senior official in Beijing has suggested that China should move back toward a more vegetarian diet.

Economic growth could also slow or come to a halt, dropping incomes and food purchasing power throughout the world. In an article on the fragility of the Chinese economy's environmental underpinnings, New York Times correspondent Patrick Tyler wonders "How long can China's economic engine roar?" Acute food scarcity could bring the Chinese economic miracle to a premature end.

On the supply side of the equation, higher prices will doubtless stimulate greater investment in production, but unfortunately some once-promising avenues are closed. When world grain prices doubled in the early 1970s, farmers expanded the cultivated area, only to eventually pull back as the mostly marginal land eroded and as profits fell. With water tables already falling in so many farming areas, drilling more irrigation wells will only hasten aquifer depletion. Unless new, more fertilizer-responsive grain varieties can be developed, applying more fertilizer will have limited effect. Investing more in agricultural research can help, but there are no new technologies in prospect that will lead to a quantum jump in output.

The bottom line is that when China turns to world markets on an ongoing basis, its food scarcity will become the world's scarcity; its shortages of cropland and water will become the world's shortages. Its failure to check population growth much more aggressively will affect the entire world.

Whether or not we are ready to accept it, the economic future of the world outside of China and that of China's 1.2 billion people are now inextricably linked. This prospective deficit in China will force other governments--however reluctantly--to painstakingly reassess their countries' population carrying capacity and the closely related questions of population and consumption policies.

It will probably not be in the devastation of poverty-stricken Somalia or Haiti, but in the booming economy of China, that we will see the inevitable collision between expanding human demand for food and the limits of some of the earth's most basic natural systems--including the capacity of oceanic fisheries to produce seafood, of the hydrological cycle to supply fresh water, and of crops to effectively use more fertilizer. The shock waves from this collision will reverberate throughout the world economy with consequences that we can now only begin to foresee.

Lester R. Brown is president of the Worldwatch Institute, and a senior researcher. A more detailed analysis of the changing population/food balance, and its implications for both China and the world at large, can be found in his new book *Full House: Reassessing the Earth's Population Carrying Capacity*, co-authored with Hal Kane and published this month by Worldwatch Institute and W. W. Norton.

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