'Ultimately, all physical and chemical processes in soils are molecular by nature, and it must be possible for them to be modeled in terms of molecular properties'. While this march to molecular scales appears necessary, we should also mind the way back to scales much beyond 1 m and ponder hierarchies of emerging structures on ever coarser scales and evanescence of most, but not all, finer scale features.

This book is certainly not for the novice who does not yet know how to weigh the various aspects presented. It is likely to be most useful for those who pursue research in the field, and for them it is recommended. Through its selective choice of topics from a broad range, it is certain to contain for most of them chapters with new and fascinating approaches that deserve further pursuit.

K. ROTH

Lindert, P.H. *Shifting Ground: The Changing Agricultural Soils of China and Indonesia*. MIT Press, Cambridge, MA, 2000. xii + 351 pp. US$45, £30.95, hardback. ISBN 0-262-12227-8.

We know that with proper care we can crop some soil indefinitely. Equally, however, improper and thoughtless use of the soil can degrade it, and it is this second aspect of land use that attracts most attention among environmental scientists, the international agencies, politicians, and the press. Professor Lindert, an economist, sets out on the one hand to challenge the vociferous prophets of doom who see only the degradation caused by improvident cultivators and graziers and on the other to stir the silent majority out of its complacency. He makes the point early in his book that the popular perception of accelerated degradation caused by us humans is not backed by hard quantitative data, even in his own country, the USA, where the Soil Conservation Service has done so much good work. The results of erosion are all too evident, but there are few measurements of the proportion of the land that is affected or the rate at which productive soil is lost. Neither are there many data on loss of fertility or productivity from farmland (as distinct from experimental plots). There are abundant figures for gains in agricultural productivity, but few relating these gains to improved soil.

The author attempts to rectify these deficiencies in information for two large, populous countries that are dominantly agrarian and where erosion, whether of the Loess Plateau in China or the steep volcanic lands of Indonesia, has set alarms ringing in many quarters. He does so by analysing data from soil surveys spanning the era from the 1930s to the mid-1990s. His basic tool is multiple regression analysis. He chooses several variables to represent soil quality, such as pH, organic matter content, and concentration of phosphorus, and he relates each in turn to time and one or more other variables (in some instances as many as 93 in total!). He presents the resulting regression coefficients, with associated values of Student's t and stars to indicate statistical significance, in numerous tables. Finally, he summarizes the results. The soil's organic matter and nitrogen contents seem to have declined somewhat under cultivation, whereas the concentrations of phosphorus (P) and potassium (K) have increased. Over much of both countries the soil is either more acid or more alkaline than is desirable for arable cropping, but with few exceptions has the soil got worse (or better) over the 60 or so years. Lindert sees little to support the view that erosion under agriculture has diminished the soil's fertility. On the contrary, he believes that farmers have increased the P and K in the soil by fertilization, and he predicts that in both countries industrialization and the consequent demand for cash crops will enable farmers to invest in their land and improve its fertility further.

How should we judge this book? The author's motivation and diligence are to be applauded. So, too, is his independent thinking. But his wisdom is in doubt. He recognizes that his samples are almost certainly biased, for a variety of reasons which he lists, and he accordingly hedges against criticism with numerous caveats. Nevertheless, he should have known that statistical inference depends on some element of randomization in the sample, and there clearly was none. We can be sure that there will be substantial correlation among so many predictor variables, yet Lindert makes no attempt at selection or elimination by stepwise regression. Also, he should have known that if you make many t tests then some of the differences will appear significant by chance. His conclusions might be correct, but not as a result of statistical rigour.

And what of the concerns about erosion? Lindert's comparisons are for land actually under cultivation. If land went out of use as a result of erosion then it does not appear in the figures. All the author tells us is that the loss of agricultural land on the Loess Plateau of China, for example, which is spectacular, is compensated by cultivators' extending on to new land. This practice is hardly good stewardship, and it clearly cannot continue indefinitely. Lindert might have wanted to take his seemingly detached approach so that his analysis and conclusions were not unduly influenced by preconceptions, but he left me unconvinced.

R. WEBSTER

Smil, V. *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production*. MIT Press, Cambridge, MA, 2001. xvii + 338 pp. £23.95, cloth. ISBN 0-262-19449-X.

During a debate in the British House of Commons in 1917, Sir William Pierce described the Haber–Bosch process for the synthesis of ammonia as 'one of the greatest achievements of the German intellect during the [First World] war'. 'Yet', says Vaclav Smil, 'just a few generations later surprisingly few people know of the discovery, and even fewer are aware of its fundamental, and steadily increasing, importance for modern civilization'. He estimates that some 40% of the world's current

population could not be fed were it not for the Haber–Bosch process. His book gives an admirably clear account of the development of the process and its consequences, not all of which were desirable.

This is emphatically not just a boring book about fertilizers. It is about some difficult physical chemistry and its industrial application. It is about war and history; nitrate is needed for explosives as well as plant nutrition. It is about demography, food supply and the environment. And it is about personalities. Students of physical chemistry will meet some old acquaintances but not always in a favourable light. Ostwald thought he had synthesized ammonia when all he had achieved was the hydrogenolysis of iron nitride already on his iron catalyst, and he was not pleasant to Bosch who identified the mistake. Nernst was so abominably, and quite unjustifiably, rude about some of Haber's results that the latter became ill. Arrhenius seems to have been of a kinder disposition and was helpful to him.

Enriching the Earth begins by assessing the unique role and status of nitrogen in natural and agricultural ecosystems. It then examines traditional methods of supplying it to crops and the various methods used to increase inputs. The central part of the book describes the various attempts to synthesize ammonia from its elements which culminated with Haber's successful identification of a suitable method and the correct combination of temperature, pressure and catalyst. The synthesis is rightly known as the Haber–Bosch process because it was Bosch who was responsible for the rapid conversion of Haber's bench-top process into a large-scale industrial plant which produced 10 tons of ammonia per day by 1913. Sadly, World War I began in 1914 and a year later, the process was part of a military–industrial complex producing nitrate for munitions without which the German war effort would have collapsed much sooner than it did.

The basic principle of ammonia synthesis has not changed since those early days, but the process has been subjected to innovations which have made it ever more energy-efficient over the years. Vaclav Smil charts these innovations together with the development of the nitrogen fertilizer industry and its impact on food supply and the environment. He makes the point that the world now depends on nitrogen fixed by the Haber–Bosch process and examines the consequences of this dependence. It is a sobering thought that virtually all the protein needed for the growth of the 2–4 billion children to be born during the next two generations will, he reckons, have to come from the synthesis of ammonia from its elements.

This review would be incomplete without mention of Vaclav Smil's postscript about the lives of Haber and Bosch after their great achievement. Haber fits the role of flawed and tragic genius. As a German patriot, he proceeded to other war work – on gas weapons including chlorine which by the end of the war caused about 1.3 million casualties. He was awarded the Nobel Prize in 1918 – controversially because of his work on gas. Also perhaps because of this work, his wife shot herself with his army revolver in 1915. He remarried, but suffered greatly from depression which eventually led to a divorce in 1927. Worse was to come when Hitler came to power because Haber was a Jew. His patriotic record and his Nobel Prize stood for nothing; he had to resign his institute directorship in 1933, and he died in 1934. Bosch fared better, playing an important and honoured role in the redevelopment of the German chemical industry in the 1920s and receiving his Nobel prize in 1932. He did his best to protect Jewish scientists from the Nazis, but he too suffered increasingly from depression, in his case about the fate of Germany under Hitler, and he died in 1940.

This is a good, even prophetic, book with a very broad scope, well written and comprehensively illustrated and documented. It is both a good read and an invaluable repository of information. I shall treasure it.

T. M. ADDISCOTT

Cornejo, J. & Jamet, P. (eds) *Pesticide/Soil Interactions: Some Current Research Methods*. INRA Editions, Paris, 2000. 479 pp. Ffr 530 (€80.80), paperback. ISBN 2-7380-0922-0.

The editors present a compendium of methods and computer models used in Europe to investigate the behaviour of pesticides in soils. The project was executed under the European Union's COST Action 66 programme: 'Fate of pesticides in soil and the environment'. More than 100 European authors contributed. The work is appropriately dedicated to Dr Mohamed Mansour, whose distinguished research was on the fate and transport of organic compounds in soil and water. However, there is no section on photolytic degradation of pesticides, a topic that was of great interest to Dr Mansour.

The manual is divided into three parts, describing laboratory, outdoor and modelling methods. The first and second parts contain several subsections, each headed by an introductory paper. The first part, on laboratory experiments, covers choice of soils, volatilization, leaching, sorption, degradation and bound residues. The authors usually describe fairly standard and sometimes long-used methods with the slight idiosyncrasies of the particular research group. The materials and methods section for each topic is not very different from that found in research papers. Additionally, there are headed paragraphs that discuss advantages, drawbacks, improvements and validation of the method. Clearly, one or two paragraphs are insufficient to address thoroughly any complex issues arising under these headings. References are split into two groups to separate those in which the proposed method was used from those dealing with other similar methods. A topic that is barely addressed in the degradation section is the unequivocal determination of metabolic pathways of pesticide degradation. More challenging topics of this sort would go some way to avoiding the impression that the book presents largely a series of different vessels in which soil experiments can be done.