Technology, Land, and Fate

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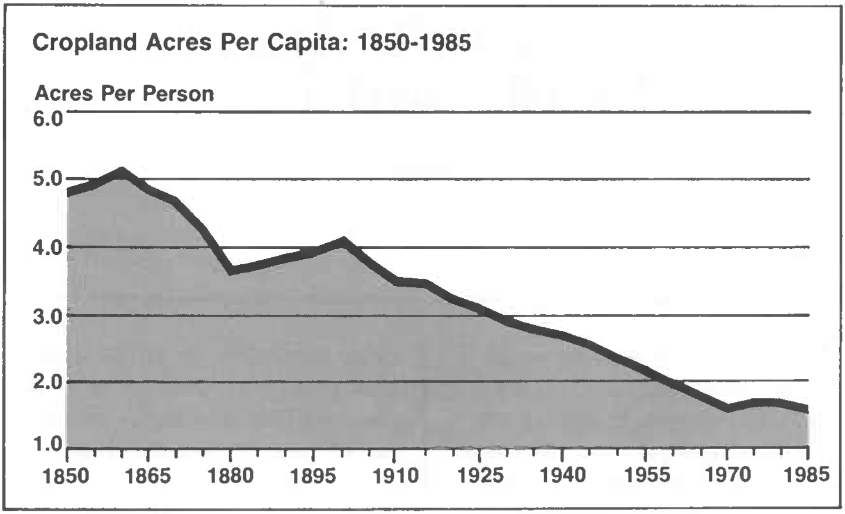
Agricultural research and recent advances—particularly in biotechnology—promise to revolutionize agricultural production. A continuation of the century-old Agricultural Revolution, today's advances have profound implications for America's relationship with its land. The society of Jefferson's yeoman farmers has been supplanted by a landless society of technical innovators who entrust the land and its productivity to a mere 1 percent of its members.

Concern for the land fluctuates over time. Two hundred years ago Malthus wrote that scarcity and eventual famine was inevitable given our predilection for procreation, a thesis that forever earned economics the appellation "dismal science." In 1898, a world "wheat crisis" evoked a new round of worry over scarcities. In the present century, concerns of scarcity crop up periodically, the last in the mid-1970's. Now, in 10 year's time, declining demand has pushed prices to new lows and economic stress in the farm sector to new highs. What is the norm? Will food supplies be in shortage or in surfeit? Will land undergo intense pressure for food production or lie unattended? The advent of new food production technology, as in the past, will have great impact on the use of—and the need for—land.

Knowledge, Productivity, and Land

Midway between Malthus and the 20th Century the Industrial Revolution began to displace the frontiers of resource scarcity. One of its offshoots is, of course, the Agricultural Revolution which has a direct bearing on the use of land for food and fiber production. Professor Vernon Ruttan, in a 1982 book, has written that the significance of technical change is that it permits the substitution of knowledge for resources and increases productivity.

The term "productivity" refers to the amount of output (product) generated per unit of input or per unit of an amalgam of several inputs. It is measured as a ratio. For productivity growth to occur, new knowledge (technology) must be combined with appropriate input factors to enlarge the productivity ratio, that is, increase the amount of output per unit of input.



Labor Productivity. Historically, innovation has increased agricultural productivity ratios over time whether they be ratios of output to labor, output to capital, or output to land. A century ago labor was beginning to become scarce, partly because of the Civil War and partly because of increased labor costs fostered by off-farm competition from the factories of the Industrial Revolution. In response, for example, the binder introduced in the late 19th century harvested wheat with 60 percent fewer workers than with the McCormick reaper. This innovation significantly increased the ratio of output to agricultural labor.

Land Productivity. Ratios of outputs to land—land productivity ratios—also have increased. The close of the frontier made it more difficult to increase production simply by expanding to new acreages. In fact, total cropland acreage has been roughly constant since about 1910. In 1910 land used for crops totaled 324 million acres; in 1985 it was 372 million acres, with 87 million acres producing commodities for export. However, output has increased tremendously. Between 1910 and 1985 the U.S. population had increased from 92 million to 239 million while corn and wheat production increased three times.

Land productivity ratios can be depicted in several ways, the most usual being a composite index of crop production per acre. Another indicator of land productivity is acres per capita. For the last 135 years—and especially since 1900—acres of cropland per person have been steadily declining. The trend was halted in 1970 because of the greater role of exports in the agricultural demand picture. If exports and government programs were accounted for, the downtrend would be even more precipitous.

Early agricultural innovation served

to substitute knowledge and capital for labor. Later in the Agricultural Revolution, knowledge and capital began to substitute for land, increasing output per unit of land input. Plant breeding, fertilizer, chemicals, and irrigation combined with improved management techniques to increase yields. Improvement in livestock productivity reduced the land needed for producing livestock feed.

Technology and Conservation

While some analysts argue that yields appear to be leveling off and that the Agricultural Revolution is over, others point to research and development—both public and private— in biotechnology and information management.

Within the decade, animal agriculture will become more efficient because of biotechnical breakthroughs. The bovine growth hormone developed at Cornell University is a dramatic example. Improvements in plant productivity resulting from advances in biotechnology will occur sometime after 2000.

The information revolution also will influence agriculture. Computerized information data bases and decision models will greatly improve agricultural decisionmaking and management efficiency. These changes should be firmly entrenched in another decade.

What do these new technologies mean for land use and conservation? Projections of land productivity improvements to 2000 and 2030 range from 1.2 to 1.7 percent annually for corn, soybeans, and wheat. The Census Bureau projects a decline in U.S. population growth rates from 1 percent annually in 1985 to 0.1 percent annually by 2040. The need for cropland acreage will decline unless export demands increase steadily over time. With the long-term trends indicating that technology will increasingly substitute for cropland, is there really a need to preserve the cropland base and to conserve the soil and water resources it represents?

In the short term there will be aberrations that will depart from the long-term trend. Weather is an important and uncontrollable factor in agricultural production. A sharp increase in the cost of fossil fuels relative to other inputs, too, can have an impact on cropland use, particularly if the cost differences foster the development of an extensive, land-using type of agricultural technology.

It is not certain, either, if trends in the long term will follow historic patterns. Global climate change is well within the realm of possibility. The "greenhouse effect," if viable, can have drastic impacts on agricultural production, effectively moving the temperate cropping zone several hundred miles to the north or south.

The United States has the luxury and responsibility of adequate cropland. If this resource is compromised, the risk exists that it will become inadequate. The need to conserve and improve agricultural land is as great as ever.