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The Environmental Trends That Are Shaping Our Future

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OVERVIEW
The Acceleration of Change

Lester R. Brown

We have noted in earlier editions of *Vital Signs* that history appeared to be accelerating, that everything was moving faster. The last year of the old century was no exception. Records were being set on so many fronts that we could scarcely keep track. In 1999, world population passed 6 billion, adding the last billion in a record 12 years. And India's population reached 1 billion. Neither demographic milestone was a cause for celebration.

During the last half of the twentieth century, world population increased from 2.5 billion to 6 billion, with most of the increase coming in the developing world. In country after country, the population was outrunning the water supply. The demand for firewood and lumber was outrunning the sustainable yield of forests. And the demand for food was outrunning the cropland area.

The world ended the twentieth century on a strong economic note. The global economy had just completed a sixfold expansion in 50 years. Powering this was a fourfold growth in fossil fuel use, accompanied by a similar increase in carbon dioxide (CO_2) emissions. Each year since systematic air sampling began, atmospheric CO_2 levels have moved to a new high, climbing from 317 parts per million (ppm) in 1959 to 368 ppm in 1999.

This 16-percent rise in the concentration of CO_2, the principal greenhouse gas, was accompanied by a record rise in temperatures, which contributed to some of the most destructive storms and floods on record. And as Earth's temperature rises, its ice cover is melting. Scientists report that the Arctic sea ice has thinned by 40 percent over the last three decades. Ice sheets around the Antarctic Peninsula have broken up, yielding Delaware-sized icebergs. The vast snow-ice mass in the Himalayas—the third largest after that of the two poles—is melting rapidly.

Even as these signs of climate disruption were multiplying, signs of a new climate-benign energy economy based on renewable energy resources were emerging. While coal production dropped by 3 percent in 1999, wind electric generation increased by 39 percent as new wind farms came on line in Minnesota, Iowa, Texas, Wyoming, and Oregon in the United States, in Spain, in northwestern Europe, and in China. Solar cell production, including a large component of solar roofing materials, jumped by 30 percent in 1999.

These were encouraging signs that the world is beginning to respond to the environmental threats that promise to undermine our future, but the gap between what we need to be doing to reverse the environmental deterioration of the planet and what we are actually doing continues to widen. Many have come to expect that the progress in improving the human condition that marked the last half of the twentieth century would continue during the twenty-first, but in sub-Saharan Africa—where the capacity to respond to new threats has been weakened by continuing rapid population growth—progress is being reversed. The HIV epidemic in this region has reached epic proportions, threatening to take more lives during the first two decades of this century than World War II did in the last century.

ENERGY TRANSITION ACCELERATES

The transition from fossil fuels to a solar/hydrogen energy economy accelerated sharply in 1999. (See Table 1.) The burning of coal, the fossil fuel that launched the industrial era, declined by 3 percent in 1999; oil increased by 1 percent; and natural gas, the cleanest burning, least climate-disruptive of the three fossil fuels, expanded by 3 percent. (See pages 52–53.) Nuclear power, once seen as the energy source of the future, barely maintained its expansion in 1999 with a growth of 0.4 percent. (See pages 54–55.) Meanwhile, world wind generating capacity grew by 39 percent and sales of solar cells by 30 percent. (See pages 56–59.)

World coal consumption is the first of the fossil fuels to peak and begin to decline. After reaching a historic high in 1996, it has dropped by 6 percent and is expected to continue declining as the shift to natural gas and renewables gains momentum. Some estimates have oil production peaking before the end of this decade. Only natural gas, now viewed by many as the transition fuel from the fossil era to the solar/hydrogen era, is likely to continue growing for an extended period.

Coal consumption is declining sharply in the United Kingdom, where the Industrial Revolution began, and in China, the world's largest user of coal. Cuts in subsidies for coal in China and the closing of inefficient state-owned mines have both contributed to its declining use. These changes are being driven by air pollution in Chinese cities, which include some of the most polluted urban areas in the world. By shifting from coal to natural gas, cities can begin to reduce the urban air pollution that has claimed literally millions of lives in China in recent years.

As part of its long-term planning, China is building a new pipeline from the gas fields discovered in its northwest to Lanzhou in Gansu Province. China has also approved the import of natural gas and is now planning to build a pipeline linking Russia's Siberian gas fields with Beijing and Tianjin, two leading industrial cities.

The shift in the fortunes of nuclear power could hardly be more dramatic. In the 1980s, world nuclear generating capacity expanded by 140 percent; during the 1990s, it expanded by less than 5 percent. The energy source that was to be "too cheap to meter" is now too costly to use. Wherever electricity markets are opened to competition, nuclear power is in trouble. Its use is likely to peak within the next three years.

Nuclear power plant closings are now under way or slated in the years immediately ahead in many countries, including Bulgaria,

TABLE 1. TRENDS IN ENERGY USE, BY SOURCE, 1990–99[1]

ENERGY SOURCE	ANNUAL RATE OF GROWTH (percent)
Wind power	+24.2
Solar photovoltaics	+17.3
Geothermal power[2]	+ 4.3
Natural gas	+ 1.9
Hydroelectric power[2]	+ 1.8
Oil	+ 0.8
Nuclear power	+ 0.5
Coal	– 0.5

[1]Trends measured in varying units: installed generating capacity (megawatts or gigawatts) for wind, geothermal, hydro, and nuclear power; million tons of oil equivalent for oil, natural gas, and coal; megawatts for shipments of solar photovoltaic cells.
[2]1990–98 only.
SOURCE: See pages 52–59.

Germany, Kazakhstan, the Netherlands, Russia, the Slovak Republic, Sweden, and the United States. In three countries once solidly committed to nuclear power—France, China, and Japan—nuclear power is losing its appeal. France has extended its moratorium on new nuclear power plants. China has said it will not approve any additional plants for the next three years. Japan's once ambitious nuclear program is in trouble. A serious accident in September 1999 at a nuclear fuel fabrication plant north of Tokyo has reinforced the fast-growing anti-nuclear movement in Japan.

Meanwhile, the use of wind and solar cells, the cornerstones of the new energy economy, is growing by leaps and bounds. One of the attractions of wind-generated electricity is its falling cost. With the new advanced design wind turbines, electricity is typically being generated at 4–6¢ per kilowatt-hour, one fourth the cost of a decade ago and a figure that is competitive with traditional energy sources. Indeed, annual additions of wind capacity during the late 1990s exceeded those of nuclear power. In effect, the torch is passing to a new generation of energy technologies.

Germany has emerged as the world leader in wind electrical generating capacity, with the United States in second place. Major new wind farms have begun operation over the last two years in Minnesota, Iowa, Texas, Wyoming, and Oregon. This growth in wind electric generation in the Corn Belt and the Great Plains is providing farmers and ranchers with welcome supplemental income. Indeed, the Great Plains has enormous wind-generating potential, making it the Saudi Arabia of wind power.

Europe is moving quickly to develop its wind energy resources. Denmark, the world leader in advanced design wind turbine manufacturing, continues to add new capacity. The country where wind power is growing fastest is Spain. Starting from zero four years ago, Spain moved into second place in terms of new wind installations in 1999 with 750 megawatts, trailing only Germany at 1,570 megawatts. In early 2000, Energia Hidroelectrica de Navarra, the leader in wind energy development in Spain, announced an order for some 1,400 megawatts worth of wind turbines—the largest order ever placed.

European countries are now excited by the offshore potential for generating wind. A new study indicates that in the coastal regions of the North Sea and the Baltic Sea, out to a depth of 30 meters, there is enough harnessable wind to satisfy the continent's electricity needs.

In addition to being a climate-benign source of energy, wind power is also labor-intensive. In Germany, for example, where wind supplies 2 percent of electricity generation, in 1998 the industry employed an estimated 15,000 workers in the manufacture, installation, and operation of wind turbines. (See pages 146–47.) By contrast, nuclear power, which supplies 31 percent of electricity, offered only 40,000 jobs. In Europe, where double-digit unemployment rates are not uncommon, the large number of jobs created in a wind power energy economy are a definite plus.

The growth in solar cell manufacturing is also accelerating, jumping from an average of 16 percent a year from 1990 to 1998 to 30 percent in 1999. Japan, the United States, and several countries in Europe now have solar cell manufacturing facilities. The largest producer in the world today is BP Solarex. In Germany, Royal Dutch Shell opened a 25-megawatt, fully automated production facility. The big advance in solar cell potential came with the development by the Japanese of a solar roofing material, which means that the roof can become the power plant for the building.

As the world turns to new sources of energy, new technologies are substantially boosting the efficiency of energy use. Among the more dramatic of these are compact fluorescent lamps, light bulbs that provide the same amount of lighting as an incandescent bulb but use only one fourth as much electricity. The estimated 1.3 billion compact fluorescents in use today are operating on 20,000 megawatts of electricity, a huge saving over the 80,000 megawatts of capacity that would be needed to light the same number of incandescent bulbs. (See pages 60–61.)

CLIMATE CHANGE BUILDING MOMENTUM

Earth's average temperature in 1999 was down somewhat from 1998, which was the highest in the last century. (See pages 64–65.) Nonetheless, 1999 was the seventh warmest year since 1866, when continuous recordkeeping began. (See Figure 1.) The average temperature in 1998 was well above trend because of the El Niño warming of Pacific equatorial waters, and conversely it dropped below trend in 1999 due to La Niña, the flip side of the El Niño effect. As atmospheric CO_2 levels rise, Earth's average temperature is also rising.

Carbon emissions from fossil fuel burning have been more or less flat for the last three years at roughly 6.3 billion tons per year. (See pages 66–67.) At this level, however, they far exceed nature's capacity to fix carbon, thus pushing atmospheric concentrations of CO_2 higher. This rise in CO_2 levels, which have climbed higher every year since air sampling began in 1959, has become one of the most predictable of all the trends shaping our future.

Some of the expected effects of climate change, such as more destructive storms and the melting of Earth's ice cover, are now becoming evident. Weather-related damage in 1999 totaled $67 billion worldwide, the second highest after the 1998 figure of $93 billion. (See pages 76–77.) Weather-related damage worldwide during the 1990s was more than five times the figure during the 1980s.

Among the more devastating storms in 1999 was one in Venezuela that claimed 30,000 lives and destroyed an estimated $15 billion worth of property. One of Latin America's worst natural disasters in this century, it was the product of not only an uncommonly destructive storm but also extensive deforestation and construction in high-risk areas. A series of wind storms that hit Western Europe, importantly France, Germany, Spain, and Switzerland, did $9.6 billion worth of damage in late 1999. And a super cyclone with winds of 300 kilometers (190 miles) per hour that moved out of the Bay of Bengal into the East Indian state of Orissa in October took 15,000 lives.

Another consequence of higher temperatures is the melting of ice, a process that accelerated during the 1990s. Arctic sea ice, for example, has thinned by a staggering 40 percent within the last 30 years. (See pages 126–27.) The Antarctic's continent-sized ice sheet, which is on average 2.3 kilometers thick, is relatively stable, but the ice shelves—the part that floats on the surrounding seas—are melting rapidly. Three ice shelves along the West Antarctic peninsula—the Wordie, the Larsen A, and the Prince Gustav—have broken up entirely. Delaware-sized icebergs that have broken off are threatening ships in the area.

Ice is also melting rapidly in subpolar regions and mountains. For example, the Alps have lost 50 percent of their glacial mass over the last century. In the United States, Glacier

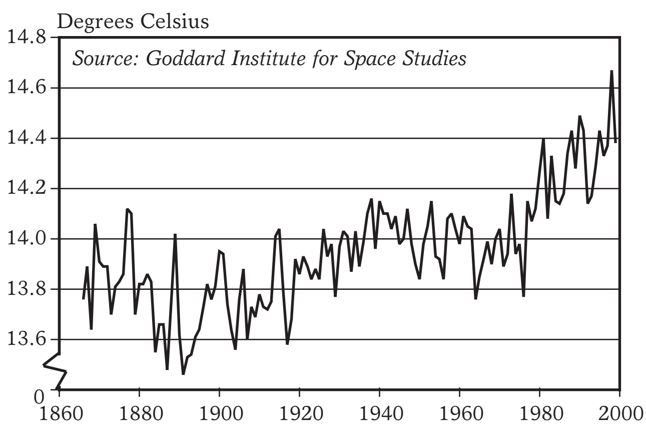

Figure 1: Average Temperature at Earth's Surface (Land-Based Series), 1866–1999

National Park has lost two thirds of its glaciers since 1850. Those remaining could disappear within the next 30 years. The Himalayan snow-ice mass is also melting. Feeding all the major rivers of Asia, including the Ganges, Indus, Mekong, Yangtze, and Yellow rivers, it is projected to shrink by 20 percent over the next 35 years.

FOOD TRENDS MIXED

World grain production in 1999 fell by 1 percent from the year before, dropping the per capita supply by more than 2 percent. (See pages 34–35.) Among the big three grains—wheat, corn, and rice—production of wheat and corn dropped by 1 percent each while rice increased by 1 percent.

World grain production per person dropped by more than 2 percent in 1999. This drop extended a decline that has been under way since 1984, one that has reduced per capita grain production worldwide by some 10 percent.

Trends contrast widely among regions. Much of the per capita decline has come in the republics of the former Soviet Union, including the two large ones—Russia and the Ukraine. The other major region suffering a decline is Africa. Continuing rapid population growth, steadily shrinking cropland area per person, and the loss of soil from erosion have all contributed to the region's deteriorating food situation.

One manifestation of growing demand for animal protein (see Figure 2) has been the extraordinary ninefold growth in the world soybean harvest from 1950 to 1999, a jump from 17 million to 154 million tons. (See pages 36–37.) A modest amount of soybean meal added to grain consumed by livestock and poultry greatly enhances the efficiency of the grain used. This ninefold expansion contrasts with a threefold growth in the world grain harvest during the same period.

Although the soybean originated in China, it has found an ecological and economic niche in the United States, which today produces nearly half of the world's soybeans. Indeed, in 1999, the U.S. soybean harvested area eclipsed that of corn and wheat, traditionally the two leading crops, for the first time in history.

World meat production, which increased by 1 percent in 1999, has now risen for 41 consecutive years—making it one of the most predictable of the world's food consumption trends. (See pages 38–39.) Of the three meats that dominate human diets, beef and pork each increased by 0.5 percent in 1999 while poultry increased by nearly 3 percent, accounting for most of the growth in the world's meat supply.

Twenty years ago, the United States was the world's leading consumer of meat. But this has now changed. After the economic reforms in China in 1978, Chinese incomes multiplied fourfold within two decades. As a result, in 1999 China consumed 55 million tons of meat compared with 34 million tons in the United States.

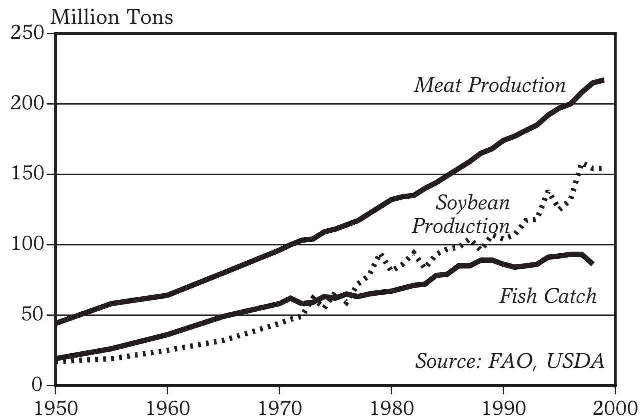

Figure 2: World Protein Production, Selected Sources, 1950–99

Two of the resource systems that support traditional sources of animal protein in the human diet—rangelands, which account for much of the world's beef and mutton production, and oceanic fisheries, which supported a fivefold growth in the world fish catch between 1950 and 1998—are approaching their productive limits.

One reason world beef production increased little during the 1990s is that most of the world's rangelands are being grazed at or beyond capacity. A similar situation exists in fisheries—some 60 percent of all oceanic fisheries are now being fished at or beyond capacity. In 1998, the last year for which data are available, the catch dropped from 93 million tons to 86 million tons. (See pages 40–41.) This precipitous drop of nearly 8 percent reflected a decline in catch in some overworked fisheries and the El Niño weather event, which warmed the eastern Pacific waters, sharply reducing fish stocks there.

While the oceanic catch was dropping, fish farming continued to expand, going from 29 million tons in 1997 to 31 million tons in 1998. Two thirds of world output is concentrated in China, where people rely on several species of carp for much of their fish consumption.

UNSUSTAINABLE OUTPUT GROWING

A small but growing share of the world grain harvest is being produced with the unsustainable use of land and water. In 1999, world grain area totaled 674 million hectares, down some 8 percent from the historical high of 732 million hectares in 1981. (See pages 44–45.) Part of this decline was because highly erodible cropland was being returned to grass or trees. This is most evident in the United States, where some 12 million hectares—nearly one tenth of U.S. cropland—was returned to grass or trees under the Conservation Reserve Program. In China, the leading loss of cropland is also the conversion of highly erodible cropland to its original vegetative cover.

Some countries are losing cropland to nonfarm uses. Between 1982 and 1997, more than 5 million hectares of U.S cropland were converted to other uses. An estimated one fifth of China's cropland loss is attributed to the construction of roads, factories, and homes.

The other major source of unsustainable food production is that resulting from the overpumping of underground aquifers. Overpumping worldwide is now conservatively estimated at 160 billion cubic meters of water per year. (See pages 122–23.) Using the rule of thumb to convert water into grain of a thousand cubic meters of water to produce a ton of grain, this would total 160 million tons of grain. Stated otherwise, if we were to decide this year to stabilize water tables throughout the world, the world grain harvest would drop by something like 160 million tons. At average world consumption of roughly one third of a ton of grain per person per year, this would feed 480 million people. In effect, 480 million of the world's current population of 6 billion are being fed with food produced with the unsustainable use of water.

In summary, the sustainability of world food production and of the population that depends on it is being threatened by the loss of cropland from erosion and conversion to nonfarm uses and by the overpumping of aquifers.

THE PRODUCTIVITY CHALLENGE

One of the keys to the tripling of the world grain harvest over the last half-century was the rise in land productivity. Farmers in a growing number of countries, however, are finding it difficult to sustain this historically rapid growth. Among them are rice farmers in Japan and wheat farmers in the United States and Mexico. In part this is because of the declining response of crops to additional applications of fertilizer. Many high-yielding crops are simply approaching their physiological capacity to absorb additional nutrients.

Efforts to maintain land productivity are further complicated by the urbanization of world population, which has led to a wholesale disruption of nutrient recycling. One reason world fertilizer use increased from 14 million tons in 1950 to 134 million tons in 1999 (see pages 46–47), nearly a 10-fold increase, was as a replacement for the nutrients being lost from farmland as crops are exported to cities where the nutrients enter local sewage systems, often ending up in a nearby river or the ocean.

The United States, for example, exports roughly 100 million tons of grain per year and with it all the nutrients in the grain. Without fertilizer to replace these nutrients, land productivity in major grain-producing states like Kansas and Iowa would be gradually declining over time as a result of nutrient depletion.

One hope for raising land productivity that is widely heralded by the seed-producing industry, namely the genetic modification of crops by transferring germplasm from other species, has not materialized. Thus far the growth in the area planted to genetically modified crops, which expanded from scratch in 1995 to 40 million hectares in 1999, has had no measurable effect on crop production. (See pages 118–19.) The use of these genetically modified crops has, however, affected pesticide use. It has reduced insecticide use on cotton and, to a lesser degree, on corn, and has dramatically raised herbicide use on soybeans.

Even as the economic gains for farmers from these genetically modified crops are perhaps less than expected, there is mounting concern among consumers and environmentalists about the effects on human health and on the environment. As a result of this growing concern, the U.S. area planted to genetically modified crops in 2000 is likely to drop by some 15–25 percent.

Another agricultural trend, the shift to organic farming, is continuing to gain momentum, reaching an estimated 7 million hectares in 1999. (See pages 120–21.) Aside from eliminating the risk of pesticide contamination of food, organic farming also reduces pesticide and nutrient runoff from cropland.

The area of land that is farmed organically, which is less than 1 percent of world cropland, contrasts sharply with the growth in the area planted to genetically modified crops, which reached 40 million hectares in just four years. In 2000, the area farmed organically is projected to continue expanding while that planted to genetically modified crops is expected to shrink. Ironically, neither trend appears to be contributing to any growth in the world food supply.

ECONOMIC TRENDS MIXED

In 1999, the world economy expanded by 3 percent, up from 2.5 percent the year before. (See pages 70–71.) The $40.5 trillion worth of goods and services produced in 1999 was up more than sixfold from the $6.3 trillion output of goods and services in 1950.

The global economy is becoming huge compared with the capacities of Earth's ecosystems to supply basic goods, such as forest products, fresh water, and seafood. The $1.2 trillion expansion in output during 1999 exceeded the growth in the global economy during the entire nineteenth century.

While the global economy was expanding in 1999, international trade was virtually unchanged, thus slightly reducing the share of world economic output traded in 1999. (See pages 74–75.) According to this key indicator, globalization declined slightly in 1999.

World trade consists of both goods and services. The principal services include tourism, banking, insurance, and licenses for intellectual property, such as software and movies. While international trade in goods barely increased in 1999, international tourism rose 3 percent. (See pages 82–83.) Although this is below the average annual rate of growth of 7 percent since 1950, it brought the number of international tourist arrivals in 1999 to 657 million. As tourism, which today accounts for 12 percent of global economic activity, has expanded since 1980, the number of hotel beds worldwide has jumped by more than 80 percent and now exceeds 29 million. Each hotel room added typically creates at least one new job.

Although earnings in developing countries from international tourism have been rising rapidly, they have not been sufficient to avoid a rise in the external debt of developing countries. Expanding 5 percent in 1998, this debt grew faster than both the world economy and international trade. (See pages 72–73.) For some of the most heavily indebted poor countries, servicing external debt is siphoning resources away from meeting basic needs. In Zambia, for example, 30 percent of government spending is used to pay off foreign debt while only 10 percent is available to invest in health, education, and other basic social services. To help alleviate this financial stress, industrial-country governments have agreed to write off roughly two thirds of the official debt owed by the poorest countries.

In the transportation sector, global passenger car production expanded 3 percent in 1999, reaching an all-time high of 39 million vehicles. (See pages 86–87.) In North America, the share of automobile sales accounted for by light trucks, sport utility vehicles, and pickup trucks increased from 20 percent in 1975 to 46 percent in 1999. One consequence of this is a decline in fuel efficiency of the U.S. passenger vehicle fleet from 25.9 miles per gallon in the early 1980s to 23.8 miles per gallon in 1999.

While automobile production was reaching an all-time high, bicycle production sagged for the third year in a row. (See pages 88–89.) In 1995, when output peaked at 107 million, three times as many bikes were produced as cars. With bicycle manufacturing dropping to 79 million in 1998, the margin of bicycles over cars has been reduced from three-to-one to two-to-one. (See Figure 3.)

The principal reason for the decline in bicycle manufacturing has been the saturation of the huge bicycle market in China that occurred as economic reforms and rising affluence enabled literally hundreds of millions of Chinese to buy bicycles during the 1980s and early 1990s. Once this market demand was met, bicycle manufacturing and production dropped sharply in China.

Elsewhere, however, many cities are turning to bicycles partly because of frustration with automobile traffic congestion and pollution. Bogota, for example, is investing heavily in bicycle infrastructure to encourage the use of bicycles. The United Kingdom has built an 8,000-kilometer National Cycle Network that is scheduled to open in June 2000. This will pass within 4 kilometers of half the country's population, making it highly accessible and an obvious inducement to people to shift from cars to bicycles on short trips for shopping, commuting, and recreational riding.

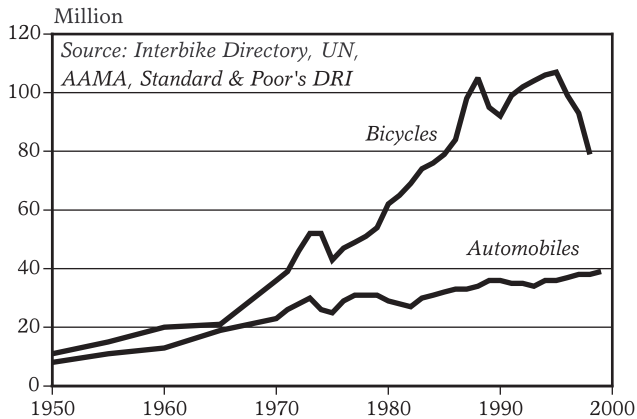

Figure 3: World Automobile and Bicycle Production, 1950–99

THE GLOBALIZATION OF INFORMATION

In 1998, the number of fixed-line phone connections worldwide reached 844 million, a gain of 7 percent over the preceding year. (See pages 92–93.) The number of cellular phone subscribers increased to 319 million, a phenomenal jump of 48 percent over the preceding year. In 1996, the number of new mobile phones exceeded the number of new fixed-line installations for the first time. Well before the end of this decade, the total number of cellular phones in use is likely to surpass the number of fixed-line phones.

Growth in the Internet has been even more impressive. By the end of 1999, some 72 million host computers were linked to the Internet, marking an expansion of 67 percent over 1998. (See pages 94–95.) They enabled 260 million people to go online. Although the U.S. share of this total is declining steadily, the United States—with 111 million Internet users—still accounts for 43 percent of the world total. The next four countries are Japan, with 18 million Internet users, and Canada, Germany, and the United Kingdom, with 14 million each.

Perhaps the most spectacular growth in 1999 occurred in developing countries, like Brazil (7 million users), China, and South Korea (about 6 million each). Internet access in developing countries nearly doubled in 1999. China alone expanded its access by fourfold, exceeding all projections.

The Internet has a huge potential for saving resources. Worldwide e-commerce in 1999 totaled $111 billion, triple the level for 1998. With the growing potential of ordering products from home and also working from home, one study projects that the U.S. area for malls and office buildings will be reduced by 3 billion square feet, greatly lowering use of both materials and energy.

Another environmental benefit of new technologies involves the use of satellites to monitor changes in Earth's physical condition. (See pages 140–41.) In 1997, for example, when fires were burning out of control during an intense drought in Indonesia, bringing air travel to a halt and making millions of people in the region physically sick, satellite images revealed the cause. The fires were concentrated in areas where plantation owners wanted to clear land for additional palm oil plantings; the fires that were burning out of control were not all accidental.

Some of the most helpful Earth-monitoring satellites are those used for weather. The science of weather forecasting and analysis has come a long way since the first weather satellite was launched in 1960. Today World Weather Watch, operated by the World Meteorological Organization, combines satellite observations with readings at ground, sea, and air monitoring stations, telecommunications links, and computer analysis centers to provide a highly sophisticated analysis and short-term forecast of weather trends.

Satellites are playing an important role in measuring changes in snow cover as temperatures rise. They are also ideally situated to monitor the breakup of major ice sheets, such as those in West Antarctica. They can chronicle with great detail the shrinkage of the Aral Sea in Central Asia or Lake Chad in Africa. By recording fires in the Amazon, floods in China, and dust storms in the Sahara, they help us to monitor Earth's health.

SOCIAL TRENDS GRIM

During 1999, our numbers increased by 77 million, bringing world population to 6 billion. (See pages 98–99.) India, meanwhile, logged a demographic milestone of its own, surpassing 1 billion and joining China in the 1-billion club.

Nearly all the 77 million added to world population in 1999 were born in developing countries. Despite the obvious urgency of slowing population growth everywhere, some 120 million women have no access to family planning services at all. Another 350 million women in developing countries still lack convenient, regular access to safe family planning services.

The annual rate of world population growth, which dropped from more than 2 percent a generation ago to 1.3 percent in 1999, is now slowing in part because of rising mortality from the HIV epidemic. In 1999, 5.8 million people were infected with HIV, raising the total number infected to date to 49.9 million in 1999. (See pages 100–01.) AIDS deaths, which lag behind new infections by roughly eight years, totaled 2.6 million in 1999, up from 2.4 million the year before. An estimated 23 million Africans entered the new century with a death sentence imposed by the virus.

In a number of countries, including Botswana, Namibia, South Africa, and Zimbabwe, one fifth to one third of the adult population is HIV-positive. Unless there is a medical miracle, these countries will lose this huge segment of their adult population well before the end of this decade. Life expectancy is dropping precipitously in southern Africa, where expected life span had climbed from 44 in the early 1950s to 59 in the early 1990s, but is now expected to drop back to 45 during this decade. By 2010, AIDS orphans in Africa are expected to total 40 million, creating a new subclass and a massive social challenge.

After tracking HIV infection rates, mortality rates, and life expectancy changes associated with the disease, we are now beginning to see some of the secondary effects of the epidemic. In South Africa, more than 60 percent of the beds in some hospitals are occupied by AIDS patients, impairing the capacity of the health care system to satisfy basic heath care needs. Education, too, is being affected. While Zambia last year graduated 300 new teachers, AIDS claimed the lives of 600 teachers.

For some corporations operating in countries like Zimbabwe, Botswana, and South Africa, the cost of employee health insurance has doubled, tripled, or quadrupled over the last decade as the number of employees with AIDS has soared. The combination of declining life expectancy, falling investment levels, and the loss of a large share of the productive segment of the population to the virus is undermining the economic future of Africa.

Closely related to the spread of HIV is the dramatic resurgence in tuberculosis (TB) worldwide. (See pages 148–49.) In 1998, 8 million new TB cases were recorded, 95 percent of them in developing countries. Swelling populations of HIV-positive individuals with impaired immune systems provide a fertile ground for the TB virus to spread. And like other infectious diseases, TB moves rapidly around the world in an age of air travel.

A third epidemic, cigarette smoking in developing countries, is also measurably reducing life expectancy. Worldwide, the number of deaths from smoking-related causes is projected by the World Health Organization to increase from 4 million in 1998 to 10 million in 2030. (See pages 106–07.) Between now and 2015, cigarettes are projected to claim more lives than World War II did.

As public awareness of the social toll of cigarettes spreads, opposition to smoking is also growing. A movement that has gained great momentum in the United States is now spreading into Europe and many developing countries. In the United States, per capita cigarette consumption dropped by a record 9 percent in 1999 as a result of stiffer taxes, higher prices, and increased awareness of the health risks of smoking. The number of cigarettes smoked per person in the United States has dropped from about 2,875 in 1980 to 1,634 in 1999, a fall of 43 percent. In Europe, the number of smokers has dropped by 10 percent over the last decade. The European Union has banned all cigarette advertising after 2005.

Worldwide, cigarette consumption per person dropped from the historical high of 1,027 in 1990 to 915 in 1999, a drop of 11 percent. The World Health Organization has launched a major worldwide campaign to restrict cigarette smoking and to reduce the health toll associated with this often lethal habit.

The spread of the HIV virus, the resurgence of tuberculosis, and the increase in cigarette smoking in developing countries together may well reverse the steady worldwide rise in life expectancy that characterized the last half of the twentieth century.

Besides the additional crowding associated with the sheer growth in human numbers, the growing concentration of the world's population in cities is creating conditions that are conducive to the spread of infectious diseases. The world's urban population is growing at nearly 60 million per year, driven by migration from the countryside, by the natural increase within existing urban populations, and the absorption of villages by expanding cities. (See pages 104–05.)

As of 1999, 47 percent of the world's people lived in cities. By 2006, according to U.N. projections, more than half will live in cities, making humans for the first time in our existence a primarily urban species.

On the positive side, the number of people officially classified as refugees by the United Nations is declining. Between 1995, the historical high, and 1999, the number of refugees declined from 27.4 million to 21.5 million, a drop of 22 percent. (See pages 102–03.)

WARS AND PEACEKEEPING BOTH INCREASING

Last year the number of wars increased to 35, up from 32 the previous year. (See pages 110–11.) Among the eight new conflicts that broke out in 1999, two—those in Chechnya and East Timor—were widely covered in the media. Others, including conflicts in Tripura in Eastern India, Krygystan, and Nigeria, received little attention.

The overwhelming majority of wars in the world today are internal conflicts that are ethnic, religious, or tribal in nature and that are sometimes exacerbated by environmental degradation. Among the few international conflicts are the one between Ethiopia and Eritrea and the clashes between India and Pakistan. In human lives lost, the civil wars taking the greatest toll are the long-running wars in Afghanistan, claiming 1.9 million thus far, and the Sudan, 1.5 million.

Just as the increase in wars reversed a decline that had been under way for several years, so too an increase in peacekeeping expenditures in 1999 represented a reversal of a decline that had been going for four years. In 1999, estimated peacekeeping expenditures exceeded $1.4 billion, up from $860 million in 1998. (See pages 112–13.) At the end of 1999, some 14,600 soldiers, military observers, and civilian police drawn from 84 countries were serving in peacekeeping missions.

U.N. peacekeeping operations are still hamstrung by lagging financial support by the members of the United Nations. At the end of 1999, U.N. members were in arrears by a total of $1.7 billion, of which more than $1 billion was due from just one country—the United States.

ENVIRONMENTAL DETERIORATION

In recent years we have advanced our understanding of some of the effects of our chemical-dependent, throwaway economy on our natural environment. One of the more disturbing findings is the rise in pollutants in underground water supplies. Among the principal pollutants now widely found are pesticides, nitrates, petrochemicals, chlorinated solvents, heavy metals, and radioactive waste. (See pages 124–25.) Once long-lived pollutants make their way into the underground water supply, the damage is virtually irreversible. The health of hundreds of millions of people is now being affected by one or more of these water pollutants.

One particularly disturbing group of chemicals is the persistent organic pollutants, which have the potential to mimic the hormones that control reproduction, metabolism, and the functioning of immune systems. These disruptions appear to be affecting reproductive capacity in a number of species, including humans. (See pages 130–31.)

Another indicator of a deterioration of Earth's environment is the decline in various types of amphibians—frogs, toads, and salamanders. (See pages 128–29.) Evidence that amphibian populations were disappearing initially surfaced at the first World Congress of Herpetology in Canterbury, England, in 1989. At that time, it was thought that the observed declines might be the result of natural fluctuations. Today there is evidence worldwide that amphibian populations are indeed declining and disappearing. Among the apparent contributing factors are the clearcutting of forests, the loss of wetlands, the introduction of alien species, changes in climate, increased ultraviolet radiation, acid rain, and pollution from agriculture and industry.

In some situations, the immune systems of amphibians are weakened as a result of climate change or increased ultraviolet radiation, leaving them vulnerable to infectious diseases. Amphibians are particularly sensitive to change because they spend their lives in both aquatic and terrestrial environments and are affected by changes in both. In this sense, they are one of the most sensitive barometers of Earth's changing physical condition.

One way to reduce the pollutant load on the environment is to increase the recycling of materials, such as steel, tin, aluminum, plastic, and paper. For example, over the last quarter-century the amount of recovered paper has more than tripled, going from 35 million to nearly 110 million tons. (See pages 132–33.) But because the amount of paper used has increased so rapidly, the share of paper that is recycled increased only from 38 percent to 43 percent during this period. Nonetheless, this gradual rise is helping to reduce the pressure on forests and waste disposal systems, and is reducing both energy use and pollution.

Despite the emergence of the computer age and the "paperless office," world paper use continues to climb, increasing nearly 2 percent in 1998. (See pages 78–79.) Since 1950, paper use has increased sixfold, closely paralleling growth in the world economy. While 10 percent of the paper used worldwide goes into long-lasting products like books, the other 90 percent is used once as newspapers, packaging, or writing paper and then discarded. Among leading industrial countries, paper recycling rates range from a high of 72 percent in Germany to a low of 31 percent in Italy.

One social indicator of the response to environmental threats is the number of environmental treaties forged at the international level. Five new environmental agreements reached in 1999 brought this total to nearly 240. (See pages 134–35.) Some treaties are regional, others are global. They may be broad, focused on reducing carbon emissions or chlorofluorocarbon manufacturing worldwide, or they may be more narrow—devoted, for example, to reducing sulfur emissions in Europe or to managing a shared river system among neighboring countries in the Middle East.

Reaching agreement at the international level and signing a treaty is only the beginning. The treaties must then be enforced. Here the international community's performance is mixed. One of the most clearcut successes began with the Montreal Protocol in 1987, which initiated the phaseout of chlorofluorocarbons, the family of chemicals that is depleting the stratospheric ozone layer.

The environmental diplomacy that leads to the drafting and adoption of international treaties is emerging as a major component of international diplomacy. In many cases, it now supersedes the traditionally dominant activities, such as diplomacy related to military security issues. Among other things, this shift reflects the realization that threats to future political stability are becoming more environmental and less military in nature.

TAX SHIFTING TO SAVE THE ENVIRONMENT

As environmental threats have multiplied, environmentalists and political leaders have looked for ways to reverse the trends that are undermining our future. By far the most promising of these is shifting taxes from personal and corporate income to environmentally destructive activities, such as carbon emissions, the generation of toxic waste, the use of pesticides, and the use of virgin raw materials as opposed to recycled materials.

Sweden, starting in 1991, began shifting some of the tax burden from income to taxes on carbon and sulfur dioxide emissions. (See pages 138–39.) In the mid-1990s, several other countries followed suit, including Denmark, Finland, and the Netherlands. More recently, a second surge in tax shifting has occurred in Europe's largest industrial countries, including France, Germany, Italy, and the United Kingdom.

In some ways, the most dramatic environmental "tax" was introduced in the United States when the tobacco industry agreed to reimburse the 50 state governments with $251 billion for smoking-related health care expenditures incurred in the past. This sum, nearly $1,000 for each man, woman, and child in the country, in effect is a retroactive tax on cigarettes. In agreeing to this settlement, the tobacco industry implicitly accepted the principle that manufacturers are responsible for the indirect as well as the direct effects of using their products. In order to pay this enormous sum, the cigarette companies are forced to boost the prices of their cigarettes sharply, thus further discouraging consumption.

The great advantage of tax shifting is that it is far less cumbersome than regulation, permitting the market to continue to operate, thus exploiting its inherent efficiency. But by discouraging investments in environmentally destructive activities, such as coal burning, and encouraging investment in environmentally benign activities, such as wind electric generation, tax shifting steers the economy in an environmentally sustainable direction.

Grain Harvest Falls

Lester R. Brown

World grain production in 1999 fell to 1,855 million tons, down 1 percent from the 1,871-million-ton harvest of the year before.[1] (See Figure 1.) The fall in the 1999 harvest marked the second consecutive annual drop from the all-time high of 1,879 million tons reached in 1997.[2] In per capita terms, production declined to 309 kilograms in 1999, a fall of some 10 percent from the historical high of 342 kilograms in 1984.[3] (See Figure 2.)

Among the big three grains—wheat, rice, and corn—production of wheat and corn each fell by nearly 1 percent, while that of rice rose by just over 1 percent.[4] (See Figure 3.) At 598 million tons in 1999, the corn harvest maintained its historically recent edge over wheat, which came in at 584 million tons.[5]

China maintains its position as the world's leading grain producer: its harvest of 395 million tons exceeded the 333-million-ton harvest in the United States by some 19 percent.[6] India, with a harvest of 185 million tons, ranked third.[7] Combined, these three countries account for roughly half of the world grain harvest.[8]

The share of the world grain harvest used for feed remained essentially unchanged in 1999 at 37 percent.[9] Stated otherwise, more than one third of the world grain harvest is consumed indirectly in the form of livestock products. Among the individual grains, almost the entire rice harvest is consumed directly as food. By contrast, though corn is a food staple in many countries in Latin America and sub-Saharan Africa, worldwide it is used largely as feed. Consumption of wheat is more evenly divided between food and feed. It is the dominant food staple in the west, and also a leading staple in China and India. In Western Europe, Eastern Europe, and the former Soviet Union, wheat is also widely used for feed.

Perhaps the most interesting contrast in grain trends during the decade just ended was that between the former Soviet Union and China. Grain output in the former Soviet Union was in a free-fall during the 1990s.[10] Wheat production, for example, dropped from 102 million tons in 1990 to 66 million tons in 1999, a decline of one third.[11] Meanwhile, the coarse grain harvest dropped from roughly 103 million tons to 44 million tons, a staggering reduction of well over half, marking the first time in the modern era that a major industrial society has experienced such a sustained decline in food production.[12]

In China, by contrast, grain output during the 1990s went up by some 15 percent, climbing from 343 million to 395 million tons.[13] Few could have anticipated 20 years ago, or perhaps even 10 years ago, that the economic fortunes of the two communist giants would diverge so sharply during the 1990s. While China is emerging as an economic superpower, most of the 17 republics of the former Soviet Union are deteriorating economically. There is no indication that the worsening state of agriculture in Russia, the largest republic, will be reversed in the near future. The combination of political paralysis, corruption, and inept leadership appears likely to continue for some time.

Neither overall production nor world grain trade patterns have changed much in the last two years. Over the last four years, world wheat trade has fluctuated between 118 million and 125 million tons.[14] Trade in coarse grains, meanwhile, has remained steady at around 105 million tons, except in 1997 when higher prices cut it to roughly 100 million tons.[15] The international flow of rice, which increased from 20 million tons in 1996 to 27 million tons in 1997, has declined somewhat since then.[16]

With two consecutive declines in the world grain harvest, world carryover stocks of grain (the amount in the bin when the new harvest begins) in 2000 total some 66 days.[17] Although this is well above the all-time low of 53 days in 1996, it is still below the 70 days needed to cushion a poor harvest.[18] If the global economy expands by 3.5 percent, as projected, and world population increases by nearly 80 million, world demand for grain will climb during 2000.[19] Unless production rises accordingly, the weak grain prices of the late 1990s will start to recover.

World Grain Production, 1950–99

Year	Total (mill. tons)	Per Person (kilograms)
1950	631	247
1955	759	273
1960	824	271
1965	905	270
1970	1,079	291
1971	1,177	311
1972	1,141	295
1973	1,253	318
1974	1,204	300
1975	1,237	303
1976	1,342	323
1977	1,319	312
1978	1,445	336
1979	1,410	322
1980	1,430	321
1981	1,482	327
1982	1,533	333
1983	1,469	313
1984	1,632	342
1985	1,647	339
1986	1,665	337
1987	1,598	318
1988	1,549	304
1989	1,671	322
1990	1,769	335
1991	1,708	319
1992	1,790	329
1993	1,713	310
1994	1,760	314
1995	1,713	301
1996	1,871	325
1997	1,879	322
1998	1,871	316
1999 (prel)	1,855	309

Sources: USDA, *Production, Supply, and Distribution,* electronic database, February 2000; USDA, "World Grain Database," unpublished printout, 1991; USDA, FAS, *Grain: World Markets and Trade*, February 2000.

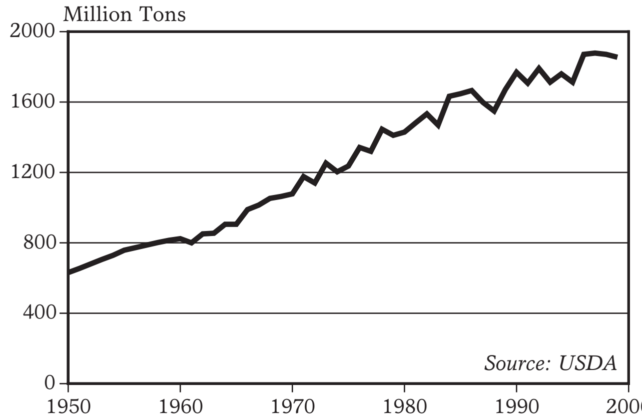

Figure 1: World Grain Production, 1950–99

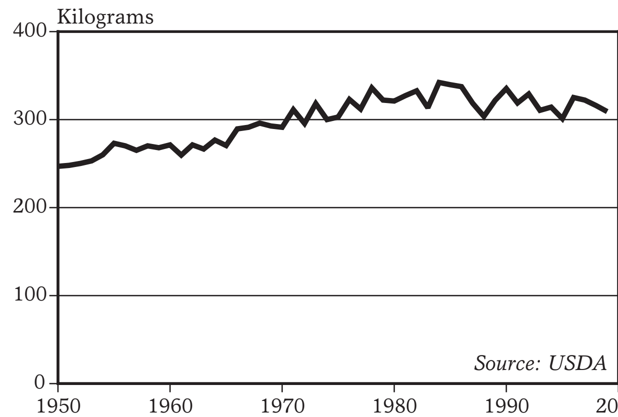

Figure 2: World Grain Production Per Person, 1950–99

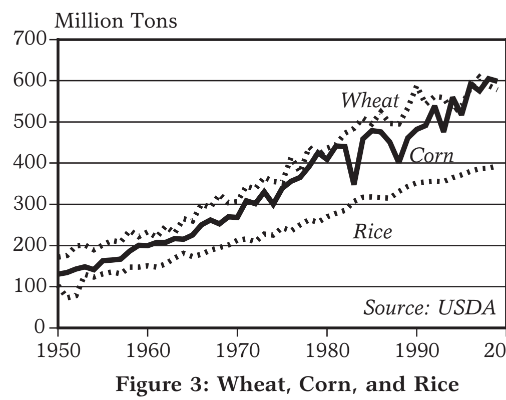

Figure 3: Wheat, Corn, and Rice Production, 1950–99

Soybean Harvest Drops

Lester R. Brown

The world soybean harvest in 1999 totaled 154 million tons, down 3 percent from the all-time record high of 159 million tons in 1998.[1] (See Figure 1.) Per capita production dropped from 26.9 to 25.6 kilograms, or 5 percent.[2] (See Figure 2.) The decline in production reflected adverse weather in some countries and lower prices from a weakening in overall demand caused by the economic disruptions in East Asia over the last couple of years.[3]

Over the last half-century, the production of soybeans has expanded faster than that of any other major crop, climbing from 17 million tons in 1950 to 154 million tons in 1999, a ninefold increase.[4] This compares with a tripling in the world grain harvest during the same period.[5]

The soybean, originally domesticated by early farmers in central China some 5,000 years ago, has come into its own during the last 50 years. In the United States, the harvested area of soybeans in 1999 was greater than that of any other crop, including wheat and corn—the traditional leaders.[6]

Demand for soybeans is closely tied to rising affluence. As incomes rise above the subsistence level, consumers everywhere begin to move up the food chain, consuming more animal protein in the form of meat, eggs, and milk. Production of poultry, eggs, and pork depends heavily on the use of soybean meal as a protein supplement to grain in feed rations.

In the world oilseeds economy, which supplies both vegetable oil and oil meal, soybeans dominate, accounting for 154 million tons of the 296-million-ton harvest in 1999.[7] (The other half consists of peanuts, sunflower seed, cottonseed, rapeseed, coconuts, and oil palm kernels.)[8]

When crushed, soybeans typically yield 68 percent meal and 16 percent oil.[9] Worldwide, they accounted for 104 million tons of the 166-million-ton production of oilseed meal, roughly 63 percent of the total.[10] For oil production, the figures are somewhat less impressive, with the soybean accounting for 24 million tons of the worldwide vegetable oil production of 85 million tons—roughly 28 percent.[11]

World production of soybeans is more concentrated than that of any other major crop: the United States, Brazil, Argentina, and China account for nearly 90 percent of the harvest.[12] The United States accounts for roughly half of the total, Brazil roughly a fifth, and Argentina and China about one tenth each.[13]

Within the United States, most of the soybeans are produced in the Corn Belt, often in an alternate-year rotation with corn. This helps control insects and diseases of both crops, and since the soybean is a legume, it fixes nitrogen—a nutrient for which the corn plant has a ravenous appetite. Today the Corn Belt is really the Corn-Soybean Belt.

Since 1950, the area planted to soybeans has grown from 14 million to 71 million hectares.[14] This fivefold expansion accounts for just over half of the growth in harvest, with the remainder coming from rising yield.[15]

Some countries, such as the United States, export soybeans largely as whole beans. Indeed, the United States accounts for 24 million tons of world soybean exports of 41 million tons.[16] The principal importers are the European Union, Japan, and China.[17]

Brazil and Argentina, the second and third ranking producers, crush most of their soybeans before exporting them as meal and oil. This helps explain why Argentina and Brazil dominate world soybean meal exports.[18] The leading importers are the European Union, which gets half of world soybean meal imports, and East Asia, particularly China and Japan, which takes much of the remainder.[19] Not surprisingly, Argentina and Brazil lead in oil exports as well, accounting for some 60 percent of the total.[20] Among the leading importers of soybean oil are China and India.[21]

If the global economy continues to expand and incomes continue to rise, particularly in low- and middle-income countries, the demand for the soybean either as meal or as oil is certain to increase. It also seems likely that the share of the world soybean harvest consumed directly as food, now less than one tenth, will expand in the years ahead as soybean products such as tofu compete with animal protein, such as meat and eggs, for a place in the human diet.[22]

Soybean Harvest Drops

World Soybean Production, 1950–99

YEAR	TOTAL (mill. tons)	PER PERSON (kilograms)
1950	17	6.5
1955	19	7.0
1960	25	8.2
1965	32	9.5
1970	44	11.9
1971	47	12.5
1972	49	12.7
1973	62	15.9
1974	55	13.6
1975	66	16.1
1976	59	14.3
1977	72	17.1
1978	78	18.0
1979	94	21.4
1980	81	18.2
1981	86	19.0
1982	94	20.3
1983	83	17.7
1984	93	19.5
1985	97	20.0
1986	98	19.9
1987	104	20.6
1988	96	18.8
1989	107	20.7
1990	104	19.7
1991	107	20.0
1992	117	21.6
1993	118	21.3
1994	138	24.6
1995	125	22.0
1996	132	22.9
1997	158	27.1
1998	159	26.9
1999 (prel)	154	25.6

SOURCES: USDA, *Production, Supply, and Distribution*, electronic database, February 2000; USDA, FAS, *Oilseeds: World Markets and Trade*, February 2000.

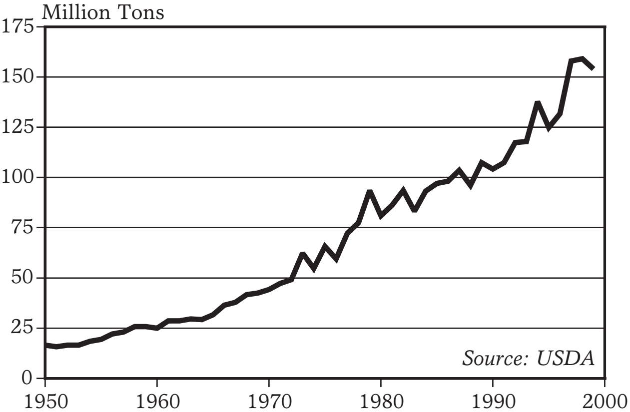

Figure 1: World Soybean Production, 1950–99

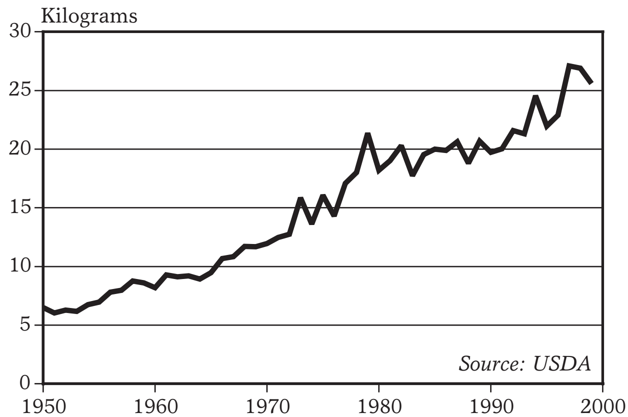

Figure 2: World Soybean Production Per Person, 1950–99

Meat Production Up Again

Lester R. Brown

World meat production in 1999 totaled 217 million tons, up from 215 million tons in 1998—a gain of just 1 percent.[1] (See Figure 1.) With production lagging population growth ever so slightly, output per person fell from 36.4 kilograms in 1998 to 36.3 in 1999. (See Figure 2.)

The annual rise in meat production has become one of the most predictable trends in the world economy, increasing in each of the 39 years since 1960.

Production of beef, which increased little during the 1990s, maintained its slow growth at less than half of 1 percent in 1999.[2] (See Figure 3.) In the United States, the leading producer, it was up 2 percent from 11.8 million to slightly over 12 million tons.[3] In Brazil, the second ranking producer, output rose from 6.1 million to 6.3 million tons, a gain of over 3 percent.[4] In China, where beef production is being encouraged by the government, output was up nearly 2 percent.[5]

In two nations with export-oriented beef industries, Argentina and Australia, output was up 8 percent in the former and down 5 percent in the latter.[6] Production in Russia, which has been in an economic free-fall since 1990, dropped 9 percent from the preceding year.[7]

Production of pork, the world's leading source of meat, was up by less than 1 percent in 1999, climbing from 87.8 million to 88.3 million tons.[8] Production in China, which totally dominates the world pork economy, was up by roughly 2 percent, reaching 37 million tons.[9] In both the United States and the European Union, the other two big producers, it was up by 1 percent.[10] China and the United States (which produces 9 million tons) together account for half of the world's pork supply.[11]

World mutton production, which is a distant fourth on the meat production chart at scarcely 11 million tons, declined slightly in 1999.[12] Mutton production is concentrated in China, which accounts for a fourth of world consumption, and in Australia and New Zealand.[13] Annual consumption per person in New Zealand leads the world, at 29 kilograms, followed by two other mutton exporters—Australia at 18 kilograms and Ireland at 9 kilograms.[14] Affluent Saudi Arabia, heavily dependent on imported mutton, consumes 12 kilograms per person.[15]

World poultry production was up by nearly 3 percent in 1999, continuing to expand more rapidly than any other meat.[16] In the United States, the leading producer, output was up by nearly 6 percent.[17] In second-ranking China, growth slowed to less than 2 percent.[18] In Brazil, the number three producer, output was up by some 10 percent.[19] The three leading producers—the United States at 16 million tons, China at 12 million tons, and Brazil at 5 million tons—account for over half of world poultry production.[20]

World meat production increased from 44 million tons in 1950 to 217 million tons in 1999, gaining fivefold.[21] Expanding at roughly twice the rate of population, this more than doubled the meat produced per person.[22]

Accompanying this rapid growth was a dramatic shift in the pattern of world meat output. In 1950, beef was the leading source of meat, at 19 million tons, with pork following at 16 million tons, mutton a distant third at 5 million tons, and poultry at 4 million tons.[23] Today, pork has emerged as the leader largely because of the strong gains in output in China. Poultry has moved into second place; over-taking beef in 1995, it has steadily widened its margin since then. Mutton production remains a distant fourth.

The world's leading consumers of meat today are China and the United States.[24] Twenty years ago, the United States led the world by a wide margin.[25] But after the economic reforms in China in 1978, the Chinese economy expanded fourfold within two decades, and meat production surged ahead.[26] By 1999, China was eating 55 million tons of meat compared with 34 million tons in the United States.[27] With meat production growing faster in China than in the United States, this margin could widen even more as the decade unfolds.[28]

World Meat Production, 1950–99

YEAR	TOTAL (mill. tons)	PER PERSON (kilograms)
1950	44	17.2
1955	58	20.7
1960	64	21.0
1965	80	24.0
1970	96	26.0
1971	100	26.5
1972	103	26.7
1973	104	26.3
1974	109	27.2
1975	111	27.1
1976	114	27.3
1977	117	27.8
1978	122	28.4
1979	127	21.1
1980	132	29.5
1981	134	29.6
1982	135	29.3
1983	140	29.8
1984	144	30.1
1985	149	30.6
1986	154	31.2
1987	159	31.7
1988	165	32.4
1989	168	32.4
1990	174	32.9
1991	177	33.1
1992	181	33.2
1993	185	33.6
1994	192	34.2
1995	197	34.8
1996	200	34.7
1997	208	35.6
1998	215	36.4
1999 (prel)	217	36.3

Sources: FAO, *1948–1985 World Crop and Livestock Statistics* (Rome: 1987); FAO, *FAOSTATS*, electronic database,updated 7 December 1999.

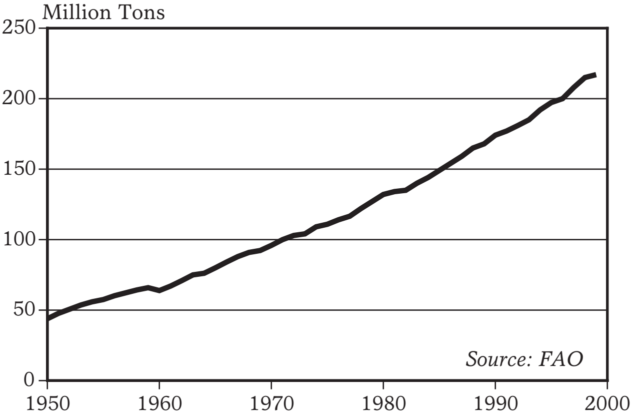

Figure 1: World Meat Production, 1950–99

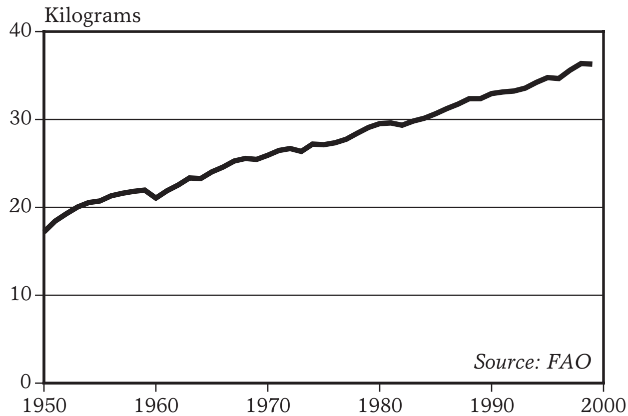

Figure 2: World Meat Production Per Person, 1950–99

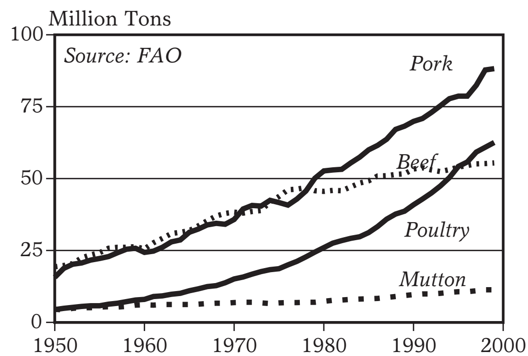

Figure 3: World Meat Production, by Type, 1950–99

Fish Harvest Down

Gary Gardner

Global fish catch was down sharply in 1998, the latest year with data available; it dropped by some 7.5 percent as unusual weather patterns reduced fish stocks in major fishing areas.[1] (See Figure 1.)

The decline in fish catch was partially offset by a robust 6.5-percent increase in output of farmed fish, as the aquaculture industry continued its rapid growth.[2] Overall, however, the depressed fish catch dominated fish supply in 1998, and total global supply fell 4.2 percent to 117 million tons.[3] Harvest per person fell 5 percent, to 19.8 kilograms.[4] (See Figure 2.)

The decline in fish catch resulted in part from the strongest El Niño weather event on record, which warmed the eastern Pacific in 1997–98 and reduced fish stocks.[5] Three of the world's five top producers—Peru, Chile, and the United States—all fish in waters affected by El Niño, and all saw declines in the catch.[6] China, on the other hand, the world's leading producer, saw fish catch increase in 1998 by a strong 9.6 percent.[7]

Fishing stress extends beyond areas affected by El Niño, however. The U.N. Food and Agriculture Organization (FAO) estimates that some 60 percent of the world's oceanic fisheries are fished at or beyond capacity.[8] Indeed, global fish catch grew by an average of more than 5 percent annually between 1950 and 1970, but then began to slow, dropping to just over 1 percent in the 1980s and 1990s.[9] The trend is worrisome in part because fish provides over 15 percent of humans' animal protein consumption, and about 6 percent of total protein consumption.[10]

Levels of fish catch are maintained in an increasingly depleted ocean in part by targeting smaller and smaller species. A 1999 report estimated that the average global marine catch in the past half-century has moved to a lower trophic level—a feeding scale that ranges from phytoplankton at the bottom to the largest species at the top.[11] Many of the smaller species prized today were considered inferior catch a few decades ago.

Fisheries are also depleted by high levels of bycatch, the nontargeted fish that turn up in nets. Some 20 million tons of bycatch—equal to nearly a quarter of the global fish catch—is captured each year, then thrown back to the sea, usually dead or dying. [12] The use of bycatch reduction devices is increasingly required in some countries to lessen the problem. Turtle excluder devices used in shrimping nets, for example, have meant a fourfold increase in turtle nests in the Gulf of Mexico since 1985.[13]

As fish catch has stalled over the past decade, aquaculture has picked up the slack, growing from some 8 percent of the world fish supply in 1984 to about 25 percent in 1998.[14] China is far and away the world's leading producer, accounting in 1998 for some two thirds of the global total.[15]

Aquaculture, however, often carries a stiff environmental and social toll. The feeding requirements of farmed salmon, shrimp, and other carnivorous species, for instance, often increase the pressure on fisheries to deliver more fish for use as feed.[16] Indeed, salmon farming can require two to four times more kilograms of fishmeal feed than it produces in salmon.[17]

Fish farming can also be highly polluting. The salmon fisheries of the Nordic countries release nitrogen in quantities equivalent to that found in the sewage of 3.9 million people, roughly the population of Norway.[18] This and other forms of pollution often limit the useful life of the fishery: most intensively cultivated shrimp ponds in Asia are used for no more than 5–10 years.[19] Aquaculture can be a source of biological pollution as well, when species foreign to a region escape into the wild and dominate ecosystems in which they have no natural enemies.

The future of global fisheries is uncertain. FAO projections of total fish harvest in 2010 range from 107 million to 144 million tons, depending on how fisheries and fish farms are managed.[20] The higher projection yields a fish availability per person that is barely above the 1998 level.[21] The lower projection would cut per capita levels by nearly a third, giving fish a much lower place in the diets of many in the future.[22]

World Fish Harvest, 1950–98

YEAR	WORLD CATCH (mill. tons)	AQUA-CULTURE (mill. tons)	HARVEST PER PERSON (kilograms)
1950	19		7.5
1955	26		9.4
1960	36		11.9
1965	49		14.7
1970	58		15.7
1971	62		16.4
1972	58		15.1
1973	59		15.0
1974	63		15.8
1975	62		15.2
1976	65		15.7
1977	63		14.9
1978	65		15.1
1979	66		15.1
1980	67		15.1
1981	69		15.3
1982	71		15.4
1983	72		15.4
1984	78	7	17.8
1985	79	8	17.9
1986	85	9	19.1
1987	85	10	19.0
1988	89	12	19.8
1989	89	12	19.6
1990	86	13	18.8
1991	84	14	18.3
1992	85	15	18.5
1993	86	18	18.9
1994	91	21	20.0
1995	92	24	20.5
1996	93	27	20.9
1997	93	29	20.9
1998	86	31	19.8

Sources: FAO, *Yearbook of Fishery Statistics: Capture Production* (various years); FAO, *Aquaculture Production* (various years); FAO, Fisheries Web site.

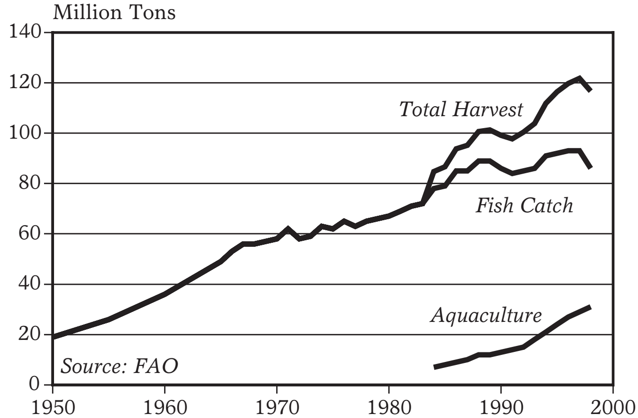

Figure 1: World Fish Harvest, 1950–98

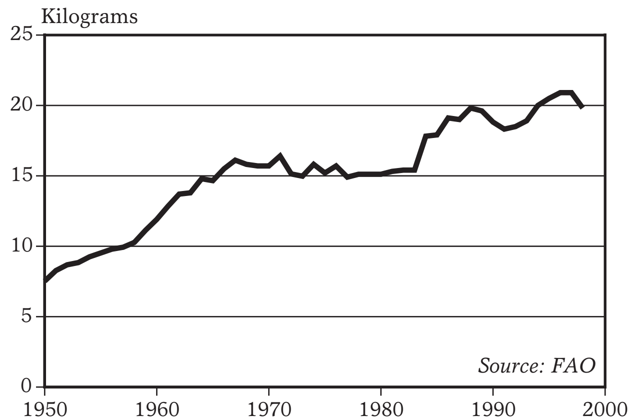

Figure 2: World Fish Harvest Per Person, 1950–98

Grain Area Shrinks Again

Gary Gardner

Grain harvested area fell to 674 million hectares in 1999, the smallest area since 1972.[1] (See Figure 1.) The reduction continues the general trend toward shrinkage that began in 1982. As global population increases, the harvested area per person continues to fall; it now stands at 0.11 hectares—more than a third smaller than in 1972.[2] (See Figure 2.)

Harvested area is the grain area that is reaped in a single year. (A hectare that is double-cropped in one year is counted as two hectares of harvested area.) Grains—principally corn, wheat, and rice—supply more than half the calories and protein eaten directly by humans.[3] Thus grain area tracks the resource base of the dominant component of the global food supply.

Wheat area fell by 3.6 percent while corn and rice area expanded marginally, by less than 1 percent each.[4] The trends in grain area swamped any increase in yields: corn and rice yields showed no increase, while a robust 3-percent increase in wheat yields was more than offset by the contraction in wheat area.[5]

Sometimes a contraction in grain area can be positive, as when growth in yields reduces the area needed to meet global grain demand, or when the area is reduced for fallowing, or when marginal land is converted from grain production to more sustainable uses such as pastureland. And grain area is often reduced simply because falling grain prices prompt some farmers to switch to more profitable crops. But reductions in area are problematic if yield growth is slow or nonexistent, as in 1999, or if land is lost permanently from cultivation.

Conversion of marginal land to more sustainable uses is now a common cause of cropland loss in some countries. The Chinese government is converting hillside farms and other marginal land to forests and pastureland; this laudable initiative is now the leading cause of cropland loss there.[6] In the United States, the Conservation Reserve Program (CRP) has removed some 12 million hectares of highly erodible land from production for 10–15 years to protect it and adjoining waterways from degradation.[7]

Urbanization is a small but growing threat to cropland in many countries. In China, construction of new roads, factories, and houses accounts for about one fifth of cropland loss.[8] In the United States, some 5.2 million hectares of cropland were lost between 1982 and 1997, while developed land expanded by 12 million hectares.[9] Most of the newly urbanized land was taken from forest or pastureland, but the trend is also of concern for cropland as urbanization rates increase.[10] Rates of urbanization in the United States doubled in the 1992–97 period compared with 1982–92.[11] Developed land now constitutes 7 percent of all U.S. non-Federal land, up from 5 percent in 1982.[12]

Degraded land is also removed from production, or loses productivity, in many parts of the world. In China, degradation—primarily erosion, but also desertification, salinization, and waterlogging—is responsible for as much cropland loss each year as urban and rural construction.[13] In the United States, the CRP reduced cropland erosion by 38 percent between 1985 and 1995, but erosion levels have plateaued since then.[14]

As area per person falls, countries turn increasingly to foreign markets for their grain. Japan, South Korea, and Taiwan, for example, now have less than a quarter of the world average grain area per person, and each imports more than 70 percent of its grain.[15] Population growth in many other Asian nations will reduce area per person to levels that have never supported food self-sufficiency anywhere. Indeed, by 2020 an estimated 70 percent of the people in Asia could depend on foreign markets for one fifth or more of their grain.[16]

Many see careful management of cropland as good for not only agriculture but the environment in general. Wetlands on farms often serve as stopovers for migratory birds, for example. And increasing soil carbon levels on farms could help sop up the excess carbon that is driving climate change. A 1999 study by the International Soil Reference and Information Centre estimated that 9–12 percent of human-produced carbon emissions could be absorbed by properly managed farms.[17]

World Grain Harvested Area, 1950–99

YEAR	AREA HARVESTED (mill. hectares)	AREA PER PERSON (hectares)
1950	587	0.23
1955	639	0.23
1960	639	0.21
1965	653	0.20
1970	663	0.18
1971	672	0.18
1972	661	0.17
1973	688	0.18
1974	691	0.17
1975	708	0.17
1976	716	0.17
1977	714	0.17
1978	713	0.17
1979	710	0.16
1980	722	0.16
1981	732	0.16
1982	716	0.16
1983	707	0.15
1984	711	0.15
1985	715	0.15
1986	709	0.14
1987	686	0.14
1988	688	0.14
1989	694	0.13
1990	694	0.13
1991	692	0.13
1992	693	0.13
1993	684	0.12
1994	684	0.12
1995	681	0.12
1996	702	0.12
1997	690	0.12
1998	686	0.12
1999 (prel)	674	0.11

Source: USDA, *Production, Supply, and Distribution*, electronic database, February 2000.

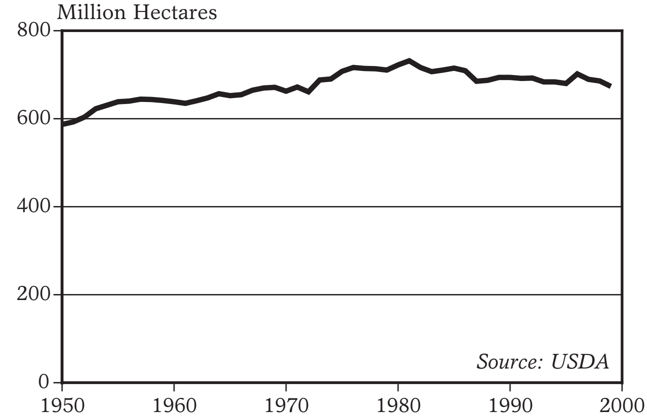

Figure 1: World Grain Harvested Area, 1950–99

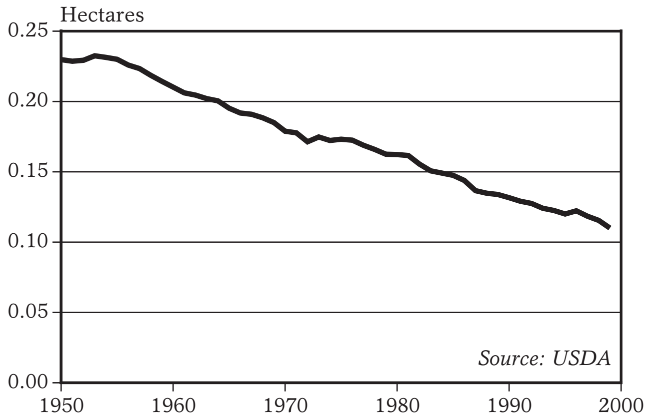

Figure 2: World Grain Harvested Area Per Person, 1950–99

Fertilizer Use Down

Lester R. Brown

World fertilizer use in 1999 totaled 134 million tons, down from 137 million tons in 1998.[1] (See Figure 1.) Indeed, in each of the last three years, 1997 to 1999, fertilizer use has been essentially flat, fluctuating narrowly between 134 million and 137 million tons.[2] As a result, fertilizer use per person worldwide is slowly declining as population continues to grow by nearly 80 million per year.[3] In 1999, it was just above 22 kilograms per person, a drop of 21 percent from the peak of 28 kilograms in 1989.[4]

Fertilizer use has leveled off since 1997 largely because of disruptions in the global economy. The demand for agricultural commodities began to weaken after the Asian financial crisis began in July 1997 with the devaluation of the Thai baht.[5] This weakening was reinforced by the massive debt default in Russia in September 1998, and by Brazil's devaluation of its currency in January 1999.[6] With world grain prices in 1999 at their lowest level in two decades or so, there was little incentive for farmers to raise fertilizer use.[7]

Another reason fertilizer consumption is stagnant is the diminishing production response to additional usage in key countries. Among the countries or regions where fertilizer use has plateaued are the United States, Canada, Western Europe, Japan, Taiwan, and perhaps China. In contrast, usage is still growing vigorously in India and Brazil. Fertilizer applications in India leveled off in 1999, but had jumped by 13 percent in 1998.[8] And in Brazil, usage grew by 13 percent in 1998 and by 6 percent in 1999, one of the strongest growth trends in any country.[9]

Trends in the big four agricultural countries—China, India, the former Soviet Union, and the United States—show some sharp contrasts over the last two decades. Perhaps the most dramatic and unexpected change was the precipitous decline in fertilizer use in the Soviet Union after the economic decline that began a decade ago.[10] (See Figure 2.)

In China, on the other hand, fertilizer use soared after the economic reforms in 1978, climbing from some 6 million tons in 1977 to the all-time high of nearly 36 million tons in 1997.[11] Since then, it has fallen to 31 million tons.[12] Given the intensity of current fertilizer applications in China, it seems unlikely that usage will expand much in the future. Indeed, we may have witnessed a plateauing of fertilizer use in China in the late 1990s that is similar to the one that began in the United States in the early 1980s.[13]

In the United States, the leader in applying fertilizer throughout most of the third quarter of this century, usage hit an all-time high in 1980 of just over 21 million tons.[14] (See Figure 3.) Since then, it has averaged roughly 19 million tons a year.[15]

In India, which used hardly any fertilizer in 1960, consumption has increased rather steadily since 1975, climbing to 16 million tons in 1999.[16] It may increase somewhat further, but not a great deal since it is already approaching the amount used by U.S. farmers in 1999.[17]

Given the growing world demand for food, fertilizer use is likely to continue rising at the global level. But the growth rate will probably be modest simply because in more and more countries farmers are reaching the point where additional fertilizer use has little effect on production. Crops now in use are physiologically incapable of absorbing many more nutrients.

Another emerging constraint on the growth in world fertilizer demand is water scarcity, especially in China and India, the world's two most populous countries.[18] In both, farmers are losing irrigation water to cities and to aquifer depletion.

Further constraining fertilizer use is nutrient runoff. This is seen as a serious problem in Europe, where fertilizer use has declined somewhat in recent years, and in the United States, where fertilizer nutrients flowing down the Mississippi River and into the Gulf of Mexico are leading to explosions of algae.[19] When these algae concentrations die, they absorb the free oxygen in the water, leading to the death of all marine life in that area, including various types of seafood. In effect, efforts to expand the harvest from the land are reducing the harvest from the oceans.

Fertilizer Use Down

WORLD FERTILIZER USE, 1950–99

YEAR	TOTAL (mill. tons)	PER PERSON (kilograms)
1950	14	5.5
1955	18	6.5
1960	27	8.9
1965	40	12.0
1970	66	17.8
1971	69	18.2
1972	73	18.9
1973	79	20.1
1974	85	21.2
1975	82	20.1
1976	90	21.6
1977	95	22.5
1978	100	23.2
1979	111	25.4
1980	112	25.1
1981	117	25.8
1982	115	24.9
1983	115	24.5
1984	126	26.4
1985	131	27.0
1986	129	26.2
1987	132	26.3
1988	140	27.4
1989	146	28.1
1990	143	27.1
1991	138	25.7
1992	134	24.6
1993	126	22.8
1994	121	21.6
1995	122	21.5
1996	129	22.4
1997	135	23.1
1998	137	23.1
1999 (prel)	134	22.3

SOURCES: FAO, *Fertilizer Yearbook* (Rome: various years); Soh and Isherwood, "Short Term Prospects for World Agriculture and Fertilizer use," IFA Meeting, 30 November–3 December 1999; Aholou-Putz, IFA, e-mail, 27 January 2000.

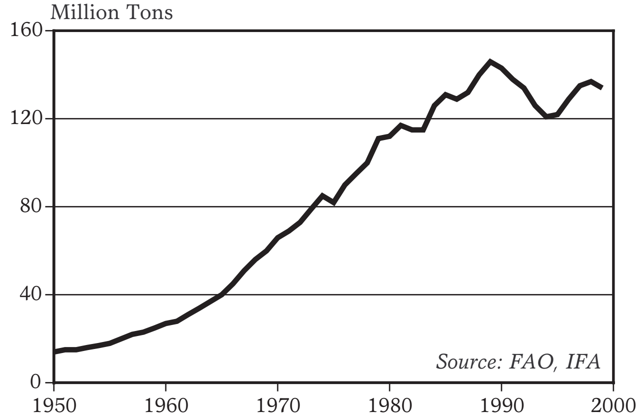

Figure 1: World Fertilizer Use, 1950–99

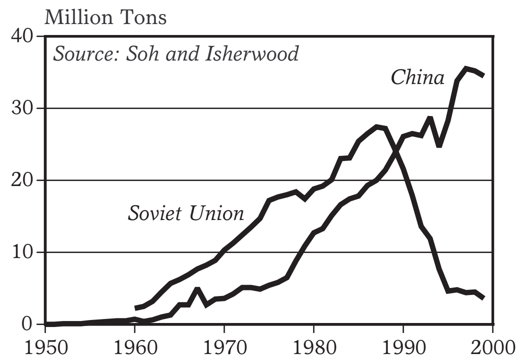

Figure 2: Fertilizer Use in China and the Soviet Union, 1950–99

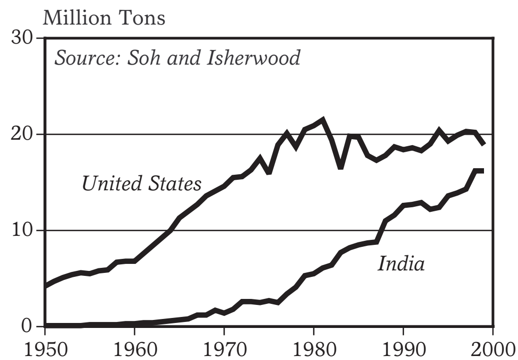

Figure 3: Fertilizer Use in the United States and India, 1950–99

Pesticide Trade Nears New High

Sarah Porter

In 1998, world exports of pesticides stood at $11.4 billion (in 1998 dollars), nearly nine times the level in 1961.[1] (See Figure 1.) This is a 5.4-percent increase over 1997, when trade was adversely affected by the economic slump in Asia. Indeed, exports in 1998 were just below their peak of $11.7 billion in 1996.[2]

The last three decades have seen strong growth in pesticide trade, as pesticide-intensive farm practices spread throughout the industrial world and to many developing nations.[3] In the early 1980s, trade slowed as many countries went into recession. After resuming growth of almost 5 percent annually, trade slumped again in the early 1990s due to renewed recession as well as farmer uncertainty over agricultural reforms in Western Europe.[4]

Industrial-country exports accounted for 85 percent of the value of trade in 1998.[5] Western Europe and the United States exported $7.1 billion and $1.7 billion in pesticides respectively, representing 62 and 15 percent of the world trade total.[6] France and Germany retained their positions as the world's top two exporters.[7]

With 15 percent of world exports but 33 percent of world imports, developing countries had net imports of pesticides worth $2.2 billion in 1998.[8] (See Figure 2.) China is the largest exporter and importer in the group, and it ranks sixth worldwide in the value of its exports.[9] For the first time since 1973, however, the value of Latin American pesticide imports passed that of Asian developing countries in 1997 and 1998.[10] Argentina, Brazil, and Mexico are the second, third, and fourth largest developing-country importers.[11]

International trade of pesticides accounted for about 37 percent of an estimated $31 billion in world sales in 1998.[12] Based on value of sales, North America uses about 30 percent of the world's pesticides, while Western Europe uses 26 percent and East Asia 22–24 percent. Latin America accounts for about 11 percent of world pesticide sales, with Brazil being one of the top five users in the world. Africa uses some 4 percent.[13]

But a region's share of global pesticides sales may not correspond exactly with its share of pesticide usage. For instance, many farmers in industrial countries have been moving toward higher-value chemicals that are more pest-specific and used in lower doses than older pesticides. At the same time, cheaper, older, and higher-dose pesticides are the mainstays of farmers in many developing nations.[14]

Pesticide use per hectare has risen dramatically worldwide since 1961, from 0.49 kilograms per hectare to 1.79 kilograms in 1995.[15] (See Figure 3.) By the 1990s, pesticide use began leveling off in most industrial countries and is not expected to increase dramatically.[16] The agrochemical industry increasingly expects growth to come from developing nations.[17]

Poor weather conditions and pest outbreaks, changes in crop acreages, government regulations, and economic factors such as commodity prices all have an impact on pesticide usage.[18] Flooding in the U.S. Midwest in 1993 reduced usage, while a severe drought in 1997 caused pesticide use to fall in India and Thailand by more than 10 percent.[19] Other countries, such as Sweden and Denmark, are deliberately cutting pesticide use.[20] And in 1986, Indonesia began promoting integrated pest management, banning the import of 57 pesticides. The value of its pesticide imports dropped from $124.9 million in 1976 to $22.4 million in 1986. Since then, they have not risen above $37 million.[21]

At the international level, there has been a move to regulate pesticides with especially adverse effects on human and environmental health. In September 1998, negotiations concluded on the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.[22] This treaty requires importing countries to be told whether a chemical is banned or severely restricted in the exporting country and what its harmful effects are. By late 1999, 73 countries had signed the treaty.[23]

Pesticide Trade Nears New High

World Exports of Pesticides, 1961–98

YEAR	EXPORTS (bill. 1998 dollars)
1961	1.3
1962	1.5
1963	1.6
1964	1.8
1965	1.6
1966	1.9
1967	2.0
1968	2.0
1969	2.2
1970	2.3
1971	2.5
1972	2.7
1973	3.6
1974	4.9
1975	5.4
1976	4.8
1977	5.5
1978	6.5
1979	7.0
1980	7.6
1981	6.5
1982	6.1
1983	6.3
1984	6.6
1985	6.4
1986	7.0
1987	7.8
1988	8.2
1989	8.6
1990	9.0
1991	8.5
1992	8.4
1993	8.4
1994	9.7
1995	11.0
1996	11.7
1997	10.8
1998	11.4

Sources: FAO, *FAOSTAT Statistics Database*, 21 December 1999.

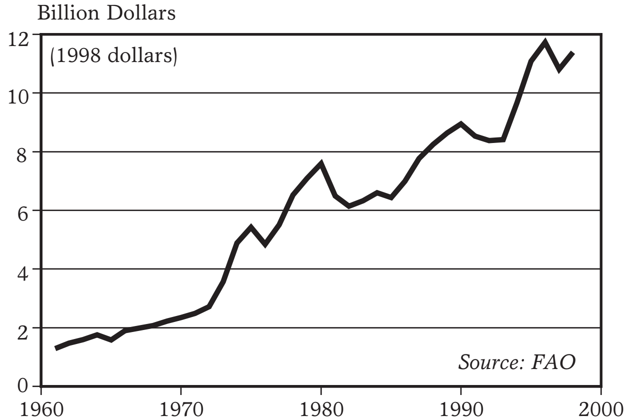

Figure 1: World Exports of Pesticides, 1960–98

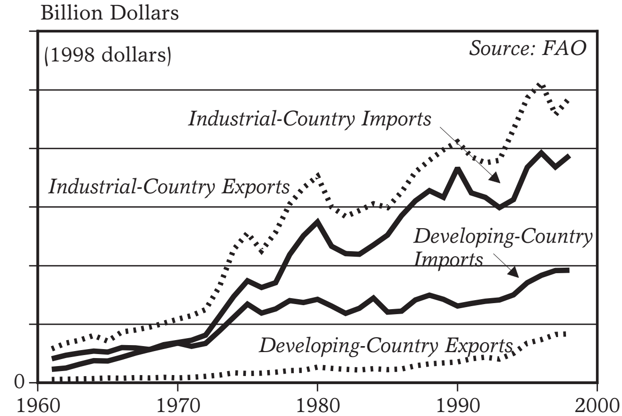

Figure 2: Pesticide Exports and Imports in Industrial and Developing Countries, 1961–98

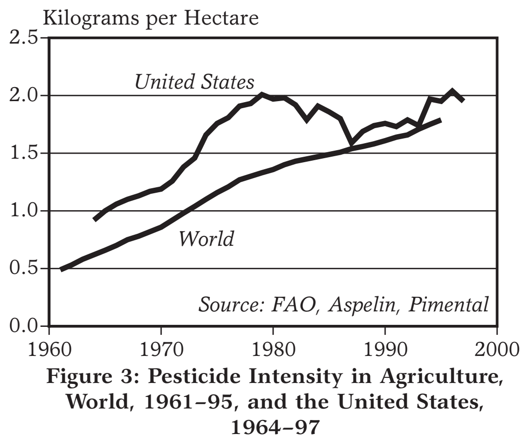

Figure 3: Pesticide Intensity in Agriculture, World, 1961–95, and the United States, 1964–97

Transgenic Crop Area Surges

Brian Halweil

The global area planted to transgenic crops jumped by 44 percent between 1998 and 1999, from 27.8 million hectares to 39.9 million.[1] The area has grown 23-fold since 1996, the first year of large-scale commercialization, when just 1.7 million hectares were planted.[2] But 99 percent of the current global transgenic area is found in just three nations—the United States, Argentina, and Canada; 72 percent of the global area is in the United States alone.[3] (See Table 1.)

More than half of the American soybean and cotton crops and one third of the corn crop is modified; 90 percent of the Argentine soy crop is modified, as is nearly two thirds of the Canadian rapeseed (canola) crop.[4] Because these three nations are dominant food exporters, much of the corn, soy, canola, and cottonseed on the world market is transgenic.[5] Elsewhere, public concerns or ongoing government evaluation of these crops has delayed widespread planting.

Also known as genetically engineered or genetically modified crops, transgenics often contain genes from viruses, bacteria, animals, and other organisms with which the crop could not reproduce naturally. Traditional breeding, in contrast, involves humans crossing only closely related plant species.

Dozens of crops—from apples to lettuce to wheat—have been modified and are near commercialization, though only transgenic varieties of soybean, corn, cotton, canola, potato, squash, and papaya are currently grown commercially.[6] Of these seven crops, soybeans and corn account for 54 percent and 28 percent of the global transgenic area, respectively, while cotton and canola share most of the remainder, with nearly 9 percent each.[7]

The transgenic crops currently being grown have been engineered to resist spraying of herbicides, to churn out the insecticide produced by the soil bacterium *Bacillus thuringiensis* (Bt), or to do both. In 1999, herbicide-resistant varieties of soy, corn, cotton, and canola were planted on 71 percent of the global transgenic area, while Bt-corn and Bt-cotton were sown on 22 percent.[8] Corn and cotton varieties that both produce Bt and resist herbicides were planted on the remaining 7 percent—a sevenfold increase in the use of such "trait-stacked" varieties.[9] These traits offer large-scale, industrial farmers reduced production costs or increased ease of crop management by lowering the need to scout for pests, cutting labor costs, allowing a shift to cheaper chemicals, and generally simplifying pest control—which explains the exceptionally rapid adoption of transgenics in a few nations.[10]

Public resistance to transgenic crops spread from Europe to the rest of the world in 1999, galvanized by several risk assessment studies and high-profile lawsuits. A hotly debated study suggested that genetically engineered potatoes

Table 1: Global Area of Transgenic Crops, 1999

Country	1999 (million hectares)	Share of Global Acreage (percent)
United States	28.7	72
Argentina	6.7	17
Canada	4.0	10
China	0.3	1
Australia	0.1	<1
South Africa	0.1	<1
Mexico	<0.1	<1
Spain	<0.1	<1
France	<0.1	<1
Portugal	<0.1	<1
Romania	<0.1	<1
Ukraine	<0.1	<1
Total	39.9	100

Source: Clive James, *Global Review of Commercialized Transgenic Crops: 1999 (Preview)* (Ithaca, NY: International Service for the Acquisition of Agri-Biotech Applications, 1999).

could damage the immune system and internal organs of rats, bolstering concerns that transgenic foods might induce allergies or toxic reactions in humans.[11] Scientists also showed that the pollen produced by Bt-corn killed Monarch butterfly larvae in the lab, while another study reported that the toxin produced by Bt-corn could accumulate—in its active form—in the soil for extended periods of time.[12] Both studies raised concerns about possible unanticipated or untested ecological impacts.

Monsanto and AstraZeneca bowed to public pressure by deciding in 1999 not to commercialize so-called terminator technologies that would have rendered seeds sterile and prevented the age-old practice of seed saving—though research on these technologies seems to be proceeding nonetheless.[13] And a lawsuit brought in December charged that Monsanto Company, the leading producer of transgenic seeds, had not adequately tested its seeds before commercialization and that it was trying to monopolize the seed supply through gene patenting.[14]

Such events rippled throughout the food chain and the investment community. Most major food manufacturers and retailers decided to remove transgenic ingredients from their products sold in Europe.[15] Several Japanese and American food companies, including Asahi, Heinz, Gerber, and Frito-Lay, followed suit.[16] Japan, South Korea, Australia, Mexico, the members of the European Union, and other nations began to draft laws requiring mandatory labeling of food products containing transgenic ingredients.[17]

The shift in public perception cost U.S. agriculture hundreds of millions of dollars, as exports to Europe plummeted.[18] Top commodity handlers, including Archer Daniels Midland and A.E. Staley, began to discount transgenic crops because of the greater financial risk.[19] And several major players in the biotech industry, including Novartis, Astra-Zeneca, and the newly merged Pharmacia Upjohn and Monsanto, spun off their ailing agricultural units.[20]

A series of studies in 1999 indicated that—in contrast to claims by biotech proponents—the adoption of such crops is not reducing the use of harmful pesticides, and in some cases has increased it by making spraying easier.[21] (Bt-cotton stands as the exception: studies have indicated as much as a 12-percent reduction in insecticide applications on Bt-cotton in the United States compared with conventional cotton systems.)[22] Other observers have also noted that Bt- and herbicide-resistant crops keep farmers firmly rooted on the pesticide treadmill and vulnerable to pesticide resistance.[23]

In early 2000, scientists in Switzerland announced that they had developed a variety of transgenic rice that was enhanced with beta-carotene—dubbed "golden rice" for its yellow color and intended to alleviate debilitating vitamin A deficiency throughout Asia.[24] This breakthrough was heralded as evidence that transgenic crops could help reduce malnutrition. Issues of cultural acceptance remain, however, as well as concern that such a technology does not sufficiently address the poverty and overly monotonous diet at the root of the deficiency.[25]

The first international treaty regulating trade in transgenic products was established in January 2000, allowing nations to bar imports of transgenic crops and other organisms based on environmental, human health, and social risks, even in the face of scientific uncertainty over such risks.[26] This biosafety protocol also requires that shipments of agricultural commodities indicate whether they "may contain" transgenic ingredients. The protocol was more ambiguous on its relationship with the World Trade Organization, setting the stage for future trade disputes.[27]

Global planting in coming years will largely be affected by the evolution of public sentiment in the United States—the largest producer and consumer of transgenics. Labeling bills have been introduced in the U.S. Congress, and U.S. regulatory agencies are reviewing their oversight of transgenics.[28] Faced with uncertain domestic and export markets, surveys show that U.S. farmers plan to scale back the area planted to transgenics by 15–25 percent in 2000.[29]

Organic Farming Thrives Worldwide

Brian Halweil

Driven by rising consumer demand and growing dissatisfaction with conventional farming practices, the organic agriculture industry is soaring. A recent U.N. survey found that farmers in at least 130 countries on all continents produce organic food commercially.[1] The International Federation of Organic Agriculture Movements (IFOAM)—the primary international standard setting and lobbying body for the organic industry—has more than 750 members in 107 nations today, up from 5 members in 3 nations in 1972, with most of the new members in the developing world.[2] Total global organic area is now estimated at more than 7 million hectares, while the market for organic food has swelled to an estimated $22 billion a year.[3]

The term "organic" describes a system of farming that prohibits the use of synthetic pesticides and artificial fertilizers, and instead relies on ecological interactions to raise yields, reduce pest pressures, and build soil fertility. Diverse planting patterns, frequent rotations, and attraction of beneficial insects, for instance, would all be "organic" means of pest control.[4]

The European Union (EU) leads the global organic explosion, with a 35-fold expansion in organic area since 1985—an average annual growth rate of 30 percent.[5] (See Figure 1.) At nearly 4 million hectares in 1999, organic area accounts for roughly 3 percent of total EU agricultural area, while the retail market for organic products has hit some $7.3 billion.[6] In several European nations, including Sweden, Finland, Switzerland, and Italy, 5–10 percent of total agricultural area is now organic.[7] In Austria, 13 percent of the farmland is organic, with the share reaching half in some provinces.[8]

But Australia is the nation with the most organic area, with 1.7 million certified organic hectares, raising mostly organic range-fed beef for export to Japan—where the organic market is now worth $3.5 billion.[9] In the United States and Canada, the organic area grew 15–20 percent each year during the 1990s, and now stands at roughly 550,000 and 1 million hectares—0.2 and 1.3 percent of the respective nation's cropland.[10] Retail sales of organic produce and products in North America have also grown 20 percent annually since 1989, and were estimated at $10 billion in 1999.[11]

These swelling markets for organic products have sometimes been driven by policies to promote organic farming, and at other times by market forces. For example, 80 percent of the growth in EU area occurred in the last six years, spurred by the 1993 establishment of a common EU definition for "organic"—which is integral to boosting consumer awareness—and subsequent policies to support conversion to organic farming, such as subsidies in the early years of conversion and organic farming research at agricultural universities.[12]

In contrast, growth in the United States has come despite little government support. A study by the Organic Farming Research Foundation found that less than one tenth of 1 percent of U.S. Department of Agriculture research projects in 1995 had any relevance for organic agriculture.[13] And an aborted 1997 effort by the government to set federal organic standards would actually have weakened the industry by permitting transgenic seeds, confined livestock operations, and other inputs and practices never before considered organic.[14]

A series of food safety, ecological, and other troubles associated with the conventional food sector, including the "mad cow" scare in the United Kingdom, has also inspired a fierce market demand for organic.[15] Among the British, recent concerns over genetically engineered crops (which are not permitted in organic production) caused an avalanche of consumer inquiries about organic and a parallel flood of farmer applications for conversion.[16] Since 1996, organic area in the United Kingdom surged 10-fold, from 50,000 to 500,000 hectares.[17]

Statistics for the developing world are spotty, although anecdotal evidence points to rapid growth, especially for export markets.[18]

In Argentina, the total area devoted to organic production jumped 7,000 percent since 1992 to an estimated 350,000 hectares today.[19] Argentina is expected to export more than $100 million of organic products in 2000.[20] An Export Promotion of Organic Products from Africa project was started in 1995 in Mozambique, Tanzania, Uganda, and Zimbabwe, with the dual goal of addressing rural poverty and resource conservation.[21] At least 7,000 small farmers in Uganda—up from 220 in 1995—now produce about 10 percent of the organic cotton on the world market.[22]

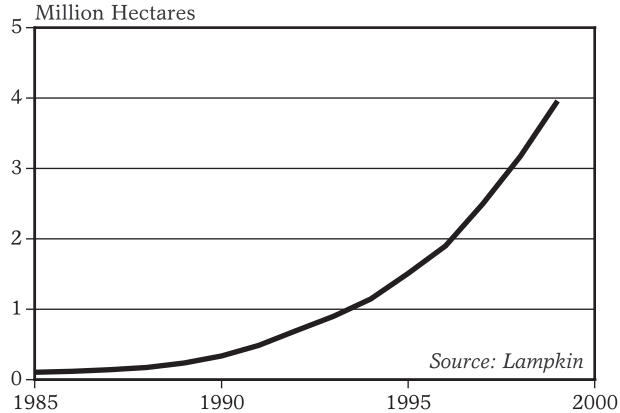

Figure 1: Certified Organic Area in European Union, 1985–99

Local organic markets are also emerging in the developing world. In Egypt, where tea drinking is a daily ritual, the top national brand is Sekem's certified organic tea.[23] And in Cuba, a nationwide shift to organic farming includes an estimated 30,000 urban gardens, which are a principal source of fresh produce for city dwellers.[24]

Several recent studies have indicated that yields from organic production are comparable to conventional systems, especially over the long term.[25] Combined with the price premiums that organic produce often fetches in the market, organic systems are thus generally more profitable for the farmer. A recent study of organic grain and soybean production in the U.S. Midwest found that organic systems were often more profitable even without the price premium because of the lower input costs, a greater diversity of products being sold, and greater yield stability in bad-weather years—all pluses for subsistence farmers in ecologically sensitive areas.[26]

Organic farming has also demonstrated a wide range of ecological benefits, including reduced soil erosion, improved soil health, and reduced groundwater contamination.[27] A joint declaration from IFOAM and the World Conservation Union–IUCN supported organic agriculture based on its role in the conservation of biodiversity and habitat.[28] Direct human health benefits from organic farming include the reduced risk of pesticide poisoning for farm workers, as well as lower exposure to pesticide residues for consumers of organic foods—the primary driver of the booming organic baby foods market. [29]

With more and more nations drafting organic standards, setting organic area goals, and supporting organic agriculture, the prospects for further growth are bright.[30] In January 1999, the U.N. Food and Agriculture Organization said it will begin providing information on organic farming and trade, give related institutional and policy support, and explore the feasibility of organic farming for improving food security and natural resource use in the developing world.[31]

On the current trajectory, as much as 30 percent of total EU farmed area could be organic by 2010.[32] In the United States, revised national organic standards released in March 2000 will spur the domestic market.[33] And most major food manufacturers and retailers in Europe and North America have introduced their own organic product lines, while several large apparel companies, including The Gap, Levi's, and Patagonia, have begun to purchase organic cotton.[34]

Groundwater Depletion Widespread

Sandra Postel

As farmers have increasingly turned to underground sources of water to irrigate their crops, the overpumping of groundwater is causing water tables to decline beneath vast areas of agricultural land. Based on the best data available, farmers are collectively overpumping regional groundwater sources by at least 160 billion cubic meters a year—the amount of water used to produce nearly one tenth of the world's current grain supply.[1] The problem, moreover, is worsening and represents one of the largest threats to future food production.

Groundwater, stored in underground geologic formations called aquifers, is in many ways an ideal source of water. Whereas large river-based canal systems often deliver water unreliably and lose a significant portion of water stored in reservoirs to evaporation, groundwater usually can be tapped whenever a farmer needs it. And because water is stored underground, none is lost to evaporation. Affordable and decentralized, groundwater wells have proliferated mainly through private farmer investments—in stark contrast to the large government subsidies often doled out for large dams and river diversion projects.

In India, the number of groundwater wells climbed from 4 million in 1951 to 17 million in 1997, allowing the area irrigated by groundwater to climb sixfold—to 36 million hectares.[2] This rapid growth was a major contributor to food production gains during the Green Revolution, which combined high-yielding seeds, fertilizer, and water to boost land productivity. Groundwater now accounts for half of India's total irrigation water use, as well as half of the water used by cities and industries.[3]

Groundwater development has fueled food production gains in the three other top irrigators as well. In China, the number of irrigation wells increased more than 20-fold between 1961 and the mid-1980s.[4] In Pakistan, where 80 percent of all cropland is now irrigated, the number of wells rose from some 25,000 in 1964 to nearly 360,000 in 1993.[5]

In the United States, third in total irrigated area (after India and China), a groundwater boom occurred during the last half of the twentieth century. Farmers in California stepped up their pumping beneath the rich soils of the Central Valley, turning this region into the nation's premier fruit and vegetable basket. And in the Great Plains, farmers began to tap on a large scale one of the planet's greatest aquifers—the Ogallala. Spanning portions of eight states, the Ogallala covers some 453,000 square kilometers, and, prior to exploitation, held 3,700 cubic kilometers of water—a volume equal to the annual flow of more than 200 Colorado Rivers.[6] (A cubic kilometer is a billion cubic meters.) Today, the Ogallala alone waters one fifth of U.S. irrigated land.[7]

Like any renewable resource, groundwater can be tapped indefinitely as long as the rate of extraction does not exceed the rate of replenishment. But just like a bank account, a groundwater reserve will dwindle if withdrawals exceed deposits. Few governments have established and enforced rules and regulations to ensure that groundwater sources are exploited at a sustainable rate. As a result, a classic "tragedy of the commons" has unfolded: acting in their own self-interest, individual irrigators pump as much water as they desire, which collectively depletes the resource.

In India, the situation became so severe over the last decade that the Supreme Court directed one of the nation's premier research centers to study it. The National Environmental Engineering Research Institute found that "overexploitation of ground water resources is widespread across the country," and that water tables in critical agricultural areas were dropping "at an alarming rate."[8] Nine Indian states are now running major water deficits, which in the aggregate total just over 100 billion cubic meters (bcm) a year.[9] (See Table 1.)

Northern China is also running a chronic water deficit, with groundwater overpumping of some 30 bcm a year.[10] Water tables have been dropping 1–1.5 meters a year under much of the north China plain, which produces some 40 percent of China's grain.[11] The projected 2025 water deficit for the Hai and

Table 1: Water Deficits in Key Countries and Regions, Mid-1990s

COUNTRY/ REGION	ESTIMATED ANNUAL WATER DEFICIT (billion cubic meters per year)
India	104.0
China	30.0
United States	13.6
North Africa	10.0
Saudi Arabia	6.0
Minimum Global Total	163.6

Source: Various references cited in the text and author's estimates.

Yellow river basins roughly equals the volume of water needed to grow 55 million tons of grain—14 percent of the nation's current annual grain consumption.[12]

In the United States, several decades of heavy pumping have depleted the Ogallala aquifer by 325 bcm, a volume equal to the annual flow of 18 Colorado Rivers.[13] More than two thirds of this depletion has occurred in the Texas High Plains.[14] Annual net depletion of the Ogallala averages about 12 bcm a year.[15] Particularly in its southern reaches, the Ogallala gets very little replenishment from rainfall, so pumping the large volumes of water needed to grow cotton and corn inevitably diminishes the supply.

Irrigation in the arid regions of North Africa and the Arabian Peninsula depends heavily on fossil aquifers—groundwater reserves that formed thousands of years ago, when local climates were wetter than at present. Saudi Arabia, for example, is estimated to have some 2,000 cubic kilometers of 10,000- to 30,000-year-old water stored in aquifers down to a depth of 300 meters.[16] Since fossil reserves get negligible replenishment from rainfall, they are essentially nonrenewable: pumping water from them depletes the supply just as pumping from an oil reserve does.

How farmers and governments respond to declining groundwater supplies will greatly influence future global crop production. At some point, pumping costs climb too high or well yields drop too low to continue business-as-usual. Farmers can then choose to take land out of production, eliminate a harvest or two, switch to less water-intensive crops, or adopt more-efficient irrigation practices. Improving efficiency is the only option that can sustain crop production while lowering water use. Yet virtually everywhere groundwater depletion is occurring, efforts to raise efficiency—including, for example, the use of drip irrigation systems, precision sprinklers, laser-leveling of fields, and better irrigation scheduling—pale in comparison to the scale of the problem.[17]

More than food security is at stake. Because groundwater often sustains rivers, wetlands, and lakes, the overpumping of aquifers can cause serious ecological harm. In the Upper Guadiana catchment in Spain, for instance, a 30–40 meter decline in the water table has dried out valuable wetlands.[18] Rivers that depend on groundwater for their base flow can run dry when water tables drop too far, decimating fisheries. And overpumping of coastal aquifers can reverse the hydraulic gradient between land and sea, causing saltwater to invade freshwater sources. Israel, Florida in the United States, and the Indian state of Gujurat are among the areas battling the contamination of drinking water supplies by seawater.[19] Finally, if aquifers compress when water is removed from their pores, the overlying land can subside and cause considerable damage to buildings and infrastructure. Bangkok, Mexico City, and Venice are among the major cities faced with this problem.

No government has yet adequately tackled the issue of groundwater depletion, but it is at least getting more attention. The first big hurdle is overcoming the out-of-sight, out-of-mind syndrome and the human tendency to deny problems that seem too big or difficult to confront.

Groundwater Quality Deteriorating

Payal Sampat

Even as our dependence on groundwater has grown over the past 50 years, the quality of this vital resource has been deteriorating in several parts of the world. The pollution of the world's aquifers, which are vast underground stores of water, represents a serious threat to global freshwater availability.

Aquifers store most of the world's unfrozen fresh water—some 97 percent—and provide drinking water to almost a third of the planet's people.[1] Over a billion residents of Asia alone depend on groundwater for drinking.[2] And groundwater has been central to the global expansion in irrigated agriculture. For instance, aquifers water more than half of irrigated land in India and 43 percent in the United States.[3] Groundwater also replenishes streams, lakes, wetlands, and other surface water bodies; it provides the base flow for some of the world's great rivers, including the Yangtze and the Mississippi.[4]

But the capacity of groundwater to sustain people and ecosystems is under enormous threat.[5] (See Table 1.) Across the United States and in parts of Asia, Latin America, and Europe, human activities are sending massive quantities of chemicals into aquifers, causing irreversible damage to freshwater supplies. Pesticides and fertilizers that run off from farms and front lawns, petrochemicals that drip out of leaky storage tanks, chlorinated solvents and heavy metals discarded by industries, and radioactive wastes from nuclear operations are among the principal contaminants of groundwater.

Nitrates are commonly found in shallow aquifers near farms and urban areas. In Sri Lanka, 79 percent of groundwater samples contained nitrates at levels above the World Health Organization (WHO) drinking water guideline of 10 milligrams per liter.[6] A study in northern China found nitrates in groundwater at five times this guideline in more than half of the 69 locations tested.[7] Much of this contamination was the result of excessive fertilizer applications: the Chinese scientists found that crops in the region used only 40 percent of the nitrogen that was applied.[8] Consumed at high concentrations, nitrates can cause suffocation in infants and have been implicated in digestive tract cancers.[9]

Petrochemicals, many of which are known or suspected human carcinogens, are among the most pervasive groundwater contaminants in oil-dependent countries.[10] The U.S. Environment Protection Agency found in 1998 that 100,000 underground storage tanks for petroleum were leaking beneath gas stations and factories across the country.[11]

Some 30–80 million people in Bangladesh and the Indian state of West Bengal are drinking water containing arsenic at levels between 5 and 100 times the WHO guideline.[12] Scientists believe that aquifer sediments in the Ganges delta are naturally rich in arsenic, but that residents were not exposed to the heavy metal until the 1970s, when their water supply was switched from surface to groundwater.[13]

Fluoride is another naturally occurring contaminant.[14] Fluoride is an essential nutrient, but consuming it at high concentrations can cause dental problems and crippling neck and back damage.[15] WHO estimates that 70 million people in northern China and 30 million in northwestern India are drinking water with high fluoride levels.[16]

In some cases, aquifers are polluted by effluents intentionally sent there. For instance, some 60 percent of U.S. liquid hazardous waste—34 billion liters of solvents, heavy metals, and radioactive materials each year—is injected into deep underground wells for disposal.[17] Although the effluents are sent below the deepest sources of drinking water, some wastes have managed to enter drinking water supplies in parts of Florida, Ohio, Oklahoma, and Texas.[18]

Once persistent pollutants get into groundwater, the damage is virtually irreversible.[19] In part this is because the water remains in aquifers for very long periods: on average, the residence time for groundwater is 1,400 years, in comparison with just 16 days for river water.[20] So pollutants accumulate, unlike in rivers and streams, where they are more easily flushed out. For this reason, chemicals used several decades ago are still found in groundwater. The pesticide DDT, for instance, still lingers in U.S. groundwater even though its use was banned in the late 1960s.[21]

It may take several years before we discover the aftereffects of today's chemical-dependent, throwaway economy, in part because of the unique nature of aquifers. Few countries track the health of these reservoirs—their enormous size and remoteness make them extremely expensive to monitor. And because groundwater moves very slowly—less than a foot a day in some cases—damage done to aquifers may not be detected for decades.[22]

The pollution of groundwater strains the availability of an already limited resource. On every continent, many major aquifers are being drained faster than their natural rate of recharge, resulting in an annual overdraft of at least 160 billion cubic meters.[23] In some cases, the overpumping causes the aquifer's sediments to compact, permanently shrinking its storage capacity. In California's Central Valley, this loss is equal to more than 40 percent of the combined storage capacity of all human-made reservoirs across the state.[24]

Table 1: Selected Chemical Threats to Groundwater

Threat	Sources	Health and Ecosystem Effects	Principal Regions Affected
Pesticides	Runoff from farms, backyards, golf courses; landfills	Organochlorines linked to reproductive and endocrine damage in wildlife; organophosphates and carbamates linked to liver and nervous system damage and cancers	United States, Eastern Europe, China, India
Nitrates	Fertilizer runoff; manure from livestock operations; septic systems	Restricts amount of oxygen reaching brain, which can cause death in infants ("blue-baby syndrome")	Mid-Atlantic United States, north China plain, Western Europe, Northern India
Petrochemicals	Underground petroleum storage tanks	Benzene and other petrochemicals can be cancer-causing even at a low exposure	United States, United Kingdom, parts of former Soviet Union
Chlorinated Solvents	Metals and plastics degreasing; fabric cleaning, electronics and aircraft manufacture	Linked to reproductive disorders and some cancers	Western United States, industrial zones in East Asia
Arsenic	Naturally occurring	Nervous system and liver damage; skin cancers	Bangladesh, Eastern India, Nepal, Taiwan
Fluoride	Naturally occurring	Dental problems; crippling spinal and bone damage	Northern China, northwestern India

Source: See endnote 5.

World Population Passes 6 Billion

Brian Halweil

On October 12, 1999, our numbers officially reached 6 billion, double the population in 1960.[1] (See Figure 1.) Last year world population swelled by 77 million—roughly equivalent to adding another Philippines.[2] (See Figure 2.)

In addition, 1999 witnessed another population milestone when India's population surpassed 1 billion.[3] China, with 1.25 billion, still reigns as the world's most populous nation, but fast-growing India is projected to have that dubious honor by 2037.[4]

It took less time—just 12 years—to add this last billion to the planet than any previous billion, despite an annual rate of growth at its lowest level in a half-century: 1.3 percent.[5] (See Figure 3.) But because this lower rate comes on top of the largest population base ever, the world added more people in 1999 than in 1963, when the annual growth rate peaked at 2.2 percent.[6]

Even with this declining rate of growth, more young men and women—1.1 billion—are reaching reproductive age than ever before.[7] Our annual addition will still average over 70 million people each year for the next two decades before declining to roughly 30 million by 2050, when total population is expected to reach nearly 9 billion.[8]

Global population growth is concentrated in South Asia and Africa. Nearly 3 out of 10 people added to the planet in 1999 were born in the Indian subcontinent, while another 2.5 were born in Africa.[9] Most of the remainder were born in China, Latin America and the Caribbean, and Southeast Asia.

Falling death rates and rising life spans—the result of improved nutrition, sanitation, immunizations, and other public health advances—underpin the dramatic population increases in these regions. Infant and child mortality have plummeted in Latin America, Africa, and Asia since 1950, while the average life span increased from 41 to 64 years.[10] Because fertility rates—the number of children each woman bears—have not declined as fast, national populations surged in the twentieth century. (After similar but more gradual quality-of-life improvements in the nineteenth century, European and North American populations swelled, though they are now stable, or even declining in some of Europe.)

The world's poorest regions are growing most rapidly because inadequate social services and economic opportunities leave couples dependent on large families for financial security and with little power to determine their family size. Some 350 million women, nearly a third of all women of reproductive age in developing countries, have incomplete or sporadic access to safe family planning services.[11] For another 120 million women, such services simply do not exist, or cultural and religious barriers prevent their use.[12]

Fertility rates also remain high because women are not given the same opportunities as men: worldwide, women and girls make up more than two thirds of the world's illiterate population and three fifths of the poor.[13] Girls who attend school tend to delay their first child and bear fewer children overall. In Egypt, 56 percent of women with no schooling become mothers in their teens, compared with just 5 percent of women who remained in school past the primary level.[14]

Population growth can strain the capacity of governments and the environment to meet human needs. With freshwater availability essentially fixed, the number of people living in water-scarce regions will jump from 470 million to more than 3 billion by 2030.[15] In sub-Saharan Africa, where literacy and school enrollment are already well below international averages, the school-age population will expand by more than one third by then.[16]

A 1999 assessment of the progress made toward the goals laid out at the 1994 International Conference on Population and Development—universal access to family planning services, gender equity in education, and improved health care and sanitation services—found inadequate financial resources have kept these development goals beyond reach.[17] Of the estimated $17 billion needed to ensure universal access to family planning, developing nations have honored nearly 70 percent of their commitment, while industrial nations have honored only one third of theirs.[18]

World Population Passes 6 Billion

WORLD POPULATION, TOTAL AND ANNUAL ADDITION, 1950–99

YEAR	TOTAL[1] (billion)	ANNUAL ADDITION (million)
1950	2.556	38
1955	2.780	53
1960	3.039	41
1965	3.345	70
1970	3.707	77
1971	3.784	77
1972	3.861	76
1973	3.937	76
1974	4.013	73
1975	4.086	72
1976	4.158	72
1977	4.231	72
1978	4.303	75
1979	4.378	76
1980	4.454	76
1981	4.530	80
1982	4.610	80
1983	4.690	79
1984	4.770	81
1985	4.851	82
1986	4.933	86
1987	5.018	86
1988	5.105	86
1989	5.190	87
1990	5.277	82
1991	5.359	82
1992	5.442	81
1993	5.523	80
1994	5.603	80
1995	5.682	79
1996	5.761	80
1997	5.840	78
1998	5.919	78
1999 (prel)	5.996	77

[1]Total at mid-year.
SOURCE: U.S. Bureau of the Census, *International Data Base*, electronic database, Suitland, MD, updated 28 December 1999.

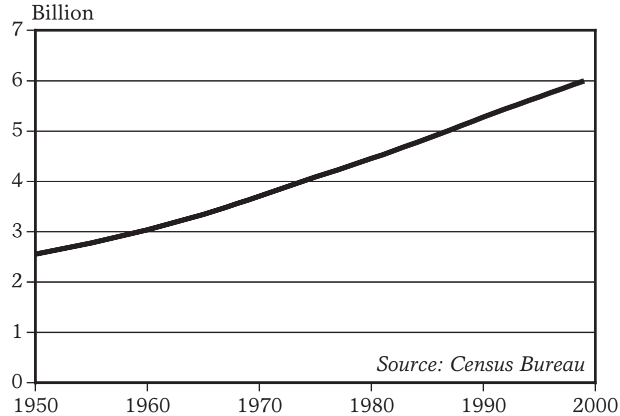

Figure 1: World Population, 1950–99

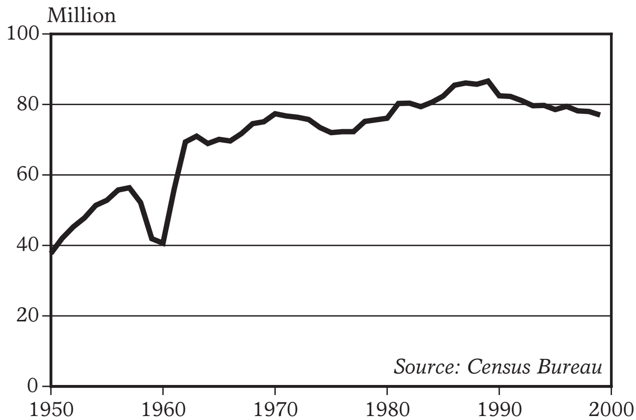

Figure 2: Annual Addition to World Population, 1950–99

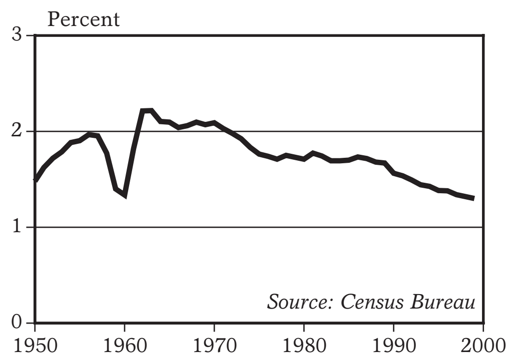

Figure 3: Annual Growth Rate of World Population, 1950–99

Urban Population Continues to Rise

Molly O. Sheehan

Between 1996 and 1999—years that mark the most recent U.N. assessments of urban population—some 200 million people were added to the world's urban areas.[1] At 2.8 billion, nearly four times as many people lived in urban areas in 1999 as in 1950.[2] (See Figure 1.) Global urban population estimates are difficult to make, as the definition of "urban" and the reliability of census data vary from country to country. The U.N. figures cited here are for "urban agglomerations," which generally include the population in a city or town as well as adjacent suburbs.

Urban population growth is outstripping rural population growth by three to one as a result of rural-to-urban migration, the natural increase of existing urban populations, and the reclassification of areas that were once rural villages. Thus this century is likely to become the first one in which most of the world's people live in cities. Of the 5.9 billion people on the planet in mid-1999, 47 percent resided in urban areas.[3] (See Figure 2.) By 2006, according to U.N. projections, half of the world will live in cities, and by 2030, three out of five people could be urbanites.[4]

Global environmental challenges such as climate change and deforestation have many urban roots.[5] Cities generate some three quarters of the carbon dioxide that is released from fossil fuel burning worldwide; a similar share of industrial timber is used in cities.[6]

Industrial nations tend to be more urbanized than developing ones and to consume a disproportionate share of Earth's resources. More than 70 percent of national populations live in cities and suburbs in the United States, Canada, Western Europe, and Japan.[7] Urban agglomerations in these countries draw heavily on far-flung resources.[8] One estimate finds that London, for instance, requires roughly 58 times its land area just to supply its residents with food and timber.[9]

Over the past century, the location of the world's most populous cities has shifted from industrial countries to the developing world. In 1900, 9 of the world's 10 largest cities were in Europe and the United States.[10] In contrast, only Tokyo, New York, and Los Angeles in the industrial world make the Top 10 list in 2000. They join Mexico City, Bombay, São Paolo, Shanghai, Lagos, Calcutta, and Buenos Aires.[11]

Population increase in urban centers of developing countries is expected to account for nearly 90 percent of the 2.7 billion people likely to be added to world population between 1995 and 2030.[12] (See Figure 3.) Some 74 percent of Latin Americans now live in cities, making the region roughly as urbanized as Europe and North America. Thus the most explosive urban growth in the future is expected in Africa and Asia, where only 30–35 percent of the population is now urban.[13]

Local environmental problems, such as water and air pollution, are worst in cities where population size or growth exceeds the capability of governments to build and maintain critical water, waste, and transportation infrastructure.[14] At least 220 million people in cities of the developing world lack clean drinking water, and 1.1 billion choke on air pollution.[15]

The battle to achieve a sustainable balance between Earth's resource base and its human energy will be largely won or lost in the world's cities. By concentrating populations, cities have a natural environmental advantage: people clustered together should in theory be able to use less materials and energy than widely dispersed populations can, and to recycle resources more easily.[16] The challenge will lie in mustering the political and financial resources needed to build the urban water, waste, transportation, and energy systems to exploit this advantage.

Urban Population Continues to Rise

WORLD URBAN POPULATION, AND SHARE THAT IS URBAN, 1950–99

YEAR	POPULATION (billion)
1950	0.750
1955	0.872
1960	1.017
1965	1.185
1970	1.357
1975	1.543
1980	1.754
1985	1.997
1990	2.280
1995	2.574
1999 (prel)	2.800

YEAR	SHARE (percent)
1950	29.7
1955	31.6
1960	33.6
1965	35.5
1970	36.7
1975	37.8
1980	39.4
1985	41.2
1990	43.2
1995	45.3
1999 (prel)	47.0

SOURCE: U.N Population Division.

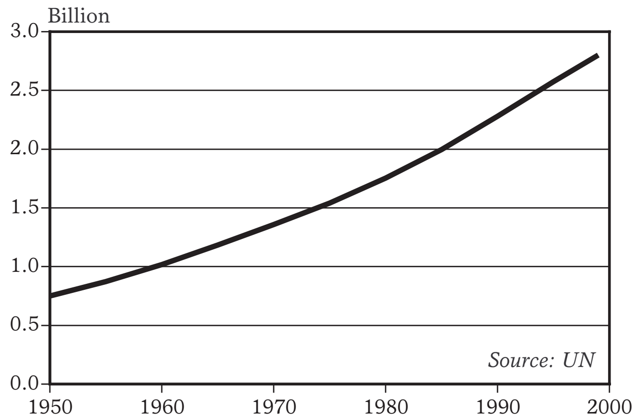

Figure 1: World Urban Population, 1950–99

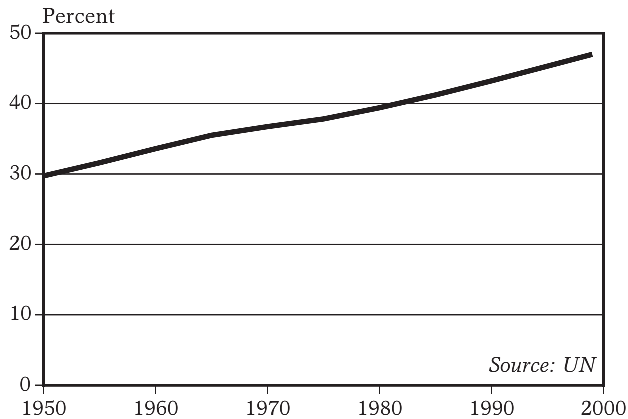

Figure 2: Share of World Population That Is Urban, 1950–99

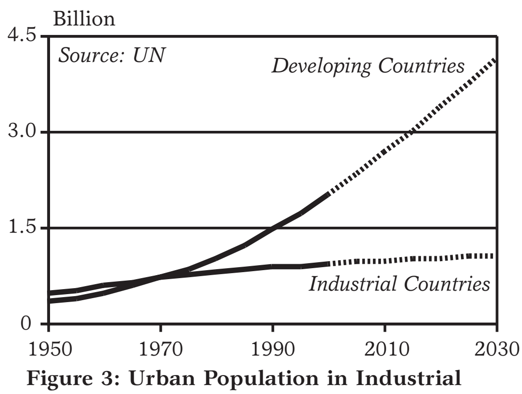

Figure 3: Urban Population in Industrial and Developing Countries, 1950–95, With Projections to 2030

Prison Populations Exploding

Gary Gardner

Some 8 million people were held in prisons and jails in the mid- to late 1990s in the 180 countries for which data are available.[1] The total reflects inmates who are serving sentences as well as those awaiting trial. It does not, however, include millions more who are denied their freedom in non-prison circumstances such as forced labor. When these are included, the global prison population could be 10–30 million.[2]

In at least 18 countries, prisoners held in pre-trial detention constitute the majority of the prison population, according to the international monitoring group Human Rights Watch.[3] In some countries, pre-trial detainees spend more time locked up than if they had been tried and convicted.

Just three countries—the United States, China, and Russia—hold more than half of the global prison population.[4] The United States has 1.7 million persons behind bars, while China has 1.4 million and Russia has 1 million.[5] (See Table 1.) On a per capita basis, Russia and the United States had by far the largest prison populations in the late 1990s: 687 and 645 people per 100,000 population, respectively.[6] The global average is 137 prisoners per 100,000 population.[7]

National rates of imprisonment reflect particular mixes of criminal, law enforcement, judicial, and penal characteristics. Japan's exceptionally low rate of incarceration—just 39 people per 100,000 population—is consistent with its low rate of crime.[8] But in other countries a low rate might mean that police, courts, or corrections systems are not well developed; these factors might allow many criminals to avoid jail time.[9] Similarly, high imprisonment rates can reflect the work of a repressive police state, a high rate of crime, long prison sentences, or the use of mandatory sentences.

The top three incarcerating countries use jails heavily for different reasons. Russia has a long history of imprisonment: one of every four males in Russia has spent some time in jail, according to the Moscow Center for Prison Reform.[10] Most are held in work camps rather than in western-style prisons. The camps once manufactured a variety of products for sale to the public, generating great profit for the government. Today, however, the market for prison manufactures is limited and the camps are experiencing acute financial difficulties.[11]

China's rate of imprisonment appears to be on the low side, at 113 people per 100,000. But official figures may represent only 13 percent of those deprived of freedom.[12] Dissident Harry Wu, a former prisoner who has studied

TABLE 1: HIGHEST AND LOWEST PRISON POPULATIONS AND RATES OF IMPRISONMENT IN COUNTRIES WITH AT LEAST 20 MILLION POPULATION, LATE 1990S

NUMBER OF PRISONERS		IMPRISONMENT RATE (per 100,000 population)	
HIGHEST			
United States	1,700,000	Russia	687
China	1,410,000	United States	645
Russia	1,010,000	Ukraine	413
India	231,325	South Africa	321
Ukraine	211,568	Uzbekistan	258
LOWEST			
Nepal	6,200	Indonesia	20
Peru	20,899	India	24
Uganda	21,971	Nepal	29
Malaysia	24,400	Bangladesh	37
Venezuela	25,000	Japan	39

SOURCE: Roy Walmsley, "World Population Prison List," Research Findings No. 88 (London: Development and Statistics Directorate, Home Office Research, 1999).

the Chinese system, estimates that 4–6 million people are sentenced to "reform through labor," 3–5 million are in "re-education" labor camps, and 8–10 million are forced to work in prison factories or farms.[13] Millions more are held in pre-trial detention.[14]

In the United States, the prison population has risen rapidly since the 1970s, when state and federal governments began to require mandatory and increasingly lengthy prison sentences for drug possession.[15] The population in state and federal prisons grew from fewer than 200,000 inmates in 1970 to 1.2 million in 1998, with another 600,000 in local jails.[16] Some 36 percent of prisoners entering state prisons and 71 percent of those in federal prisons were convicted of drug offenses.[17] The drug-driven rapid increase in prison populations has led to widespread overcrowding; California's system, for example, is running at twice its intended capacity—despite the construction of 21 new prisons in the past 20 years.[18]

Overcrowding is common in prison systems globally as well. Combined with poor sanitation and lack of food and health care, overcrowding facilitates the spread of disease, including killers such as tuberculosis and AIDS. In many countries, tuberculosis cases run 5–20 times higher in prison than in society at large; in Russia, the prevalence is 40 times higher in prison than outside.[19] AIDS, too, is increasing rapidly among some prison populations. In the United States, new cases appear in prison at five times the frequency found in the general population.[20]

The past decade has seen a shift toward privately run prisons in some countries. Although these hold less than 2 percent of the world's prisoners, the concept is spreading rapidly: the number of beds in private prisons globally increased more than ninefold between 1990 and 1999.[21] Some 85 percent of these—158 facilities—are found in the United States.[22] Australia, England, Netherlands Antilles, New Zealand, Scotland, and South Africa have another 30 private prisons between them.[23]

Private prisons are promoted as a less expensive way to handle incarceration, since they are often cheaper to build and operate than state-run facilities.[24] But critics charge that the savings come at the expense of other considerations, including just wages for guards, and health care and programs for prisoners.[25] And because private prisons, like hotels, are most profitable when run at peak capacity, they create an incentive to maximize incarceration.[26]

For many, the debate on public versus private prisons begs the question of whether prison is the answer to most crime. In many countries, drug offenses are handled through treatment programs rather than through imprisonment. Arizona recently adopted such an approach. Because imprisonment costs the state $50 per day, while treatment, counseling, and probation run just $16 per day, Arizona saved more than $2.5 million the first year of the change in policy.[27] More than three quarters of the people on probation stayed free of drugs thus far.[28]

Even for non-drug offenses, prisons may do more harm than good if their primary purpose is to punish rather than to rehabilitate. "Prison is an expensive way of making bad people worse," noted David Waddington, U.K. Home Secretary in 1989–91.[29] Often, prison does not address the underlying causes of crime. More than 70 percent of prison inmates in the United States had a history of drug abuse before entering prison, but only 10 percent received drug treatment once inside.[30] And 70 percent are reported to be illiterate.[31] With these handicaps, it is little wonder that two thirds of U.S. inmates are rearrested within three years of release.[32]

NOTES

GRAIN HARVEST FALLS
(pages 34–35)

1. U.S. Department of Agriculture (USDA), Foreign Agricultural Service (FAS), *Grain: World Markets and Trade* (Washington, DC: February 2000).
2. Ibid.; USDA, *Production, Supply, and Distribution*, electronic database, Washington, DC, updated February 2000.
3. USDA, op. cit. note 2; U.S. Bureau of the Census, *International Data Base*, electronic database, Suitland, MD, updated 28 December 1999.
4. USDA, op. cit. note 1.
5. USDA, op. cit. note 1; USDA, op. cit. note 2.
6. USDA, op. cit. note 1.
7. Ibid.
8. Ibid.
9. USDA, op. cit. note 2.
10. Ibid.
11. Ibid.
12. Ibid.
13. Ibid.
14. Ibid.
15. Ibid.
16. Ibid.
17. Ibid. Days of consumption are calculated by dividing annual global grain consumption by 365 and then dividing the result by world carryover stocks.
18. Ibid.
19. Projected 3-percent rise in global economy from International Monetary Fund, *World Economic Outlook* (Washington, DC: October 1999).

SOYBEAN HARVEST DROPS
(pages 36–37)

1. U.S. Department of Agriculture (USDA), Foreign Agricultural Service (FAS), *Oilseeds: World Markets and Trade* (Washington, DC: February 2000); USDA, *Production, Supply, and Distribution (PS&D)*, electronic database, Washington, DC, updated February 2000.
2. USDA, *Oilseeds*, op. cit. note 1; U.S. Bureau of the Census, *International Data Base*, electronic database, Suitland, MD, updated 28 December 1999.
3. USDA, *Oilseeds*, op. cit. note 1.
4. USDA, *PS&D*, op. cit. note 1.
5. Ibid.
6. Ibid.
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