

FOOD AND NUTRITION

Despite dire predictions that runaway population growth would soon lead to terrible famines (chapter 7), world food supplies have more than kept up with increasing human numbers over the past two centuries. The past 40 years have seen especially encouraging strides in reducing world hunger. While population growth averaged 1.7 percent per year during that time, world food production increased an average of 2.2 percent. Increased use of irrigation, improved crop varieties, more readily available fertilizers, and distribution systems to transport food from regions with surpluses to those in need have brought improved nutrition to billions of people. In this section, we'll look at the causes and effects of remaining chronic and acute food shortages, as well as recommendations for a balanced, healthful diet.

Millions of people don't have enough to eat

In 1960, nearly 60 percent of the residents of developing countries were considered **chronically undernourished**, meaning their diet didn't provide the 2,200 kcal per day, on average, considered necessary for a healthy productive life. Today, despite the fact that their population has doubled over the past 40 years, the proportion

in these countries suffering from chronic caloric deficiency has fallen to less than 14 percent.

The UN Food and Agriculture Organization (FAO) expects agricultural production to continue to grow over the next few decades. Where the current world food supply would be sufficient, if equitably distributed, to provide an average of 2,800 kcal per person per day, the FAO predicts that by 2030, there will be enough food available to supply 3,050 kcal per day to everyone, or about 30 percent more than most of us need. In countries such as the United States, the problem already has become what to do with surplus food. Farmers in these countries are paid billions of dollars per year not to grow crops.

Still, in a world of surplus food, some 852 million people don't have enough to eat. Figure 9.4 shows countries with the highest risk of food shortages. As you can see, most of sub-Saharan Africa, South and Southeast Asia, and parts of Latin America fall in this category. Ninety-five percent of the chronically undernourished are in developing countries, but an increasing number are in transition countries (primarily states of the former Soviet Union and its allies undergoing a change from socialism to market economies) where bad weather, poor management, and social crises have resulted in sharply falling agricultural production (fig. 9.5). Even in the richest countries, where excess calories are the greatest problem for the majority, some 11 million people don't have enough to eat.

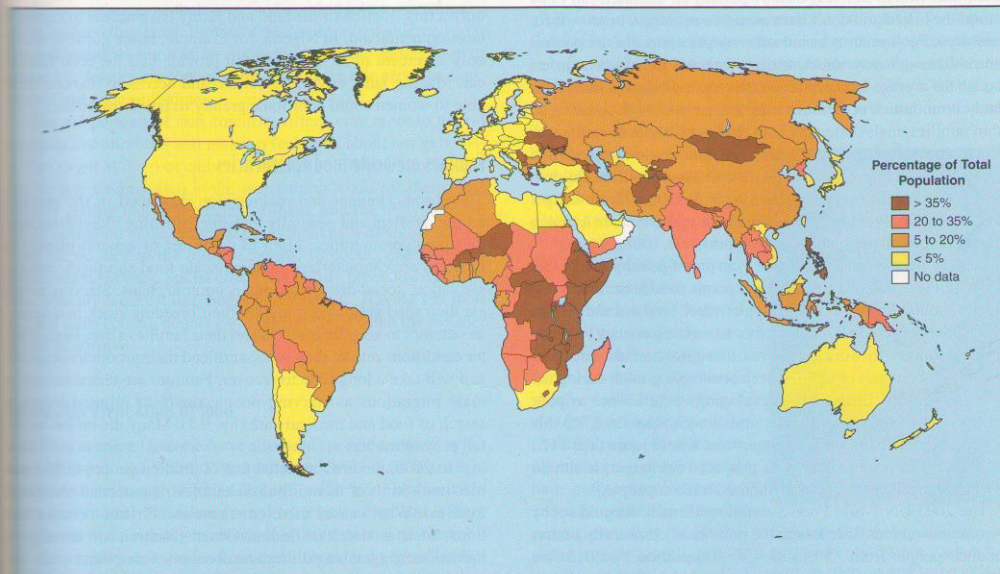


Figure 9.4 Hunger around the world. In 2005, the United Nations reported that 852 million people—815 million of them in developing countries—suffered from chronic hunger and malnutrition. Africa has the largest number of countries with food shortages.

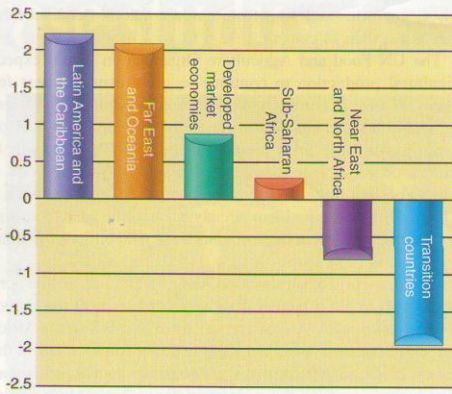


Figure 9.5 Changes in agricultural production in 2000. Transition nations are states from the former Soviet Union undergoing a change from socialism to capitalism. Source: Food and Agriculture Organization (FAO), 2002.

Poverty is the greatest threat to **food security**, or the ability to obtain sufficient food on a day-to-day basis. The 1.5 billion people in the world who live on less than \$1 per day all too often can't buy the food they need and don't have access to resources to grow it for themselves. Food security occurs at multiple scales. In the poorest countries, hunger may affect nearly everyone. In other countries, although the average food availability may be satisfactory, some individual communities or families may not have enough to eat. And within families, males often get both the largest share as well as the most nutritious food, while women and children—who need food most—all too often get the poorest diet. At least 6 million children under 5 years old die every year (one every 5 seconds) from hunger and malnutrition. Providing a healthy diet might eliminate as much as 60 percent of all premature deaths worldwide.

Hungry people can't work their way out of poverty, the Nobel Prize-winning economist Robert Fogel points out. He estimates that in 1790, about 20 percent of the population of England and France was effectively excluded from the labor force because they were too weak and hungry to work. Improved nutrition, he calculates, accounted for about half of all European economic growth during the nineteenth century. Since many developing countries are as poor now (in relative terms) as Britain and France were in 1790, his analysis suggests that reducing hunger could yield more than \$120 billion (U.S.) in economic growth produced by longer, healthier, more productive lives for several hundred million people.

The 2003 UN World Food Summit reaffirmed the goal set by previous conventions of reducing the number of chronically undernourished people from 850 million to 400 million by 2015. We aren't on track to meet that goal, but some countries have made impressive progress. China, alone, has reduced its number of undernourished people by 74 million over the past decade. Indonesia, Vietnam, Thailand, Nigeria, Ghana, and Peru each reduced chronic

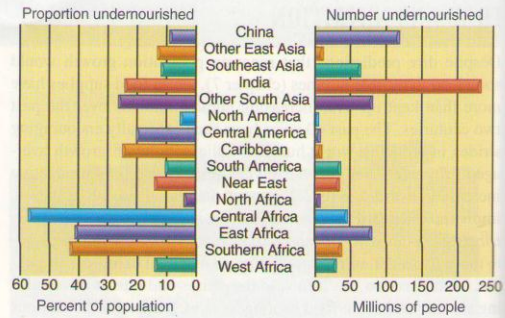


Figure 9.6 Number and percent of population chronically undernourished by region in the developing world. Source: Food and Agriculture Organization (FAO), 2002.

hunger by about 3 million people. In 47 other countries, however, the numbers of chronically underfed people have increased. India now has by far the largest number of persistently hungry people in the world, while central Africa has the highest percentage (fig. 9.6).

Recognizing the role of women in food production is an important step toward food security for all. Throughout the developing world, women do 50 to 70 percent of all farm work but control only a tiny fraction of the land and rarely have access to capital or developmental aid. In Nigeria, for example, home gardens occupy only 2 percent of all cropland, but provide half the food families eat. Making land, credit, education, and access to markets available to women could contribute greatly to family nutrition.

Famines are acute food emergencies

The chronic hunger and malnutrition described in the previous section is silent and generally invisible, affecting individuals, families, and communities, often in the midst of general plenty, but **famines** are characterized by large-scale food shortages, massive starvation, social disruption, and economic chaos. Starving people eat their seed grain and slaughter their breeding stock in a desperate attempt to keep themselves and their families alive. Even if better conditions return, they have sacrificed their productive capacity and will take a long time to recover. Famines are characterized by mass migrations as starving people travel to refugee camps in search of food and medical care (fig. 9.7). Many die on the way or fall prey to robbers.

In 2005, the FAO reported that 60 million people in 36 countries (two-thirds of them in sub-Saharan Africa) needed emergency food aid. What causes these emergencies? Environmental conditions, such as the 2004 Indian Ocean tsunami, are usually the immediate trigger, but politics and economics are often equally important. Bad weather, insect outbreaks (see Case Study: A Plague of Locusts, p. 127), and other natural disasters cause crop failures and create food shortages. But the Nobel Prize-winning work of Harvard economist Amartya K. Sen shows that these factors have often



Figure 9.7 Children wait for their daily ration of porridge at a feeding station in Somalia. When people are driven from their homes by hunger or war, social systems collapse, diseases spread rapidly, and the situation quickly becomes desperate.

been around for a long time, and local people usually have adaptations to get through hard times if they aren't thwarted by inept or corrupt governments and greedy elites. National politics, however, together with commodity hoarding, price gouging, poverty, wars, selfishness, and other external factors often conspire so that poor people can neither grow their own food nor find jobs to earn money to buy the food they need. Professor Sen points out that armed conflict and political oppression almost always are at the root of famine. No democratic country with a relatively free press, he says, has ever had a major famine.

The aid policies of rich countries often serve more to get rid of surplus commodities and make us feel good about our generosity than to get at the root causes of starvation. But herding people into feeding camps often is the worst thing to do for them. The stress of getting there kills many of them, and the crowding and lack of sanitation in the camps exposes them to epidemic diseases. There are no jobs in the refugee camps, so people can't support themselves if they try. Social chaos and family breakdown expose those who are weakest to robbery and violence. Having left their land and tools behind, people can't replant crops when the weather turns to normal.

We need the right kinds of food

In addition to energy (calories), we also need specific nutrients in our diet, such as proteins, vitamins, and certain trace minerals. You might have more than enough calories and still suffer from **malnourishment**, a nutritional imbalance caused by a lack of specific dietary components or an inability to absorb or utilize essential nutrients.

Many poor people can't afford meat, fruits, and vegetables that would provide a balanced diet. The FAO estimates that nearly 3 billion people (half the world population) suffer from vitamin, mineral, or protein deficiencies. This results in devastating illnesses and deaths as well as reduced mental capacity, developmental abnormalities, and

stunted growth. Altogether, these problems bring an incalculable loss of human potential and social capital.

Anemia (low hemoglobin levels in the blood, usually caused by dietary iron deficiency) is the most common nutritional problem in the world. According to the FAO, more than 2 billion people (52 percent are pregnant women and 39 percent are children under age 5) suffer from iron deficiencies. The problem is most severe in India, where it's estimated that 80 percent of all pregnant women are anemic. Anemia increases the risk of maternal deaths from hemorrhage in childbirth and affects childhood development. Red meat, eggs, legumes, and green vegetables all are good sources of dietary iron.

Iodine is essential for synthesis of thyroxin, an endocrine hormone that regulates metabolism and brain development, among other things. Chronic iodine deficiency causes goiter (a swollen thyroid gland, fig. 9.8), stunted growth, and reduced mental ability. The FAO estimates that 740 million people—mainly in South and Southeast Asia—suffer from iodine deficiency and that 177 million children have stunted growth and development. Adding a few pennies worth of iodine to our salt has largely eliminated this problem in developed countries.

Starchy foods like maize (corn), polished rice, and manioc (tapioca), which form the bulk of the diet for many poor people, tend to be low in several essential vitamins as well as minerals. According to the FAO, vitamin A deficiencies affect 100–140 million children at any given time. At least 350,000 go blind every year from the effects of this vitamin shortage. Folic acid (found in dark green, leafy vegetables) is essential for early fetal development. Folic acid deficiencies have been linked to neurological problems in babies including microencephaly (an abnormally small head) or even anencephaly (lacking a brain).

Protein is also essential for normal growth and development.

The two most widespread human protein deficiency diseases are kwashiorkor and marasmus. **Kwashiorkor** is a West African word meaning "displaced child." (A young child is displaced—and deprived of nutritious breast milk—when a new baby is born.) This condition most often occurs in young children who eat mainly cheap starchy food and don't get enough good-quality protein. Children with kwashiorkor often have reddish-orange hair, puffy, discolored skin, and a bloated belly. **Marasmus** (from the Greek "to waste away") is caused by a diet low in both calories and protein. A child suffering from severe marasmus is generally thin and shriveled, like



Figure 9.8 Goiter, a swelling of the thyroid gland at the base of the neck, is often caused by an iodine deficiency. It is a common problem in many parts of the world, particularly where soil iodine is low and seafood is unavailable.

a tiny, very old starving person (fig. 9.9). Children with both these deficiencies have low resistance to infections and are likely to suffer from stunted growth, mental retardation, and other developmental problems. Altogether, the FAO estimates that the annual losses due to deaths and diseases caused by calorie and nutrient deficiencies are equivalent to 46 million years of productive life (see more in chapter 8 on disability-adjusted life years).

Eating a balanced diet is essential for good health

Those of us in richer countries often eat too much meat, salt, and saturated fat, and too little fiber, vitamins, trace minerals, and other components lost from highly processed foods. On average, we consume about one-third more calories than we need and get too little exercise. Food provides solace in stressful lives, and we're constantly bombarded with advertising tempting us to consume more. According to the U.S. Surgeon General, 62 percent of all adult Americans are overweight, up from 40 percent only a decade ago, and about one-third of us are seriously overweight or **obese**—generally considered to be a body mass greater than 30 kg/m², or roughly 30 pounds above normal for an average person.

Being overweight substantially raises your risk of hypertension, diabetes, heart attacks, stroke, gallbladder disease, osteoarthritis, respiratory problems, and certain cancers. Every year, about 300,000 in the United States die from illnesses related to obesity. This number is close to the 400,000 annual deaths from diseases related to smoking. Paradoxically, food insecurity and poverty can contribute to obesity. In one study, more than half of the women who reported not having enough to eat were overweight compared to one-third of food-secure

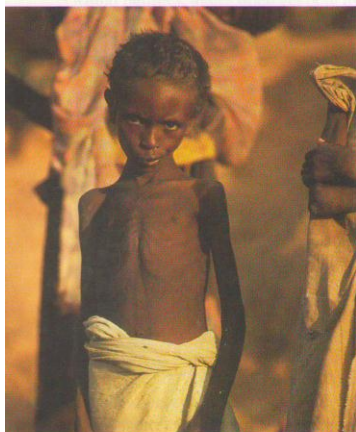


Figure 9.9 Marasmus is caused by combined energy (calorie) and protein deficiencies. Children with marasmus have the wizened look and dry, flaky skin of an old person.

women. Lack of time for cooking and access to health food choices along with ready availability of fast-food snacks and calorie-laden drinks lead to dangerous dietary imbalances for many people.

This trend isn't limited to richer countries. Obesity is spreading around the world (fig. 9.10). For the first time in history, there are probably more overweight people (more than 1 billion) than underweight. As chapter 8 points out, western diets and lifestyles are being adopted by many in the developing world, and diseases such as heart attack, stroke, diabetes, and depression that once were thought to inflict only wealthy

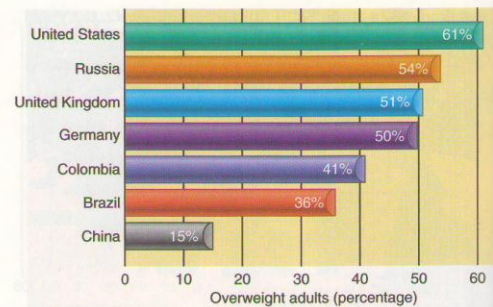


Figure 9.10 While nearly a billion people are chronically undernourished, people in wealthier countries are at risk from eating too much. Source: Worldwatch Institute, 2001.

nations are now becoming the most prevalent causes of death and disability everywhere.

What's the best way to be sure you're getting a healthy diet? Generally, it isn't necessary to take synthetic dietary supplements. Eating a good variety of foods should give you all the nutrients you need. For years, Americans were advised to eat daily servings of four major food groups: meat, dairy products, grains, and fruits and vegetables. These recommendations were revised in 1992 to emphasize only sparing servings of meat, dairy, fats, and sweets.

Some nutritionists believe that the 1992 recommendations for 6 to 11 servings a day of bread, cereal, rice, and pasta still provides too

TABLE 9.1

Some Important Food Sources

Crop	2004 Yield (Million Metric Tons)
Wheat	620
Rice (paddy)	610
Maize (corn)	643
Potatoes	310
Coarse grains*	1,013
Soybeans	221
Cassava and sweet potato	449
Sugar (cane and beet)	144
Pulses (beans, peas)	55
Oil seeds	375
Vegetables and fruits	1,206
Meat and milk	870
Fish and seafood	140

*Barley, oats, sorghum, rye, millet.

Source: Food and Agriculture Organization (FAO), 2005.

A few major crops supply most of our food

The three crops on which humanity depends for the majority of its nutrients and calories are wheat, rice, and maize (called corn in the United States). Together, 1,900 million metric tons of these three grains are grown each year. Wheat and rice are especially important since they are the staple foods for most of the 5 billion people in the developing countries of the world. These two grass species supply around 60 percent of the calories consumed directly by humans.

Potatoes, barley, oats, and rye are staples in mountainous regions and high latitudes (northern Europe, north Asia) because they grow well in cool, moist climates. Cassava, sweet potatoes, and other roots and tubers grow well in warm, wet areas and are staples in Amazonian, Africa, Melanesia, and the South Pacific. Barley, oats, and rye can grow in cool, short-season climates. Sorghum and millet are drought resistant and are staples in the dry regions of Africa.

Fruits, vegetables, and vegetable oils make a surprisingly large contribution to human diets. They are especially welcome because they typically contain high levels of vitamins, minerals, dietary fiber, and complex carbohydrates.

Meat and dairy are important protein sources

Protein-rich foods are prized by people nearly everywhere. In the past, the rich countries consumed a vast majority of the meat, dairy, and high-quality seafood traded internationally. The four-fifths of the world's people in less-developed countries generally raised 60 percent of the 3 billion domestic ruminants and 6 billion poultry in the world but consumed only one-fifth of all commercial animal products. The FAO reports, however, that as incomes rise in developing countries, food choices throughout the world are shifting toward higher-quality and more expensive foods. Meat consumption in developing countries, for example, has risen from only 10 kg per person annually in the 1960s to 26 kg currently (fig. 9.12). By 2030, average annual meat consumption in those countries is expected to be nearly 40 kg per person. As the opening case study for this chapter shows, much of the increased soybean production in Brazil has gone to fuel this rapid growth in meat

FOOD SOURCES

thousands of edible plants and animals in the world, only a few hundred types of seeds and grains, three root crops, twenty common fruits and vegetables, six mammals, two domestic

Multiple vitamins (for most people)
Alcohol in moderation (unless not advised)
Dairy or calcium supplements (1-2 servings)
Fish, poultry, eggs (0-2 servings)
Nuts and legumes (1-3 servings)
Vegetables (in abundance)
Grains (most meals)
Exercises and weight control

Red meat and butter (use sparingly)
White rice, pasta, white bread, potatoes, sugar (use sparingly)
Plant oils (olive, corn, canola, soy, sunflower) (at most meals)

Figure 9.11 A food pyramid proposed by Drs. Walter Willett and Meir Stampfer deemphasizes consumption of red meat, butter, white rice, potatoes, and pasta, and suggests a diet rich in whole grains, unsaturated plant oils, fruits, and vegetables. Source: Willett and Stampfer, 2002.

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Figure 9.12 Meat and dairy consumption have quadrupled in the past 40 years, and China represents about 40 percent of that increased demand.

consumption. Far more grain will be needed to raise livestock if this trend continues.

Most of the livestock grown in North America are confined in **concentrated animal feeding operations (CAFOs)** for part or all of their lifetime. A diet rich in grain, oil, and protein fattens animals quickly and produces meat preferred by many consumers. Globally, some 680 million metric tons of cereals are used as livestock feed each year, representing more than one-third of the total maize, soy, and coarse grain production. It's often pointed out that we could feed about ten times as many people if we ate grain directly rather than feeding it to livestock. Surprisingly, the FAO



Figure 9.13 Most livestock grown in the United States are raised in large-scale, concentrated animal-feeding operations. Up to a million animals can be held in a single facility. High population densities require heavy use of antibiotics and can cause severe local air and water pollution.

claims that using cereals as animal feed does not contribute to hunger and under nutrition. Given current agricultural economics, if these cereals were not used as animal feed, they would probably not be produced at all, and thus would not be available as food. According to this view, if everyone became a vegetarian, the lack of demand for cereals for livestock production would simply lead to lower crop production, not more food for the hungry.

The rapid proliferation of CAFOs raises a number of social and environmental concerns. Housing up to a million animals in a single facility can cause serious local air and water pollution (fig. 9.13). Altogether, CAFOs in the United States are estimated to generate some 500 million metric tons of manure annually, or roughly 25 times all the human waste produced in the country each year. Storage and disposal of this waste is a serious problem. CAFOs are almost never served by sewage treatment plants. Land disposal of waste overloads soil with nutrients and can contaminate groundwater supplies. Local residents often find the stench of so many animals and so much waste overwhelming. A study by the University of North Carolina found that people living near large CAFOs suffer high levels of respiratory illness. Many communities have tried to restrict or regulate CAFOs, but find it difficult to do.

Animal wastes, particularly from hog farms, often are stored in huge open lagoons that can leak or rupture, poisoning local surface waters. In 1999, for example, Hurricane Floyd dumped torrential rains on North Carolina. An estimated 10 million m³ (2.5 billion gal) of hog and poultry waste overflowed from storage lagoons into local rivers. Bacterial growth, which was stimulated by the manure, deoxygenated the water, killed millions of fish, and created a "dead zone" in Pamlico Sound that lasted for months.

The high density of animals in these facilities and the rich diet they're fed to speed weight gain requires a constant use of antibiotics and growth hormones. About 25 million pounds of antibiotics are added to animal feed annually in the United States, mostly in CAFOs. This is eight times as much as is used in human therapy. A big part of the rapid rise in antibiotic resistant pathogens is due to this massive and constant dosing of domestic livestock with drugs.

Seafood is another important protein source

The 140 million metric tons of seafood eaten every year is an important part of our diet. Seafood provides about 15 percent of all animal protein eaten by humans, and is the main animal protein source for about 1.5 billion people in developing countries. Unfortunately, overharvesting and habitat destruction threaten most of the world's wild fisheries. Annual catches of ocean fish rose by about 4 percent annually between 1950 and 1988. Since 1989, however, 13 of 17 major marine fisheries have declined dramatically or become commercially unsustainable. According to the United Nations, three-quarters of the world's edible ocean fish, crustaceans, and mollusks are declining and in urgent need of managed conservation.

The problem is too many boats using efficient but destructive technology to exploit a dwindling resource base. Boats as big as

...fishers travel thousands of kilometers and drag nets large enough to scoop up a dozen jumbo jets, sweeping a large patch of ocean clean of fish in a few hours. Long-line fishing boats set cables up to 30 km long with hooks every 2 meters that catch birds, turtles, and other unwanted "by-catch" along with targeted species. Fishers drag heavy nets across the bottom, scooping up everything indiscriminately and reducing broad swaths of habitat to rubble. The marine biologist compared the technique to harvesting mushroomrooms with a bulldozer. In some operations, up to 15 tons of dead and dying by-catch is dumped back into the ocean every kilogram of marketable food. The FAO estimates that fishing costs for the 4 million boats now harvesting wild fish exceed sales by \$50 billion (U.S.) per year. Countries subsidize fishing fleets to preserve jobs and to ensure access to this valuable resource.

Think About It

...Americans spend a smaller proportion of their income on food than any other industrial nation. A major reason for this is that we have industrialized our food supply in the same way that we produce cars, shoes, and television sets. Are there reasons that we should treat food differently from other commodities? What would be our ideal food production system? What could you do to attain that ideal?

Aquaculture (growing aquatic species in net pens or tanks) now produces about one-quarter of the world's seafood. Fish can be raised in farm ponds that take relatively little space but are highly productive. Cultivation of high-value carnivorous species, however, such as salmon, sea bass, and tuna threaten wild stocks if used to stock captive operations or to provide fish food. Building artificial fish-rearing ponds causes destruction of hundreds of hectares of mangrove forests and wetlands that serve as irreplaceable nurseries for marine species. Net pens anchored in shallow areas allow spread of diseases, escape of exotic species, release of feces, uneaten food, antibiotics, and other pollutants into surrounding ecosystems (fig. 9.14).

Aquaculture systems of mixed species of herbivores or filter feeders can alleviate many aquaculture problems. Raising species in enclosed, land-based ponds or warehouses can eliminate the disease problems associated with net pens in lakes or oceans. In Asia, for example, most fish are raised in ponds or rice paddies. An ecologically balanced system uses four carp species that feed at different levels of the food chain. The grass carp, as its name implies, feeds largely on vegetation, while the common carp is a bottom feeder, living on detritus that settles to the bottom. Silver carp and bighead carp are filter feeders that feed on phytoplankton and zooplankton, respectively. Agricultural wastes such as manure, fish silk worms, and rice straw fertilize ponds and encourage phytoplankton growth. All these carp species are considered dangerous invasive species in North America. Still, these integrated aquaculture systems typically boost fish yields per hectare by 50 percent or more compared with monoculture farming. Of the top 10 food species recommended by the Monterey Aquarium as ecologically acceptable, six are farmed.

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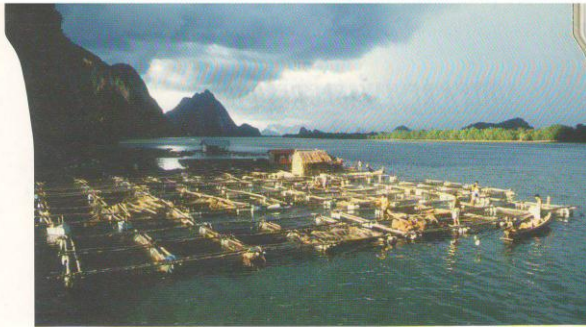


Figure 9.14 Pens for fish-rearing in Thailand.

FARM POLICY

Much of the increase in food production over the past 50 years has been fueled by public support for agricultural education, research, and development projects such as irrigation systems, transportation networks, and crop insurance. While helping local farmers, agricultural subsidies also can distort markets and cripple production in developing countries. The World Bank estimates that rich countries pay their own farmers \$350 billion per year, or nearly six times as much as all developmental aid to poor countries. A typical cow in Europe enjoys annual subsidies three times the average yearly income for African farmers. In the past, European countries have had the highest aid per farm, but recent policy reforms have promised to decouple farm support from crop production.

Farm subsidies in many countries are protected by powerful political and economical interests. The most recent U.S. Farm Bill, for example, promised \$180 billion in payments over the next decade for American farmers. Most of this aid goes to heavily supported crops such as corn, wheat, cotton, rice, and soybeans along with certain specially protected commodities such as milk, sugar, and peanuts. For some crops, this bill represented an 80 percent increase in support. Legislators claimed that subsidies are intended to preserve "family farms," but analysis of previous payments shows that 10 percent of all farms received 70 percent of all support. One giant farm in Arkansas, for example, received \$38 million in payments between 1996 and 2001.

Agricultural subsidies encourage surpluses and allow American farmers to sell their products overseas at as much as 20 percent below the actual cost of production. This makes imported food cheaper than locally grown crops in many developing countries, and destroys the livelihoods of millions of indigenous farmers. The FAO argues that ending distorting financial support in the richer countries would have a far more positive impact on food supplies and livelihoods in the developing world than any aid program. In 2005, the World Trade Organization (WTO) ruled that American farm subsidies are illegal. This ruling could have dramatic implications for international agriculture. What do you think? Does agriculture deserve special protections that we don't extend to other sectors of our economy? How might we protect our own farms without threatening those of our global neighbors?