Book review

Earthworm Management in Tropical Agroecosystems

Edited by P. Lavelle, L. Brussaard and P. Hendrix. Published by CABI Publishing, Wallingford, UK & New York, USA, 1999. 320 pp. ISBN 0 85199 270 6. £49.95.

The 46 authors who have contributed to this book are research workers who, from 1989 to 1996, have been toilers in the MACROFAUNA network of the MAB-UNESCO Tropical Soil Biology & Fertility Program.

The book should be required reading for all who aspire to understand and contribute to the sustainable use of tropical agroecosystems. The data presented here show how earthworms can be managed, with minimal inputs of capital and resources, to enhance their productivity and sustainability.

In Chapter 1, Fragoso *et al.* survey the taxonomy, biogeography and environmental plasticity of tropical species in natural and managed tropical ecosystems and establish a data base including 457 species, from 745 localities in 28 countries. From these, they select 21 exotic and 27 native species that show potential for management in tropical ecosystems; these are species with wide ranges of climatic and edaphic tolerances (environmental plasticity). Most species with potential for manipulation in agroecosystems are large species that live in the soil and ingest a mixture of soil and surface litter; these are keystone species in agroecosystems, ecosystem engineers whose burrows and casts transform soil profiles.

Chapter 2, again with Fragoso as first author, analyses data for 145 and 69 earthworm communities from managed and natural ecosystems, respectively, and from 15 tropical countries, in Mexico, Central and South America, western Africa and India. The aim is to separate the influences of phylogenetic, environmental and agricultural factors on the structure of earthworm communities in agroecosystems, and to evaluate their relative importance in the whole soil macrofaunal community.

In Chapter 3, Barois *et al.* examine some ecological and demographic parameters of 26 species of native and exotic earthworms that are common in tropical ecosystems, have wide environmental tolerance and/or extensive distribution patterns, and so are particularly significant as a component of the soil fauna of tropical agroecosystems. In particular, they evaluate these species': ability to colonise new environments; patterns of spatial distribution, especially in changing environments; short-term effects on soil structure, related to rates of soil ingestion, selective ingestion of particle size fractions and cast production; relationships with soil microorganisms, whether as part of their diet or mutualistic; and short-term effects on mineralisation of N and transformations of P. The authors conclude that earthworms may affect the soil dramatically, altering it in many ways, and that their communities are susceptible to manipulation that can impact favourably on soil fertility.

Brown *et al.* then continue, with a discussion (Chapter 4) of the effects of earthworms on plant production in the tropics. Sixteen experiments were conducted over a 7-year period at both greenhouse and field level, in 6 tropical countries, and involving 14 plant species, 6 great soil groups, and at least 13 species of earthworms. These experiments, supplemented by a wide spectrum of additional data from the literature, demonstrated overall increases in shoot and grain mass production of >55% and >35%, respectively, resulting from earthworm introductions. The highest increases were observed in soils with sandy textures, poor in organic matter, and with moderately acid pH. Earthworm biomass of around 30 g liveweight/m^2 or more was shown to be necessary to promote grain increases >40%. Earthworm introduction should include a suite of selected species at sustainable numbers and biomass, and once they are established, long-cycle crops or perennials with organic matter additions favour long-lasting benefits from the earthworms.

Chapter 5, by Blanchart *et al.*, examines the effects of tropical earthworms on soil structure and physical properties. The authors distinguish 'compacting species', large earthworms that egest large, compact casts that increase bulk density and the proportion of large aggregates in the soil, and tend to decrease water infiltration rate and increase water holding capacity, from 'decompacting species', smaller earthworms that feed at least partly on the large compact casts of compacting species, and egest smaller more fragile aggregates that decrease bulk density and tend to increase water infiltration rate and decrease water holding capacity. In kaolinitic soils, earthworms have a major role in producing stable and long-lasting structural aggregates, while in smectitic soils their effects on soil structure are not clear. The presence of organic residues or leguminous mulch, combined with a mixture of compacting and decompacting earthworm species, permits the conservation of structure that favours and sustains soil fertility.

Villenave *et al*., in Chapter 6, examine the effects of field-scale earthworm inoculation over 3–6 years in low-input agricultural systems in Africa, the Caribbean, Central and South America. They aimed to test whether the introduction of selected earthworms would reduce the loss of soil organic matter and plant nutrients generally observed in such systems, and stimulate plant growth. In soils in Martinique, planted to pasture after being degraded by 15 years of continuous crop production, earthworms accelerated the restoration of soil organic matter, but in cultivated soils, earthworms did not prevent the depletion of soil organic matter. Annual cropping systems were shown not to favour the establishment of earthworm populations unless crop residues were incorporated, mechanically or by soil organisms; ingestion of these residues resulted in release of readily available plant nutrients, especially N and P.

There follow 2 chapters devoted to practical aspects of the introduction and use of earthworms in agroecosystems.

Senapati *et al*. examine techniques and costs of large-scale earthworm culture. They conclude that management of organic matter inputs and introduction of earthworms raised in culture are worthwhile techniques for high value crops such as tea, where production and profit were as much as trebled in their experiments. However, in many, if not most, circumstances the high costs of producing huge numbers of earthworms in culture dictate that indirect stimulation of earthworm communities in the field, by increasing and managing organic matter inputs to the soil, is the only feasible way to take advantage of their beneficial activities.

Ortiz *et al*. interviewed 202 farmers in 4 tropical countries, seeking to clarify farmers' perceptions of relationships between soil fertility and earthworm activity. In Mexico, Peru and India, they found that most farmers recognised a beneficial effect from earthworms, while in Congo there was a general lack of knowledge. They conclude that, although some traditional knowledge exists, it is important to build on the judgement, intuition, knowledge and experimental capacity of indigenous farmers and further educate them in soil biology.

The final chapter, by Aranda *et al*., reviews technologies and programs of vermicomposting, *i.e.*, the use of carefully selected species of earthworms to assist in the composting of organic wastes, to produce useful and plant nutrient-rich products that can be applied to the land to improve soil structure and fertility, or used in the preparation of potting soils and plant growth media. Very large numbers of earthworms are also produced and these can find uses as a protein source for animal feeds. Much work on vermicomposting, its practical application in the tropics, and the biology of suitable earthworm species, has been done in India. The Indian work is not covered in this chapter, but a case study of the successful use of vermicomposting of coffee pulp, in Mexico, using the earthworm species *Eisenia andrei* and *Perionyx excavatus*, is described.

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