papers emphasize quantitative aspects of the input-output processes of the N cycle in West Africa. However, three of them do not deal with West African ecosystems. One of these three discusses N cycling at Katherine, Australia, which is shown to have a climate very similar to that of Kano, in the Sudan savanna zone of Nigeria. Another discusses the principles of the response to disturbance of terrestrial ecosystems, with examples taken from North American watersheds, while the third is yet another general review of soil N transformations, with no special reference to tropical soils.

The book could have been improved by placing the paper on farming systems, which also contains much information on the physical environment, climate, vegetation and soils, before the papers that discuss N cycling in detail in the various ecosystems. Division of the List of Contents into sections would have been helpful to readers.

The keynote papers are followed by 28 "contributed" papers which mostly report experiment observations on various aspects of the cycle. These include soil N status, N fixation by blue-green algal crusts, nodulation and N fixation in native and cultivated legumes, N fertilization of maize, N mineralization, nitrification, denitrification and leaching, the effects of fire on N cycling, N cycling in a teak plantation and in a soil-*Acacia* system. Curiously, there is also a paper on the introduction of ammonia into combustion stack gases to reduce sulphur dioxide emission.

The work groups undertook the formidable task of quantifying the N balance in Sahel, savanna, tropical forest, and agro-ecosystems. Even for selected examples of these ecosystems, this exercise highlighted many gaps in quantitative data. The discussion of research priorities emphasized the need for baseline data on changes in total soil N over time, and integrated studies to obtain an understanding of ecosystem dynamics. The research priorities for processes in the various ecosystems were judged according to five main criteria.

This book will interest specialists in quantitative aspects of N cycling. However, two of the keynote papers and three of the contributed papers deal with grasslands and will interest grassland scientists.

I. VALLIS

*Environmental Adaptation of Tropical Pasture Plants*. L. R. Humphreys, 1981. Macmillan Publishers Ltd., London. pp 220. Price $55.

Twenty years ago there was no worthwhile reference book on legume-based tropical pastures. Today there are at least twenty books devoted partly or entirely to aspects of tropical pasture science, mostly published within the last five years and mostly written by Australian authors (including four by Dr Humphreys). This proliferation reflects the tremendous advances that have been made in tropical pasture science, and also signifies a desire by scientists to examine and analyse the results achieved to date as we move out of the pioneering phase in Australia.

Dr Humphrey's new book will be welcomed by agricultural scientists and students in the tropics. It is concerned with variation between and within tropical pasture plant species and the principles of agronomic/ecological success. Many readers, particularly in developing countries, will appreciate the agronomic bias of Dr Humphreys which enables him to describe and interpret the results of experiments by specialists in a manner that is easily understood by the more general reader. They will also appreciate the extent of his literature survey (almost 700 references in a book of 220 pages), the good choice of tables, figures and photographs to illustrate the text, the summarising paragraphs at the ends of sections and chapters, the very useful cross-referencing of topics within the book, and the indices to species and subject matter. However, the price may deter many individual readers and restrict sales to libraries, and inevitably the individual reader will find some statements with which he will disagree.

The flavour of the book is very well illustrated by two quotations. The first occurs on the last text page, but is repeated in essence in the preface and in the first chapter:

"The incorporation of elite seed or planting material in tropical farming systems is the single innovation most effective in contributing to sustained gains in productivity". The second is found on page 30: "The adaptive significance of some forms has become clear, but the coexistence of dissimilar forms in the same farm environment underlines plant versatility in providing dissimilar solutions to similar requirements for ecological success; our failure to understand the basis of these cohabitations is a challenge to investigation". Thus, the book is primarily devoted to species domesticated and deliberately sown by man, and the emphasis is on genetic diversity among and within species and the need for a better understanding of the requirements for ecological success.

There are ten chapters, of which the first is an introduction and the last a conclusion. In Chapter 2, the author describes geographical patterns of plant distribution and the concepts used by collectors in the plant introduction process. If this chapter leaves the reader dissatisfied, the reason must partly be that successful plant introduction is always a blend of art and science, of pedantics and practicalities, of logic and pure luck. Plant introductionists are a race apart and their worth is above rubies. In Chapter 3, patterns of genetic variation imposed by different breeding systems are discussed. Thus, Chapters 2 and 3 together introduce the reader to the concept of genetic variation occurring both between and within species, which permeates the entire book.

Chapter 4, entitled "Survival mechanisms" is actually concerned with pathways to persistence of plants in pastures. Flowering and seed formation are discussed authoritatively, as one would expect from the author's considerable involvement in this field. The significance of soil seed reserves and seedling regeneration is emphasised (but actual levels of soil seed reserves are not detailed until Chapter 7). The next three chapters are concerned with adaptation to specific environmental stresses imposed by climate (drought, chilling temperatures and frost; Chapter 5), soil (waterlogging, acidity, mineral toxicity, salinity and soil texture; Chapter 6) and biotic hazards (grazing and cutting, burning, and diseases and pests; Chapter 7). These chapters are full of interesting and useful information, and the author's ability to "agronomise" the data is particularly helpful in Chapters 5 and 6. The contribution made by the late Dr Colin Andrew to our knowledge of the nutritional requirements of tropical pasture legumes is abundantly clear in Chapter 6.

Chapters 8 and 9 are concerned with adaptive superiority which results from superior growth rate and/or superior competitive ability, rather than survival under stress. This arrangement of subject matter had led to some problems in presentation (e.g. plant nutritional aspects are split between Chapters 6 and 9, and aspects of growth under grazing are treated in Chapter 7), but it is not illogical. Symbiotic nitrogen fixation is included as a topic in Chapter 9.

In the concluding chapter, Dr Humphreys provides a brief summary of the particular adaptive characteristics of the main sown tropical grasses and legumes, and lists some general deficiencies of each group. These are: (1) low nutritive value of both grasses and legumes; (2) poor seed production and establishment characteristics of grasses; (3) generally poorer drought and cold tolerance of legumes; (4) limited adaptation of legume species to waterlogged, saline and very acid soils; and (5) relatively poor resistance of many legumes to biotic hazards (grazing, pests and diseases, and fire). The reader may quibble over priorities (for example, only some aspects of nutritive value to animals are of significance to the ecological success of plants), and might wish to add to the list (e.g. poor adaptation of most legumes to clay soils), but will certainly agree with the author's concluding plea for a continuing research investment on species adaptation.

R. J. CLEMENTS