Koch's 1882 discovery of the organism that causes tuberculosis was hailed by the world press as the end of that great scourge. Yet it was to be another 70 years, with innumerable false starts and dashed hopes, before Selman Waxman's discovery of streptomycin opened the way to a definitive cure for the disease. There is always a long gap between work in the research laboratory and its application in the clinic. The clinical applications of the Genome Project will, as Watson understands so well, be no exception.

There are long passages in this book that lull the reader into the belief that Jim Watson has finally become a sedate member of the scientific establishment. Every so often, however, the Chicago schoolboy makes a brief but reassuring reappearance. His third rule in a pithy guide to success for young scientists reads "be sure you always have someone up your sleeve who will save you when you find yourself in deep shit." That is an environment to which, as evidenced by these essays, he must have become well-accustomed over the years. Clearly, as Gratzer emphasizes in his summary, at the age of 70 the enfant terrible has lost none of his evangelical enthusiasm for science and is still captivated by the richness and promise of what flowed from the discovery he made with Crick all those years ago. *A Passion for DNA* is a reminder, if any were needed, that we should be equally indebted to Watson for his efforts in what must often have seemed the much more difficult task of overcoming the innumerable controversies and doubts that could have seriously interfered with molecular biology's long-term potential for the benefit of humanity. We owe him a great deal.

BOOKS: AGRICULTURE

Ensuring Enough to Eat

Adrienne E. Clarke

Can human ingenuity produce enough food to support healthy and vigorous life for the 10 billion people projected to live on Earth in 2050 without irreparably damaging the integrity of the biosphere? Vaclav Smil's book *Feeding the World* sets out to answer this question.

Smil, a geographer at the University of Manitoba, calculates how much food can be theoretically produced and estimates how much is actually needed. His approach is to examine issues such as the potential availability of arable land, the supply of water and plant nutrients, and the maximum theoretical photosynthetic efficiency. He considers the proportion of the food produced that is actually eaten and the nutritive requirements of individuals. He discusses the ecological risks that growing this amount of food will pose, including loss of topsoil, loss of biodiversity, and the addition of reactive nitrogen from synthetic nitrogen fertilizers to the atmosphere.

Feeding the World
A Challenge for the Twenty-First Century
Vaclav Smil
MIT Press, Cambridge, MA, 2000. 388 pp. $32.95. ISBN 0-262-19432-5.

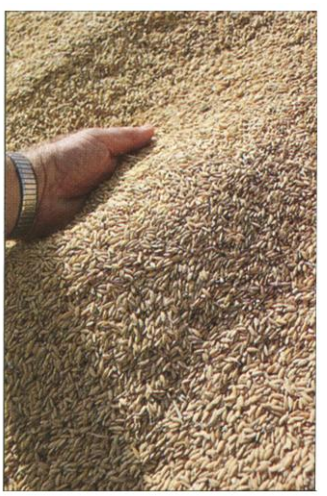
One of Smil's most important messages is that some of the conventional wisdom leading to the "catastrophists'" outlook on these questions may not be well founded. For example, loss of topsoil is often cited as having a major negative impact on food-growing capacity, but how robust is the evidence that degradation-induced productivity losses are rising? The problem may be real and urgent in many regions; for example, in large parts of Africa the annual soil degradation equates to millions of metric tons of grains and tubers lost per year. But from a global perspective, the losses may not be significant. Is there enough arable land? The answer is probably yes—when Earth is viewed as a whole. From the perspective of a poor African country, the answer may well be no.

What about water? Although current human uses of water show that overall there is stress on supply, there are many opportunities for more efficient use, particularly in irrigation. Again, the problem may be manageable at a global level, but at the local level, in some countries, water scarcity is devastating.

The view that emerges from Smil's account is that the inputs and assumptions underlying calculations of global resources are in many cases debatable. The variations in estimates give comfort that the world as a whole probably has the resources to adapt to demand and produce sufficient food. The picture at other levels, however, is not so optimistic. Existing and worsening constraints on food production at regional and local levels are real and urgent. The gravity of the situation is reinforced by the fact that most of the population growth is predicted to occur in the countries with the greatest local problems—nations in Africa, Asia, and Latin America. Interestingly, Brazil is the only modernizing country that has abundant reserves of both water and arable land. Another compelling point made by Smil is that post-harvest losses due to spoilage and waste can amount to more than 15% of the yield. Stemming these losses should be as important a target as increasing productivity, and in many cases doing so would require less sophisticated approaches. Insect pests and plant pathogens, which account for huge losses under some conditions, should also be a target.

The book provides a valuable contribution to current understanding of this critically important topic. Read along with papers from the December 1998 National Academy of Sciences colloquium "Plants and Population: Is There Time?" (*Proc. Natl. Acad. Sci. U.S.A.* **96**, 5903–6008 [1999]); it offers readers new to the field good insights into the major questions being asked and the uncertainty of the answers.

This uncertainty is compounded by the recognition that biological and physical systems (such as climate) often behave nonlinearly. In addition, the assumptions underlying predictions of the impact of climate change may be flawed. We should expect the unexpected. Another area likely to throw up the unexpected is biotechnology. Although Smil does not deal with biotechnology's potential in any detail, its impact, especially for the impoverished local communities in developing countries, may be profound. A major challenge will be finding ways to make the intellectual property rights, usually held by institutions in the developed world, available to the poor countries.



A dominant staple. In parts of monsoonal Asia, rice supplies over 65% of all food energy.

Are we capable of developing the institutions to plan for and manage these known and unknown challenges? As globalization proceeds, more issues that transcend national boundaries are developing. As a global community, we can point to one success: we did manage to arrest the use of chlorofluorocarbons responsible for the breakdown of stratospheric ozone. We can therefore be optimistic that we are capable of meeting the challenges and that we will find ways to work across boundaries. Smil's conclusions are also cautiously optimistic: we probably will be able to feed the world, or at least a great part of its future population, without irreversibly damaging the biosphere.

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