

nessing water power to produce scythes for farmers, spindles for textile mills, and cotton thread. Small emphasizes that these were not the activities of absentee investors but of local men and women who mixed manufacturing with agriculture.

Beauty and Convenience focuses on a farming community that has received scant attention from historians, but Small makes a convincing case that the way in which the farmers of Sutton fashioned and re-fashioned their houses and landscape reveals their full participation in the historic transformations of their era.

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Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production. By Vaclav Smil. Cambridge: MIT Press, 2004. 360 pp., \$19.95, paperback, ISBN 0-262-69313-5.

What is the most important technological invention in the twentieth century? Vaclav Smil makes the cogent argument that it is the discovery and industrialization of ammonia synthesis by Fritz Haber and Carl Bosch. Without industrial N-fixation, as much as two-fifths of the world's population would starve for want of available protein in their diet, and major advances in high-pressure industrial processes would have been delayed. Likewise, the Haber-Bosch process facilitated world munitions production; encouraged agricultural expansion onto marginal lands, leading to greater greenhouse emissions and soil degradation; and (because of inherent inefficiencies in nitrogen recovery by plants) has led to an unbalanced enrichment of natural ecosystems by nitrogen.

It is an odd book given the title. History and society would be unalterably different without Haber and Bosch, but these protagonists do not appear until chapters four and five, respectively; then their lives are described in the most perfunctory manner. Ultimately, this book is less about Haber and Bosch than it is about the necessity for their invention, its technological innovations, and its consequences. For that purpose, the book's appeal to agronomists, historians of technology, and ecologists is masterful. The graphs and tables are clear, concise, informative, and provide a globally balanced perspective.

Chapters one and two outline the significance of nitrogen chemically and agriculturally. Chapter three details the search for production and industrial systems to make fixed nitrogen. Chapter four introduces Fritz Haber and the chemical synthesis of fixed nitrogen, and chapter five introduces Carl Bosch

and industrialization. Chapter six describes the development of the nitrogen fertilizer industry, and therein ends the technological history.

The last chapters of this book should be required reading for every agronomist, ecologist, and environmentalist interested in sustainable agricultural production. Smil introduces the increasing significance of fixed nitrogen and world fertilization in chapter seven. In chapter eight Smil produces the key premise that global crop production would be halved without fertilizer nitrogen, half of which comes from the Haber-Bosch process. The consequences of this dependence on global ecosystems are addressed in chapter nine. Luxury food production to support an ever-growing world population damages the environment while permitting changes in diet that are, in many ways, inherently unhealthy.

What is to be done? Returning to purely organic farming is a luxury most nations have neither the resources nor land to support. Smil readily dismisses arguments against the energy costs of industrial fixation by comparing those costs with the energy saved by small economies in automobile fuel consumption. However, even with nitrogen fertilization, the dietary habits of industrial agricultural nations are unsupportable globally. But switching to healthier diets could increase environmental problems, as some of these crops have poor nitrogen use efficiency. Chapter ten concludes with an unresolved question: Now that humanity depends on fixed nitrogen, what should we do about it?

Smil returns to Haber and Bosch in his postscript for one last bit of history. Haber and Bosch represent the ego and superego of German scientific industrialism; their fate is tragic. Haber—bright, famous, driven—allows his energies to be subverted to producing weapons of mass destruction, is vilified by the court of public opinion, abandoned by the suicide of his wife, and, though a convert, ostracized by Aryanism in the nation to which he devoted his life. Bosch—bright, thoughtful, moral—develops the technology by which Germany prolongs two world wars, helplessly predicts Germany's fate in World War II, and dies before he can see his company, I. G. Farben, engage in Nazi crimes against humanity.

It is always a pleasure to encounter a book that is easy to read, informative, and stimulating. This book meets those criteria and is well worth having.

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