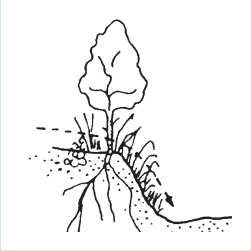
Agrodok-series No. 16

Agroforestry



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Agrodok 16

Agroforestry

Ed Verheij

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Author: Ed Verheij
Editor: Catharina de Kat-Reynen
Illustrators: Barbera Oranje, Toon Helmink
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Foreword

Each year, Agromisa receives many enquiries on agroforestry from persons and institutions in the South. There is thus clearly a need for practical information on the subject. It is in this context that this Agrodok is presented. It describes the essential elements of agroforestry, from some basic principles to their practical application; looking at the benefits but also paying attention to the difficulties and constraints. The aim is to offer options for improved land-use in the tropics. Extension issues are also addressed, because recommendations by scientists or extension workers to introduce certain agroforestry systems can only be successful if village people are convinced that the proposed change in their land-use is beneficial.

Certain aspects of agroforestry systems are also covered in other Agromisa publications:

- AgroBrief no. 1 (Van Tol, 2002: *Fodder trees*)
- Agrodok no. 5 (*Fruit growing in the tropics*)
- Agrodok no. 11 (*Erosion control in the tropics*)
- Agrodok no. 19 (Schreppers et al., 1998: *Propagating and planting trees*)

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Ed Verheij, September 2003

Contents

1 Introduction

1.1 Annual crops and trees in agricultural development

Farmers in large parts of the tropics have no tradition of aiming at maximum production per hectare; their main concern was to reduce the risk of crop failure. The principal reason is that - except in the main population centres - there were no convenient markets for food surpluses. The traditional farming systems were integrated, based on self-sufficiency and hence on internal supplies and services between different farm components: mixed cropping with a legume supplying nitrogen to a cereal, field crops supplying fodder for livestock in exchange for manure, etc.

However, in the last century these systems proved to be not sufficiently productive to feed the rapidly growing population. That is not surprising, because these traditional systems were not touched by agricultural science, which was the driving force for ever-increasing yield levels in the temperate zones of the world. Agronomists neglected the traditional mixed farming systems for two reasons:

- the prevailing notion that the market economy demands specialization;
- the lack of suitable research methods to study the intricately interwoven farm components.

The second reason of course follows from the first; modern agricultural science, in spite of its roots in systems research, gradually became very much preoccupied with the improvement of single crops. When called upon to combat hunger in tropical regions, agronomists knew no better than to concentrate on raising yield of the principal annual staple food crops, such as rice and wheat. These crops were already grown as mono-crops for the market and lent themselves to the approach which had been so successful in the temperate zones. Agronomists indeed succeeded with these crops, as for instance shown by the ‘green revolution’ in Asia.

Unfortunately this approach failed to alleviate hunger, in particular in tropical regions with rainfed farming systems and underdeveloped markets for food crops. In those regions the situation continued to deteriorate, also because the prices of non-food commodities (e.g. cotton, coffee, spices, fibres) kept falling worldwide, strapping smallholders of cash income and reducing them to subsistence levels of farming. Mounting population pressure resulted in ever-smaller farm size and the need to sacrifice 'unproductive' trees in favour of planting food crops. Moreover, the inability to raise yield levels forced the growing population to bring more land (often marginal land) under cultivation at the expense of the natural vegetation.

Before long these trends led to alarming reports about deteriorating land use systems: expanding 'dust bowls' and deserts (because of wind erosion), degraded land following loss of topsoil and silting up of irrigation systems (all because of water erosion), declining soil fertility and yield levels (because of inadequate inputs of manure and fertilizer and the opening up of marginal lands), etc. And then it was realized that these precarious situations had something in common: trees were vanishing from the landscape. Deforestation to open more arable fields, trees and shrubs killed by overgrazing, cutting of trees for fuelwood, etc., all add up to a landscape being denuded of its permanent vegetation (mainly forests and grazing land for cattle).

Thus it became clear that trees not only yield useful products but also play a vital role as more permanent elements in the landscape, sustaining the capacity of the land to feed people. This brought trees onto the agenda of agricultural development. Although trees are the largest perennial plants and they best exhibit the qualities which are important in sustaining the productive capacity of the land, the most important factor is that permanent vegetation covers the land, whether it consists of trees, shrubs, vines or perennial herbs (such as grasses, banana/plantain, yams). Therefore, where the term 'trees' is used in this booklet, it usually stands for all woody plants (and large perennials such as banana as well). In Chapter 2 the benefits and limitations of trees are discussed in more detail.

Unfortunately the benefits of a permanent vegetation cover of trees and other perennials only become obvious when the land has been denuded under excessive population pressure, overgrazing and deforestation. Then it is too late; once the elements have free play over the bare land 're-greening' becomes very difficult, because only the hardiest of plants can reclaim the area, and these tend to produce little in the way of food for man and beast. It is therefore of the utmost importance to reverse this overexploitation process before land degradation has impoverished the people who live in the area.

Figure 1: Wood being carried home to be burnt; but will the loss be compensated by new growth?

Annual crops cannot provide permanent cover and in dryland farming the fields lie a large part of the year unprotected. The realization that these crops should benefit from suitable combinations with tree crops in mixed cropping systems gave rise to AGROFORESTRY as a distinct discipline in agricultural science in the 1970s. Further consideration of the role of trees, shrubs and vines in mixed cropping systems resulted in the inclusion of crop mixtures of woody plants as well as cropping systems combining woody plants and animal husbandry.

Meanwhile agricultural science had rediscovered its origins - dating back to the early 19th century - in farming systems research, and was developing methods to study the mixed farming systems in the tropics. Crop science had already extended its reach from single crops to the study of mixed crops. This research confirmed the farmers' claim that

mixed cropping reduces the risk of crop failure, but it also dampens the response to crop care. To demonstrate that a simple crop mixture of e.g. maize and beans outyields two plots of maize and beans grown separately requires many years of painstaking research and the outcome is not spectacular at all: the mixture yields only slightly more than the sum of the two crops on their own, mainly because the total yield of the mixture is more stable from year to year. The difference is larger - but the yields are much lower - at low input levels (no fertilizer, imperfect crop protection, etc.).

Compared to the interactions between maize and beans in mixed cropping, the interactions in agroforestry systems are a good deal more complex. Moreover, trees require years before they reach an effective size. During these years their interactions with companion crops and/or livestock keep changing. Thus the results will not be achieved quickly, nor will they be spectacular (if they were, farmers would have discovered this long before agronomists became involved). The hoped-for result of agroforestry technology is the reversal of a downward trend in land use into an upward trend, putting land-use back on a sustainable basis.

In fact the main benefit of agroforestry so far has been descriptive: studying the role of trees in traditional farming systems in various parts of the tropics and sounding the alarm over the dramatic losses of trees in the vegetation in many regions. The information collected regarding the many auxiliary woody plants and their uses in farming systems and descriptions of traditional forms of agroforestry provide the basis for experimental work. It took about a dozen years before the first agroforestry field experiment was laid out in 1984. Up till now the only system that has been tried well enough for a provisional evaluation of its usefulness is alley cropping, described in Section 4.5. In recent years the focus of attention has shifted to improved fallows, described in Section 4.6. This promising agroforestry system also requires long-term research work, but the complexity of the interactions is greatly reduced because the woody plants and the crops are not grown side by side, but one after the other.

1.2 The scope of agroforestry and of this Agrodok

Agroforestry is concerned with the role of woody plants in farming systems; it deals in particular with mixed cropping systems on the farm which comprise:

- several woody plants, e.g. coconut casting shade over cocoa or a windscreen of trees along an orchard of fruit trees;
- woody plants and herbaceous (usually annual) plants, e.g. improved fallows of fast-growing trees which restore soil fertility for the field crops grown after the fallow period;
- woody plants and livestock, e.g. scattered trees in parklands, which provide shade for cattle and lopped branches for fodder in periods of scarcity.

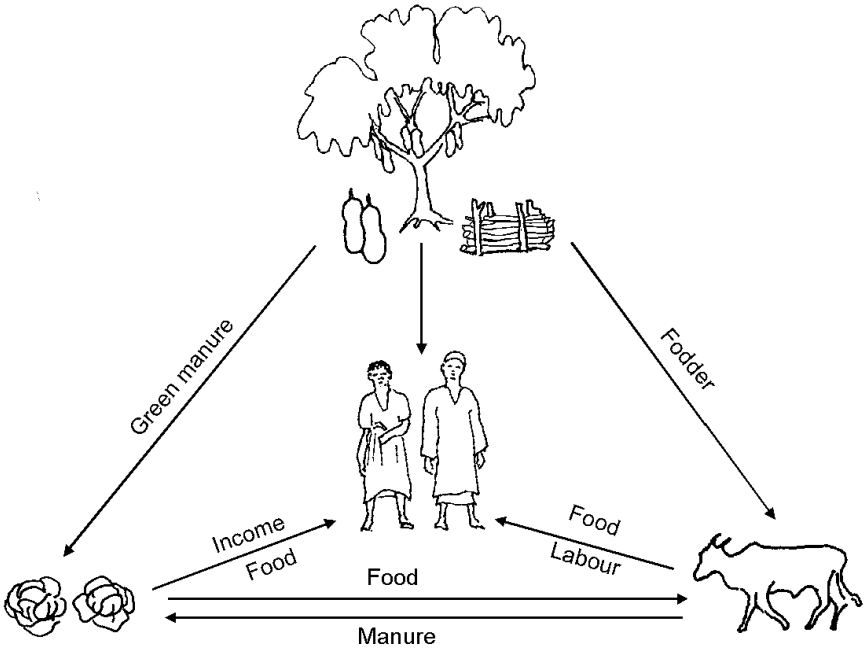

Figure 2: Interactions between trees, field crops, animals and people

This Agrodok does not give recipes for agroforestry plantings. That would be impossible in view of the diversity of the tropical environments, and of the large numbers of woody plants deserving consideration. Rather it is hoped that the reader gains insight in the scope and limitations of trees (Chapter 2) and in their possible roles within the farm (Chapter 3), in order to be able to choose practical applications of agroforestry (Chapter 4) which suit the local conditions. In Chapter 4 conditions under which an agroforestry approach is applicable are spelled out and examples of woody plants used for that application are given. Moreover, important characteristics of these plants are listed in Appendix 1; on the basis of these characteristics locally available plants may be selected which have similar properties. In other words: it is hoped that this Agrodok will foster understanding of the issues, so that the reader can adapt a specific agroforestry application to his or her local conditions, making good use of trees which have proven their usefulness locally, perhaps supplemented by some of the trees mentioned in Chapter 4.

To end this introduction the scope of agroforestry is briefly considered in relation to other disciplines in agriculture and forestry dealing with trees. Taking a historical perspective, public concern for the development of tropical tree crops emerged during the colonial era. This era started off with sea voyages from Portugal around Africa to give Europe direct access to the oriental spices, in particular black pepper and clove (borne on a vine and a tree resp.). Soon other tree crops were moved across the oceans, to set up large-scale production of what came to be known as plantation crops: coffee, tea, cocoa, coconut, oil palm, rubber, etc. These are still the best-researched tropical tree crops; they cover vast areas, now mainly in the hands of small farmers.

Likewise the tropical rain forests were a welcome source of timber for the colonial powers. They logged the valuable hardwoods and initiated plantation forestry - e.g. teak plantations - to supply the mother countries (with lasting consequences for the organization of forestry in the former colonies).

The tremendous variety of tropical fruits also aroused attention in the colonial period. Because transporting fresh fruit to the mother country was not feasible, the study of these trees was largely left to botanists; agronomically the tropical fruits remain ill-understood tree crops.

This episode in agricultural development is related here because it marked the beginning of new disciplines in agricultural science: tropical forestry, plantation tree crops, and tropical fruit growing. Is there really a need for agroforestry to supplement these older disciplines? Yes, there is. For one thing the other disciplines operate mainly in the humid tropics and in the tropical highlands; their impact in drier regions is quite small. Sisal, for instance, is practically the only plantation tree crop in low-rainfall areas.

Secondly, these other disciplines stand on their own; unfortunately the study of tropical trees is largely fragmented. There is little exchange of information, which weakens the impact of science on tree crops. Agroforestry, by cutting across these barriers, can play a unifying role: fostering the understanding of how trees function in order to give them their due place in the tropical environment.

Thirdly, the formal disciplines leave a large category of so-called auxiliary woody plants unattended. These auxiliary plants produce no marketable product; they play a supportive role in cropping systems, by providing shade or shelter, serving as a hedge or live stake (to support a trellis for climbers), providing fodder, etc. The supportive role on the farm implies that we must not only get to know these plants themselves; we also must study how the woody plants interact with the crops or animals on the farm which they shade, shelter, support, feed, etc. That is the scope of agroforestry.