

from the page bottom) should be replaced by 'A' in the future edition of Volume 3.

Unfortunately, not all (even overpriced!) books may be identified as treasures. It is a sad fact that there are books which may be classified as 'unwanted advances'. Volume 3 (as well as Volumes 1 and 2 of the reviewed manual) is a very wise and simple book. I have to admit that while reading this book I discovered that I had forgotten many details relating to soil laboratory testing.

A prospective reader of this manual (and particularly Volume 3) is a very fortunate person; it was written by a kind, knowledgeable teacher and excellent geotechnical specialist!

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Agroforestry for Soil Management, 2nd edition by A. Young. CAB International, Wallingford (in association with the International Centre for Research in Agroforestry, Nairobi), 320 pp, 1997. Softcover. ISBN 0 85199 189 0 (£25).

Back in 1940, Geoffrey Milne working as a soil scientist in Tanganyika wrote; "If then the soil is to continue to grow plants for us, in turn we must grow plants for the soil". Milne was referring to cover crops and green manures as a means to conserve the soil under continuous cropping. Cover crops have never been widely used by smallscale farmers although they have been well adopted in plantation agriculture. For most of this century, soil fertility research focussed on inorganic fertilizers, driven amongst others by the idea that shifting cultivation inevitably led to land degradation and the 'Freedom From Hunger Campaign'. In the 1960s, gloomy pictures started to appear on the future of soil resources in the tropics with the following actors: increasing population, high land pressure, shortening of fallow periods, cultivation of marginal lands, soil degradation, reduced crop yields, food shortage, etc. There is little doubt that this pattern occurs but how the problems should be tackled is a far less clear picture. Some believe that a new green revolution is needed including new crop varieties combined with judicious use of inorganic fertilizers and biocides. Others have suggested that farmers should rely more on soil biological properties with the help of small amounts of external inputs to maintain and improve crop yields. Agroforestry, the spatial and/or temporal combination of trees and agricultural crops, fits in that picture.

In January 1978, the first meeting of the International Council for Research in Agroforestry (ICRAF) was held in which the above sketched picture was recognized as a major obstacle for development. Initially, a massive inventory of traditional agroforestry systems was made followed by several classification

schemes. This was synthesized together with some early ‘try-it-and-see-it’ agroforestry experiments and more general literature on agriculture, forestry and soil science in *Agroforestry for Soil Conservation*, the precursor of the current book. The descriptive and inventory period ended at the end of the 1980s and was followed by a more scientific approach based on process-oriented research. Hence, ICRAF which had joined the CGIAR in 1991, transformed from a council into a centre, and from an organization producing glossy posters saying ‘Agroforestry for better land-use’ to a true research organization publishing hard data in scientific journals. That change of emphasis is clearly reflected in the current book with hundreds of agroforestry publications from the 1990s.

An important part of the first chapter is devoted to the 12 hypotheses which form the basis on which agroforestry is developing as a new and strongly interdisciplinary science (and what an exciting one it may be! as ICRAF’s DG once remarked). They are grouped into hypotheses related to processes (e.g. agroforestry controls erosion, increase nitrogen levels in the soils), agents (e.g. tree litter improves soil fertility, tree roots provide a safety net against leaching) and systems (e.g. agroforestry can be employed to reclaim degraded lands, agroforestry systems increase the biological productivity). The hypotheses form the thread that is subtly woven throughout the entire book.

Trees have beneficial effects on physical, chemical and biological soil properties through the addition of nutrients and organic matter, and the reduction of losses (Chapter 2). However, there are also some adverse effects of trees like allelopathy, soil acidification and the removal of nutrients and organic matter. Agroforestry systems aim to maximize the positive effects and to minimize the negative effects through choosing suitable trees for specific agro-ecological zones. Suitable trees are generally those that fix atmospheric nitrogen, produce ample biomass, have an extensive root system and produce no toxic substances. There are quite a few such trees like for example *Leucaena leucocephala*, *Sesbania sesban*, *Gliricidia sepium* or *Flemingia congesta*. Although the choice of the tree is crucial, this book contains no details for such evaluation but there are other ICRAF publications providing that information.

In Chapter 3, the contribution of agroforestry to reduction in runoff and soil erosion is treated. The author firstly describes the important change of emphasis in soil and water conservation studies. In the conventional approach, rates of soil loss, construction of earth bunds and a top-down enforced policy were key issues but successes were limited, particularly in the less-developed countries. In the late 1980s, a new approach was formulated focussing on the effects of soil loss on crop yield. Earth bunds were given less emphasis and biological methods of conservation including the maintenance of soil cover were advocated. Agroforestry has a role to play in this new approach as trees provide soil cover, increase water infiltration, and/or may increase soil organic matter contents which lowers the susceptibility to soil erosion. The author summarizes studies from various parts of the world, which generally prove these hypotheses.

Particularly hedgerow-intercropping systems are beneficial and these may reduce soil loss by a factor 10 to 100.

Chapter 4 discusses the positive and negative effects of trees in the management of soil water. Positive effects include deep uptake, reduction in evapotranspiration losses and increased infiltration. The negative effect is the competition for water with the crop and there is evidence with hedgerow-intercropping systems in areas where annual rainfall is below 1000 mm. However, as the author points out, traditional agroforestry systems are widespread in the semi-arid areas but water competition is limited in such systems because of the lower growth rate of traditional trees as compared to planted multipurpose trees.

Agroforestry systems are perceived to maintain soil organic matter, which is an essential prerequisite for sustainable land use (Chapter 5). This maintenance is likely to occur through the addition of tree crop residues, reduced erosion losses, and a reduction in organic matter decomposition due to shading and mulching. The author calculates that about 10 to 15 t biomass/ha are needed to maintain soil organic matter levels in the humid tropics. Such amounts have been produced in various trials with multipurpose trees. Overall, it is only partially proven that agroforestry systems maintain soil organic matter at levels satisfactory for soil fertility. In some experiments organic matter increased whereas in others it hardly changed as compared to the control plots. The authors explain this by saying that at least 3 to 5 years are needed before conventional total carbon tests (Walkley and Black, dry combustion) pick up differences caused by soil management. There is evidence, however, that agroforestry changes the active fractions of the organic matter, which for some soils is the major source of nutrients.

Six of the 12 hypotheses are linked to nutrient cycling and these are reviewed in Chapter 6. Agroforestry systems are halfway between forested ecosystems and annual cropping systems and their major benefits may include a reduction of leaching losses, fixation of nitrogen, deep uptake of nutrients and mycorrhizal associations of the treeroots. Through the addition of leaf litter, agroforestry offers a possibility of synchronizing nutrient supply and nutrient demand by the crop. This can be done by selecting different tree species that have different leaf composition, by adjusting the time of treepruning to the time of planting of the crop, or by incorporating prunings in the soil or applying them as a surface mulch. These strategies are promising to optimize nutrient availability and reduce losses, but much remains to be explored for different tree-crops combinations under different environmental conditions.

Chapter 7 describes the role of roots—the hidden half—in agroforestry systems. Root studies are tedious, difficult and expensive and therefore only a few studies have been conducted. They are, however, of great importance because of the deep uptake of water and nutrients, the safeguard of nutrients against leaching, and the competition with the crop, particularly by lateral roots. Research has indicated that the amount of roots in agroforestry systems is only

slightly higher than that of annual crops but far below forested ecosystems. When they die, for example when the tree is pruned or cut, treeroots are an important source of nutrients and organic matter comparable with aboveground litter.

The individual aspects or system components treated in the previous chapters are synthesized in Chapter 8 analyzing the effects of agroforestry systems as a whole upon soils. This chapter covers nearly one-quarter of the main text. The author describes systems where soil and water conservation are the major function (e.g. contour hedgerows), systems where soil-fertility maintenance is the major function (e.g. managed tree fallows), and other systems where soil aspects are secondary such as in taungya and entomofostery (e.g. trees and bees). Not all systems have received the same amount of research effort. Hedgerow intercropping systems have been much researched and a large table summarizes 600 scientists-years of research into hedgerow intercropping systems. Many of these trials were conducted in the first era of agroforestry research following diagnosis and design surveys and most trials have not been conducted for sufficient period of time to draw hard conclusions. Various recent reviews have shown that hedgerow intercropping systems, though technically successful, are seldom adopted by farmers. Competition for resources, mainly water, between the crop and tree is an important explanation but also the absence of yield response in the short term explains their non-success. The many research years were probably better spent on managed or improved tree fallow systems and the author summarizes several success stories with those systems. Also transferring biomass from trees growing on derelict lands to cropland has shown invariably high and positive yield responses.

Self-respecting agricultural disciplines can hardly do without modelling their experimental data, and there are many other reasons to do so. The use of models in agroforestry research is treated in Chapter 9 and starts with an overview of different aspects of modelling and some distinctive features of agroforestry as a basis for modelling. SCUAF (Soil Changes Under AgroForestry), the author's own model, is described but other models like CENTURY, ROTATE and SHIELD are also discussed. SCUAF does not require a vast amount of input data, is relatively simple and user-friendly. The author recommends that for agroforestry research SCUAF is to be used in combination with the more complex and rigorous CENTURY model.

Chapter 10 is devoted to strategies for soil research in agroforestry. Initially, in agroforestry research trials were conducted with systems that could directly be applied by farmers. This approach was for several reasons not a roaring success. Modern agroforestry research aims to gain the knowledge needed to design agroforestry systems that are acceptable to farmers. The author identifies several key areas of research and provides some guidelines on how to conduct proper research. Some of the environmental aspects of agroforestry including the control of land degradation, carbon sequestration by trees, and reduction of

forest clearance are treated in Chapter 11. In the last chapter, the previous information is summarized discussing each of the 12 hypotheses given in the first chapter, and how far they have been confirmed. This is followed by 36 pages of references and a useful index of 13 pages. The index is worth mentioning because in the past years I have seen quite a number of newly published books containing horrible indexes with far too few entries and 20 to 30 page numbers per entry.

Everyone can write 'but some write better than others'. They write clear language that is pleasant to read. It is wellknown that Anthony Young is one of them and if it were not for the subject, you may as well read the book for his excellent writing style. The author has a magnificent capacity to synthesize large amounts of information from different disciplines. In addition, he is able to define buzzwords in a few words where others need half a paragraph for the same word. For example agroforestry is defined in a recent ICRAF publication as "A dynamic, ecologically based natural resources management system that, through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels". There are a few more of such lengthy definitions but the author summarizes agroforestry simply as: growing trees on farms. Such definition is shorter, easier to remember and may be more precise as it has not been proven that under all conditions the integration of trees means increased social, economical and environmental benefits. A second example of a concise definition put forward by the author is that of sustainable agriculture. Again, a plethora of definitions have seen the light in the past decade but the author summarized them nicely in a pseudo-equation: sustainability = production + conservation.

In conclusion, this is a marvelous synthesis of twenty years of agroforestry research written by an eminent and generally optimistic author. The message is: agroforestry has a large potential to combat land degradation and achieve sustainable land use in an affordable and socially acceptable way. If Milne had not died so untimely (and would have lived a long life), he would have it summarized as: If then the soil is to continue to grow crops for us, in turn we must grow trees for the soil.

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