How to Feed 8 Billion People
The world is entering a new food era. It will be marked by higher food prices, rapidly growing numbers of hungry people, and an intensifying competition for land and water resources that crosses national boundaries when food-importing countries buy or lease vast tracts of land in other countries. Because some of the countries where land is being acquired do not have enough land to adequately feed their own people, the stage is being set for future conflicts.

The sharp rise of grain prices in recent years underlines the gravity of the situation. From mid-2006 to mid-2008, world prices of wheat, rice, corn, and soybeans roughly tripled, reaching historic highs. It was not until the global economic crisis beginning in 2008 that grain prices began to level off and recede slightly.

The world has experienced several grain price surges over the last half century, but none like this. Earlier surges were event-driven, weather-related, and temporary—caused by monsoons, droughts, heat waves, etc.

The recent record surge in grain prices has been trend-driven. Working our way out of this tightening food situation means reversing the trends that are causing it, such as soil erosion, falling water tables, and rising carbon emissions.

As a result of persistently high food prices, hunger is spreading. In the mid-1990s, the number of hungry people had fallen to 825 million. But instead of continuing to decline, the number of people facing chronic food insecurity and undernourishment started to edge upward, jumping to more than 1 billion in 2009.

Rising food prices and the swelling ranks of the hungry are among the early signs of a tightening world food situation. More and more, food is looking like the weak link in our civilization, much as it was for the earlier ones whose archaeological sites we now study.

Food: The Weak Link

As the world struggles to feed all its people, farmers are facing some worrying trends. On the demand side of the food equation are three consumption-boosting trends: population growth, the growing consumption of grain-based animal protein, and, most recently, the massive use of grain to fuel cars.

Each year there are 79 million more people at the dinner table, and the overwhelming majority of these individuals are being added in countries where soils are eroding, water tables are falling, and irrigation wells are going dry.

Even as our numbers are multiplying, some 3 billion people are trying to add to their diets, consuming more meat and dairy products. At the top of the food-consumption ranking are the United States and Canada, where people consume on average 800 kilograms of grain per year, most of it indirectly as beef, pork, poultry, milk, and eggs. Near the bottom of this ranking is India, where people have less than 200 kilograms of grain each, and thus must consume nearly all of it directly, leaving little for conversion into animal protein.

The orgy of investment in ethanol fuel distilleries that followed the 2005 surge in U.S. gas prices doubled grain consumption to 40 million tons by 2008.

On the supply side, ongoing environmental trends are making it very difficult to expand food production fast enough. These include soil erosion, aquifer depletion, crop-shrinking heat waves, melting ice sheets and rising sea levels, and the melting of the mountain glaciers that feed major rivers and irrigation systems.

In addition, three resource trends are affecting our food supply: the loss of cropland to non-farm uses, the diversion of irrigation water to cities, and the coming reduction in oil supplies.
Soil erosion is currently lowering the inherent productivity of some 30% of the world’s cropland. In some countries, it has reduced grain production by half or more over the last three decades. Vast dust storms coming out of sub-Saharan Africa, northern China, western Mongolia, and Central Asia remind us that the loss of topsoil is not only continuing but expanding. Advancing deserts in China—the result of overgrazing, overplowing, and deforestation—have forced the complete or partial abandonment of some 24,000 villages and the cropland surrounding them.

The loss of topsoil began with the first wheat and barley plantings, but falling water tables are historically quite recent, simply because the pumping capacity to deplete aquifers has evolved only in recent decades. Water tables are now falling in countries that together contain half the world’s people. An estimated 400 million people (including 175 million in India and 130 million in China) are being fed by overpumping, a process that is by definition short term. Saudi Arabia has announced that, because its major aquifer, a nonreplenishable fossil aquifer, is largely depleted, it will be phasing out wheat production entirely by 2016.

Climate change also threatens food security. For each 1°C rise in temperature above the norm during the growing season, farmers can expect a 10% decline in wheat, rice, and corn yields. Since 1970, the earth’s average surface temperature has increased by 0.6°C. And the Intergovernmental Panel on Climate Change projects that the temperature will rise by up to 6°C during this century.

As the earth’s temperature continues to rise, mountain glaciers are melting throughout the world. The projected melting of the glaciers on which China and India depend presents the most massive threat to food security that humanity has ever faced. China and India are the world’s leading wheat producers and also dominate the world rice harvest. Whatever happens to the wheat and rice harvests in these two population giants will affect food prices everywhere.

The accelerating melting of the Greenland and West Antarctic ice sheets combined with thermal expansion of the oceans could raise sea level by up to six feet during this century. Every rice-growing river delta in Asia is threatened by the melting of these ice sheets. Even a three-foot rise would devastate the rice harvest in the Mekong Delta, which produces more than half the rice in Vietnam, the world’s number-two rice exporter. Three-fourths of oceanic fisheries are now being fished at or beyond capacity or are recovering from over-exploitation. If we continue with business as usual, many of these fisheries will collapse. We are taking fish from the oceans faster than they can reproduce.

With additional water no longer available in many countries, growing urban thirst can be satisfied only by taking irrigation water from farmers. Thousands of farmers in California find it more profitable to sell their irrigation water to Los Angeles and San Diego and leave their land idle. China’s farmers are also losing irrigation water to the country’s fast-growing cities.

If we paid the full cost of producing it—including the true cost of the oil used in producing it, the future costs of overpumping aquifers, the destruction of land through erosion, and the carbon-dioxide emissions from land clearing—food would cost far more than we now pay for it in the supermarket.

The question—at least for now—is: Will the world grain harvest expand fast enough to keep pace with steadily growing demand? Food security will deteriorate further unless leading countries collectively mobilize to stabilize population, stabilize climate, stabilize aquifers, conserve soils, protect cropland, and restrict the use of grain to produce fuel for cars.

The Emerging Geopolitics Of Food Scarcity

As world food security deteriorates, individual countries, acting in their narrowly defined self-interest, are banning or limiting grain exports.

In response, other countries have been trying to nail down long-term bilateral trade agreements that would lock up future grain supplies. Several have succeeded. Egypt, for example, has reached a long-term agreement with Russia for more than 3 million tons of wheat each year.

The more affluent food-importing countries have sought to buy or lease for the long term large blocks of land to farm in other countries. Libya, which imports 90% of its grain and has been worried about access to supplies, was one of the first to look
abroad for land. After more than a year of negotiations, it reached an agreement to farm 100,000 hectares (250,000 acres) of land in Ukraine to grow wheat for its own people.

Countries selling or leasing their land are often low-income countries and, more often than not, those where chronic hunger and malnutrition are commonplace. A major acquisition site for Saudi Arabia and several other countries is Sudan — the site of the World Food Programme’s largest famine relief effort.

The growing competition for land across national boundaries is also an indirect competition for water. In effect, land acquisitions are also water acquisitions. Land acquisitions in Sudan that tap water from the Nile, which is already fully utilized, may mean that Egypt will get less water from the river — making it even more dependent on imported grain.

Such bilateral land acquisitions raise many questions. To begin with, negotiations and the agreements they lead to tend to lack transparency. Typically, only a few high-ranking officials are involved, and the terms are confidential. Not only are many stakeholders such as farmers not at the table when the agreements are negotiated, they do not even learn about the deals until after they have been signed. And since there is rarely idle productive land in the countries where the land is being purchased or leased, the agreements suggest that many local farmers will be displaced. Their land may be confiscated or bought from them at a price over which they have little say.

This helps explain the public hostility that often arises within host countries. China, for example, signed an agreement with the Philippine government to lease more than a million hectares of land on which to produce crops that would be shipped home. Once word leaked out, the public outcry — much of it from Filipino farmers — forced the government to suspend the agreement. A similar situation developed in Madagascar, where South Korea’s Daewoo Logistics had pursued rights to an area half the size of Belgium. The political furor led to a change in government and cancellation of the agreement.

Raising Land Productivity

There are many things that can be done in agriculture to raise land and water productivity. The challenge is for each country to fashion agricultural and economic policies that enable it to realize its unique potential.

Prior to 1950, expansion of the food supply came almost entirely from expanding cropland area. Then as frontiers disappeared and population growth accelerated after World War II, the world quickly shifted to raising land productivity. After several decades of rapid rise, however, it is now becoming more difficult to continue increasing productivity.

Gains in land productivity have come primarily from three sources: the growing use of fertilizer, the spread of irrigation, and the development of higher-yielding varieties of wheat, rice, and corn.

Among the three grains, corn is the only one where the yield is continuing to rise in high-yield countries. Even though fertilizer use has not increased since 1980, corn yields continue to edge upward as seed companies invest huge sums in corn breeding.

Despite dramatic past leaps in grain yields, it is becoming more difficult to expand world food output. There is little productive new land to bring under the plow. Expanding the irrigated area is difficult. Returns on the use of additional fertilizer are mostly diminishing. In the more arid countries of Africa, there is not enough rainfall to raise yields dramatically.

One way is to breed crops that are more tolerant of drought and cold. Another way to raise land productivity, where soil moisture permits, is to expand the area of land that produces more than one crop per year. Indeed, the tripling in the world grain harvest from 1950 to 2000 was due in part to widespread increases in multiple cropping in Asia. The spread of double cropping of winter wheat and corn on the North China Plain helped boost China’s grain production to where it now rivals that of the United States.

A concerted U.S. effort to both breed earlier-maturing varieties and develop cultural practices that would facilitate multiple cropping could boost crop output. If China’s farmers can extensively double crop wheat and corn, then U.S. farmers — at a similar latitude and with similar climate patterns — could do more if agricultural research and farm policy were reoriented to support it. Western Europe, with its mild winters and high-yielding winter wheat, might also be able to double crop more with a summer grain, such as corn, or an oilseed crop. Brazil and...
A drip system also raises yields because it provides a steady supply of water with minimal losses to evaporation. Since drip systems are both labor-intensive and water-efficient, they are well suited to countries with a surplus of labor and a shortage of water. Israel (where the method was pioneered) and neighboring Jordan both rely heavily on drip irrigation. In contrast, among the big three agricultural producers, this more-efficient technology is used on roughly 3% of irrigated land in India and China and on roughly 4% in the United States.

In recent years, small-scale drip-irrigation systems—literally a bucket or drum with flexible plastic tubing to distribute the water—have been developed to irrigate small vegetable gardens. The containers are elevated slightly so that gravity distributes the water. Large-scale drip systems using plastic lines that can be moved easily are also becoming popular. These simple systems can pay for themselves in one year. By simultaneously reducing water costs and raising yields, they can dramatically raise incomes.

Shifting to more water-efficient crops wherever possible also boosts water productivity. Rice production is being phased out around Beijing because rice is such a thirsty crop. Similarly, Egypt restricts rice production in favor of wheat.

Strategic Reductions in the Demand for Grain

Although we seldom consider the climate effect of various dietary options, they are substantial, to say the least. A plant-based diet requires roughly one-fourth as much energy as a diet rich in red meat. Shifting to a vegetarian diet cuts greenhouse gas emissions almost as much as shifting from an SUV to a hybrid vehicle does.

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When considering how much animal protein to consume, it is useful to distinguish between grass-fed and grain-fed products. For example, most of the world’s beef is produced.
with grass. Even in the United States, with an abundance of feedlots, over half of all beef cattle weight gain comes from grass rather than grain. Grasslands are usually too steeply sloping or too arid to plow, and can contribute to the food supply only if used for grazing.

Beyond the role of grass in providing high-quality protein in our diets, it is sometimes assumed that we can increase the efficiency of land and water use by shifting from animal protein to high-quality plant protein, such as that from soybeans. It turns out, however, that since corn yields in the U.S. Midwest are three to four times those of soybeans, it may be more resource-efficient to produce corn and convert it into poultry or catfish at a ratio of two to one than to have everyone heavily reliant on soy.

The massive conversion of grain into biofuel began just a few years ago. If we are to reverse the spread of hunger, we will almost certainly have to cut back on ethanol production. Removing the incentives for converting food into fuel will help ensure that everyone has enough to eat. It will also lessen the pressures that lead to overpumping of groundwater and the clearing of tropical rain forests. If the U.S. government were to abolish the subsidies and mandates that are driving the conversion of grain into fuel, it would help stabilize grain prices and set the stage for relaxing the political tensions that have emerged within importing countries.

The Localization of Agriculture

In the United States, there has been a surge of interest in eating fresh local foods, corresponding with mounting concerns about the climate effects of consuming food from distant places. This is reflected in the rise in urban gardening, school gardening, and farmers’ markets.

Food from more distant locations boosts carbon emissions while losing flavor and nutrition. A localized food economy reduces fossil fuel usage. Supermarkets are increasingly contracting with local farmers, and upscale restaurants are emphasizing locally grown food on their menus.

In school gardens, children learn how food is produced, a skill often lacking in urban settings, and they may get their first taste of freshly picked peas or vine-ripened tomatoes. School gardens also provide fresh produce for school lunches. California, a leader in this area, has 6,000 school gardens.

Many universities are now making a point of buying local food as well. Some universities compost kitchen and cafeteria food waste and make the compost available to the farmers who supply them with fresh produce.

Community gardens can be used by those who would otherwise not have access to land for gardening. Providing space for community gardens is seen by many local governments as an essential service.

Many market outlets are opening up for local produce. Perhaps the best known of these are the farmers’ markets where local farmers bring their produce for sale. Many farmers’ markets also now take food stamps, giving low-income consumers access to fresh produce that they might not otherwise be able to afford.

A survey of food consumed in Iowa showed conventional produce traveled on average 1,500 miles, not including food imported from other countries. In contrast, locally grown produce traveled on average 56 miles—a huge difference in fuel investment.

Concerns about the climate effects of transporting food long distances has led Tesco, the leading U.K. supermarket chain, to begin labeling products with their carbon footprint, indicating the greenhouse gas contribution of food items from the farm to supermarket shelf.

The shift from factory farm production of milk, meat, and eggs to mixed crop–livestock operations also facilitates nutrient recycling as local farmers return livestock manure to the land. The combination of high prices of natural gas, which is used to make nitrogen fertilizer, and of phosphate, as reserves are depleted, suggests a much greater future emphasis on nutrient recycling—an area where small farmers producing for local markets have a distinct advantage over massive feeding operations.

Costs and Solutions

If we cannot quickly cut carbon emissions, the world will face cropshrinking heat waves that can massively and unpredictably reduce harvests. A hotter world will mean melting ice sheets, rising sea levels, and the inundation of the highly productive rice-growing river deltas of Asia. The loss of glaciers in the Himalayas and on the Tibetan Plateau will shrink wheat and rice harvests in both India and China, the world’s most populous countries. Both are already facing water shortages driven by aquifer depletion and melting glaciers.

Since hunger is almost always the result of poverty, eradicating hunger depends on eradicating poverty. And where people are outrunning their land and water resources, this means stabilizing population.

Given that a handful of the more affluent grain-importing countries are reportedly investing some $20–30 billion in land acquisition, there is no shortage of capital to invest in agricultural development. Why not invest it across the board in helping low-income countries develop their unrealized potential for expanding food production, enabling them to export more grain?

We have a role to play as individuals. Whether we bike, bus, or drive to work will affect carbon emissions, climate change, and food security. The size of the car we drive to the supermarket and its effect on climate may indirectly affect the size of the bill at the supermarket checkout counter. If we are living high on the food-consumption chain, we can move down, improving our health while helping to stabilize climate. Food security is something in which we all have a stake—and a responsibility.

About the Author

Lester R. Brown is the founder and president of the Washington, D.C.-based nonprofit Earth Policy Institute. This article draws from his most recent book, Plan B 4.0: Mobilizing to Save Civilization (W.W. Norton and Co., 2009). For additional information, visit www.earth-policy.org.