Topic Page: Agriculture

Definition: **agriculture** from *Dictionary of Energy*

Consumption & Efficiency. the process, business, or science of producing food, feed, fiber and other desired products by the cultivation of certain plants and the raising of domesticated animals (livestock). See next column.

Image from: **Paddy rice cultivation is an important...** in *Encyclopedia of Environment and Society*

Summary Article: **Agriculture**
From *Encyclopedia of Environment and Society*

AGRICULTURE IS THE practice of cultivating plants and herding animals for food, fiber, and other products. Agriculture is the single largest land use in the world and it is the single greatest employer. Nearly 38 percent of the earth's land area is in agriculture. In 2004, more than 2.6 billion people, or 42 percent of the world's population, were engaged in agriculture. 10,000 years ago, only a trivial fraction of the earth's surface was dedicated to agriculture. Since then, agriculture has replaced prairies, wetlands, forests, and other ecosystems, allowing the global population to exceed 6.3 billion. Agriculture features prominently in many debates linking environment and society. It is blamed for reducing biodiversity, polluting aquatic ecosystems with eroded soils and toxic chemicals, and contributing to global climate change. Agriculture is also at the center of the debate about genetically altered food, trade, and globalization. Developing more sustainable agricultural systems will be required to reduce the impact of agriculture on the environment and provide enough food for the projected 8 billion people who will inhabit the planet by 2036.

ORIGINS AND DIFFUSION

The first Agricultural Revolution was the transition of societies from hunting and gathering to agriculture. This transition occurred independently in numerous locations around the world, but emerged first about 10,000–12,000 b.c.e. in the Fertile Crescent in the present-day countries of Syria, Turkey, and Iraq. Plants and animals have been bred to exhibit traits that are useful to people, called domestication. It is likely that favorable environmental factors, the availability of wild plants, complex social groups, and food surplus and sedentary livelihoods were important in this revolution. The rise of agriculture is considered revolutionary because of the changes it spawned: population growth, the development of cities, and a greater specialization of labor. People's ability to transform the earth increased markedly with agriculture. The need to feed greater populations created a greater need to transform ecosystems into agricultural systems.

Paddy rice cultivation is an important agricultural system in east and southeast Asia. Small plots of land are flooded for much of the growing season, which requires careful water management—but it is highly productive and feeds millions.

Trade, warfare, and migration diffused agricultural plants and animals. The European discovery and conquest of the Americas (1492–1533) was an important moment in agricultural diffusion. The exchange of plants and animals between the Old and New Worlds is called the Columbian Exchange, after Christopher Columbus. Maize (corn), tomatoes, potatoes, cotton, cassava, and tobacco were unknown in the Old World, and commodities such as wheat, sugar, coffee, cattle, and pigs were unknown in the Americas. This exchange radically changed diets, ecologies, and even demands for labor. For example, to satisfy European demand for sugar, Africans were brought as slaves to the Caribbean and Brazil to work on a new agricultural system—the plantation.

The Columbian Exchange was equally important in Europe. Maize and potatoes became critical components of the Second Agricultural Revolution, which occurred from approximately the late 17th century to the mid-19th century in Great Britain. Agricultural production increased substantially; rotating crops, using new crops, and early mechanization allowed farmers to grow enough food for an expanding urban population. The Second Agricultural Revolution made the Industrial Revolution possible. Although the Columbian Exchange made more crops and animals available in the Old and New Worlds, humans have come to rely on fewer crops for the majority of their diet. About 200 of the 300,000 terrestrial species of plants have been domesticated. Humans rely most heavily on about 20 species for their diets, with corn, wheat, rice, soybeans, potatoes, and cassava (yucca) being the most important staple crops.

INDUSTRIALIZATION OF AGRICULTURE

During the 19th and first half of the 20th century, many technological and scientific advances were made in agriculture, especially in the United States. The steel plow, tractor, combine, and hybrid corn are examples. These technologies were the predecessors of substantial changes in agriculture that occurred after 1940 in the United States, and soon thereafter in Europe, Japan, and other developed countries. World War II and its aftermath precipitated the industrialization of agriculture, with breeding technologies, mechanization, science, and economies of scale. Until the 1940s, most agriculture utilized organic fertilizers (manure), heirloom seeds, and human and animal labor. Mules and horses pulled plows and combines; people weeded and harvested the crop by hand. Many farmers were generalists, planting several crops and raising a variety of livestock.

From 1940 to 1970, machines (tractors) and synthetic fertilizers and pesticides, or agrochemicals, replaced many of the people who worked in agriculture. Fossil fuels became the main energy source. New varieties of crops that responded well to nitrogen were developed. Fertilizer applications to U.S. farmland increased nearly 700 percent. DDT and other pesticides became common. Farmers were forced to expand their operations (economy of scale). The number of farms in the United States dropped in half, but their size more than doubled. Many farmers also became specialists, focusing on producing only a few crops or livestock. Yields increased substantially; yields for wheat and cotton doubled and potato yields tripled. Farmers relied more on inputs from other sectors of the economy, such as industry for tractors and chemical companies for fertilizers and pesticides. Similarly, crops became inputs into processed foods and other products. Soy, for example, is processed into hundreds of products, from salad dressing to tofu.

Hybrid corn exemplifies the impact of the industrialization of agriculture. Farmers became dependent on annual purchases of hybrid seed and the fertilizer it requires. Hybrid corn—produced when two stunted varieties of corn are bred—came from advances in agronomic science at the start of the 20th century, and essentially replaced nonhybrid corn by 1960. The result is high yields, but only one generation of high-yielding corn. Thus, farmers must purchase hybrid seed corn annually. To obtain high yields, many farmers apply anhydrous ammonia, a powerul nitrogen fertilizer. Some of this nitrogen has seeped into groundwater, rivers, and lakes, creating serious pollution of aquatic ecosystems. Very little harvested corn is consumed directly; approximately half of all U.S. yield is fed to livestock, especially cattle. Corn is also an important ingredient for high-fructose corn syrup.

THE DEVELOPING WORLD

Because industrial agriculture in the developed world has replaced most human labor with machines and other fossil-fuel technologies, less than three percent of the workforce in Western Europe and the United States is engaged in agriculture. Even though these farmers are very productive, agriculture accounts for a small part of the Gross Domestic Product (GDP)—less than 3 percent. In the developing world, however, agriculture remains an important employer and component of the economy. At least one third, and as much as 75 percent of the work force, are engaged in agriculture. Agriculture accounts for at least 20 percent and as much as 75 percent of the GDP of these countries.

There is considerable diversity among farmers in the developing world, in part because each agricultural system is dependent on the environment and economy. Farmers typically have relatively small plots of land and live in basic conditions or poverty. They produce both for their families' consumption (subsistence) and to sell (market). Agricultural labor utilizes people and animals, although agrochemicals and mechanization are increasingly common. Many households combine off-farm employment with semi-subsistence agriculture. One or more of the adults and the eldest children may work for wealthier farmers or migrate to a city temporarily. In much of northern China, south Asia, southern Mexico, the Andes, and parts of Africa, farmers grow grains (wheat, corn, rice, barley, sorghum); and/or root crops (potatoes, cassava); and raise livestock, especially cattle, pigs, and sheep. Farmers commonly intercrop fields, planting several crops to diversify their diet, reduce risk, and improve the soil.

Paddy rice cultivation is an important agricultural system in east and sSoutheast Asia. Small plots of land, typically close to rivers, are flooded for much of the time the rice is growing. This system requires careful water management and constant maintenance, but it is highly productive and feeds millions of people. In tropical climates, farmers are able to multi-crop, which means harvesting at least two crops

in less than one year. Another common agricultural system in developing countries in the tropics is shifting cultivation. In this system, farmers cut trees and brush on a field and burn them when they dry. This process transfers the nutrients from the vegetation to the soil; seeds are planted in the ash. Farmers will commonly cultivate the field for a few years, and then allow it to return to brush and eventually forest (fallow). This system makes use of infertile tropical soils and can be sustainable if the length of the fallow is sufficient.

Plantation agriculture is also found in many developing countries in the tropics. In this system, wealthy and sometimes foreign owners control large stretches of fertile land and plant crops for export. Cocoa, palm oil, bananas, and coffee are examples. Plantation agriculture uses cheap labor, but also very modern agricultural technologies.

FACTORY FARMING

Factory farming became the logical extension of applying industrial practices to agriculture. Factory farming broadly describes agricultural systems that are intensive, usually large-scale, and designed to produce a product at the least cost in the shortest time possible. Factory farms use practices common in industry and rely on veterinary and agronomic science and agrochemicals. The term is most commonly applied to large animal confinements and greenhouses with highly controlled environments. The term is sometimes used to describe any agricultural system that is large-scale, relies on agrochemicals and monocropping (growing one crop in a field) and is either highly mechanized or uses cheap labor. This would include vegetable farming in California, fruit orchards in Spain or Israel, and soybeans in Argentina. Most of the food consumed in the developed world is produced in this fashion.

The Green Revolution

Many of the breeding and agrochemical technologies associated with industrial agriculture were applied to crops in the developing world, starting in the 1960s. The Green Revolution refers to a major transformation in agricultural practices in the developing world based on a specific technological and institutional package, including high-yielding variety seeds (HYVs), fertilizers, and irrigation. In the late 1960s, millions of hectares of HYVs of wheat and rice varieties were planted in south and southeast Asia. The Green Revolution allowed countries to stay ahead of population growth, but it caused serious environmental problems. Most of the beneficiaries of the Green Revolution were relatively well-off farmers and the companies that sold the equipment and chemicals. The most disadvantaged, in particular women who grew subsistence crops and did not have secure land tenure, bore the greatest burdens of the Green Revolution. The Green Revolution continues, with new crops, newly targeted areas, and recognition that the impact of agricultural development must be more socially conscious and environmentally friendly.

Animal confinement operations group large numbers of animals in closely controlled operations. U.S. beef cattle spend most of their lives on pasture, but when they reach a certain age and weight they are commonly shipped to large feedlots on the Great Plains—Texas, Nebraska, Kansas, and Colorado. The largest feedlots hold more than 100,000 cattle. The cattle will spend up to two months on the feedlot before they are sent to a nearby meatpacking plant, where they are slaughtered, packaged, and sent to retail outlets. The meatpacking plants are also built for economy of scale, some slaughtering more than 3,000 head per day.

This method of producing beef requires large quantities of fossil fuel energy, making it highly energy inefficient. In the case of the Great Plains, cattle are shipped hundreds of miles. Since cattle are poor converters of the energy in grains, much is wasted. Traveling great distances is stressful to cattle, making them vulnerable to illness. When they arrive at a feedlot, they are often given antibiotics. This concentration of cattle produces an enormous amount of organic waste. Feedlots typically sell the manure to farmers, but if waste management is poor, surface and groundwater contamination will occur.

The concentration of the beef industry and the conditions in the meatpacking plants is controversial. Starting in the 1980s, the industry consolidated, meaning that companies merged or were purchased by larger companies. This left few companies to purchase cattle; only four meatpacking plants control nearly 80 percent of all cattle slaughtered, prompting complaints from farmers that the concentration has driven down prices. Concentration is also found in the pork industry, where four companies control approximately 63 percent of all hogs slaughtered. Many of the workers in the plants are poorly paid immigrants from Latin America.

Industrial practices have been applied to the chicken industry as well. Almost all chickens in the United States are raised under a system called production contract farming. A company contracts with a "grower" to raise chickens. The company provides the animals, feed, and medicine, and remains the owner of the animals. The grower provides the land, buildings, and the management/labor. The grower is paid on a predetermined price. More than half of the country's chickens come from relatively few growers who sell more than 500,000 a year.

In the developing world, many tropical fruits, such as bananas and flowers, are grown with industrial practices. Most cut flowers, such as roses and carnations sold in Europe and North America, come from Colombia, Ecuador, or East Africa. They are raised on good soils in large and highly controlled greenhouses. Agrochemicals are used to produce a "flawless" product for demanding, overseas consumers. Corporations own the rights to certain varieties of flowers, and require a royalty on every flower sold. These greenhouses are controversial for their heavy use of agrochemicals; relying on cheap, female labor; and the fact that some of the best land in poor countries is used to raise a luxury item.

Factory farming has been accompanied by the increase of corporate influence. In the latter half of the 20th century, transnational corporations (TNCs) that purchase and processes agricultural products developed global strategies, and now a few enormous corporations exert considerable control. Cargill, for example, has economic interests in many agricultural sectors around the world. They have offices in more than 60 countries and are major purchasers and processors of cocoa, wheat, soybeans, and fruit juices. They own the second-largest meat processing and turkey processing companies in the United States. For many agricultural products there are few purchasers, raising the concern that farmers are not receiving a fair price.

Only four meatpacking plants control nearly 80 percent of all cattle slaughtered, sparking price controversies.

GENETICALLY MODIFIED ORGANISMS

A more recent and controversial trend in agriculture is the increasing use of genetically modified organisms (GMOs) in agriculture. A GMO is a plant that has been altered using scientific techniques—other than breeding—to change the genetic makeup of the plant. One common form of a GMO is a transgenic plant, which received the gene(s) of a completely different species. The two most common applications of GMOs in agriculture are herbicide tolerance and insect resistance. Herbicide-tolerant soybeans tolerate an herbicide called glyphosate. Fields can then be sprayed with glyphosate, killing the weeds, but not the crop. Insect-resistant corn contains a gene from a soil bacterium called Bt (*Bacillus thuringiensis)* that produces a protein that kills a larva that would otherwise destroy the plant.

Adoption of these "biotech" crops has been remarkable since their introduction in 1996. In 2005, 8.5 million farmers in 21 countries planted more than 90 million hectares (1 hectare = 2.47 acres), half of which was planted in the United States. Soybeans, corn, and cotton account for the vast majority of the crops. The proportion grown in developing countries is growing quickly. Much of the food consumed in the United States, especially processed foods, derives from GM crops. GM seed companies and other advocates argue that GM crops are a natural extension of modifying plants that has been done since the First Agricultural Revolution. Companies are applying the knowledge of the day—genetic engineering—to plants and animals. They argue that the GM crops could produce higher yields and more food, have more resistance to pests—thus requiring less pesticide—and have desired traits, such as rice with more nutrition.

Criticisms of GM crops can be grouped into three categories: environmental, health, and political/economic. Critics worry that targeted pests will develop a resistance to Bt and that the genetic material will drift onto other plants, creating unintended "genetic pollution." The most common health concern is that the long-term consequences of consuming GM food is unknown. Labeling food with GM products is not required in the United States, but in Europe, where very little GM food is consumed, labeling is required. The political and economic concerns fit into a larger concern over corporate control over agriculture, and agricultural biodiversity. GM crops are increasingly common, but only a few corporations own the seed patents. The Monsanto Corporation, for example, owns the patents on most of the soybeans and much of the corn crop grown in the United States. Another political and economic concern is the U.S. government's interest in pushing markets for GM crops. Europe and many developing nations have resisted GM grain imports from the United States, prompting the United States to sue the European Union through the World Trade Organization on the

grounds that the EU has no legitimate health reasons for rejecting the imports.

ENVIRONMENTAL IMPACTS

The environmental impacts of agriculture are substantial. Agriculture has replaced many biodiverse ecosystems with monocropping, reducing natural habitat. For example, the primary cause of deforestation in the Amazon forest in 2004 was the conversion of forests to monocropped soybean fields. Intensive cultivation practices have caused erosion, as well as clogging and degrading of rivers and other aquatic ecosystems with sediment. Agrochemicals have accompanied the sediment, polluting streams and aquifers. Fertilizer runoff creates fertile conditions for some plants and algae to thrive in lakes. Microorganisms consume the plants and lower the dissolved oxygen in the water, depriving fish and other aquatic life of dissolved oxygen. Although developed countries use most of the agrochemicals in the world, the use of these chemicals is most dangerous in developing countries, which still use some chemicals taken off the market in North America and Europe. Farmers unintentionally poison themselves, and an unhealthy chemical residue remains on many crops.

ALTERNATIVE AGRICULTURE

A number of alternative perspectives have developed in response to the perceived environmental and social effects of industrial agriculture. One such movement, agroecology, calls for the application of ecological principles to agriculture in order to create sustainable agricultural systems. Sustainable agriculture produces healthy food in a way that would not undermine the ability to do so in the future. It minimize the impact on the environment by not releasing toxic chemicals, and uses local resources and organic material to replenish soils and conserve biodiversity. Many of these practices—biological pest control, crop rotations, multi-year fallows, intercropping, minimal tilling, and raising livestock with cultivated crops—were common practices before the industrialization of agriculture. Other movements, such as buying organically grown products, are commonly based in similar principles as agroecology. Buying locally grown, organic food is touted as an important way to eat healthy, minimize damage to ecosystems, reduce energy costs, and be in touch with local environmental conditions and farmers.

CONCLUSION

More food will need to be produced to feed a growing population, but how much food will depend on yields, consumption, how efficiently food is used, and whether luxury crops (drugs, flowers, bananas) are replaced with staples. The environmental and social conditions of food production, and who benefits from it, are critical issues. Industrial agriculture has caused serious environmental problems, but has also produced an abundance of food in developed countries. Proponents of biotechnology see GMOs as a way to produce more food efficiently. Advocates of agroecology see GM crops, industrial agriculture, and corporate control of the food supply as problems, and advocate alternative agriculture as a way to produce healthy food without undermining the ability to produce in the future.

SEE ALSO:
Agroecosystems; Agronomy; Cash Crop; Cattle; Crop Plants; Dryland Farming; Farmers' Markets; Farming Systems; Genetically Modified Organisms (GMOs); No-Till Agriculture; Organic Agriculture.

BIBLIOGRAPHY

- J. W. Clay, World Agriculture and the Environment: A Commodity-By-Commodity Guide to Impacts and Practices (Island Press, 2004).
- G. Conway, The Doubly Green Revolution: Food for All in the Twenty-First Century (Comstock, 1998).

- Food and Agriculture Organization, www.fao.org (cited October 2006).
- S. Nottingham, Eat Your Genes: How Genetically Modified Food is Entering Our Diet (Zed Press, 2003).
- Michael M. Pollan, The Omnivore's Dilemma: A Natural History of Four Meals (Penguin Press, 2006).
- E. Schlosser, Fast Food Nation: The Dark Side of the All-American Meal (Perennial Press, 2001).
- O. T.; D. J. Solbrig, So Shall You Reap: Farming and Crops in Human Affairs (Island Press, 1994).

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Jokisch, B. (2007). Agriculture. In P. Robbins, *Encyclopedia of environment and society*. Thousand Oaks, CA: Sage Publications. Retrieved from https://search.credoreference.com/content/topic/agriculture

Chicago

Jokisch, Brad. "Agriculture." In *Encyclopedia of Environment and Society*, by Paul Robbins. Sage Publications, 2007. https://search.credoreference.com/content/topic/agriculture

Harvard

Jokisch, B. (2007). Agriculture. In P. Robbins, *Encyclopedia of environment and society*. [Online]. Thousand Oaks: Sage Publications. Available from: https://search.credoreference.com/content/topic/agriculture [Accessed 19 September 2019].

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