but now farmers are far more likely to specialize, growing corn for livestock feed, for example, or raising hogs. In crop agriculture, specialization means monoculture — growing only one crop in a field, often on a very extensive scale. Monoculture allows more efficient use of farm machinery for cultivation, sowing, weed control, and harvest, and can create economies of scale with regard to purchase of seeds, fertilizer, and pesticides. Monoculture is a natural outgrowth of an industrial approach to agriculture, where labor inputs are minimized and technology-based inputs are maximized in order to increase productive efficiency. Monoculture techniques mesh well with the other practices of modern agriculture: monoculture tends to favor intensive cultivation, application of inorganic fertilizer, irrigation, chemical control of pests, and specialized plant varieties. The link with chemical pesticides is particularly strong; vast fields of the same plant are more susceptible to devastating attack by specific pests and diseases and require protection by pesticides.

Application of Synthetic Fertilizer

The spectacular increases in yields in the second half of the 20th century were due in large part to the widespread and intensive use of synthetic chemical fertilizers. In the U.S., the amount of fertilizer applied to fields each year increased rapidly after World War II, from 9 million tons in 1940 to more than 47 million tons in 1980. Worldwide, the use of fertilizer increased tenfold between 1950 and 1992; since then, the increase has moderated, but in 2002, the total world consumption of fertilizers was estimated to be 141.6 million metric tons (FAOSTAT, 2005).

Produced in large quantities at relatively low cost using fossil fuels and mined mineral deposits, fertilizers can be applied easily and uniformly to crops to supply them with ample amounts of the most essential plant nutrients. Because they meet plants' nutrient needs for the short term, fertilizers have allowed farmers to ignore long-term soil fertility and the processes by which it is maintained.

The mineral components of synthetic fertilizers, however, are easily leached out of the soil. In irrigated systems, the leaching problem may be particularly acute; a large amount of the fertilizer applied to fields actually ends up in streams, lakes, and rivers, where it causes *eutrophication* (excessive growth of oxygen-depleting plant and algal life). Fertilizer can also be leached into groundwater used for drinking, where it poses a significant health hazard. Furthermore, the cost of fertilizer is a variable over which farmers have no control since it rises with increases in the cost of petroleum.

Irrigation

An adequate supply of water is the limiting factor for food production in many parts of the world. Thus supplying water to fields from underground aquifers, reservoirs, and diverted rivers has been key to increasing overall yield and the amount of land that can be farmed. Although only 18% of the world's crop land is irrigated (FAOSTAT, 2005), this land produces 40% of the world's food (Serageldin, 1995; FAO, 2002). Currently, there are more than 44 ha of irrigated land per 1000 people in the world (FAOSTAT, 2005).

All sectors of society have placed rapidly increasing demands on fresh water supplies over the past half-century, but agricultural purposes account for the lion's share of the demand — about 70% of water use worldwide (Postel and Vickers, 2004). Unfortunately, agriculture is such a prodigious user of water that in many areas where land is irrigated for farming, irrigation has a significant effect on regional hydrology. One problem is that groundwater is often pumped faster than it is renewed by rainfall. This overdraft can cause land subsidence, and near the coast it can lead to saltwater intrusion. In addition, overdrafting groundwater is essentially borrowing water from the future. Where water for irrigation is drawn from rivers, agriculture is often competing for water with water-dependent wildlife and urban areas. Where dams have been built to hold water supplies, there are usually dramatic effects downstream on the ecology of rivers. Irrigation has another type of impact as well: it increases the likelihood that fertilizers will be leached from fields and into local streams and rivers, and it can greatly increase the rate of soil erosion.

Chemical Pest and Weed Control

After World War II, chemical pesticides were widely touted as the new, scientific weapon in humankind's war against plant pests and pathogens. These chemical agents had the appeal of offering farmers a way to rid their fields once and for all of organisms that continually threatened their crops and literally ate up their profits. But this promise has proven to be false. Pesticides can dramatically lower pest populations in the short term, but because they also kill pests' natural predators, pest populations can often quickly rebound and reach even greater numbers than before. The farmer is then forced to use even more of the chemical agents. The dependence on pesticide use that results has been called the "pesticide treadmill." Augmenting the dependence problem is the phenomenon of increased resistance: pest populations continually exposed to pesticides are subjected to intense natural selection for pesticide resistance. When resistance among the pests increases, farmers are forced to apply larger amounts of pesticide or to use different pesticides, further contributing to the conditions that promote even greater resistance.

Although the problem of pesticide dependence is widely recognized, many farmers — especially those in developing nations — do not use other options. Even in the U.S., the amount of pesticides applied to major field crops, fruits, and vegetables each year remains at twice

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FIGURE 1.2 Broadcast spraying to control codling moth in an apple orchard in the Pajaro Valley, California.

of their nonhybrid cousins. In addition, hybrid plants cannot produce seeds with the same genome as their parents, making farmers dependent on commercial seed producers.

More recently, breakthroughs in genetic engineering have allowed the customized production of plant and animal varieties through the ability to splice genes from a variety of organisms into the target genome. The resulting organisms are referred to as *transgenic*, *genetically modified* (GM), or *genetically engineered* (GE).

Only a few animal species used for food have been genetically engineered as yet — these include pigs with spinach genes that produce lower-fat bacon and cows that produce milk with higher casein levels — but transgenic crop plants are now widespread and important in agricultural production. Between 1996 and 2003, the area planted to genetically engineered crops worldwide increased almost 40-fold, from 1.7 million ha to 67.7 million ha (James, 2003). The U.S., Argentina, Canada, Brazil, China, South Africa, Australia, and India all planted at least 100,000 ha to transgenic crops in 2003. Of the world's soybean crop, 55% was transgenic in 2003, as was 21% of the world's cotton crop (James, 2003).

Although genetically engineered organisms hold many promises — reducing the use of pesticides and irrigation, allowing agriculture on soils too saline for normal crops, and increasing the nutritional value of some crops — there are many concerns about the spread of this and related biotechnologies. The main source of concern is the potential for the migration of modified genes into other populations, both wild and domestic. This could result, for example, in more aggressive weeds or the introduction of toxins into crop plants. Increased use of transgenic crops may also diminish biodiversity, as traditional cultivars are abandoned, and increase the dependence of farmers on the transnational corporations owning the patents on the new organisms.

Factory Farming of Animals

If you live in a developed country, a large portion of the meat, eggs, and milk that you eat probably comes from large-scale, industrialized operations driven by the goal of bringing these food products to market at the lowest possible unit cost. The animals in these "confined animal feeding operations" (CAFOs) are typically crowded so tightly they can barely move, given antibiotics to prevent

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WHY CONVENTIONAL AGRICULTURE IS NOT SUSTAINABLE

The practices of conventional agriculture all tend to compromise future productivity in favor of high productivity in the present. Therefore, signs that the conditions necessary to sustain production are being eroded should be increasingly apparent over time. Today, there is in fact a growing body of evidence that this erosion is underway. In the last 15 yr, for example, all countries in which Green Revolution practices were adopted at a large scale have experienced declines in the annual growth rate of the agricultural sector. Further, in many areas where modern practices were instituted for growing grain in the 1960s (improved seeds, monoculture, and fertilizer application), yields have begun to level off and have even decreased following the initial spectacular improvements in yield. Mexico, for example, has seen little change in wheat yields since 1980, after climbing from about 0.9 tons/ha in 1950 to 4.4 tons in 1982 (Brown, 2001). For the world as a whole, the rise in land productivity has slowed markedly since about 1990. In the 40 years before 1990, world grain yield per hectare rose an average of 2.1% a year, but between 1900 and 2000, the annual gain was only 1.1 percent (Brown, 2001). From 2000 to 2003, global grain reserves shrank alarmingly every year, from 635 million tons (a 121-d supply), to 382 million tons (a 71-d supply).

Figure 1.4 shows the world's annual per capita grain production for each year from 1961 to 2004, as calculated by the Food and Agriculture Organization (FAO) of the United Nations. These data indicate that after trending upward for many years, per capita production of cereal grains has trended downward since reaching a peak in 1984. This situation is the result of reduced annual yield increases combined with continued logarithmic population growth.

The ways in which conventional agriculture puts future productivity at risk are many. Agricultural resources such as soil, water, and genetic diversity are overdrawn and degraded, global ecological processes on which agriculture ultimately depends are altered, human health suffers, and the social conditions conducive to resource conservation are weakened and dismantled. In economic terms, these adverse impacts are called *externalized costs*. They are real and serious, but because their consequences can be temporarily ignored or absorbed by society in general, they are excluded from the cost–benefit calculus that allows conventional agricultural operations to continue to make economic "sense."

Soil Degradation

Every year, according to the Food and Agriculture Organization of the United Nations, between 5 and 7 million ha of valuable agricultural land are lost to soil degradation. Other estimates run as high as 10 million ha per year (e.g., World Congress on Conservation Agriculture, 2001). Degradation of soil can involve salting, waterlogging, compaction, contamination by pesticides, decline in the quality of soil structure, loss of fertility, and erosion by wind and water. Although all these forms of soil degradation are severe problems, erosion is the most widespread. Worldwide, 25,000 million tons of topsoil are washed away annually (Loftas et al., 1995). Soil is lost to wind and water erosion at the rate of 5 to 10 tons/ha

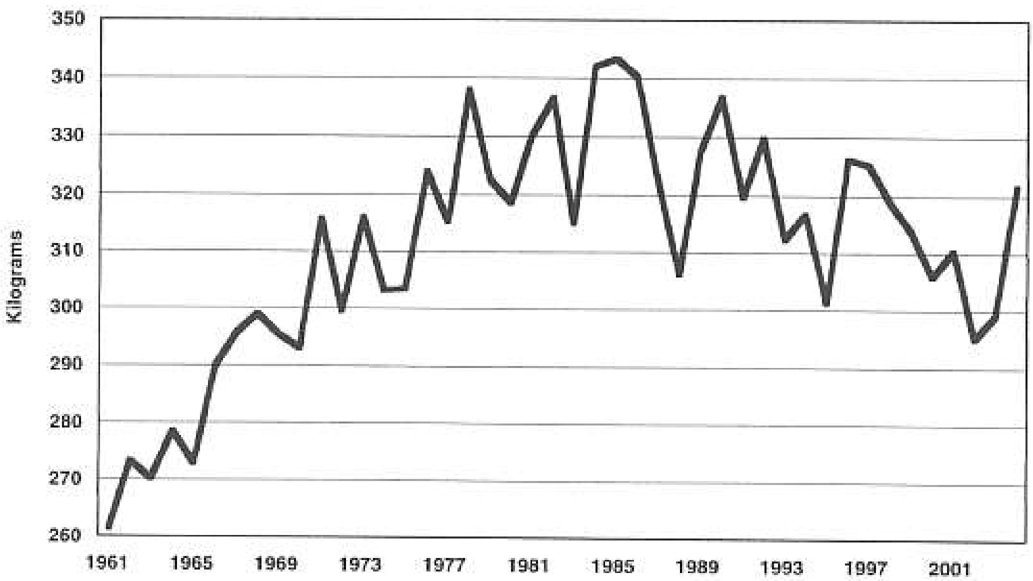

FIGURE 1.4 Worldwide grain production per capita, 1961 to 2004. *Data source*: Food and Agricultural Organization, FAOSTAT database; Worldwatch Institute.

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Overuse of Water and Damage to Hydrological Systems

Fresh water is becoming increasingly scarce in many parts of the world as industry, expanding cities, and agriculture compete for limited supplies. Some countries have too little water for any additional agricultural or industrial development to occur. To meet demands for water in many other places, water is being drawn from underground aquifers much faster than it can be replenished by rainfall, and rivers are being drained of their water to the detriment of aquatic and riparian ecosystems and their dependent wildlife. Many of the world's major rivers — including the Colorado, Ganges, and Yellow — now run dry for part of the year as a result.

Agriculture accounts for more than two thirds of global water use. For every person on the planet, there are more than 0.04 ha of irrigated land. Agriculture uses so much water in part because it uses water wastefully. More than half of the water applied to crops is never taken up by the plants it is intended for (Van Tuijl, 1993). Instead, this water either evaporates or drains out of fields. Some wastage of water is inevitable, but a great deal of waste could be eliminated if agricultural practices were oriented toward conservation of water rather than maximization of production. For example, crop plants could be watered with drip irrigation systems, and production of water-intensive crops such as rice could be shifted away from regions with limited water supplies.

The increasing importance of meat in human diets worldwide is another factor in agriculture's rising demand for water, as is the trend toward concentrated grain feeding of livestock. Animal factories use prodigious amounts of water for cooling the animals and flushing their wastes, and many animals drink large amounts of water. Hogs, for example, can consume up to 8 gallons per animal per day (Marks and Knuffke, 1998). And these are just the direct uses of water for raising livestock. Factoring in the water needed to grow the biomass fed to animals, animal-derived food requires at least twice as much water to produce as plant-derived food, and usually much more.

FIGURE 1.6 The San Luis Dam in California. Built in part to hold irrigation water for farms on the west side of the San Joaquin Valley, it is one of an estimated 800,000 dams in the world that trap life-giving silt, destroy riverine and riparian ecosystems, and completely alter natural hydrological functioning.

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THE GULF OF MEXICO'S HYPOXIC "DEAD ZONE"

Every summer, a large area of the Gulf of Mexico near the mouth of the Mississippi River loses most of its dissolved oxygen and thus its ability to support nearly all species of marine life. It has been appropriately named the "dead zone." The size of the dead zone varies, but in recent years it has been alarmingly large; in 2002 it encompassed about 8500 square miles, nearly the size of New Jersey. The dead zone has many direct negative effects on human society, most notably threatening the important commercial fisheries of the Gulf coast region by killing fish and shrimp directly, compromising the ability of many species to reproduce, and altering migration patterns.

The dead zone is a direct result of massive amounts of nitrogen and phosphorus leaching out of the agricultural lands of the Mississippi River basin and causing excessive growth ("blooms") of phytoplankton in the Gulf. When the phytoplankton die, their decomposition by bacteria uses up much of the oxygen dissolved in the water. The relatively calm summer weather prevents mixing of the water column, resulting in the sustained hypoxic (low oxygen) conditions that kill fish and bottom-dwelling organisms.

The dead zone phenomenon shows the multifaceted and interrelated ways in which conventional agriculture impacts the environment. Irrigation, intensive tillage, monoculture, over-application of inorganic fertilizer, and factory farming of animals all play a role in causing unnaturally large amounts of nitrogen and phosphorus to flow into the Gulf of Mexico.

A little more than half of the excess nitrogen (an estimated 56%) comes from the inorganic fertilizer applied to fields in Kansas, Missouri, the Dakotas, Arkansas, and the other agricultural states in the Mississippi's vast watershed. Much of this nitrogen leaches into the region's rivers because much more nitrogen is applied than can be taken up by plants or chemically bound in the soil; excess fertilizer is applied because monocropped high-yield varieties require it for maximum production. And even more nitrogen ends up in the rivers because of irrigation and the erosion caused by intensive tillage.

About 25% of the excess nitrogen, and an even greater proportion of the excess phosphorus, comes from the animal waste produced by hog, poultry, and cattle CAFOs. These nutrients find their way into the rivers from manure spills, leaching of manure-treatment lagoons, and leaching from the excess treated manure applied to fields.

Ironically, if the Mississippi River and its tributaries were not so thoroughly engineered for human purposes — dammed for flood control and irrigation, channelized and locked for shipping—its healthy aquatic and wetland ecosystems and functioning floodplains would be able to remove much of the excess nitrogen and phosphorus from the rivers before these nutrients reached the Gulf of Mexico. Since much of the altering of the rivers in the Mississippi's watershed was done for the sake of agriculture — irrigation and transport of agricultural commodities — this is just one more way in which conventional agriculture is implicated in a continuing environmental disaster with huge impacts on human society.

FIGURE 1.7 Satellite image of the "dead zone" in the Gulf of Mexico. The darker areas indicate highly turbid waters with high concentrations of phytoplankton fed largely by agricultural runoff from the huge Mississippi River basin. The phytoplankton in the blooms will die and sink to the bottom, causing bacterial decay that removes oxygen from the surrounding water. *Source*: NASA.

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of having a large genetic reservoir can be illustrated by example. In 1968, greenbugs attacked the U.S. sorghum crop, causing an estimated $100 million in damage. The next year, insecticides were used to control the greenbugs at a cost of about $50 million. Soon thereafter, however, researchers discovered a sorghum variety that carried resistance to the greenbugs. No one had known of the greenbug resistance, but it was there nonetheless. This variety was used to create a hybrid that was grown extensively and not eaten by greenbugs, making the use of pesticides unnecessary. Such pest resistance is common in domesticated plants, "hiding" in the genome but waiting to be used by plant breeders. As varieties are lost, however, the valuable genetic reservoir of traits is reduced in size, and certain traits potentially invaluable for future breeding are lost forever. There may very well be a soybean variety somewhere in the world resistant to the new soybean rust, but will plant scientists locate it before it goes extinct?

Increasing vulnerability to disease is also a serious concern for domesticated animal species as they lose their genetic diversity, but perhaps more serious is increased dependence on methods of industrial food production. Livestock breeds that are not adapted to local conditions require climate-controlled environments, doses of antibiotics, and large amounts of high-protein feed.

Loss of Local Control Over Agricultural Production

Accompanying the concentration of agriculture into large-scale monocultural systems and factory farms has been a dramatic decline in the number of farms and farmers, especially in developed countries where mechanization and high levels of external inputs are the norm. From 1920 to the present, the number of farms in the U.S. has dropped from more that 6.5 million to just over 2 million, and the percentage of the population that lives and works on farms has dropped below 2%. Data from the 2000 U.S. census show that only 0.4% of the employed civilians in the U.S. listed their occupation as "farmer or rancher" (U.S. Census Bureau, 2005). In developing countries as well, rural people who work primarily in agriculture continue to abandon the land to move to urban and industrial areas, which will hold an estimated 60% of the world's population by 2030. As shown in Figure 1.8, there are now far more people in the world whose livelihoods are nonagricultural than there are people who grow food, and this gap continues to widen over time.

Besides encouraging an exodus from rural areas, large-scale commodity-oriented farming tends to wrest control of food production from rural communities. This trend is disturbing because local control and place-based knowledge and connection are crucial to the kind of management required for sustainable production. Food production carried out according to the dictates of the global market, and through technologies developed elsewhere, inevitably severs the connection to ecological principles. Experience-based management skill is replaced by purchased inputs requiring more capital, energy, and use of nonrenewable resources. Farmers become mere instruments of technology application, rather than independent decision-makers and managers.

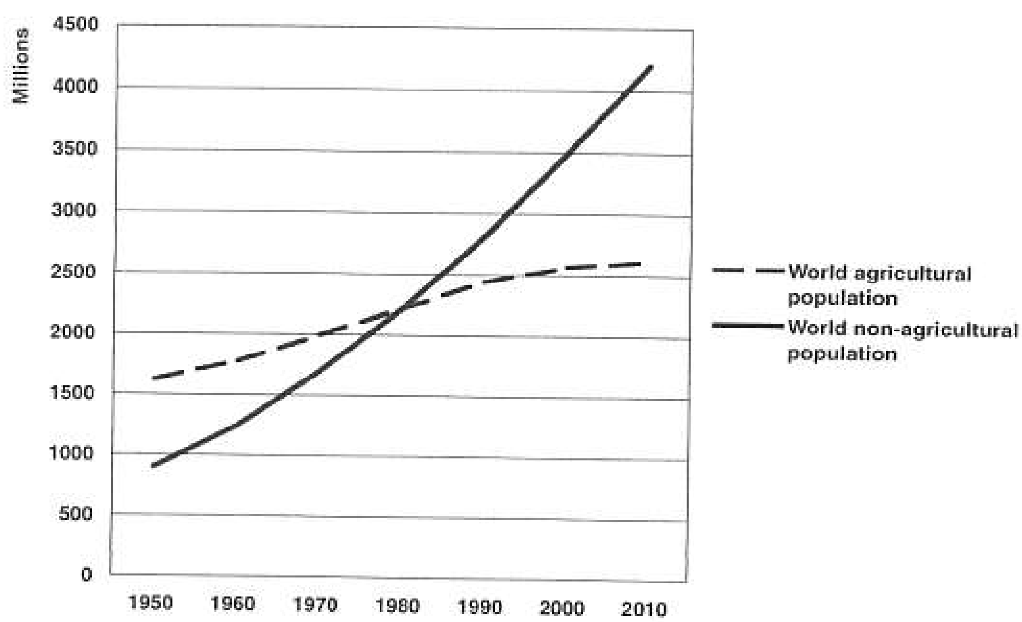

FIGURE 1.8 Number of people worldwide involved in agriculture and not involved in agriculture. *Source*: Data from FAOSTAT (2005). Figures for 2010 are projections.

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the world reached a dubious milestone: the number of overweight people (about 1.1 billion) grew roughly equal to the number of underweight people (Gardner and Halweil, 2000). This statistic indicates that the unequal distribution of food — which is both a cause and a consequence of global inequality — is at least as serious a problem as the threats to global food production.

Developing nations too often grow food mainly for export to developed nations, using external inputs purchased from the developed nations. While the profits from the sale of the export crops enrich small numbers of elite landowners, many people in the developing nations go hungry — an estimated 815 million in 2002 (FAO, 2004). In addition, those with any land are often displaced as the privileged seek more land on which to grow export crops.

Besides causing unnecessary human suffering, relationships of inequality tend to promote agricultural policies and farmer practices that are driven more by economic considerations than by ecological wisdom and long-term thinking. For example, subsistence farmers in developing nations, displaced by large landowners increasing production for export, are often forced to farm marginal lands. The results are deforestation, severe erosion, and serious social and ecological harm.

Although inequality has always existed between countries and between groups within countries, the modernization of agriculture has tended to accentuate this inequality because its benefits are not evenly distributed. Those with more land and resources have had better access to the new technologies. Therefore, as long as conventional agriculture is based on First World technology and external inputs accessible to so few, the practice of agriculture will perpetuate inequality, and inequality will remain a barrier to sustainability.

RUNNING OUT OF SOLUTIONS

During the 20th century, food production was increased in two ways: by bringing more land under production and by increasing the land's productivity — the amount of food produced per unit of land. As detailed above, many of the techniques that have been used to increase productivity have a great many negative consequences that in the long term work to undermine the productivity of agricultural land, and in many cases these techniques have approached their physical and practical limits. Conventional means of increasing productivity, therefore, cannot be relied on to help meet the increasing food needs of an expanding global population — a population that surpassed 6 billion in 2004, according to U.N. estimates.

However, increasing food production by cultivating more land is also problematic. Most of the land on the Earth's surface that is amenable to agriculture has already been converted to human use, and of this chunk of land, the proportion that can be farmed is actually shrinking due to urban expansion, soil degradation, and desertification. In the coming years, the growth of cities and industrialization will continue to claim more agricultural land — and often the best land, too. In addition, climate change threatens to take large areas of agricultural land out of production, especially in the tropics, where warming and drying may accelerate desertification in some areas and rising sea levels will inundate low-lying land.

Figure 1.10 shows the problem graphically. In the mid-1980s, the regular annual increases in the area of arable land worldwide observed since the 1970s (and earlier) ceased, and shrinkages have been observed in the periods 1988 to 1992, 1994 to 1995, 1997 to 1999, and 2001 to 2003.

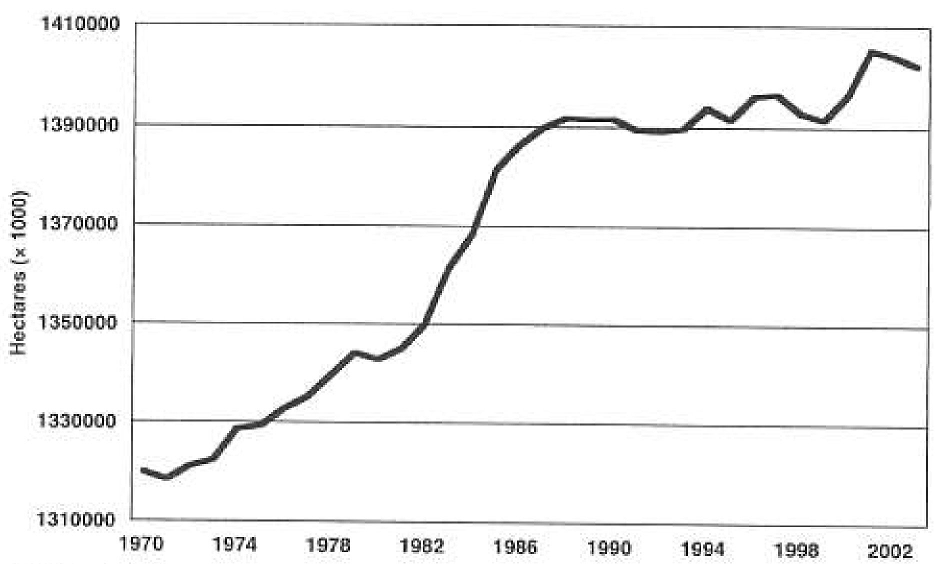

FIGURE 1.10 Worldwide arable land area, 1970 to 2003. As the total amount of arable land remains about the same each year, population growth continues its upward trend. *Data source*: Food and Agriculture Organization, FAOSTAT database, 2006.

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The Role of Agroecology

The agriculture of the future must be both sustainable *and* highly productive if it is to feed the growing human population. This twin challenge means that we cannot simply abandon conventional practices wholesale and return to traditional or indigenous practices. Although traditional agriculture can provide models and practices valuable in developing sustainable agriculture, it cannot produce the amount of food required to supply distant urban centers and global markets because of its focus on meeting local and small-scale needs.

What is called for, then, is a new approach to agriculture and agricultural development that builds on the resource-conserving aspects of traditional, local, and small-scale agriculture while at the same time drawing on modern ecological knowledge and methods. This approach is embodied in the science of *agroecology*, which is defined as "the application of ecological concepts and principles to the design and management of sustainable food systems."

Agroecology provides the knowledge and methodology necessary for developing an agriculture that is on the one hand environmentally sound and on the other hand highly productive and economically viable. It opens the door to the development of new paradigms for agriculture, in part because it undercuts the distinction between the production of knowledge and its application. It values the local, empirical knowledge of farmers, the sharing of this knowledge, and its application to the common goal of sustainability.

Ecological methods and principles form the foundation of agroecology. They are essential for determining (1) if a particular agricultural practice, input, or management decision is sustainable, and (2) the ecological basis for the functioning of the chosen management strategy over the long term. Once these are known, practices can be developed that reduce purchased external inputs, lessen the impacts of such inputs when they are used, and establish a basis for designing systems that help farmers sustain their farms and their farming communities.

Even though an agroecological approach begins by focusing on particular components of a cropping system and the ecology of alternative management strategies, it establishes in the process the basis for much more. Applied more broadly, it can help us examine the historical development of agricultural activities in a region and determine the ecological basis for selecting more sustainable practices adapted to that region. It can also trace the causes of problems that have arisen as a result of unsustainable practices. Even more broadly, an agroecological approach helps us explore the theoretical basis for developing models that can facilitate the design, testing, and evaluation of sustainable agroecosystems. Ultimately, ecological knowledge of agroecosystem sustainability must reshape humanity's approach to growing and raising food in order for sustainable food systems to be achieved worldwide.

THE HISTORY OF AGROECOLOGY

The two sciences from which agroecology is derived — ecology and agronomy — had an uneasy relationship during the 20th century. Ecology had been concerned primarily with the study of natural systems, whereas agronomy dealt with applying the methods of scientific investigation to the practice of agriculture. The boundary between pure science and nature on the one hand, and applied science and human endeavor on the other, has kept the two disciplines relatively separate, with agriculture ceded to the domain of agronomy. With a few important exceptions, little attention was devoted to the ecological analysis of agriculture until the mid-1990s.

An early instance of cross-fertilization between ecology and agronomy occurred in the late 1920s with the development of the field of crop ecology. Crop ecologists were concerned with where crops were grown and the ecological conditions under which they grew best. In the 1930s, crop ecologists actually proposed the term *agroecology* as the applied ecology of agriculture. However, since ecology was becoming more of an experimental science of natural systems, ecologists left the *applied ecology* of agriculture to agronomists, and the term agroecology seems to have been forgotten.

Following World War II, while ecology moved in the pure science direction, agronomy became increasingly results-oriented, in part because of the growing mechanization of agriculture and the greater use of agricultural chemicals. Researchers in each field became less likely to see any commonalties between the disciplines and the gulf between them widened.

In the late 1950s, the maturing of the ecosystem concept prompted some renewed interest in crop ecology and some work in what was termed agricultural ecology. The ecosystem concept provided, for the first time, an overall framework for examining agriculture from an ecological perspective, although few researchers actually used it in this way.

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FOOD FOR THOUGHT

1. How does the holistic approach of agroecology allow for the integration of the three most important components of sustainability: ecological soundness, economic viability, and social equity?
2. Why has it been so difficult for humans to see that much of the environmental degradation caused by conventional agriculture is a consequence of the lack of an ecological approach to agriculture?
3. What common ground is there between agronomy and ecology with respect to sustainable agriculture?
4. What are the issues of greatest importance that threaten the sustainability of agriculture in the town or region in which you live?

INTERNET RESOURCES

Agroecology
www.agroecology.org
A primary site for information, concepts, and case studies in the field of agroecology.

Earth Policy Institute
www.earth-policy.org
Led by the well-known eco-economist Lester Brown, this organization is dedicated to providing a vision of an eco-economy and a roadmap on how to get there. The website provides information on major milestones and setbacks in building a sustainable society.

Food and Agriculture Organization of the United Nations
www.fao.org

Food First: Institute for Food and Development Policy
www.foodfirst.org
Food First is a nonprofit think-tank and "education-for-action center" focused on revealing and changing the root causes of hunger and poverty around the world.

Pesticide Action Network International
www.pan-international.org
Pesticide Action Network (PAN) is a network of over 600 participating nongovernmental organizations, institutions and individuals in over 90 countries working to replace the use of hazardous pesticides with ecologically sound alternatives.

Sustainable Table
www.sustainabletable.org
Sustainable Table is a consumer campaign developed by the Global Resource Action Center for the Environment.

Worldwatch Institute
www.worldwatch.org
A nonprofit public policy research organization dedicated to informing policy makers and the public about emerging global problems and trends, and the complex links between the world economy and its environmental support systems. Food and farming are key support systems they monitor.

RECOMMENDED READING

Altieri, M.A. *Agroecology: The Science of Sustainable Agriculture*. 3rd ed. Boulder, CO: Westview Press, 1995. An important pioneering work on the need for sustainability and a review of the kinds of agroecosystems that will help lead us toward it.

Brown, L. Feeding everyone well. *Eco-Economy: Building an Economy for the Earth*. New York and London: W.W. Norton & Co, 2001, 145–168. An in-depth analysis of the crises facing food production systems and the kinds of strategies needed to eradicate hunger and achieve food security.

Clements, D. and Shrestha, A., (eds.) *New Dimensions in Agroecology*. New York: Food Products Press, 2004. An important collection of contributions from prominent agroecologists that covers the state of the art in agroecological research, showing the progress that has been made over the last decade in scientific thinking and research in agroecology.

Douglass, G.K., (ed.) *Agricultural Sustainability in a Changing World Order*. Boulder, Colorado: Westview Press, 1984. Proceedings of a landmark symposium that helped define the trajectory for future work on the interdisciplinary nature of agricultural sustainability.

Freyfogle, Eric T., (ed.) *The New Agrarianism: Land, Culture, and the Community of Life*. Washington, D.C.: Island Press, 2001. An exciting collection of essays and writing that paint a hopeful vision for reestablishing a new relationship between humans, their food, and the communities in which they live.

Gliessman, S.R., (ed.) *Agroecology: Researching the Ecological Basis for Sustainable Agriculture*. Ecological Studies Series #78. New York: Springer-Verlag, 1990. An excellent overview of what research is needed to identify the ecological basis for sustainable agroecosystems.

Halweil, B. *Eat Here: Reclaiming Homegrown Pleasures in a Global Supermarket*. Washington, D.C.: Worldwatch Institute, 2004. An engaging analysis of the current crisis in farm and food systems, accompanied by a convincing argument for reconnecting what we eat with how and where food is grown.

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