at lower costs. The central point is that when market failures make it possible for producers and consumers to use scarce resources (especially the limited capacity of the atmosphere and water to assimilate wastes) without paying the full social cost of this use, forces of competitive profit-seeking by producers and utility maximization by consumers are likely to lead them to overuse and pollute these scarce environmental resources.

An economic remedy is to confront these users with the full social cost of their actions (e.g., through emission charges), in order to provide them with economic incentives to act in the public interest by limiting their use of environmental resources to efficient levels. The authors’ comparative evaluations of a wide range of policy instruments and analyses of the appropriate application of each are especially valuable. Many problems can arise however, such as that of estimating the appropriate costs and charges where markets for environmental resources do not exist. The authors explain and evaluate the various methodologies economists have devised for estimating the value of these nonmarket environmental goods and services.

Mainstream economists place primary emphasis upon the concept of efficiency. An important contribution of environmental economics has been to introduce the neglected concepts of mass balance, thermodynamics, and entropy into their environmental economic models. Given the resistance to introducing these concepts into the canon of economics, which these authors have helped overcome, it is not surprising that they explicitly reject the further step of moving on to the more general approach now being developed under the banner of ecological economics, with its concern for life-support systems and species interdependence (see Daly and Cobb 1990 and any or all issues of the journal Ecological Economics).

Because many of the concepts the authors describe (e.g., damage functions, dose-response relationships, and environmental standards) require physical science inputs, a critical next step for environmental and ecological economists is to interact with experts in these fields to develop a more transdisciplinary approach. R. K. Turner, D. Pearce, and I. Bateman have, however, done a superb job of providing the general reader with an authoritative, exceptionally well-written overview of the contributions environmental economics can make to the analysis and improvement of environmental management policy.

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AGRICULTURE’S RELATION TO CIVILIZATION

So Shall You Reap is much more than a history of agriculture. With this text, the Solbrigs have been able to clearly connect the development of agriculture with the growth of civilization and the major historical events that influence human lives.

For approximately two million years humans sustained themselves as hunters-gatherers, with minimal social organization. The book features an especially interesting discussion of how prehistoric societies fed themselves and how and why foraging for food changed into organized agriculture.

Agriculture appears to have developed independently in each of five world areas: Middle East, China, Southeast Asia, Mesoamerica, and the Andean Highlands of South America. The authors suggest that more than 2000 years elapsed from the time humans first started cultivating crops to when farming became their principal way to provide subsistence.

Over time crops were modified for domestication. Farmers selected for replanting those plant types that held their seeds for longer periods of time, which enabled the farmers to harvest more grain without losing portions that fell to the ground. Grains were as important an early crop as they are today because they are easily harvested, stored, and transported. In part, these benefits are due to their low moisture content compared to other plant foods. At present, grains make up approximately 80% of human food worldwide.

The book provides valuable information concerning the evolution and development of the use of grains in agriculture and relates their use to the evolution of civilization. I found only a few errors in the text: the average consumption by Americans is 3600 kilocalories, not 2700, kilocalories per day, and the fat content of oats is 4%, not 8%.

Labor-intensive farming, both in early history and as now practiced in the developing countries, requires much time and human energy to be expended by individuals. For instance, approximately 1200 hours of manpower are expended to cultivate one hectare of grain. The yields of grains range from 1000 to 1500 kilograms per hectare. An individual requires approximately 250 kilograms of grains per year for minimal food support. Because so much time is devoted to farming, there is little time or opportunity for much industrial or economic development to occur in these areas.

With the availability of fertilizers, pesticides, irrigation, and mechanization, people were freed to devote their energies to development, and the standard of living of many improved. Today, for example, one hectare of US grain is produced with only four hours of farm labor. These modern farming techniques are primarily fossil-energy based. Approximately 1000 liters of oil equivalents are required to produce a hectare of food in the United States and Europe. Yet, in many developing countries, less than 1 liter of oil equivalent is used to farm one hectare.
There human and animal power must be relied on, because fossil-based inputs are too expensive.

Agriculture as it is practiced in modern time, especially in developed countries, is aptly termed industrial agriculture. In its practice, the earth's environment is rapidly being transformed while valuable, often finite, resources are being depleted. Yet more food and fodder need to be produced to sustain the ever-increasing human population. The present situation contrasts with the early times of relatively few people, when agriculture's impact on the environment was scarcely perceptible.

The benefits and problems associated with modern, industrial agriculture are well documented. Of special interest is the analysis of the Green Revolution, which involves planting high-yield varieties of rice, corn, and wheat. These new varieties require large inputs of fertilizers and pesticides, making their production relatively expensive. The high yields have helped the more affluent and better educated farmers to prosper, while the small farmers on the poorer land have received few of the benefits. In addition to some of the social problems, the Green Revolution technology has impacted negatively as agricultural chemicals are damaging water supplies, fish, and other animals used as food by the poor. In some areas, new pest problems have arisen, requiring more and more pesticides.

In addressing the future of food in their last chapter, the authors focus on land degradation, especially erosion; use of resources; maintenance of environmental integrity; biodiversity; and chemical pollution of soil, water, and air. Also, they briefly consider the promise of bio-technologies and the anticipated effects of global climate changes on agriculture.

Underlying the effectiveness of all suggested strategies to double world agricultural production is the unprecedented growth of the human population—more than a quarter million people are added daily. To date agricultural production has been increasing linearly, while the world population is increasing geometrically and is expected to double in approximately 40 years. I wish that the urgency of the population problem had been a major issue for discussion in the book.

The authors have achieved their goal of documenting in clear, readable terms how agriculture has affected human survival and influenced changes in social organization and cultural practices. The unspoken but obvious message in So Shall You Reap is that how we shall sow is ever more vital an issue for human survival in the future. This informed perspective of agriculture, traditional and modern, is recommended to agriculturists, biologists, geographers, historians, and others who value the status of our food supply for themselves and future generations.

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LANDSCAPE DEBATES

The title of this book led me to expect ecological papers on landscape restoration. Instead, Beyond Preservation is a philosophical dialogue between two 1990 seminar speakers (William R. Jordan III and Frederick Turner) and various faculty members at Miami University of Ohio: an architect, two artists, a professor of classics, a literary critic, three historians, a philosopher, a sociologist, an environmental engineer, a geologist, and four biologists, all of whom contribute essays from different academic perspectives. Only 2 of the 21 contributions concentrate on restoration projects: geologist A. D. Baldwin Jr. discusses the strip-mined landscape of eastern Ohio, and biologist K. E. Medley summarizes attempts to improve habitat for two rare primates in Kenya.

Those of us who did not hear the presentations and subsequent discussions are eavesdroppers, with little information to understand the controversy. The first contribution (an introduction by the editors) states that Jordan and Turner provoked resistance with their "vehement rejection of the philosophy of preservationism." Yet Jordan's first essay states simply that preservation cannot really protect ecosystems and that restoration activities would not only help conservation efforts but also afford opportunities for people to have a "healthy interaction" with nature. Turner calls restoration a "field of ecological philosophy," shooting down six straw men—"principles of the ecological religion" in a critique of the "traditional faith." He concludes with a new theology that would embrace restorationist environmentalism and create new landscapes—even on Mars. In their closing essays, each of the speakers claims to have been misunderstood: Jordan writes, "My argument is not at all that restoration offers a substitute or even an alternative to preservation, but only that the two together are needed to establish a sound basis for the relationship between nature and culture" (p. 249). Turner explains, "Both Jordan and I are attacked for being against ecological preservation; on the contrary, we are explicitly in favor of it" (p. 254).

After reading the speakers' first essays, I expected a debate over whether restoration should be a religious pursuit, who should be its messiah, and what restoration sites could withstand the congregation's rituals. I found little basis for the ensuing debate over preservation versus restoration. While the participants no doubt clarified their own views during the interchange, it is unclear whether retelling the argument has value outside of Miami University. The editors offer the volume as "the beginnings of a conversation on these ideas." Yet the book failed to reach me, despite my interest in prairie restoration and my reverence for nature.

The passion of the debate is hard to comprehend from material in the book. Perhaps it was the way certain statements were made by the