Trees outside forests

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Food
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FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

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PREFACE

Everybody today recognizes the urgent need to safeguard and conserve resources, particularly trees ; trees outside forests undoubtedly represent one of the pillars of strategies for conserving ecosystems and combating food insecurity. Trees outside forests, which are found both on agricultural land and in urban and peri-urban zones, represent an extremely varied resource, with orchards, home gardens, agroforestry systems, and trees planted along roads and waterways, in oases and on grazing land. Although they are part of the daily life of men and women in every region, supplying a wide range of products and services, they have not received so far the attention they deserve from managers and policy-makers in the various sectors concerned. Today, policy-makers and planners are realizing that they have to take greater advantage of the contribution of this resource, if they are to face the challenges of forest and soil degradation and desertification, meet the needs of growing populations for wood and non-wood products, and combat food insecurity.

Since trees outside forests are found on agricultural land and in urban and peri-urban areas, they fall within the spheres of agriculture, animal husbandry and forestry as well as urban development, while concern is felt both within communities and local government as well as in the context of discussion meetings and international negotiations. In order to give off-forest tree resources their own place within integrated development of rural and urban zones, common action guidelines are to be discussed, proposed, and a whole range of information is needed, corresponding to the aims of the different users. Some will be interested in economic aspects, while others will focus on the contribution to erosion control in mountain or desert zones. Some people collecting information look for simple, effective methods in order to monitor the dynamics of the resource and assist communities, decision-makers and political powers in the decision-making process. Some people analyse data with a view to immediate action, while others do so with a view to the year 2025. Unfortunately, even where information does exist, it is often scattered and does not always meet needs. For example, a bibliographical study and a critical analysis of inventory or evaluation projects for trees outside forests undertaken by CIRAD-Forêt in 2000 highlighted the absence of any overall assessment of trees outside forests and their products. The available information comes from sectorial and often geographically limited projects, and is based on a variety of methods, so that it is hard to evaluate its quality.

In view of the need for information expressed by both countries and institutions, FAO felt an initial annotated bibliography should be produced, covering the various aspects of this vast issue and encompassing over one hundred countries. This first bibliography on trees outside forests will be made available on the Internet and can be updated and expanded according to users' needs. We therefore invite readers to inform FAO of any other references that could enrich and fill out this work.

The project was supervised by Michelle Gauthier, under the general direction of Tage Michaelsen, Chief of the Forest Conservation, Research and Education Service of the Forest Resources Division. The bibliographical research was carried out by Isabelle Amsallem, with the support of CIRAD-Forêt, France. The work was completed by Mattia Biasioli and Matthieu de Carbonnel, who also supervised actual publication and page layout. The bibliography is part of the FAO Conservation Guides Series and is intended for all those involved in rural development, both in practical terms and in the research field, as well as those responsible for political decisions regarding agriculture, forestry and land-use planning.

This work will be followed by a FAO Conservation Guide entitled "Trees outside forests - *Towards better awareness"*, which is a first reflection on the whole concept of trees outside forests. The aim of these works is to give these trees and shrubs in rural, peri-urban and urban environments their own place in land management, resource conservation and development and the alleviation of food insecurity and poverty.

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The English version of this document has been finalized under the direction of Mr. José Antonio Pardo, Director, Forest Resource Division.

It was revised and coordinated by Mrs. Michelle Gauthier, Forestry Officer, Forest Conservation Service. Mrs. Aurélie Vuillermoz, FAO volunteer programme, assisted in the final editing revision and in the make-up of this document.

CONTENTS

INTRODUCTION TO THE BIBLIOGRAPHY

This first annotated bibliography on trees outside forests lists a selection of works produced mainly since 1980. The aim is to present the whole issue of the development, both conceptual and methodological, of this resource. The bibliographical research was carried out with a very broad field of key words in order to take account of the variety of the subject and of readers. Over one hundred countries from every part of the world are represented. The selected entries are reports, books and articles by scientists, researchers, students and resource users and managers. The French documentary sources used were the Agritrop and FRANCIS databases, while the multilingual (mostly English) databases used were CAB ABSTRACTS, AGRICOLA and CAB, as well as the FAO Online Catalogue.[1]

The 619 entries have been divided into five categories or chapters, in order to help readers in their research. The first chapter, "Definitions", presents the concept, terminology and classification of trees outside forests. The second, "The importance of trees outside forests", is divided into three sections: the first analyses their environmental, economic and socio-cultural roles and functions; the second presents the methods and tools used in evaluating trees outside forests and their products; and the third focuses on the dynamics of the resource and how it is developing and changing. The third chapter, "Management and development of trees outside forests", is also divided into three sections: the first presents the development and management of trees outside forests within the environment; the second analyses their influence on social, economic and cultural factors; and the third deals with political and legislative aspects. The fourth chapter, "Education and research", focuses on the spreading of knowledge and awareness of trees outside forests. The fifth and final chapter, "General works", covers works that do not fall specifically under any of the previous headings.

The entries are numbered consecutively throughout the bibliography, then arranged alphabetically by author within each chapter or section. The annexes allow the reader to search for references according to a variety of criteria: conferences (Annex 1), countries (Annex 2), key words (Annex 3), authors (Annex 4) and journals (Annex 5).

This first bibliography on trees outside forests will shortly be made available on FAO's website, and can then be updated according to the needs of users. We therefore invite readers to inform FAO of other references that could enrich and fill out this bibliography.

[1] Agritrop, International Cooperation Centre on Agrarian Research for Development (CIRAD), Montpellier, France. FRANCIS, National Centre for Scientific Research (CNRS), France. CAB ABSTRACTS and AGRICOLA, Commonwealth Agricultural Bureaux (CAB). The FAO Online Catalogue is found at http://www4.fao.org/faobib/index.html

TREES OUTSIDE FORESTS

Trees outside forests comprise a widespread and multi-purpose resource, frequently domesticated, cultivated and tended, and offering a gamut of environmental services and products. The fact that society has appropriated this resource is plan to see in the many local practices, laws and customs governing their use, as in their symbolic and cultural representations. This is as true of countries with scant forest resources as of those more richly endowed.

Tree resource conservation and even expansion is a strategic issue in less-forested countries, where Trees outside forests – growing in rural or urban areas, in orchards, gardens, savannah or agroforestry parklands, as shade trees or permanent crops – constitute a genuine and essential source of the wood and non-wood products crucial for peoples's day-to-day needs. While their contribution to local economies is significant, their contribution to the conservation of biodiversity is inestimable.

Trees outside forests have a similar social impact in countries with abundant forest resources, though it may not seem so, and the economic necessity for this resource may, at first sight, appear less urgent, but the environmental need is clearly just as crucial. There may be no present concern over their disappearance, but the degradation of off-forest tree systems is often irreversible and there is a clear risk of ecosystem deterioration.

Well-forested or not, all countries face the same constraints regarding the management of Trees outside forests. Despite land insecurity and unfavourable economic guidelines, rural and urban communities attempt to maintain and preserve there stree systems, calling on skills and practices handed down from one generation to the next. As for the institutions, many working under difficult material and financial circumstances, there is a need to take a fresh look at certain legal contradictions, confront the drastic rules of the international market-place, and try to reconcile local strategies with policies of more general interest.

Generally speaking, the integrated development and sustainable forest and non-forest land management sectors have not paid enough attention to non-forest tree resources, whether rural or urban. Nonetheless, if we look at the environmental and development record, the topic gradually and increasingly appears on the agenda of scientific, economic and policy debates. The apparent climate degradation that took place in the 1970s provoked a rush of aid to countries hit by drought and desertification. This was followed in the 1980s by a wealth of agroforestry research that acknowledged the major role of trees in rural development and soil fertility. Environment, sustainable developement and biological diversity were heigh on the agenda of the 1992 United Nations Conference on Environment and Development (UNCED). During the 1980s and 1990s, interest mounted in non-wood forest products. Trees, especially trees growing outside forests, began to be viewed in terms of their contribution to social well-being and to the environment. Policy-makers and planners gradually evolved and converged in their thinking to acknowledge the promise of this resource, in all its myriad forms, as a key to multisector, sustainable development.

And yet, while the wide-ranging uses and services of these resources are increasingly well-known, hard numerical data and information are still lacking worldwide. Deforestation has been mapped and quantified, but we know very little about the fate of land formerly under forest, and the parallel changes in tree cover in fields and towns. What we do know about Trees outside forests comes mostly from local studies, so that our knowledge is quite diffuse, and much of it remains untapped, lodged in the local lore of rural societies.

What is needed, then, is an overall grasp of the socioeconomic and environmental implications of these resources at every level, a better understanding of what influences their expansion or regression, identification of the institutional underpinnings, a closer look at the relevant practices and underlying knowledge, and a thorough review of resource assessment experiences in the sector.

Following this line of reasoning, the first part of the paper attempts to highlight the importance of Trees outside forests, constraints to overcome and forces to enhance to ensure their sustainable development, plus the assessment mechanisms needed to track their evolution. The context of Trees outside forests and their contribution to development, dynamics, and management are summarily defined in an attempt to pinpoint the main factors to consider in designing promotion strategies. This part of the paper ends with a preliminary review of the various resource assessment tool and methods.

Introduction of FAO, 2002,
Trees outside forests – Towards better awareness
FAO Conservation Guide no. 35. FAO and CIRAD, Rome.

CHAPTER 1: DEFINITIONS

1 **Ambouta, J.M.K.** 1997. Définition et caractérisation des structures de végétation contractée au Sahel: cas de la brousse tigrée de l'ouest nigérien. *In* J.M. D'Herbès, J.M.K. Ambouta & R. Peltier. *Fonctionnement et gestion des écosystèmes forestiers contractés sahéliens,* p. 41-57. Paris, J. Libbey Eurotext.
On aerial photographs of the Sahel, vegetation on the sandstone uplands of the continental terminal seems to form alternating light and dark stripes (bare areas and vegetation), which may be in straight or wavy. In western Niger, this striped bush disappears north of latitude 15º N, where rainfall is insufficient to allow the growth of woody vegetation, and south of latitude 13º N, where the uplands are covered by a uniform and evenly distributed vegetation. Between these two extremes, the striped bush structure has a wide range of variations. Close to latitude 15º N, the dark stripes are short and broken, like hyphens. The area between latitudes 14º30 and 13º N is the home of true striped bush, while towards latitude 13º N, the stripes grow narrower and the contrast between them grows less: this is the home of spotted bush. Further south, the striped structure becomes blurred, with pale oval or round areas appearing against a dark background—formations known as flecked and leopard bush. Other differences are a result of differing landforms, with rosette formations being found on rolling uplands, and short, regular, straight stripes on plateaux. A typical example of striped bush is described as the repetition of an ordered sequence from the top down: wooded zone, stumpy fringe, bare zone, decantation fringe, and grassy fringe. The distribution of woody species in the wooded stripe respects and highlights this zoning. The zones that reveal most about the changing dynamics of the system are certainly the stumpy fringe and the grassy fringe.

2 **Baumer, M.** 1994. Forêts-parcs ou parcs arborés? *Bois et Forêts des Tropiques,* 240: 53-68.
A brief description of the two commonest types of forest parkland in West Africa is followed by references to other tree systems, showing that concepts are not clear. Parkland can be residual, selected or constructed. A definition is suggested that would confine the meaning of the term "forest parkland" to cultivated land. The terms "orchard grassland" and "fruit-tree meadow" are also defined.

3 **Baumer, M.** 1997. Caractérisation des forêts-parcs. *In* G. Bonkoungou, E. Ayuk & I. Zoungrana, eds. *Les parcs agroforestiers des zones semi-arides d'Afrique de l'Ouest,* p. 148-163. Meeting held in Ouagadougou, 1993. Nairobi, ICRAF.
A brief description of the two commonest types of forest parkland in West Africa is followed by references to other tree systems, showing that concepts are not clear. Parkland can be residual, selected or constructed. A definition is suggested that would confine the meaning of the term "forest parkland" to cultivated land. The terms "orchard grassland" and "fruit-tree meadow" are also defined.

4 **Diatta, M., Grouzis, M.** ***et al.*** 1998. Typologie de la végétation ligneuse en zone soudanienne. *Bois et Forêts des Tropiques,* 157: 23-36.
The present environmental conditions in Sudano-Sahelian zones (a lack of rainfall and overexploitation) are unfavourable to maintenance of the natural vegetation. This applies particularly to woody vegetation, which plays a major socio-economic role (fuelwood, grazing, medicines, etc.). Better knowledge of the floristic composition, structure and environmental distribution of this vegetation is thus needed in order to draw up development and/or conservation proposals. However, the wide range of works on analysis of vegetation diversity, in both methodological and investigative terms, makes it hard to use these works or make generalizations on their basis. In terms of ecology, the successive application of factorial

analysis of correspondences to matrices recorded x species of woody vegetation has allowed the easy identification of plant groups corresponding to topographical situations and specific soil features. It is suggested to use the results of the differentiation between the vegetation units in the management of woody resources.

5 **FAO** 1997. *AFRICOVER. Classification de l'occupation des sols.* Rome, FAO, 78 pp.
This publication aims at presenting the current state of classification of land cover adopted by the Land Cover Key and Classification International Working Group for the Africover Project. The first part consists of a technical document describing the main concepts and bases for the basic classification, together with a presentation of the main definitions used. The second part is a report of a seminar held in Sali, Senegal, attended by members of the same international working group. The third part describes the architecture of the classification system.

6 **Huxley, P.A.** 1983. Comments on agroforestry classifications: with special reference to plant aspects. *In* P.A. Huxley, ed. *Plant research and agroforestry,* p. 161-172. Proceedings of a consultative meeting held in Nairobi, 8 to 15 April 1981. Nairobi, ICRAF.
This article suggests a structural process for the creation of classifications for specific aims. Clearer concepts and time and space models concerning the various uses of agroforestry land are needed if these uses are to be adequately classified. The chronology of land cover by plants is linked to the sequence of cultivated species and to the succession. The use of space must also take account of cropping patterns. A standard terminology, covering all the various forms of land use, is proposed.

7 **Jancet, R.** 1997. Typologie des espaces verts. *In* L.M. Rivière, ed. *La plante dans la ville, 1996,* p. 69-80. Meeting held in Angers, France, 1996. Paris, INRA.
The author presents a reliable tool—the typology of green spaces—that can be used as a first step in any technical or financial approach to managing vegetation in towns, and can be the first stage in drawing up standardized inventories.

8 **Jeanes, K.W. & Baars, R.M.T.** 1997. Landscape and grassland mapping of Western Province, Zambia. *ITC Journal,* 1: 9-14.
A hierarchical land classification into land regions (LRs), land systems (LSs), land units (LUs) and land facets (LFs) was carried out as part of a land evaluation for extensive grazing (based on FAO guidelines) in the western Province of Zambia. Existing maps and literature were studied to make initial botanical descriptions at LU and LF levels. During a field survey, the botanical descriptions were verified or identified if not known. A 1:500,000 scale colour map of landscapes and grasslands, describing 71 map units (MUs), resulted. The delineation of the MUs was based on landforms, dominant and common tree and grass species, and vegetation structure. The classification of vegetation structure was based on the cover by trees (>5 m), shrubs (<5 m) and grasses/subshrubs (<0.5 m). The LUs and/or LFs of the land classification were lumped or separated to form MUs, determined by the results of the field survey and the scale of the final map. The MUs also describe scattered and present grass species.

9 **Laamouri, A.** 1990. Les systèmes agroforestiers: classification, potentialités et aménagement. *In* A. Kaabia, A. Benzarti, A. Ben Boubaker, Y. Saadani & A. Jemai, eds. *Séminaire maghrébin d'agroforesterie,* p. 11-18. Seminar held in Jebel Oust, Tunisia, 1989. GTZ.
Agroforestry is an approach to land use that plays on the interdependence of various inputs in a given area. It is based on the integration of woody vegetation (trees, shrubs and bushes) with other products of the soil (agricultural and/or animal). After defining the concept of agroforestry, the author offers a classification based on the limits, structure, function and evolution of these systems. He also proposes possible ways of developing agroforestry systems.

10 **MacDicken, K.G. & Vergara, N.T.** 1990. *Agroforestry: classification and management.* New York, NY, John Wiley & Sons, 382 pp.
This work offers useful models of agroforestry systems for a wide range of applications, from research and exploratory development to the creation of sustainable and integrated production systems for small farmers.

11 **Nair, P.K.R.** 1985. *Classification of agroforestry systems.* Nairobi, ICRAF, 32 pp.
Agroforestry systems have to be classified in order to provide a framework for evaluating systems and developing action plans for their improvement. The agroforestry inventory system developed by ICRAF provides information that will allow a classification to be made. Various criteria can be used to classify and group agroforestry systems, the most common being based on their structure, functions, management level, socio-economic scale, and environmental extent. Each of these criteria can be applied in specific situations, but each also has limitations, so that no classification can be universal and inevitably depends on the objective in question.

12 **Nair, P.K.R.** 1987. *Agroforestry systems in major ecological zones of the tropics and subtropics.* Nairobi, ICRAF, 15 pp.
Through its Agroforestry Systems Inventory, ICRAF has gathered together, evaluated, summarized and distributed information on systems and associated practices in different parts of the tropics. Classification was carried out on the basis of a variety of criteria, such as structure, function and socio-economic aspects. An ecological analysis of the various agroforestry systems shows that their existence or adoption in a given region is conditioned first by the ecological potential of the zone, although the complexity of the system and how intensively it is managed are determined by socio-cultural and economic factors. The author presents the various types of agroforestry system according to the different tropical and subtropical ecological zones.

13 **Raison, J.P.** 1988. *Les "parcs" en Afrique. Etat des connaissances et perspectives de recherches.* Paris, Ecole des Hautes Etudes en Sciences Sociales, Centre d'Etudes Africaines, 117 pp.
This work offers a typology of parkland based on both use and origin, and then describes the various types of Sudanian, Sahelian and Guinean parkland.

14 **Torquebiau, E.** 1990. *Introduction to the concept of agroforestry.* Nairobi, ICRAF, 121 pp.
This working document is intended first to present the main basic concepts of agroforestry and then to describe how ICRAF is approaching this complex new discipline. The text was essentially written as a training document and has already been used as lecture notes. It was produced in both English and French, so that it could be used to crosscheck and standardize the use of certain agroforestry terms in the two languages.

15 **UNEP/FAO** 1994. *Report of the UNEP/FAO expert meeting on harmonizing land cover and land use classifications.* Geneva, Switzerland, 23-25 November 1993. Nairobi, UNEP/FAO, 44 pp.
This document provides information connected with land cover and land use, as well as interrelations between these two concepts on the global, national and local levels.

CHAPTER 2: THE IMPORTANCE OF TREES OUTSIDE FORESTS

2.1 ROLES AND FUNCTIONS

25 **Allnutt, J.** 1993. *The role of trees in sustainable agriculture.* Meeting held in Albury, Victoria, Australia, 30 September-3 October 1991. Victoria, Australia, Kluwer Academic, 186 pp.
Agroforestry can improve farm production, diversify and increase farm income, help to conserve resources and maintain biodiversity, and contribute to meeting national wood needs. All these functions are described in the form of a review of research on the following subjects: salinization control, hedges and protection against erosion, development of the original vegetation, timber production, and production of minor forest
products. The work focuses mainly on Australian agroforestry, but also includes some more international research.

26 **Baldy, C.** 1997. Systèmes traditionnels d'arboriculture et conservation des sols dans le bassin méditerranéen. *Cahiers Agricultures,* 6: 31-44.
Rainfed Mediterranean orchards traditionally corresponded to very specialized cropping systems, which have too often been replaced by techniques derived from those used for major crops. Some systems still found in some very different environmental regions are presented here: Italian mixed cropping, stone-built terraces, the Tunisian *tabiâ, meskât* and *jessour*, and Spanish and Syrian fruit tree and grape combinations. The article shows how such systems, which are often neglected today, can be rehabilitated and updated, thus helping in the development of a sustainable and economically viable arboriculture in these regions.

27 **Bannister, M.E. & Nair, P.K.R.** 1990. Alley cropping as a sustainable agricultural technology for the hillsides of Haiti: experience of an agroforestry outreach project. *American Journal of Alternative Agriculture,* 5: 51-59.
The agroforestry technique of planting hedges on sloping land seems promising for small farmers in the hilly areas of Haiti. An agroforestry project in operation since 1981 helped thousands of farmers to plant hedges on their farms. The farmers by and large accepted the technique, and the length of hedges planted each year rose from 11 kilometers in 1987 to 140 in 1988. An evaluation carried out on 50 farms where hedges were established shows the effects of this technique on soil conservation and fodder and fuelwood supplies.

28 **Baumer, M.** 1987. *Agroforesterie et désertification. Le rôle possible de l'agroforesterie dans la lutte contre la désertification et la dégradation de l'environnement.* Wageningen, Netherlands, CTA, 260 pp.
This work first describes and defines desertification, before moving on to present the various types of agroforestry system that can help in combating this phenomenon, thanks to analysis of different case studies. The author then lists the principles of desertification control, describing the role of woody species and agroforests, agroforestry practices, and farmer action.

29 **Baumer. M.** 1997. *L'agroforesterie pour les productions animales.* Wageningen, Netherlands, CTA, 340 pp.
This work is in essence a review, representing an attempt to gather together today's main knowledge on agroforestry and animals. There may be a variety of interactions between ruminants and woodland—technical, economic, even political. The role of livestock as a production factor is also considered, without forgetting the role of other animals (bees, game, etc.).

30 **Bazile, D.** 1998. *La gestion des espèces ligneuses dans l'approvisionnement en*

énergie des populations. Cas de la zone soudanienne du Mali. Toulouse, France, Université de Toulouse-Le-Mirail, 378 pp.
A study based largely on "ethnoscience" methods allows the author to highlight the contribution of the social and human sciences to ecology, forestry and agronomy in the context of tropical geography, in order to understand the relationships between human beings and the environment. Mali depends on fuelwood and wood charcoal for 91% of its energy needs. An ever-widening circle of deforestation around the main towns first led researchers to turn their attention to urban centres. However, the high demographic growth rate is also bringing about a major change in population densities in rural areas. With a view to gaining a better picture of small-farmer practices and decision-making processes, the research is carried out on the different organizational levels of society. An analysis based on interlocking levels constitutes the backbone of the methdology used to define an operational spatial framework for collecting and interpreting information. The systematic processing of indicators and a systematic general approach allow agrarian systems to be divided into categories in regional terms, with an understanding of the processes of access to and management of tree resources in the area, so that farmers' development strategies can be explained. A model to help in decision-making proposes management rules for the local "agrosystem", combining the results obtained on the various levels on the basis of three principles. The consumption of fuelwood in rural areas rises with the availability of the resource and the break-up of the African extended family. Fallows represent a potential source of energy (1.5 m^3/ha/year), to be boosted within the rotation system in the form of a very short rotation coppicing. Lastly, wooded parkland is a little known and scattered reserve of wood. A reflection on rationalization of the scattered trees would lead to implement linear developments combining agriculture, animal husbandry and forestry. Urban supplies must focus on sustainable management, decided on the rural community level on the basis of the wood surplus available and on the will to market it in order to provide supplementary income.

31 **Benge, M.D.** 1987. Multipurpose uses of contour hedgerows in highland regions. *World Animal Review,* 64.
The important element of hedgerow systems as presented in this article is the use of multipurpose woody perennial plants on steeply sloping land in order to produce fodder for livestock. Vegetatively propagated plantations are also used for large-scale reforestation and to increase crop yields, build up the organic matter in the soil, reduce erosion, increase water infiltration into the soil, and produce fuelwood

32 **Bergeret, A.** 1987. *Rôle alimentaire des arbres et arbustes et de quelques plantes herbacées (Communauté rurale de Sali, Sénégal).* Paris, 14 pp.
This work gives an inventory of plants that provide food products for the rural community of Sali in Senegal. The food value of each of these species is reviewed, along with the threats endangering these resources.

33 **Besse, F., Harmand, J.M. *et al.*** 1998. L'arbre et les formations arborées éléments moteurs du développement rural? *In* H. Breman & K. Sissoko, eds. *L'intensification agricole au Sahel,* p. 793-800. Paris, Karthala.
Agriculture has developed mainly to the detriment of woodland and forests. The need for space and for new land with renewed fertility has helped to push the edges of forests back towards inaccessible or poor land that is unsuitable for any viable agricultural development. Although trees are potential competitors for light, water and the elements needed for growth, they are retained within fields because of their production or service uses and functions. Despite deforestation and desertification, trees are still an important element in the agricultural landscape in Sahelian regions. The fodder produced by trees and shrubs is often the only recourse for herders during lean periods at the end of the dry season. The demand for fuel on the part of an increasingly numerous and densely concentrated population increases the need for

sustainable management of natural stands and makes household plantations even more attractive. The role of trees in improving soil and combating water or wind erosion means that they have a direct impact on agricultural production. However, woodland and trees also contribute to rural life and its maintainance because of the role played by non-wood products in the daily life of the rural population (in terms of food, health and construction) and the income they can generate. The sociological and cultural importance of trees, which cannot be assessed in monetary terms, is complemented by the place they hold in the household budget, which tends towards domestic production, and in the local economy, which is based on the trade and processing of tree products. The establishment of rural markets or structures to market fuelwood, managed by the local population, should encourage the involvement of the latter in the local management of natural resources. In view of the social and economic importance of trees, they are not competitors with agriculture, but in fact act as a major driving force in local development.

34 **Biggelaar, C.D. & Gold, M.A.** 1995. The use and value of multiple methods to capture the diversity of endogenous agroforestry knowledge: an example from Rwanda. *Agroforestry systems,* 30: 263-275.
A number of different methods are needed in order to grasp agroforestry knowledge and the process behind the generation of such knowledge. This article uses the identification and description of farmers who are expert agroforesters to illustrate this necessity. Informal, participatory methods were used to identify research subjects and understand the concepts of "knowledge" and "agroforestry". An adaptation of the wealth ranking game was used to define (i) the research subjects, using locally defined criteria of "able to be known in terms of agroforestry" and (ii) how this knowledge is distributed in a community. Supplementary information concerning the subject was gathered together by using formal surveys to collect socio-economic data and drawing up an inventory of all the tree species. The results show that it is importnat to combine qualitative and quantitative information, participatory methods and formal data collection, inasmuch as they provide complementary and supplementary perspectives on a complex situation.

35 **Blanc-Pamard, C.** 1980. De l'utilisation de trois espèces de palmiers dans le sud du "V Baoulé" (Côte d'Ivoire). *Cahiers de l'ORSTOM,* 17: 247-255.
Three varieties of palm—borassus, oil and raffia—provide a range of resources for the inhabitants of the base of the Baoulé "V" in Côte d'Ivoire, in a transitional environment between forest and peri-forest savannah. The profits from palm wine far outweigh the many other uses (food, technological, medicinal and cosmetic). However, the violent methods used by harvesters means that sap extraction leads to the death of the trees.

36 **Bompard, J.M., Ducatillion, C.** ***et al.*** 1980. *A traditional agricultural system: village, forest, gardens in West Java.* Montpellier, France, Université des Sciences et Techniques du Languedoc, 40 pp.
This text describes the home gardens in villages in West Java. The authors analyse the botanical composition and very varied products of these gardens, as well as their multistoreyed vertical structure.

37 **Boutland, A., Robinson, M.** ***et al.*** 1992. Alternative products from trees and shrubs: paper presented to the Role of Trees in Sustainable Agriculture Conference, Albury, Victoria, Australia, 30 Setpember-3 October 1991. *Agroforestry Systems*, 20: 25-58.
The incorporation of tree and shrub products into normal farm management has received little attention in Australia. Despite 40 000 years of use by the Aborigines, very few indigenous species are commercially exploited, apart from those used for construction timber and fodder. Production of the alternative products of non-indigenous species has also been neglected. This paper reviews the present economic importance of many trees and shrubs in Australia, research and development work—or the lack thereof—on these products, and lastly the potential role

they could play in improving farm income. Alternative tree and shrub products in Australia include: essential oils, honey and pollen, wild flowers and tree foliage, nuts, sandalwood, seeds, Christmas trees, medicines, tannin, gum and resin, cane, cork and wood charcoal. Many of the existing industries in this sector depend on the extraction of natural resources, but plantations are increasingly being set up. Some alternative tree and shrub products can be produced on a large scale (for example, honey), but in many cases production is confined to the vegetation of particular climatic zones (for example, the tropical rainforests of Queensland have been a rich source of medicinal plants). The study examines the industries producing major and potentially major tree and shrub products, the species on which they depend, and the agro-climatic region in which they are based. An evaluation of the economic viability of on-farm production is included wherever possible, and on the basis of these evaluations, industries are categorized as already viable, potentially viable or probably viable. It seems at present that many of the industries producing alternative tree and shrub products have little hope of improving their profits, unless there is some pre-existing resource. In many cases, the cost of setting up a plantation specifically for minor or secondary forest products exceeds the expected return, particularly if costly inputs like irrigation are needed. However, in many parts of Australia where replanting is urgently needed, it should be possible to incorporate trees or shrubs for the production of alternative products in plantations being established for shade, shelter or erosion control.

38 **Boyle, T.J.B. & Matyas, C.** 2000. Conserving genetic diversity of forest trees in managed landscapes. In *Forest genetics and sustainability*. 4th International Consultation on Forest Genetics and Tree-Breeding. Dordrecht, Netherlands, Kluwer Academic Publishers Group.
Some of the most common forms of human interventions in forests (logging, grazing, fire, harvesting of non-wood forest products), and their effects on genetic diversity, are outlined. The effects on genetic dynamics (drift, selection, migration among populations, mating systems) are then discussed. The last part of the paper describes criteria and indicators for use in evaluating and implementing sustainable forest management, and specifically addresses the 4 indicators of genetic processes that have been proposed (the level of genetic variation, directional change in gene or genotypic frequencies, changes in gene flow/migration, and mating system processes) and the demographic and genetic verifiers that can used to investigate these.

39 **Bradley, G.A.** 1995. *Urban forest landscapes: integrating multidisciplinary perspectives.* Seattle, Wash., USA, University of Washington Press, 224 pp.
Twenty chapters, written by the editor and 20 other specialists, are based on a symposium held in spring 1992. The first part of the book introduces the subject and discusses historical perspectives and the influence of European cultural tradition on urban forestry in the USA. The remaining 3 parts discuss the environmental setting (including landscape ecology, human needs, political and administrative issues), special purpose landscapes (for beauty, amenity, wildlife, water or energy conservation, fire prevention), and integration of sustainability and multiple objectives for urban forest landscapes.

40 **Breman, H. & Kessler, J.J.** 19 ?? . *Le rôle des ligneux dans les agro- écosystèmes des régions semi-arides (avec un accent particular sur les pays sahéliens).*
This book gives a quantitative analysis of the role of woody species in semi-arid regions. This analysis was carried out in order to evaluate the possibilities of integrating these plants into agrosilvopastoral systems, with a view to sustainably increasing production. The various aspects examined and the conclusions drawn are encouraging, and allow an extrapolation of the advantages offered by these plants to other climates, environments and land-use systems. The ecological dynamics and physical conditions of the resource-poor Sahelian and Sudanian zones of West Africa, the particular focus of this book,

have been the subject of indepth study. Extrapolated to other semi-arid regions, the results allow general conclusions to be drawn on the exploitation of an agroforestry potential as a possibility for sustainable land use in these regions.

41 **Buck, L.E., Lassoie, J.P. & Fernandes, E.C.M.** 1999. *Agroforestry in sustainable agricultural systems.* Boca Raton, Fla., USA, Lewis Publishers, 430 pp.
The authors examine the environmental and social conditions affecting the role and production of trees in plantations and in forest production systems. They analyse various types of ecological situation, including agroforests in temperate and tropical regions, and examine the roles of water, light, nutrition and pest and disease prevention in mixed, annual and permanent crops and in agropastoral systems. Case studies offer innovative strategies that have been successfully used in commercial-scale sustainable production of forest and tree products. These strategies also have a favourable effect on soil conservation and watershed management.

42 **Burel, F.** 1996. Hedgerows and their role in agricultural landscapes. *Critical Reviews in Plant Sciences*, 15: 169-190.
Hedgerows, the lines of trees or shrubs enclosing or separating fields, are made by man. They are part of rural landscapes and should not be studied without considering farming systems and rural societies as a whole. Their specific composition depends on the history of the countryside, as well as on present-day agricultural practices. Land use and demarcation management play major roles in determining the floristic composition of hedgerows and are strongly linked to the mosaic of the landscape. Hedgerow networks break many flows in the landscape because of their straight lines and the fact that they tend to be interconnected. Hedgerows act as a circulation and dispersion corridor for many forest species, small animals and plants. On the other hand, they also cut off or slow down flows of air, and hence the propagules they carry. In the mixed mosaic of fields and wooded areas, hedgerows often increase the interlinked functioning of rural landscapes. The future of hedgerows depends on changes in rural society, which is increasingly including non-farmers. Hedgerows will be seen not only as part of a productive sector, but also as an element in a multifunctional landscape.

43 **Caceres, A., Soto, J. *et al.*** 1997. Cortinas cortaviento: propuesta de forestación urbana y periurbana como alternativa para mejorar la calidad de vida en Río Gallegos, provincia de Santa Cruz. *Boletin de estudios geográficos*, 29: 311- 318.
This article examines the town of Río Gallegos, the capital of Santa Cruz province in Patagonia. The authors suggest setting up forest shelterbelts in order to combat serious wind problems.

44 **Calame-Griaule, G.** 1980. L'arbre et l'imaginaire. *Cahiers de l'ORSTOM*, 17: 315-320.
The imaginary landscapes in which fairytales of all origins are set borrow their features from the environment familiar to their listeners, although this landscape is not described but simply sketched in. Characters, objects, and often plants, particularly trees, appear within this landscape, and the species of such trees is never a question of chance, but is always determined by the symbolic code of the culture in question.

45 **Carter, E.J.** 1995. *L'avenir de la foresterie urbaine dans les pays en développement: un document de réflexion.* Rome, FAO, 95 pp.
This document makes a preliminary evaluation of the state of knowledge and opportunities for urban forestry in developing countries: definition, historical evaluation and present state of urbanization and urban forestry, opportunities, advantages and potential problems, social and cultural aspects, the planting and management of trees, and institutional aspects.

46 **Clarke, W.C. & Thaman, R.R.** 1993. *Agroforestry in the Pacific Islands: systems*

for sustainability. Tokyo, United Nations University Press, 297 pp.
This book describes the various traditional agroforestry systems that have been developed over thousands of years in the islands of the Pacific. Special attention is paid to modern urban agroforestry, agroforestry practised in conjunction with cash monocrops, and agroforestry projects promoted by governments and international agencies. The study consists of ten chapters based on several decades of research. Chapter 1, "Introduction", describes the framework of the study and its geographical context, defines terms and discusses deforestation and "agrodeforestation" in the Pacific. Chapter 2, "Pacific Island agroforestry : Functional and utilitarian diversity", examines the sustainable and integrated nature of agroforestry, the diversity of its functions, the bases for innovation, its sustainable character in relation to the aims of national development, and existing models and the need for appropriate innovation. Chapters 3 and 4, "Agroforestry in Melanesia : Case-studies from Vanuatu and Fiji ", describe case studies in Papua New Guinea (one), the Solomon Islands (three), Vanuatu (one) and Fiji (two). Chapter 5, "Agroforestry in Polynesia" contains an introductory note and three case studies (Tonga, Rotuma, the Cook Islands, and the Marquesas Islands). Chapter 6, "Agroforestry in Micronesia", contains an introductory note and two case studies (traditional agroforestry in the high islands and agroforestry atolls of Tarawa and Abemama, Kiribati). Chapter 7, "Pacific Island urban agroforestry", examines home gardens, practices on fairly undeveloped land, various problems, and integration into urban and political planning. Chapter 8 discusses "Agroforestry on smallholder sugar-cane farms in Fiji ". Chapter 9, "Institutional agroforestry in the Pacific Islands", examines the more official agroforestry activities promoted by various institutions, involving outside funding, training, agricultural research and development; the subjects discussed include crops combined with a tree crop for commercial or subsistence aims, plantation trees for various uses in relation to agroforestry and agriculture, silvopastoral systems, and future directions. Chapter 10, "Agroforestry in the Pacific Islands: Systems for sustainability", offers general conclusions and recommendations, and lists a large number of agroforestry species (large and small trees and shrubs) found in traditional Pacific Island systems. The annex gives further details on 100 species.

47 **Couteron, P., D'Aquino, P. *et al.*** 1993. Le *Pterocarpus lucens* dans la région de Banh au Nord Ouest du Burkina Faso. Importance pastorale et état actuel des peuplements. *In* A. Gaston, M. Kernick & H.N. Le Houérou, eds. *Congrès International des Terres de Parcours, 4,* 1: 94-100. Montpellier, France, 22-26 April 1991. Montpellier, France, CIRAD.
This paper is a report on part of a series of research projects into the use of natural resources and the dynamics of pastoral systems in the northern part of the Yatenga region. The aim is to restore *Pterocarpus lucens* to its former ecological and pastoral importance in the region and to provide an up-to-date survey of the state of stands, as well as sketching out future prospects for the species and guidelines for rational management.

48 **Cromwell, E., Brodie, A. *et al.*** 1996. *Germplasm for multipurpose trees: access and utility in small-farm communities. Case studies from Honduras, Malawi and Sri Lanka.* London, Overseas Development Institute, 93 pp.
Increasing resources are being devoted both internationally and nationally to the collection of germplasm from multipurpose trees (MPTs) for Developing Countries, but little work has been done on defining the roles that small-farm communities wish MPTs to play within their farming systems, what attributes the MPTs need to have to be useful, and how the germplasm can best be disseminated. This book reports on the situation in communities in 3 countries where MPTs are being actively promoted: Honduras, where many MPTs are within their native range; Malawi, where a number of exotic species have recently been introduced; and Sri Lanka, where MPTs such as *Gliricidia sepium* have been in use for a long time. Accounts are given of how

improved germplasm is incorporated into existing farming systems, and the broad patterns of exchange and use of indigenous and new tree germplasm within the case study communities. Various problems are highlighted. The book is arranged in 6 chapters - introduction, methodology, the 3 case studies, and conclusions.

49 **Crossa, R.P.** 1990. L'arboriculture fruitière dans les systèmes agricoles oasiens. *In* V. Dollé & G. Toutain, eds. *Les systèmes agricoles oasiens,* 11: 319-324. Meeting held in Tozeur, Tunisia, 19-21 November 1988. Montpellier, France, CIHEAM-IAM.
Three types of oasis can be distinguished in terms of fruit arboriculture: date oases, coastal oases and mountain oases. It is suggested that there is considerable potential for growing cash fruit crops in mountain oases, so long as the species and varieties are carefully selected and marketing efforts are made.

50 **Dallière, C.** 1995. *Peuplements ligneux des champs du plateau de Bondoukuy dans l'Ouest Burkinabé. Structure, dynamique et utilisations des espèces ligneuses.* Paris, Université de Paris VII Crétail, 78 pp.
This study, carried out in the Sudanian savannah zone, seeks to categorize different tree stands in cultivated fields, and to grasp their restraints and their potential for regeneration. The functions and uses of woody species by the local population are also discussed.

51 **Depierre, D. & Gillet, H.** 1991. L'arbre désertique source de vie. *Bois et Forêts des Tropiques,* 227: 43-50.
Trees in desert zones are a fundamental source of life. Suited to an arid environment in both their form and physiology, they are in the first place a source of biological benefits. However, the tree of life is threatened by overgrazing, as well as being overexploited by human beings. Trees not only provide simple sticks, but also household tools, fuelwood, construction timber, vegetable fibres, mineral resources and medicines, as well as being a source of artistic activity. Trees affect the lives of people and cattle in desert zones more than anywhere else. Tree species that have adapted to desert conditions over thousands of years must be protected and propagated. At present the only way of allowing reconstitution and development seems to be to close off certain areas.

52 **Dharmasena, P.B. & Gunasena, H.P.M.** 1997. Environmental richness in the dry zone homegardens. In *Eighth National Workshop on Multipurpose Trees, Kandy, Sri Lanka.* Maha Illuppallama, Sri Lanka, Field Crops Research and Development Institute.
With increasing demand for fuelwood and timber and growing concern for environmental protection, planners and implementers of watershed and rural development projects in Sri Lanka are focusing efforts on tree planting programmes. The success of such programmes must be monitored and evaluated not only in terms of productivity but also in terms of impact on environmental protection. Tree planting programmes can be assessed through an index termed 'Environmental Richness of Plant Community (ERPC)'. The ERPC index should emphasize 3 main aspects: plant diversity, coverage by strata and plant density. The paper introduces the ERPC, classifies existing dry zone home gardens using the ERPC, discusses the nature of variation of the index among the home gardens, and makes recommendations for the botanical composition of home gardens to be environmentally rich. An expression is given for the ERPC, which is a function of the number of species per 100 m2, modified by coefficients denoting the stratal effect of large, medium and trees, and the number of plants per 100 m2 in large, medium and small canopy categories. Some 51 home gardens in the central dry zone of Sir Lanka were surveyed. The results indicated that the environmental richness decreased exponentially as home garden size increased. A high environmental richness was found in 20% of home gardens, and in these, the average number of plants per 100 m2 was 2.9, 6.3 and 6.7 under large, medium and small canopy categories, respectively; the average number of species per 100 m.

53 **Dixon, R.K. & N.P. *et al.* eds.** 1995. Agroforestry systems: sources of sinks of greenhouse gases? *Agroforestry-Systems,* 31: 99-116.
The prominent role of forestry and agroforestry systems in the flux and long-term storage of carbon (C) in the terrestrial biosphere has increased global interest in these land-use options to stabilize greenhouse gas (GHG) emissions. Preliminary assessments suggest that some agroforestry systems (e.g. agrosilvicultural systems) can be CO2 sinks and temporarily store C, while other systems (e.g. ruminant-based silvopastoral systems) are probably sources of GHG (e.g. CH4). Agroforestry systems can be significant sources of GHG emissions, especially at low latitudes. Practices such as tillage, burning, manuring, chemical fertilizing, and frequent disturbance can lead to emission of CO2, CH4, and N2O from soils and vegetation to the atmosphere. Establishment and management of agroforestry systems incompatible with prevailing edaphic and climatic conditions can accelerate soil GHG emissions. Non-sustainable agroforestry systems are quickly degraded, and woody and herbaceous crops can become significant GHG sources. Silvopastoral systems can result in soil compaction and erosion with significant loss of labile C and N compounds to the atmosphere. Ruminant-based silvopastoral systems and rice paddy agrosilvicultural systems are well documented sources of CH4 which significantly contribute to the global CH4 budget. Early assessments of national and global terrestrial CO2 sinks reveal two primary beneficial attributes of agroforestry systems: (i) direct near-term C storage (decades to centuries) in trees and soils, and (ii) potential to offset immediate GHG emissions associated with deforestation and subsequent shifting agriculture. Within the tropical latitudes, it is estimated that one hectare of sustainable agroforestry can provide goods and services which potentially offset 5-20 ha of deforestation. At a global scale, agroforestry systems could potentially be established on 585-1275 X 106 ha of technically suitable land, and these systems could store 12-228 (median 95) t C ha-1 under current climate and edaphic conditions.

54 **Dounias, E.** 1998. Du jardin au recrû forestier: agroforêts, cueillette et chasse chez les mvae du Sud Cameroun littoral forestier. *In* B. Duguma & B. Mallet, eds. *Recherche et développement dans les zones tropicales humides d'Afrique centrale et de l'ouest,* p. 381-392. Regional symposium held in Yaoundé, 4-7 December 1995. Montpellier, France, CIRAD.

55 **Ducatillon, C. & Loup, C.** 1985. *L'arbre dans le paysage agricole. Pratiques agroforestières: description et perspectives.* Moroni, CEFADER, 195 pp.
Forests cannot be separated from agriculture because of their importance for the rural world in the Comoros Islands. Various processes were used (structural analysis of forest plots and gardens containing trees, the collection of botanical samples and surveys of local people) in order to meet the following aims: production of a diagnosis on the state of forests, discernment of farmers' problems, requirements, wishes and habits with regard to forests and woodland, identification of the plant species whose economic and ecological roles are locally recognized, carrying out of an inventory of the species to be propagated, and proposal of species to be introduced into available ecological niches.

56 **Duguma, B., Tonye, J. *et al.*** 1990. *Diagnostic survey on local multipurpose trees/shrubs, fallow systems and livestock in southern Cameroon.* Nairobi, ICRAF, 33 pp.
This text gives the results of a survey carried out in two regions in southern Cameroon in order to explore traditional crop and livestock management practices, as well as farmers' knowledge of local multipurpose trees.

57 **Dury, S., Barreteau, D. *et al.*** 1997. Approche ethnobotanique des figuiers au nord du Cameroun. In *L'homme et le milieu végétal dans le bassin du Lac Tchad,* p. 261-267. Meeting held in Sèvres, France, 18-20 September 1991. Sèvres, France.

Starting with the observation of a large number of fig trees in the landscapes of the extreme north of Cameroon, this paper investigates the human and natural reasons for their presence. On the basis of examination of biological, phenological and pharmacological knowledge and the results of interviews with about twenty ethnic groups, conclusions are proposed as to the role of these trees and shrubs. Particular stress is laid on the abundance of the root system, which is used in the mountains to help stabilize agricultural terracing. Various examples are used to show the nutritional importance of the leaves and fruit for human beings and domestic livestock. This function is linked to the special reproduction system of fig trees, which entails the almost constant present of fruit. Lastly, the authors show that the symbolic functions of these trees are often bound up with their abundant dark green foliage, the ease with which they can be propagated from cuttings, the presence of latex, and the form of their fruit. The paper concludes that systemic research is needed on this type of multipurpose resource, which is exploited locally but little known elsewhere because it is non-specific resource.

58 **FAO** 1992. *Forests, trees and food.* Rome, 26 pp.
This document is made up of four chapters: (i) "Food and Nutrition", a section describing food products from forests and trees for livestock and people; (ii) "Income" presents the income connected with forests and cultivated trees; (iii) "Agriculture": agriculture and soil erosion, and ways of improving soil and water quality; and (iv) "Strategies for improvement" : various improvement strategies from the political, legislative, institutional and research points of view.

59 **FAO** 2000. *Sistemas Agroflorestais Pecuários na America do sul.* International symposium, 18-20 September 2000. Rome, Dom Bosco.
This CD-ROM offers a select bibliography on agroforestry systems in South America which also incorporate animal husbandry.

60 **Felipe-Morales, C., Morlon, P. *et al.*** 1996. Las Campiñas. Las práticas agroforestales. *Travaux de l'IFEA,* 96: 213-225.
The *campiñas* of the Peruvian Andes are wooded or bocage landscapes intended for various agroforestry uses: timber production, marking the boundaries of cultivated plots, protection of crops against animals and weather, protection against soil erosion, water conservation, soil fertilization, stabilization of agricultural development schemes (stone walls, irrigation channels), mixed cropping with fodder plants, shelter for livestock, and frames for drying harvests. Andean landscapes have suffered very widespread deforestation since the days of the conquistadors, and this has increased in recent years. The scarcity of wood leads to the use of animal droppings as fuel, leading in turn to a reduction in soil fertility. The example of the Yungay *campiña* in Peru in 1949 is studied from various angles: land cover, land tenure, agricultural methods, livestock farming on woodland, and the marketing of agricultural produce.

61 **Fernandes, E. & Nair, P.K.R.** 1986. *An evaluation of the structure and function of tropical homegardens.* Nairobi, ICRAF, 35 pp.
This text offers an analysis of structural and functional aspects of ten selected home gardens in different ecological and geographical regions.

62 **Fonzen, P.F. & Oberholzer, E.** 1984. Use of multipurpose trees in hill farming systems in Western Nepal. *Agroforestry Systems,* 2: 187-197.
A study in two villages identified 55 woody species that are kept in the form of contour strips across slopes and around fields in a system of subsistence agriculture. These trees and shrubs produce fodder and fuelwood and reduce erosion dangers, allowing crops to be grown on very steep slopes. Data on basic farm management, crop production, etc., are discussed. The performance of the system is assessed, and its strengths and weaknesses brought out. It is suggested that various locally available medicinal plants could be incorporated into these systems.

63 **Franco, D., Perelli, M. *et al.*** 1999. Farm forestation and the control of groundwater pollution. *Genio-Rurale,* 62: 25-37.
Data on the effects of hedges, linear plantations or riparian forest vegetation on the movement of fertilizer residues into groundwater or surface water has been lacking in Italy. The Ecosystem Management Department of the comune of Venice, which has supported research into the control and protection of the Venetian lagoon, has initiated a programme to assess the role of hedges in protecting water courses from high levels of fertilizer pollution. The test site is described (cereal crops of maize are grown, and both granular and liquid fertilizers applied), and the structure of the hedge outlined - the shrub *Viburnum opulus*, coppiced *Alnus* sp., and *Salix alba*, and standard trees of *Fraxinus excelsior* and *Populus alba*. The results so far indicate that the hedge has had a significant effect on groundwater nitrate levels, even during the first year after establishment; it has also affected the field microclimate, and to date has not affected crop yields negatively.

64 **Fujisaka, S. & Wollenberg, E.** 1991. From forest to agroforestry and logger to agroforester: a case study. *Agroforestry Systems,* 14: 113-129.
This article examines the interactive changes and adaptation of human and natural systems in two pioneer forest zones (Calminoe and Magsaysay) in the Philippines. The forest ecosystem was changed by shifting cultivation and timber extraction by settlers—factors usually linked to the degradation of systems. The natural succession is rapid because of the high rainfall and the abundant stocks of seed from the forest (descriptions are given of the specific composition of short- and long-term forest fallows, as well as non-forest fallows). The high rainfall, weeds, parasites, insects and poor soil meant that annual cereals and cash crops were neither profitable nor sustainable, and the farmers therefore decided to plant mixed permanent crops. In Calminoe, this led to multistoreyed home gardens, and the development and specific composition of these are described. The systems are less varied in Magsaysay. Those that developed naturally—more sustainable agroforestry systems—were financed at the start by income from small-scale logging and the production of wood charcoal.

65 **Galle, E.** 1994. Niamey: au fil des arbres. *Autrement,* 204-209.
The trees and the river ... the river and the trees ... of the capital of Niger are like a never-ending chant repeated by the humble vendors who know the wisdom and the benefits of water and shade.

66 **Gastellu, J.M.** 1980. L'arbre ne cache pas la forêt, ou: usus, fructus et abusus. *Cahiers de l'ORSTOM,* 17: 279-282.
African farmers see their natural surroundings in terms of utility. Human beings and environment are closely interconnected. Trees are never seen as ornaments but in terms of all the uses to be found in a single exemplar—economic, climatic, religious, ownership rights, etc. Trees are vitally involved in African farmers' daily lives.

67 **Gautier, D.** 1994. Valeur d'usage des arbres en pays Bamiléké. *Bois et Forêts des Tropiques,* 240: 39-51.
Trees are found throughout the Bamiléké land, playing a role in organizing space and having a range of uses, which are to be assessed not only in economic terms. The use values of trees depend on land tenure, but also on their specific functions. Use values are analysed in terms of the economic and socio-cultural production of trees, and also in terms of their functions. These values underlie control over access to wood resources and allocation of the benefits of their management. By analysing the three levels of spatial organization (plot, settlement and landscape), the use value of trees in the Bamiléké land can be expressed in all its complexity in appropriation gradients. In the present socio-economic context, the functions of trees are often not reflected in the structure of forest stands. Tree systems become specialized, moving towards a simpler and less labour-costly organization.

68 **Gautier, D.** 1994. Fondements naturels et sociaux d'un bocage tropical: l'exemple Bamiléké. *Natures Sciences Sociétés,* 2: 6-18.
In Bamiléké land, in the highlands of western Cameroon, the Bambouto mountains have three distinct bocage formations in an altitudinal transect. Starting with botanical considerations, this study moves on successively to the structure of hedges, the organization of the network of hedges and the dynamics of bocage formations. These three types of bocage landscape found on the same slope reveal distinct dynamics—which also raises the question of their future.

69 **Guérin, J.C.** 1991. Fonction sociale, culturelle et paysagère de l'arbre et de la forêt. *Revue Forestière Française,* 3: 311-320.
In towns and the areas immediately around them, the concept of urban forests, which focuses more on trees, in gaining ground over that of green spaces, which is seen as too general. An importance place must always be given to open-air leisure developments, as well as the indispensable access to them and their control.

70 **Harvey, C.A., Guindon, C.F. *et al.*** 2000. The importance of forest patches, isolated trees and agricultural windbreaks for local and regional biodiversity: the case of Monteverde, Costa Rica. *In* B. Krishnapillay, E. Soepadmo, N.L. Arshad *et al.,* eds. *Forest and Society: the role of research,* 1: 787-798. 21st UFRO World Congress, Kuala Lumpur, 7-12 August 2000. Kuala Lumpur, IUFRO World Congress Organising Committee.
Most of the landscapes in Central America consist of a mosaic of grasslands, agricultural fields and remnants of forest, scattered with urban and residential areas. This paper describes a study carried out in Costa Rica on the importance of these forest remnants, isolated trees and windbreaks for the conservation of local and regional biodiversity in the Monteverde area, summarizing over 20 years of research in the region.

71 **Harvey, C.A. & Haber, W.A.** 1988. Remnant trees and the conservation of biodiversity in Costa Rican pastures. *Agroforestry Systems,* 44: 37-68.
Remnant trees may play an important role in conserving biodiversity within agricultural systems because they provide habitats and resources that are otherwise absent from agricultural landscapes. In order to determine the potential importance of remnant trees for conservation, the density and species composition was surveyed of remnant trees occurring in pastures of 24 dairy farms near Monteverde, Costa Rica. In addition, interviews were conducted with farmers to determine why they leave trees in pastures and how they manage them. The 237-ha survey counted 5583 trees of 190 species (mean density of 25 trees/ha). Primary forest trees accounted for 57% of all of the species and 33% of individuals. Over 90% of the species are known to provide food for forest birds and other animals. In addition, many of the species are important locally for humans as sources of timber (37%), fuelwood (36%) or fence posts (20%). Farmers mentioned 19 reasons for leaving trees in pastures. Of these, shade for cattle, timber, fruits for birds and fence posts were most commonly cited. Most farmers were well aware of both the economic and ecological benefits of pasture trees, and were interested in the possibility of increasing tree cover within their pastures. Although the current densities and richness of pasture trees in Monteverde are high, the size distribution indicates that diversity will decrease substantially in the future, both because farmers are harvesting trees and because saplings of primary forest trees are scarce within the pastures.

72 **Herzog, F.** 2000. The importance of perennial trees for the balance of northern European agricultural landscapes. *Unasylva,* 51(1): 42-48.
This article describes the ecological, socio-cultural and economic functions of *Streuobst* (fruit trees scattered over agricultural land), hedges and trees lining water courses in the countries of northern Europe.

73 **Hess, G.R. & Bay, J.M.** 2000. A regional assessment of windbreak habitat suitability.

Environmental Monitoring and Assessment, 61: 237-254.
The Environmental Monitoring and Assessment Program was initiated in 1989 by the US Environmental Protection Agency to collect, analyse and report quantitative, statistically unbiased information about the state of the nation's environment on a regional basis. During a pilot programme in Nebraska a habitat suitability index was measured for a probability sample of 40 windbreaks (shelterbelts of tree and shrub species) and the results expanded to estimate the potential value of windbreaks as wildlife habitats in Nebraska. The index estimates the suitability of a windbreak as a habitat for wildlife, including breeding birds, small mammals and deer. Index values range from zero to one, where a value of one indicates maximal habitat value. Some 50% (±13% at 90% confidence) of windbreaks in Nebraska were estimated to have a habitat suitability index of 0.25 or less, and no windbreaks had a suitability index greater than 0.6. The results indicate that increasing the area of individual windbreaks is the most effective way of improving their value as wildlife habitats. Monitoring windbreak conditions over time would alert wildlife managers to changes in the resource that might affect wildlife populations. Because the data were highly variable, the power to detect changes in habitat conditions between two measurement periods was low. A much larger sample would be required to detect small changes in habitat conditions. Variability may be reduced, and power increased, by carefully and consistently constructing the sampling frame, keeping data collection as simple as possible, appropriately stratifying sample selection, and using a small number of well-trained data collection teams. However, it is suggested that the index be adapted for use with aerial photography in future efforts to evaluate windbreaks as wildlife habitats in extensive areas.

74 **Hochegger, K.** 1998. *Farming like the forest: traditional home garden systems in Sri Lanka.* Weikersheim, Germany, Margraf Verlag, 207 pp.
The forest gardens of south and southeast Asia are a highly productive and sustainable form of agriculture. Although their efficiency has been proved over the centuries, there has been almost no research on such models. The growing destruction of tropical ecosystems is leading planners and research scientists to turn to traditional practices in order to seek solutions to the present-day problem. Such practices can be found in Sri Lanka, where “forest agriculture” has contributed to a harmonious relationship between nature and man. This work describes the forest garden systems of the country so that the traditional concept can be used in future agricultural models throughout the world.

75 **Ingram, J.** 1990. The role of trees in maintaining and improving soil productivity. A review of the literature. *In* R.T. Prinsley, ed. *Agroforestry for sustainable production. Economic implications,* p. 243-287. London, Commonwealth Science Council.
The role of trees in maintaining and improving soil productivity is considered central to the sustainability of many agroforestry systems. This article offers a bibliographical review of the subject, focusing especially on the importance of this role.

76 **Joffre, R., Hubert, B. *et al.*** 1991. *Les systèmes agro-sylvo-pastoraux méditerranéens: enjeux et réflexions pour une gestion raisonnée.* Paris, UNESCO, 96 pp.
Agrosilvopastoral systems hold an important place around the Mediterranean, where they have marked the landscape for many centuries. After an introduction, the authors describe the main types of agrosilvopastoral system found in Mediterranean countries. The variety of fodder provided and the food value of the samples taken are then analysed according to type of pasture: cultivated grassland, mixed wooded grassland, *dehesa*, etc. The authors establish the state of knowledge on their ecological functioning (primary production, animal-plant interactions). The last chapter discusses human interventions with regard to the vegetation and how the latter has responded.

77 **Joffre, R., Vacher, J. *et al.*** 1988. The dehesa: an agrosilvopastoral system of the Mediterranean region with special reference to the Sierra Morena area of Spain. *Agroforestry Systems,* 6: 71-96.
A multidisciplinary team undertook six years of study of the agro-ecological and socio-economic aspects of the *dehesa* system in the northern Sierra Morena area. The term *dehesa* is used to describe the land use system in rural zones of southwestern Spain, mainly made up of grazing land containing scattered oaks (*Quercus rotundifolia, Q. souseuh, Q. faginea*). The system has been known for many centuries for its multiple—mainly silvopastoral—uses of renewable resources and its strong links with the repeated growing of cereals on grazing land. This article summarizes the results of the study and assesses the functional aspects of the system in view of trends and developments in land use in the region over recent centuries. The synergy effects of tree cover on grassland vegetation are discussed in terms of soil fertility improvement and the development of a favourable microclimate. The potential use of this information in future research and development programmes to improve *dehesa* systems in the Mediterranean region is described.

78 **Jonsson, K.** 1995. *Agroforestry in dry savanna areas in Africa. Interactions between trees, soils and crops.* Umea, Sweden, Swedish University of Agricultural Sciences.
This work contains four articles on interactions between trees, soils and crops in dry tropical Africa. Agroforestry is a potential approach to maintaining soil fertility and crop production. This aspect was studied in terms of the distribution of tree roots, soil improvement and changes in the microclimate under trees.

79 **Jordon, C.F., Gajaseni, J. *et al.*** 1992. *Taungya forest plantations with agriculture in southeast Asia.* Oxford, UK, 153 pp.
This book describes the present and past practice of *taungya*, explaining how the system has developed in southeast Asia since its introduction to Burma in the 1860s. It also assesses the strengths and weaknesses of the system and suggests technical, social and economic modifications that would help to improve the sustainability of forestry in developing countries.

80 **Juteau, D.** 1994. *Gestion des haies en pays d'élevage. Enquêtes et analyse: la place de la haie sur l'exploitation agricole, les différents chantiers sur les haies. Sciences et techniques appliqués aux aménagements paysagers.* Ecole Nationale Supérieure d'Horticulture, 104 pp.
This work focuses on hedges in different regions of France. The author analyses the various aspects of management of this system: the composition and appearance of hedges, rights and customs, the roles of hedges in agriculture, practices in the different regions studied, hedges and cattle, the technical aspect of hedge management, and mechanization of hedges.

81 **Kuchelmeister, G.** 1989. *Hedges for resource-poor land users in developing countries.* Eschborn, Germany, GTZ, 256 pp.
This work summarizes the specific roles of hedges for resource-poor people in developing countries. The aims, extent and limitations of these systems are also discussed, as well as social and economic issues and the technical aspects of their management.

82 **Kuchelmeister, G.** 2000. Trees for the urban millennium: urban forestry update. *Unasylva,* 51(1): 49-54.
This article stresses the importance of urban trees and associated vegetation found within or near densely populated areas, both in industrialized and developing countries. It discusses the benefits of urban forests, efforts to eradicate poverty, partnership between the public and private sectors, and multiresource management.

83 **Lazarev, G.** 1989. L'oasis. Une réponse à la crise des pastoralismes dans le Sahel? *Cahiers de la Recherche Développement,* 22: 69-82.
In arid zones that have become semi-deserts, can oases become the anchoring point for a new organization of pastoralism? Historically

speaking, palm groves have not spread southwards, although well exploited water resources would have allowed the establishment of palms suited to Sahelian conditions, and irrigation know-how would have allowed their combination with a market garden, cereal or livestock type of oasis agriculture. The problems raised by the desertification of now fragile and disturbed environments and changes in pastoralism, which is becoming partially sedentarized in the wake of droughts, together with new types of land use, may perhaps find answers in an oasis model that would allow food security and be economically attractive.

84 **Lepofsky, D.** 1992. Arboriculture in the Mussau Islands, Bismarck Archipelago. *Economic Botany,* 46: 192-211.
Twenty-six species of indigenous tree are cultivated in tree gardens surrounding villages in the Mussau Islands of the Bismarck Archipelago in northeastern Papua New Guinea. The trees are used for food and non-food (building materials and medicines) purposes. Ethnobotanical information is given on cultivation methods, harvesting, processing and use. Although distribution within the tree cultivation area tends to be random, some species are gathered together within the zone. This gathering together is linked to the restricted habitat and/or the reproductive methods of certain species. The coconut palm (*Cocos nucifera*) is the most frequent species and is randomly distributed. The vertical stratification of these gardens encompasses a distinct grassy layer and an undercanopy of *Pandanus* spp. The introduction of exotic species and the growing availability of western food products are changing the composition of these gardens.

85 **Levang, P., Michon, G. *et al.*** 1996. De la jachère arborée aux agroforêts, des stratégies paysannes adaptées à des milieux de fertilité mediocre. *In* J. Pichot, N. Sibelet & J.J. Lacoeuilhe, eds. *Fertilité du milieu et stratégies paysannes sous les tropiques humides,* p. 228-235. Acts of a seminar held in Montpellier, France, 13-17 November 1995. Montpellier, France, CIRAD-SAR.
The luxuriance of the vegetation in the humid tropics has always led people to believe the environment to be remarkably fertile, while the low level of development has been attributed to the indolence of the natives. Although the practices of shifting cultivation are considered archaic, they do in fact represent a particularly effective adaptation strategy to environments with poorish fertility. In Indonesia, under cover of rationalization of land use in the outlying islands of the archipelago, various attempts to modernize agriculture have foundered in the face of prohibitive costs or environmental disasters—or both. Until now, the agroforestry strategies developed by the indigenous peoples of Sumatra and Kalimantan have received scant attention from the authorities. With their unique combination of conservation and exploitation objectives, they do, however, represent genuine and environmentally sound development models.

86 **Long, A.J., Nair, P.K.R. *et al.*** 1999. Trees outside forests: agro-, community, and urban forestry. *New Forests,* 17: 1-3, 145-174.
Planted forests are often seen as consisting of tree plantings on a scale large enough to satisfy such objectives as commercial timber and fibre production, watershed protection, and natural habitat preservation. However, trees are also planted on greatly reduced scales in agroforestry systems or as community woodlots and urban plantings, to provide a mixture of products and services to resident households, local communities, and regional cultures. Agroforestry systems represent a major form of small-scale tree planting, where trees are grown in purposeful combinations with agricultural crops and/or livestock in order to take advantage of tree-crop interactions, and thereby enhance crop production, diversify farm output, stabilize or improve soils, or relief harsh environmental conditions. Some important examples of these systems in the tropics include home gardens, alley cropping, improved fallows, intercropped trees for shade and fodder production, and trees planted in hedgerows and along fence lines. Throughout the tropics, there is a large variety of indigenous practices

and species mixtures that represent adaptations of these systems to meet localized needs and opportunities. Research and development programmes have supported the expansion and refinement of many of these systems over the last 20 yr, but substantial constraints on tree planting still exist in the form of land-tenure practices, population pressures that relegate agroforestry practices to degraded lands, subsistence needs that prevent extended periods of tree growth, and insufficient technical information or technology dissemination. Agroforestry systems in temperate, industrialized countries include combinations of trees, pasture, and livestock: fruit or nut trees interplanted with vegetable or grain crops; windbreaks and shelterbelts; multispecies riparian buffer strips; and forest farming systems for speciality crops. Compared with the tropics, however, temperate-zone systems tend to focus on one or two high-value crops, often involve some level of mechanization, and frequently represent an opportunistic approach to improving the economic profitability of farms rather than meeting subsistence needs. In both tropical and temperate regions, agroforestry systems and community woodlots will be an important component of new sustainable agriculture and environmental protection programmes. Although species diversity is an essential feature of all agroforestry systems, community forests generally involve planting only a few species in small woodlots near farms, around villages, along roads, and as riparian buffers. Provincial or state governments and the local populace are often involved in land ownership and plantation establishment. Major objectives of these forests are production of fuelwood for local consumption and of other tree products for market, soil stabilization, reclamation, or improvement, and protection of water quality. As with many other planted forests, the number of species widely used in community forests has been small (mostly from the genera Eucalyptus, Pinus and Acacia). Major issues with these planted forests focus on rights for use of the products, tending responsibilities once trees are established, protection until trees are large enough for their designated use, increasing interest in using native species, and greater community involvement in planning and management. Trees planted along streets and waterways, or as woodlots in parks and other public places, represent a major group of planted forests in many urban and periurban landscapes. In addition to providing many of the same environmental services that agroforests and community forests do, these urban plantings have unique aesthetic and recreational value.

87 **Louppe, E. & Yossi, H.** 1997. *Les haies-vives défensives en Afrique de l'Ouest sèche et subhumide (bilan des connaissances)*. Abidjan, CIRAD, 17 pp.
In many parts of West Africa, a growing demand from rural inhabitants means that there is a pressing need to develop and organize the countryside in order to improve the management of grazing lands, protect crops from cattle, and record and recognize land tenure. One of the tools for organizing the countryside is defensive living fences made up of thorny or non-thorny bushes planted very close together to create a barrier against wandering livestock. These fences also play a major role in reducing water and wind soil erosion. The criteria and methods to be used in selecting the species are described, and lists are given, based on bibliographical sources, of the species suitable, either alone or in combination, for the creation of living fences in the various climate zones. Methods of establishment—sod seeding, planting out of seedlings, or the use of cuttings—are described, together with post-planting and adult upkeep measures, particularly pruning for shaping and maintenance. The production of the fences, their effects on the environment, and their socio-ecological advantages and disadvantages are discussed.

88 **Malgras, D.** 1992. *Arbres et arbustes guérisseurs des savanes maliennes*. Paris, Karthala, 478 pp.
This study is a contribution to the programme to inventory the medicinal resources of trees and shrubs in Mali's savannah regions, which have been successfully used for a long time in traditional medical treatment. The first part of

the work is consecrated to the natural, plant and human environment and the cultural context of traditional medicine, and this is followed by a detailed study of 160 species of tree and shrub.

89 **Mallet, B. & Depommier, D.** 1997. L'arbre en milieu rural ou l'émergence de l'agroforesterie. *Bois et Forêts des Tropiques,* 252: 25-29.
Following the deforestation of the 1970s, agroforestry was seen as a way of countering degradation of plant cover and soils. Study of interfaces between trees, soils, crops or livestock for silvopastoral systems lends agroforestry systems a multidisciplinary character. The spread of the concept and the relevant methods entails the training of extension workers and technical agents, mainly in Africa. Refinement of agrosilvopastoral practices will help the inhabitants to combat erosion while carrying on their agrarian activities. In the perspective of sustainable management of existing ecosystems and reconstitution of forest plantations, the production of fuelwood is compatible with the maintainance of forests and trees in tropical regions.

90 **Marchal, J.Y.** 1980. Arbres et brousses du paysage soudano-sahelian. Dynamique des formations végétales au nord de la Haute Volta. *Cahiers de l'ORSTOM,* 17: 137-149.
This article focuses on the place of trees in the landscape and their use by the inhabitants. The method adopted entails study of the features of the landscape on various levels: dominant areas of trees and bushes; landscape facets; stocking inventory. The author considers the apparent stability of woodland in a general context of degradation of plant cover.

91 **Marechaux, S.** 1993. *Les haies fourragères dans les hauts de l'Ouest à la Réunion: l'intégration du* Calliandra calothyrsus *pour une protection productive.* CIRAD-CA, Université de Paris-Val-de-Marne, UFR de Sciences, Réunion, 110 pp.
Over half the cultivated land in Réunion is made up of andosols. Their constitution and cultivation history give them properties that make them particularly prone to rainfall erosion. Farmers will accept conservation measures only so long as they do not interfere with production and so long as they offer some possible gain. In the western highlands, fodder-focused agroforestry seems to be a satisfactory compromise for farmers. Against this background, particular attention was paid to the protective and productive potential of a pulse, *Calliandra calothyrsus*, and study indicated promising prospects for this shrub. It seems to contribute effectively to restoring fertility and to erosion control by improving the structural state of the soil. It produces good quantities of high-quality fodder, and does not seem to affect crop yields.

92 **Martinez, H.** 1989. *El componente forestal en los sistemas de finca de pequeños agricultures.* Turrialba, Costa Rica, Centro Agronomico Tropical de Investigación y Enseñanza, 80 pp.
This document describes the various types of system in which trees are found on small and medium-sized farms in Costa Rica, using this as a basis for planning future silviculture activities and offering guidelines for field staff. The introduction to the report describes the topography, soil and climate of the sites available for planting, and summarizes the possible agroforestry choices, as well as the steps in choosing the most suitable of these. The body of the report describes three types of agroforestry combination encountered, together with their objectives, the species used, their distribution, costs and yields: (i) systems that mix trees with crops—trees scattered over farms, intercropped trees, temporary and permanent shade trees, trees and secondary crops (fallow systems), alley cropping, line plantation (similar to the previous type, but with more space between trees), seed trees, and *taungya*; (ii) tree systems for protective purposes—living fences, shelterbelts and demarcation trees; and (iii) compact plantations for fuelwood, construction timber and fodder, and home gardens. More details on the species used (including those selected for the MADELENA project) are given in the appendices.

93 **Mayaux, R., Steyaert, P. *et al.*** 1992. Installation et production de haies brise-vent dans un système agricole intensifié de la zone soudano-sahélienne du Sénégal. *Bulletin des Recherches Agronomiques de Gembloux,* 27: 251-267.
The authors compare various woody species established as windbreaks on an intensive farm in the Sudano-Sahelian zone of Senegal. In terms of success of plantation, speed of growth and protection against winds, *Acacia holoserica* is far better than four local species—*Acacia raddiana, A. nilotica* var. *tomentosa, A. senegalensis* and *Bauhinia rufescens*—and two other exotic species, *Eucalyptus camaldulensis* and *Prosopis juliflora*. Regularly cut back before the tornadoes of the rainy season, *A. holoserica* produces abundant fuelwood, as well as fodder appreciated by small ruminants in this period of fodder shortage.

94 **Maydell, H.J., Nair, P.K.R. *et al.*** 1996. Agroforestry in central, northern and eastern Europe. *Agroforestry Systems*, 31: 133-142.
Integrated management of natural resources and the multiple use of trees and forests have prevailed in most European societies since prehistoric times. In the Middle Ages, expanding and intensified agriculture resulted in the separation of trees from agricultural fields. During the last century, with the introduction of sustainable and highly productive forest management, the goal of increased wood production has been achieved in most parts of central, northern, and eastern Europe. Today, agroforestry is not considered to be an important land-use option within the region; however, there are many practices that could rightfully be classified as agroforestry. These include tree/crop systems in which trees provide products and/or environmental benefits, and tree/animal systems in which animals are grazed in forests or open woodlands. The future seems to offer some prospects for agroforestry. Large areas, hitherto used for food production, are either marginally suited to agriculture, or will probably be taken out of production due to agricultural policy considerations. Agroforestry may, at least in part, offer alternatives for the use of such lands. The availability of (surplus) fertile soils, capital, and labour may provide incentives for forms of agroforestry, including improved fallow management. The focus of such systems would be on maintenance of biodiversity in the landscape, environmental protection, recreation, and product diversification. There are numerous expectations as to what agroforestry might provide for the land holder and for society as a whole. These expectations should be carefully analysed and evaluated prior to political decisions on future land use. The promotion of agroforestry requires overall investment; agroforestry does not 'happen by itself'. A set of integrated actions - not isolated efforts - must be implemented if agroforestry is to become a successful land-use option.

96 **Merot, P.** 1999. The influence of hedgerow systems on the hydrology of agricultural catchments in a temperate climate. *Agronomie,* 19: 655-669.
The bocage landscape is an ancient system of organizing rural areas by using a hedge network enclosing fields and meadows. It is one form of hedgerow system used as a windbreak, water and erosion barrier, or ecological corridor in numerous regions around the world. Its hydrological impact in temperate countries is poorly known, although paradoxically often cited as important. Research concerning the hydrologic effects of hedgerow systems mainly conducted in the region of Brittany, in France, for the last 20 years is reviewed. The actual or potential evapotranspiration seems little modified by hedges at the catchment scale for a bocage with a hedge density of _100 mthinha-1. However, local effects are observed on the actual evapotranspiration around the hedges in summer. No effect on the annual rainfall has been measured, but the spatial heterogeneity of the rainfall distribution increases close to the hedge. The bocage has a buffering effect on quick flow during storm runoff of high frequency, modifying the Hortonian overland flow and the contributing flow on saturated areas. The bank and the hedge surrounding the bottom land are the key factor for hydrological effects. Water erosion is limited in bocage

landscape, with no exportation outside the catchment.

97 **Merot, P., Reyne, S. *et al.*** 1996. Rôle hydrologique et géochimique des structures linéaires boisées: bilan bibliographique et perspectives d'étude. In *La forêt paysanne dans l'espace rural. Biodiversité, paysages, produits,* p. 83-100. Etudes et Recherches sur les Systèmes Agraires et le Développement No. 29.
A literature review of this topic indicated that there have been very few studies so far on the quantitative and qualitative impact of hedges on water resources in the temperate zone. Work in Brittany, France, shows that the bocage network, and specifically the hedge line surrounding the valley fields, have a buffering effect, by lessening stormflow volume and flood peaks. Regarding water quality, some information suggests that hedges have an impact on the movement of pollutants: hedges retain eroded particles carrying pesticides and phosphorus; anoxic conditions may occur in the soil close to hedges and support denitrification; and trees in hedges may selectively absorb some dissolved elements. Given the rapidly growing environmental problems in temperate rural areas, further research work is urgently needed, particularly to: quantify the hydrological impact of hedges in large basins; use new methods such as distributed hydrological modeling and geographic information systems; and characterize the main processes controlling the fate of pollutants in hedges, in synergy with other landscape elements.

98 **Michon, G.** 1985. *De l'homme de la forêt au paysan de l'arbre: agroforesteries indonésiennes*. Montpellier, France, Université des Sciences et Téchniques du Languedoc, 273 pp.
Agroforestry is a new science that has developed over recent years in an attempt to reconcile agronomic, agricultural and forestry sciences. However, the actual practice of agroforestry is very old: in humid tropical zones, where trees and forests were originally present everywhere, small-scale farming does not separate annual crops from tree crops, nor the maintainance of open fields from the development of natural forests. Relations between people and forests in western Indonesia are the outcome of a number of agroforestry systems. The study described here seeks to show the techniques and strategies adopted in order to use and transform the natural forest ecosystem in different situations. Two agroforestry systems are analysed in detail through a combined floristic, structural and ethnobotanical approach: one in southern Sumatra in a sparsely populated region where food crops are grown by opening up tracts in the forest; the other in western Sumatra in an area traditionally dedicated to sedentary rice farming. These two studies are filled out with an analytical review of various agroforestry practices in Sumatra, Java and Kalimantan, ranging from very heavily forested areas (man in the forest) to very humanized areas (man as farmer). The use and management of the trees, forest structures and silvogenetic mechanisms developed in these farming systems are very useful examples for the science of agroforestry. It is recommended that more precise and systematic study be made of the natural vegetation cultivated by farmers in humid tropical zones, with a view to coordinating the development of agricultural development and the preservation of useful or reserved forets in forested tropical countries.

99 **Michon, G., De Foresta, H. *et al.*** 1995. Stratégies agroforestières paysannes et développement durable: les agroforêts à damar de Sumatra. *Natures Sciences Sociétés,* 3: 207-221.
Conflict in Indonesia between the State and local inhabitants over the use and control of resources has led to an accelerated dilapidation of forest resources in the past ten years. This dilapidation goes hand in hand with rapid environmental degradation, and the sustainable development of forest areas is a major issue in national debates. However, there are examples of the positive development of small-farmer systems of forest resource management, especially in the agroforestry sphere. Half-way between

plantation and forest, Indonesian agroforests represent an original strategy for the appropriation and use of natural resources by farming communities, combining agricultural purposes and forest reconstruction. By analysing an agroforest in Sumatra and reviewing its history, an attempt is made to establish the contribution this concept could make to the debate on the dynamics and use of renewable resources in the framework of sustainable development. Focusing particularly on biological mechanisms and the social strategies that have allowed not just the conservation of a specific forest resource, but in fact the restoration of the "forest resource" as a whole, consideration is given to the viability of this agroforestry strategy in a context that is particularly unfavourable to the control of forest resources by small farmers.

100 **Miller, R.K.** 1997. Southwest woodlands: cultural uses of the "forgotten forest". *Journal of Forestry,* 95: 24-28.
This article describes the use of woodlands (defined as those dominated by tree species that are not used mainly for timber) by native Americans. It is recognized that the ecosystems of wooded regions are neglected by ranch owners and foresters, while the spiritual and cultural importance that native American tribes attribute to these lands is stressed. The use of pines (*Pinus edulis* and *P. monophylla)*, juniper *(Juniperus* spp.), mesquite (*Prosopis glandulosa* and *P. pubescens*), the Virginia poplar (*Populus* spp.), willows (*Salix* spp.), oak (*Quercus* spp.) and tanbark oak (*Lithocarpus densiflorus*) by the different tribes is described. Three case studies are given to illustrate the integrated management of the ecosystems of these wooded regions: (i) an example from the Uintah and Ouray Ute reservation; (ii) an example from the Hopi reservation in Arizona; and (iii) the inventory and restoration of culturally important resources in the Colorado River reservation (Arizona and California).

101 **Mitja, D. & Hladik, A.** 1989. Aspects de la reconstitution de la végétation dans deux jachères en zone forestière africaine humide (Makokou, Gabon). *Acta Oecologica. Oecologia Generalis,* 10: 75-94.
This study describes the state of reconstitution of the vegetation of two five-year-old fallows, with the help of various types of analysis: floristic (study of all biological forms—trees, shrubs, lianas and grasses), structural (profile, height, area covered and distribution) and dynamic (percentage of regrowth and definition of four demographic plant groups). The different results obtained on the two fallows increase understanding of the speed of reconstitution of the vegetation, which depends here on such factors as the number of previous cropping cycles and the state of the immediately surrounding environment. Study of these fallows leads to the definition of two different processes of forest reconstitution.

102 **Mollet, M., Tiki-Manga, T. *et al.*** 1995. The top 10 species in Cameroon: a survey of farmers' views on trees. *Agroforestry Today,* 7: 14-16.
This article contains the results of a survey carried out in five villages. The ten preferred species identified were (in decreasing order of preference): *Irvingia gabonensis, Baillonella toxisperma, Dacryodes edulis, Elaeis guineensis, Ricinodendron heudelotii, Alstonia boonei, Guibourtia demensei (G. demeusii), Entandrophragma cylindricum, Garcinia lucida* and *Chlorophora excelsa (Milicia excelsa)*.

103 **Nair, P.K.R.** 1989. *Agroforestry systems in the tropics.* London, Kluwer Academic Publishers, 664 pp.
This work describes the current state of knowledge on agroforestry systems in the tropics, on the basis of recent ICRAF publications of results of the global inventory of such systems. This project, which started in 1982, had the aim of increasing understanding of agroforestry systems and their very varied roles in protection and production. The exercise consisted of collecting, collating, evaluating, storing and distributing information. The data collection and collation involved a large number of institutions and individuals. This work describes over 25 agroforestry systems in different parts of the

world, and gives useful information on these systems, such as classification, ecological analysis and extent, as well as the main aspects of some technological innovations.

104 **Nicholas, I.D.** 1988. Plantings in tropical and subtropical areas. *Agriculture, Ecosystems and Environment,* 22-23: 465-482.
A bibliographical review was made of works discussing windbreak plantations in tropical and subtropical regions, particularly the humid tropics, where plantations must often be multipurpose. Economic pressures and population growth in tropical countries have led to a shift from traditional slash-and-burn cultivation to a more intensive use of land with shorter fallow periods and lower yields. Since the winds affecting tropical crops are usually hurricanes and violent storms, rather than prevailing winds, windbreaks are less common than in subtropical or temperate regions. Where soil moisture is not limited, yields of some tropical crops can be considerably increased by shelter. However, the use of hedges in the form of alley cropping is better for agricultural fallows than the use of traditional windbreaks. The planting of trees to provide shade has played a vital role in the production of certain crops such as cocoa, coffee and tea. Even so, shade trees can be harmful to yields once the crop is well established and can provide shade for itself, so that stress is now laid on varieties of crops that do not require shade, although multipurpose shade trees are still important elements on small farms. Soil erosion in the tropics and subtropics is caused by water rather than wind, and can be reduced by maintaining plant cover and planting trees. The advantages of agroforestry are also discussed. A short description is given of the main genera planted, together with those at present being considered for planting in the tropics—*Acacia, Albizia, Calliandra, Casuarina, Eucalyptus, Gliricidia, Gmelina, Leucaena* and *Sesbania*. Some other species are also discussed.

105 **Nimal, P.A.H.** 1989. Place of coconut in home gardens. *Coconut Bulletin,* 6: 16-19.
This article stresses the nutritional advantages that coconuts can offer in home gardens in Sri Lanka. Advice is given on growing methods, planting material, and the upkeep of a garden containing coconuts.

106 **Niñez, V.K.** 1984. *Household gardens: theoretical considerations on an old survival strategy.* International Potato Center, 41 pp.
Scientists, politicians and humanists discuss the contribution of home gardens to food production. This report on research discusses the importance and historical functions of this type of garden. It also gives a definition and develops a typology based on ecological and socio-economic determinants. A comparative bibliographical review is provided in conclusion. Despite growing attention to small farmers by agricultural research organizations, home gardens are still neglected, although they are an important strategy in subsistence.

107 **Nizesete, B.** 1996. Exploitation et mise en valeur traditionnelles du matériel ligneux par les peuples de l'Ouest-Cameroun. Des éléments d'archéologie, d'ethnobotanique et de technologie du bois. *Bulletin trimestriel de la Société d'Anthropologie du Sud-Ouest,* 31: 135-157.
Wood is an exceptional multipurpose material, and the people of western Cameroon have been drawing heavily on it for centuries as a raw material and energy source, in order to solve a very wide range of daily and ritual problems: building houses, making statues, masks, musical instruments, receptacles, ordinary or ritual furniture, and agricultural implements, building bridges, producing fuel, etc. Its almost excessive consumption has naturally led to exhaustion of the resource, thus upsetting certain customs and traditions. Grassland farmers have therefore implemented some creative reforestation and preservation policies for certain species. The establishment of living fences or enclosures is a fascinating example here.

108 **Njenga, A., Wamicha, W.N. *et al.*** 2000. Role of trees in smallholder farming systems of Kenya. Results from high, medium and low potential areas in Kenya. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 137-154.

Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This document describes a study carried out in Kenya with the aim of defining the role of cultivated trees in different agricultural systems and identifying factors influencing the integration of indigenous and exotic species. The information was collected through a participatory rural appraisal approach.

109 **Olembo, R.J. & de Rham, P.** 1987. In two different worlds. *Unasylva,* 39(1): 26-35.
Local councils' actions in terms of urban planning are often confined to laying out roads and seldom encompass plans for green spaces, so that new urbanized areas in the third world often lack trees.

110 **Pélissier, P.** 1980. L'arbre dans les paysages agraires de l'Afrique noire. *Cahiers de l'ORSTOM,* 17: 131-136.
From the Sahel to forests, the agrarian landscapes of sub-Saharan Africa always tend to combine trees with fields, although this article confines itself to considering trees growing with crops, and the park landscapes thus created. The composition of wooded areas on agricultural land and the role allotted to them can reveal each society's strategy with regard to its environment. Parkland throws light not only on needs and techniques, but also on the very nature of the society and its history, and to some extent its structure. Apart from the material relations of a society with the various components of its environment, its type of organization is seen in the landscape.

111 **Peltier, R.** 1991. L'arbre dans les terroirs villageois. *In* C. Piéri, ed. *Savanes d'Afrique, Terres Fertiles?,* p. 507-530. International meeting held in Montpellier, France, 10-14 December 1990. Paris, Ministère de la Coopération.
Trees used to be found in all African savannah landscapes, but are vanishing as a result of a degradation in traditional agrosilvopastoral systems. The author describes the different types of tree-crop-livestock combination found in the zone. He then gives an overview of research into possible ways of improving them, ranging from spontaneous fallows to combinations of fruit trees and irrigated crops, the maintainance of young woodlots, the growing of timber in combination with crops and with grasslands, wooded fallows enriched by planting trees and by fire protection, windbreaks for rainfed and irrigated crops, living fences, alley cropping, traditional or constructed wooded parkland, planted anti-erosion strips, and savannah woodland developed for silvopastoral use.

112 **Peltier, R. & Pity, B.** 1993. De la culture itinérante sur brûlis au jardin agroforestier en passant par les jachères enrichies. *Bois et Forêts des Tropiques,* 235: 49-57.
In humid equatorial zones, increasing population pressure is leading to intensification of tree management within agrosystems. This ranges from the archaic use of spontaneous woody species to regenerate soil exhausted by slash-and-burn cultivation to the skilful constitution of sustainable, diversified and constantly evolving agroforestry gardens. Researchers and developers can monitor these changes.

113 **Perfecto, I., Rice, R.A. *et al.*** 1996. Shade coffee: a disappearing refuge for biodiversity. *BioScience,* 46: 598-608.
The role of coffee plantations with shade trees in protecting tropical biodiversity is discussed with particular reference to Latin America. The different parts of the paper are: the economic importance of coffee; coffee cultivation techniques; shade coffee and biodiversity conservation - an overview; arthropod diversity; birds and other vertebrates; biodiversity and the impact of coffee conversion - from shade to sun cultivation; predator-prey interactions and coffee pests; diversity and economic risk reduction; promoting biodiversity on coffee farms - defining environmentally friendly coffee, foreign assistance, marketing environmentally friendly coffee, and internalization of environmental costs; and conclusions.

114 **Poulsen, G. & Le Houérou, H.N.** 1980. *Le rôle des arbres au Sahel.* Report of a study

meeting held in Dakar, 5-10 November 1979. Ottawa, CRDI, 92 pp.
The aim of this study meeting on the role of trees in the Sahel was to allow an exchange of information on the many roles of trees and shrubs in the region, in order to gain an up-to-date picture of knowledge in this regard. The meeting enabled an overview to be gained of the reforestation techniques used in semi-desert zones of sub-Saharan Africa, and also allowed forestry research priorities to be defined.

115 **Prinsley, R.T. & Swift, M.J.** 1986. *Amelioration of soil by trees. A review of current concepts and practices.* London, Commonwealth Science Council, 181 pp.

116 **Raintree, J.B. & Warner, K.** 1980. *Agroforestry pathways for the integral development of shifting cultivation.* Nairobi, ICRAF, 27 pp.
Agroforestry should be seen less as an alternative to shifting cultivation than as a systematic approach to reorganization of its basic elements into more productive, sustainable and politically viable forms of land use, under the pressure of population growth and competition for use of the resource. Any attempt at improvement, replacement or development of shifting cultivation recognizes that problems are often more political and institutional than environmental and technological. The different technological possibilities are based on the various stages in system intensification. A review of types of shifting cultivation system provides a framework both for identification of specific lines of action with regard to agroforestry systems and for development possibilities. Technical proposals are confined to the most promising: *taungya*, enriched fallows, alley cropping, and tree/agriculture mixed cropping.

117 **Rapey, H.** 1994. Les vergers à bois précieux en prairie pâturée: objectifs, principes et références. *Revue Forestière Française,* special 1994 issue: 61-72.
Low-density planting of quality timber trees on grasslands is a form of agroforestry that has appeared in Europe recently and is being considered in regions where farmland is being abandoned. This article gives the results of such research, dividing it into three points: the author first gives a summary of the objectives, then assesses various trial plantations and lists some now accepted points of reference.

118 **Rocheleau, D.E. & Raintree, J.B.** 1987. *Agroforestry and the future of food production in developing countries.* Nairobi, ICRAF, 14 pp.
Agroforestry is a new name for an old activity in the traditional farming world, in other words, a comprehensive approach to land use, in which woody vegetation, agricultural crops and sometimes livestock share the same land management unit. It also represents a new field of scientific activity, with scientists seeking to find out about traditional practices. Such an approach will have the same benefits as those brought about in the past in agricultural, forestry and livestock sciences.

119 **Rodrigo, J.** 1991. Le bidonville au million d'arbres. *Nations Solidaires,* 182: 32-33.
The Villa El Salvador shanty town in Lima is pursuing a voluntary policy of planting trees and fertilizing soil with waste water and sewage.

120 **El Lakany, M.H., Mehdipour, A.A. *et al.*** 1999. *Urban and peri-urban forestry: case studies in developing countries.* Rome, FAO, 194 pp.
Urban (including peri-urban) forestry has an important potential role in addressing issues involved in urban development. Two of the major issues to be addressed are the extent to which it can provide needed tree products and environmental services protection, and the enhancement of urban areas. The FAO Forestry Department has examined the role of urban forestry in Developing Countries, developed awareness of the issues involved, and improved documentation and accessibility of information on the subject. This publication is a compilation of 6 detailed case studies: (i) Urban and peri-urban forestry in Africa. A case study of the Sahel (Dakar [Senegal], Niamey [Niger], Nouakchott [Mauritania] and Ouagadougou [Burkina Faso]) (Rouchiche; 1-

28; 36 ref.) - data collected in 1999; (ii) Urban and peri-urban forestry in Asia. A case study of Hong Kong, Kuala Lumpur [Peninsular Malaysia] and Singapore (Webb; 29-74; 6 pp. of ref.) - data collected in 1996-97; (iii) Urban and peri-urban forestry in Latin America. A case study of Quito [Ecuador] (Murray; 75-106; 54 ref.) - data collected in 1995-96; (iv) Urban and peri-urban forestry in Latin America. A case study of Rio de Janeiro metropolitan region [Brazil] (Pastuk; 107-129; 27 ref.) - data collected in 1996-97; (v) Urban and peri-urban forestry in the near east. A case study of Cairo [Egypt] (El-Lakany; 131-161; 18 ref.) - data collected in 1996-97; and (vi) Urban and peri-urban forestry in the near east. A case study of Iran and its capital, Tehran (Ataie; 163-191; 60 ref.) - data collected in 1996-97. A range of different issues and constraints are highlighted in these studies: in the Sahel urban populations suffer from the desertification process which leads to lack of fuelwood, water and other environmental services; in cities such as Hong Kong, Kuala Lumpur and Singapore, the fast growth rate, high population density and intensively built-up environment are severe constraints to tree establishment and landscape design; in Quito, land tenure and speculation problems are obstacles to land use planning; in Rio, the favelas (shanty towns) on the hillside are a threat to stability and salubrity; and cities such as Cairo and Tehran face an extreme environmental degradation and high levels of air, noise, water and soil pollution.

121 **Rusten, E.P. & Gold, M.A.** 1991. Understanding an indigenous knowledge system for tree fodder via a multi-method on-farm research approach. *Agroforestry Systems,* 15: 2-3.
Understanding the dynamics of indigenous resource management systems can help natural resource development efforts and make on-farm agroforestry research initiatives more effective. This article reports on an investigation into an indigenous knowledge system for the management, cultivation and use of private tree fodder resources at Salija in the hills of central Nepal. It focuses on the methods used in order to understand the knowledge systems used by farmers in this community in classifying and evaluating fodder trees. A multi-method participatory research approach was used in order to overcome the limitations of traditional survey-based research. The results were analysed together with data from the participants' observations, a formal survey of households, an inventory of privately cultivated trees and ethnographic interviews. This integrated analysis led to an understanding of the indigenous knowledge system for the management of resources from fodder trees. This knowledge was then used as a basis for a classification and evaluation system for fodder trees.

122 **Schroeder, P. & P.E.** 1994. Carbon storage benefits of agroforestry systems. *Agroforestry Systems,* 27: 89-97.
The process of land degradation is a local phenomenon that occurs field by field. Because of the extent at which it is occurring, however, it also has a global dimension. Agroforestry represents a link between the local and global scales. From the farmer's perspective, agroforestry can be a way to increase crop yields and the diversity of products grown, but an additional benefit is the creation of a carbon sink that removes carbon dioxide from the atmosphere, and therefore has implications for climatic change. Successful agroforestry systems will also reduce land clearing and maintain carbon in existing vegetation. An extensive literature survey was conducted to evaluate the carbon dynamics of agroforestry practices and to assess their potential to store carbon. Data on tree growth and wood production were converted to estimates of carbon storage. Surveyed literature showed that median carbon storage by agroforestry practices was 9 t C/ha in semiarid, 21 t C/ha in subhumid, 50 t C/ha in humid, and 63 t C/ha in temperate ecozones. The limited survey information available substantiated the concept that implementing agroforestry practices can help reduce deforestation.

123 **Schulz, B., Becker, B. *et al.*** 1994. Indigenous knowledge in a "modern" sustainable

agroforestry system: a case study from eastern Brazil. *Agroforestry Systems,* 25: 59-69.
The case of 500 hectares of agroforestry farm—or forest garden—in the Gandu region in the coastal mountains of Bahia State, Brazil, is used to show the benefits of integrating traditional knowledge into a scientifically designed farming system. A traditional forest garden is a community forest managed with a view to containing a high percentage of useful indigenous tree species, while eliminating certain species and introducing other cultivated plants. Management of forest gardens seeks to imitate and control the natural sequence of plant growth and is based on two working hypotheses: (i) mature plants have an allelopathic growth, reducing the effect on neighbouring plants, while the growth of younger plants has a stimulating effect; and (ii) there is a positive relationship between the carbon and nitrogen cycles in the cropping system and its productivity. The article gives information on the choice, combination and management of crops (the main crop is cocoa) and includes a table of species used, sorted according to period of use (1-2 years, 1-4 years, 1-10 years, and over 10 years, with most of the species falling into the last category). Details of management practices are also given, including the cultivation, fertilization and protection of plants. The levels of cocoa yields reached without inputs in forest gardens cannot be reached in neighbouring cocoa plantations without the use of considerable amounts of fertilizers and pesticides.

124 **Sène, E.H.** 1993. Urban and peri-urban forests in sub-Saharan Africa: the Sahel. *Unasylva,* 44(2): 45-51.
This article gives an analysis of the development and role of urban forestry in Sahelian Africa.

125 **Serpantié, G.** 1996. Rôles des jachères dans la production arborée non ligneuse en savane soudanienne. Cas du Karité dans l'Ouest du Burkina Faso. In *La Jachère, Lieu de production,* p. 55-61. Meeting held in Bobo Dioulasso, Burkina Faso, 2-4 October 1996. Bobo Dioulasso, Burkina Faso, CNRT.
This article introduces the question of the role played by fallows in the production and reproduction of wooded parkland in African savannah regions. Analysing first the material and social functions, and then the present factors involved in maintaining parkland, the article establishes a link between parkland and fallows. The social and environmental importance of parkland species is shown, as well as the advantages of controlling their dynamics through the tools available in a liberal economy, particularly the promotion of products, the organization of producers, generally women, and decentralized community management of small rural spaces.

126 **Shelton, H.M.** 2000. Tropical forage tree legumes in agroforestry systems. *Unasylva,* 51(1): 25-32.
This article shows that the use of fodder trees to meet the needs of livestock can improve the productivity of farming systems.

127 **Shepherd, G.** 1989. *Putting trees into the farming system: land adjudication and agroforestry on the lower slopes of Mount Kenya.* London, ODI, 26 pp.
The author presents the results of a rapid rural appraisal carried out to throw light on the tree needs and concerns of small farmers, and thus to help in formulating development and planning methods for nurseries on Mount Kenya.

128 **Sinclair, F.L.** 1998. The agroforestry concept: managing complexity. Bangor, Gwynedd, UK, University of Wales, School of Agricultural and Forest Sciences.
Agroforestry involves managing interactions between tree and agricultural components to produce a stream of productive and environmental benefits over time. By selecting tree and crop species with complementary patterns of light, water and nutrient acquisition, overall system productivity can be higher than for conventional agriculture or forestry and leaching losses can be reduced. Adding trees to agricultural fields provides wildlife habitat and so increases biodiversity,

which in some circumstances may enhance biological control of crop pests through the encouragement of natural predators. The introduction of trees also creates a vegetation structure more similar to the natural ecosystems in which most domestic livestock evolved. This may have benefits for animal welfare and attract price premiums for livestock reared, in what are perceived by consumers to be natural conditions. As trees mature they ameliorate soil and cast increasingly heavy shade creating a succession of different opportunities for intercropping. Thinning and pruning allow the farmer considerable flexibility in controlling the speed and extent to which trees affect agricultural productivity. Increasing tree cover on UK farms has impacts at a range of scales from that of the field and the farm business to whole catchments at the landscape level. Isolated trees behave differently to trees in conventional, closely-spaced forests, so it is not possible to simply scale relationships for forest or woodland by tree density or leaf area to predict impacts of agroforestry. Through research in the UK a knowledge base is being developed that makes it increasingly possible to manage interactions in agroforestry practices to satisfy multiple objectives.

129 **Singh, G.S.** 1997. Socio-cultural evaluation of sacred groves for biodiversity conservation in North Western Himalaya. *Journal of Hill Research,* 10: 43-50.
Sacred groves are small plots of of natural vegetation that have traditionally been protected by local communities on the basis of religious faith. A case study is preented from the Kulu area of Himachal Pradesh, India, where social change and agricultural development (such as monocropping) are leading to the destruction of these remaining scraps of virgin forest. This deforestation has a major impact on the biodiversity of certain zones. A table is given, showing 25 tree species with socio-cultural functions that are often found in sacred groves.

130 **SOLAGRO** 2000. *Arbres et eaux. Rôle des arbres champêtres.* Toulouse, France, 30 pp.
This document shows the impact of farmland trees on water wherever they are closely linked to agricultural production, affecting both the quality and amount of water available. It also shows that throughout Europe, small farmers' anxiety to make the most of their natural resources has led them to create a wide variety of agroforestry systems, all remarkably suited to local constraints, with fruit-tree meadows, *dehesas*, windbreaks and "traditional" bocage landscapes. The lack or abundance of water is one of the factors taken into account in the positioning of trees, the density of planting, the choice of species, etc. Knowledge of this know-how means that some first management advice can now be given. The present document provides support for all those who believe that rehabilitation of agroforestry is one of the possible ways of preserving, or even improving, the quality of water and combating soil erosion.

131 **Soniia, D.** 1995. What do farmers think? Farmer evaluation of hedgerow intercropping under semi-arid conditions. *Agroforestry Systems,* 32: 15-28.
The author, a sociologist, examines farmers' perceptions of the impact, management and potential of hedgerow intercropping in a district of Kenya.

132 **Sturmheit, P.** 1990. Agroforestry and soil conservation needs of smallholders in southern Zambia. *Agroforestry Systems,* 3: 265-289.
A survey carried out in southeren Zambia to evaluate soil conservation and agroforestry needs yielded valuable information on the needs, constraints and development opportunities and choices perceived by smallholders themselves. The survey was based on questionnaire-style interviews with a sample of 479 smallholders. The results show that inadequate soil conservation efforts are a result of technical and socio-economic factors and not a lack of awareness of the threat of erosion. Planting fruit trees and establishing windbreaks, as well as protecting natural regeneration of *Faidherbia (Acacia) albida* on farmland are popular agroforestry interventions, and their positive effects have

been widely recognized. Forty-two perennial species have been found that contribute directly to food production. Although local shortages of fuelwood and fodder, together with the need for enclosure, were recognized, only a few of those questioned were planning agroforestry solutions such as establishing fuelwood and fodder plantations or living fences. Most of the smallholders were interested in planting trees, but had so far planted only a few. Those planted were exotic fruit trees, and it is recommended that development services should supply drought-, termite- and grazing-resistant perennial plants suitable for farmers to plant in combination with trees. The widespread exclusion of women from decision-making and their lack of security of tenure have hampered their participation in agroforestry development and have thus endangered sustainable development.

133 **Tassin, J.** 1993. *Regard sur les haies "traditionnelles" au Lac Alaotra: synthèse d'observations et enquêtes conduits en 1991 et 1992.* Antananarivo, FOFIFA, 38 pp.
This document gives the results of surveys concerning traditional hedges around Lake Alaotra in Madagascar. Hedges appear to be confined to colluvial and alluvial formations (which are not prone to flooding) and are very rare on the hills. Although they are not very productive and are made up of a fairly small number of woody species, they play some essential roles within rural systems. Hedges clearly have a high potential, particularly for fuelwood and fodder production, and research and development should focus on this aspect.

134 **Thapa, B., Sinclair, F.L.** ***et al.*** 1995. Incorporation of indigenous knowledge and perspectives in agroforestry development. Part 2: Case-study on the impact of explicit representation of farmers' knowledge. *Agroforestry Systems,* 30: 249-261.
Explicit representation of farmers' knowledge of fodder resources from trees on farmland has been developed, using systems software based on this knowledge and a methodology developed by an agricultural research centre in the eastern hills of Nepal. This approach revealed sophisticated knowledge of interactions between trees and crops and the food value of various fodder trees. Farmers' environmental knowledge is more developed in some zones than others and is to a large extent complementary to that of agricultural researchers in Nepal and scientific literature in general. The creation of explicit and encyclopaedic databases, allowing evaluation of farmers' knowledge combined with that of researchers on interdisciplinary problems concerning land use, offers the possibility of pinpointing gaps in research that act as a constraint on the productivity and sustainability of farming systems.

135 **Thapa, B., Walker, D.H.** ***et al.*** 1995. Incorporation of indigenous knowledge and perspectives in agroforestry development. Part 1: Review of methods and their application. *Agroforestry Systems,* 30: 235-248.
The incorporation of indigenous knowledge into agroforestry development should take place through farmers' participation in setting up and planning research. An outside survey of local needs would act as the basis for planning research, and an active synthesis of indigenous and scientific knowledge would allow the most to be made of their potential complementarity.

136 **Thapa, B., Walker, D.H.** ***et al.*** 1997. Indigenous knowledge of the feeding value of tree fodder. *Animal Feed Science and Technology,* 68: 37-54.
Fodder trees play a central role in farming systems in the hills of Nepal. With shrinking forest resources, farmers are increasingly coming to rely on the establishment of fodder resources from trees on farmland. An inventory of the fodder species cultivated and a detailed survey of farmers' knowledge concerning the comparative quality of fodder from different species revealed a complex combination of criteria used in comparing the 90 species cultivated. Fodder quality is determined by: its capacity to satisfy appetite; its effects on milk and butter (fat content); its effects on the smell of milk; its capacity to improve livestock growth (weight gain); its effects on livestock health; and the preference

of different animals for different types of fodder. A certain number of attributes are known to affect fodder quality: leaf texture, leaf maturity; leaf bitterness; toxicity; season; and how fodder trees are managed.

137 **Torquebiau, E.** 1992. Are tropical agroforestry home gardens sustainable? *Agriculture, Ecosystems and Environment,* 41: 189-216.
Although tropical agroforestry home gardens are considered a stable and sustainable production system, little detailed study has been undertaken to support this claim. A bibliographical survey of writings on home gardens was thus undertaken, in order to see how sustainable the system really is. This analysis revealed that agroforestry home gardens possess a certain number of sustainability features, and that these concern not only their capacity to satisfy farmers' needs without affecting resources, but also their capacity to meet economic, social, environmental and institutional needs, thus contributing to their maintainance.

138 **Toutain, G., Dollé, V. *et al.*** 1989. Situation des systèmes oasiens en régions chaudes. *Cahiers de la Recherche Développement,* 22: 3-14.
The geomorphological location of oases, their past, the roles they have played or continue to play, and the activities their inhabitants carry on within them affect the development issues that farming systems must face in order to continue and develop. A typology of different oasis production systems drawn up on the basis of key selected criteria highlights the delicate balance of oases and the importance of a systemic approach for development.

139 **Vabi, M.** 1996. Eliciting community knowledge about uses of trees through participatory rural appraisal methods: examples from Cameroon and the Central African Republic. Network paper. *Rural Development Forestry Network,* 30-36.
Participatory rural appraisal methods can be effective ways of collecting information on local knowledge and use of trees. This paper describes the use of transect lines followed by group discussions to identify the number of species of value for various uses in eight villages in Cameroon and the Central African Republic. Among other things, the study revealed the differences between men and women in preferences over species qualities, as well as in access to wood resources. Major differences were also revealed from village to village, suggesting that it is useful for communities to share information.

140 **Van Duijl, E.** 1997. *Monitoring women's tree planting in Kabale District, Uganda. A study of farmers' preferences among tree species and planting niches.* Nairobi, ICRAF, 48 pp.
This study analyses farmers' experiences with four tree species, and also includes a review of tree planting activities by women in a Ugandan district, as well as constraints faced by such planting.

141 **Van Nao, T.** 1980. Agro-sylviculture: production combinée de la nourriture et du bois. In *Le rôle des forêts dans le développement des collectivités rurales.* FAO/SIDA seminar, Kaolack, Senegal, 2-20 February 1981. Rome, FAO.
This paper examines agrosilvicultural systems in different countries and their contribution to food production. Socio-economic aspects are considered and the obstacles to the development of agrosilviculture in tropical zones are described. Constraints include farmers' feelings of frustration, insufficient rural investment, the lack of sufficient knowledge, and foresters' fairly narrow view of an agrosilvicultural system (*taungya*) as a cheap means of reforestation.

142 **Vir-Singh** 1993. Food producing trees: sustainable alternative to mountain slope farming. *Advances in Forestry Research in India,* 9: 127-133.
A discussion of the advantages of growing mixed species of multipurpose food (edible seeds, oils, beans, nuts, honey, etc.) producing trees in place of agricultural crops (and even fruit tree monocultures, such as apple orchards) in deforested mountain regions in the Indian Himalayas, as a means towards

conserving biodiversity, and protecting and conserving the region.

143 **Walter, A.** 1996. Utilisation et gestion traditionelles des arbres fruitiers au Vanuatu. *Cahiers des Sciences Humaines,* 32: 85-104.
This article examines the use of fruit trees in Vanuatu. Such trees include about 40 species present before the arrival of Europeans and others introduced since then. The article also includes notes on: access to land; linguistic aspects and their high intraspecific variability; the different uses of fruit trees, including a calendar of their availability, multipurpose trees, and their various uses by different communities; and traditional management of fruit trees. Fruit trees may be planted close to houses for private use or grow naturally in forests where they are accessible to all.

144 **Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J. & Dokeen, D.J.** 2000. *PCC Special report on land use, land-use change and forestry.*
This Special Report discusses the global carbon cycle and how different land use and forestry activities currently affect standing carbon stocks and emissions of greenhouse gases. It also looks forward and examines future carbon uptake and emissions that may result from employing varying definitional scenarios and carbon accounting strategies, linked to the Kyoto Protocol, within the forestry and land-use sectors.

145 **Weih, A., Papanastasis, V.P. *et al.*** 1999. Shrubs in the landscape: an agricultural resource in former times—today a problem for the protection of cultural landscapes. In *International Occasional Symposium of the European Grassland Federation,* p. 323-328. Thessaloniki, Greece, 27-29 May 1999. Thessaloniki, Greece, Hellenic Range and Pasture Society.
Bushes and hedges are important elements in the landscape in Germany. In former times most shrubs were used by farmers. Apart from use as animal fodder and for heating, brushwood fires were needed especially for baking bread. Moreover brushwood was used as working material for agricultural tools and for building timber-framed houses. Nowadays, the use of bushes has lapsed in most cases. Shrubs are seen as a hindrance to land management, and in grasslands of less favoured areas shrubs block landscape vistas and threaten species-rich, ecologically valuable biotopes. The spread of shrubs must be controlled if landscapes are to be preserved. Steep, stony and/or wetland sites are considered most endangered. Grazing animals can retard growth of shrubs; but with under-grazing shrub growth may even be accelerated. Maintenance work on pastures after grazing is necessary. Farmers' willingness to carry out manual maintenance work on grasslands was investigated. Farmers are prepared to do this work if enough money is paid, and most machines needed are available on the farms. However, scrub control on pastures is not promoted by existing conservation programmes.

146 **Wickramsinghe, A.** 1996. The non-forest woodfuel resources of Sri Lanka. *Wood Energy News,* 11: 14-18.
This article discusses the growing use of woodfuel from home gardens and trees on farmland, coconut wood and husks, rubber trees, and residues from processing.

147 **Wilkinson, M.K. & Elevitch, C.R.** 2000. *Multipurpose windbreaks: design and species for Pacific islands.* Holualoa, Hawaii, USA, PAR, 31 pp.
Windbreaks can improve crop production and health while conserving soil and water. Farmers in the Pacific islands have to face many challenges in designing windbreaks, apart from the scarcity of land, which makes its efficient use all the more vital. The planting of multipurpose windbreaks can improve benefits by producing marketable products. These guidelines describe the basic criteria in designing windbreaks, including orientation, spacing, thickness, height, breadth, the number of lines, and whether they are broken or unbroken. They also give criteria connected with the various functions and products, including wood, fruit, fodder, straw and habitats for wildlife. A list is also given of

over 90 multipurpose species suitable for use in windbreaks in the Pacific islands.

148 **Williams, P.A., Gordon, A.M. *et al.*** 1997. Agroforestry in North America and its role in farming systems. *Temperate Agroforestry Systems,* 9-84.
The first part of this chapter provides an introduction to agroforestry in North America under the following headings: history and background; farms, forests, woodlots and land-use changes; driving forces in agroforestry; and agroforestry, wildlife and biodiversity. The second part describes the agroforestry systems and related practices found: windbreak systems for fields, livestock, farmsteads and other areas; silvopastoral systems - range management and silvopasture, silvopasture in the SE, Pacific NW and British Columbia, the mid-west and NE, and mesquite [Prosopis glandulosa] in the SW (problems and opportunities). The third part discusses various aspects of intercropping/alley cropping systems: with black walnut [Juglans nigra] and other nut production systems; weed control in tree rows and other cultural considerations; and ecological interactions. The remainder of the chapter discusses integrated riparian management systems, forest farming systems, biomass production and other plantation systems, and agroforestry policy - institutional requirements and learning processes.

149 **Wolf, G.V., Roger, J.H. *et al.*** 1990. *Assessing multi-product tree yields from linear agroforestry technologies.* Nairobi, ICRAF, 59 pp.
This document gives guidelines for assessing yields of specific tree products in agroforests. Basic sampling and statistical principles are included.

150 **Young, A.** 1989. *Agroforestry for soil conservation.* Slough, CAB International, 276 pp.
This work comprises a review of the potential of agroforestry to contribute to soil conservation. It summarizes the present state of knowledge, including known capacity and apparent potential, then indicates research needs. The general conclusion is that appropriate agroforestry systems can control erosion, maintaining the organic matter and physical properties of the soil.

151 **Young, A.** 1988. Agroforestry in the control of soil erosion by water. *Agroforestry Abstracts,* 1: 39-48.
A review. Trends in soil conservation research and policy are discussed and the effects of trees and shrubs on the factors of erosion outlined. Brief experimental data on the rates of erosion under various land use systems involving trees are given (very little is available), and the use of agroforestry practices for erosion control described. These practices are: rotational (e.g. shifting cultivation, taungya), spatial mixed (plantation crop combinations, multistorey tree gardens), spatial zoned (hedgerow intercropping, trees on erosion control structures such as terraces, ditches and banks), silvopastoral, and the integration of agroforestry with reclamation forestry and watershed management. Research needs are highlighted.

152 **Zinkhan, F.C. & Mercer, D.E.** 1997. An assessment of agroforestry systems in the southern USA. *Agroforestry Systems,* 35: 303-321.
An assessment of agroforestry systems in the southern United States, based on a survey of experts concerning land use and on a bibliographical review, revealed a good potential for agroforestry. The survey indicated that silvopastoral systems are the commonest form of agroforestry in the region. Increased financial returns, diversification and a rise in liquidity were the most frequently mentioned benefits associated with the establishment of silvopastoral systems. Some of the problems found with alley cropping systems (less often observed than silvopastoral systems) are smaller than expected: lower productivity, lower profitability, damage to trees during harvesting of agricultural products, and constraints connected with labour and management skills. The advantages of establishing agroforestry systems in the region were identified on the basis of the bibliographical review and the survey:

improvement in marginal land; the use of windbreaks and buffer zones to improve water quality and as habitats for plant and animal wildlife; economic growth linked to natural conifer woodland and the plantation of hardwoods and conifers; and the supply of products, especially to small landowners.

2.2 EVALUATION

165 **Aalboek, A.** 2000. Farmer tree planting in Tanzania. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 155-169. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This paper gives the results of the planting of trees in 157 villages in Tanzania. The scale of previous planting and that envisaged by farmers are analysed, together with variations in scale within and between geographical areas, and socio-economic and demographic differences.

166 **Achard, F., Konieczka, N. *et al.*** 1996. Ressources ligneuses des jachères du Sud-Ouest du Niger. In *La Jachère, Lieu de production,* p. 43-48. Meeting held in Bobo Dioulasso, Burkina Faso, 2-4 October 1996. Bobo Dioulasso, Burkina Faso, CNRT.
The Energy II Project, which aims at promoting long-term management of fuelwood resources, launched a research and development programme in May 1996, based on selective clearing of bush cover when fallow land is put back under cultivation, and on the reintroduction of tree species that are no longer found there. The 16 fallows selected for the study take place in the south of Niamey. Inventory and analysis of the woody structure meant that clearing these plots allowed the quantity of wood produced by each fallow to be measured. The average density of the tree population of fallow land was 784 specimens.ha^{-1} (omicron = 441). The geographical positions of 24 woody species were inventoried in the 16 fallow plots studied. The number of species per plot varied considerably, but was never high: an average of 2.8 to 9.3, depending on location. The woody vegetation on 14 plots was dominated by Combretaceae (< 90% of individuals), *Guiera senegalensis* in particular (83 to 94% of individuals). The other two, which were located in valley bottoms, were covered by *Pilostigma reticulatum* (86.5% of individuals). Formations were made up for the most part of small-diameter stems: 91% were between 1 and 4 cm. The average quantity of green wood with a diameter greater than 1 cm was 2 984 kg.ha^{-1} (omicron = 3 475), including 1 126 kg of marketable wood with a diameter of 2 cm or more, representing a volume of 4.5 steres.ha^{-1} (with an average weight of 270 kg per stere). The values of the parameters studied varied widely from one fallow to another. In most cases, these differences were not linked to geographical zone, position in the toposequence or the age of the fallow, but were a result of different ways of managing the crop-fallow system. This variability meant that only major trends could be identified, particularly the floristic poverty of the vegetation and a relatively high wood production, constituting a good complement to forest wood resources.

167 **Ahimana, C. & Maghembe, J.A.** 1987. Growth and biomass production by young *Eucalyptus tereticornis* under agroforestry at Morogoro, Tanzania. *Forest Ecology and Management,* 22: 219-228.
A trial with *Eucalyptus tereticornis* was carried out in the form of a Latin cross with five trial plots. After three years, trees representing every category of size were felled and used to determine above-ground biomass production for some, while others were dug up in order to determine the biomass production of the roots. Production met the initial objectives of providing high yields of fuelwood and poles with the use of short rotations.

168 **Ahmed, S.A. & Grainge, M.** 1985. Use of indigenous plant resources in rural development: potential of the neem tree. *International Journal for Development Technology,* 3: 123-130.
The neem (*Azadirachta indica*) is a native of the Indian subcontinent, where it has a wide range of medicinal and other uses. Its potential for agriculture and rural development in

developing countries is evaluated here. Pesticides produced from it can be used effectively to reduce dependence on imported synthetic pesticides, while producing an income for poor rural inhabitants. Analysis shows that the transfer of parasite control technology should not pose any serious problem in countries where the neem is indigenous, nor in those where it has been recently introduced. The potential of the neem for agriculture and rural development lies in the manufacture and use of its oil (for soap) and of "neem cake" (used as fertilizer, nitrification inhibitor and livestock feed). Parasite control substances are found in neem leaves, fruit, bark and seeds, and also in its oil and cake. Neem oil at present sells in India for $US 1.20-1.30/kg, and neem cake for $US 0.10/kg.

169 **Akakpo, K.M.** 2000. *Arbres hors forêts en Togo. CE-FAO-Programme partenariat (1998-2000).* Togo, FAO, 66 pp.
In this report on trees outside forests in Togo, the author offers a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review.

170 **Anderson, L.M.** 1988. Influence of trees on residential property values in Athens, Georgia (USA): a survey based on actual sales prices. *Landscape and Urban Planning,* 15: 153-164.
A survey of the selling prices of 844 residential properties in Athens, Georgia, indicates that the value of land with trees is 3.5 to 4.5% higher. During the period of the study (1978-1980), the average house sold had a price of $US 38 100 and had five trees in its garden. The average increase in price resulting from the presence of trees was $US 1 475 to $US 1 750 and involved especially medium and large diameter trees, regardless of species. This increased local taxes on the property by $US 100 000.

171 **FAO** 1994. *Evaluations agro-écologiques aux fins de planification nationale: l'exemple du Kenya.* Rome, FAO, 172 pp.
The study used as an example in this teaching bulletin concerns the design and country-wide application of a methodology allowing the land resource potential of each of Kenya's 41 districts to be established, in order to facilitate formulation of development policies and planning. The bulletin describes the results obtained on the methodological level, as well as the database on resources set up for this detailed study of the country.

172 **IUFRO** 1998. *Guidelines for designing multipurpose resource inventories: a project of IUFRO Research Group.* Vienna, IUFRO, 216 pp.
This work provides basic information on multipurpose resource inventories for inventory planners and for provincial- or national-level decision-makers, although it can also be applied on the local level. The need for multipurpose resource inventories is discussed in depth, and the document also describes the information and structures needed for such an inventory, as well as problems connected with its design and implementation.

173 **Auclair, D. & Maerten, E.** 1986. Une méthode d'évaluation de la biomasse des arbres de haie. *Annales des sciences forestières,* 43: 57-66.
With a view to extending the results of the national hardwood volume forestry inventory to biomass results, a sampling of 54 small coppices and nine reserved oak forests was carried out on hedges in the bocage region of France's Loiret department. A regression equation of the type BST = aVBF+b could be calculated for the coppicing, depending neither on species (oak, hornbeam, ash) nor on the perched or normal nature of the coppicing. On the other hand, it is not comparable with results obtained previously from enclosed stands. An equation of the same type was estimated for reserved oak forests, in which the crown proportion is 42%. The validity and extended applicability of these results, which were obtained in clearly defined conditions, are discussed.

174 **Ayuk, E.** 1997. Adoption of agroforestry technology: the case of live hedges in the

central plateau of Burkina Faso. *Agricultural Systems,* 54: 189-206.
A "logit-econometric" model is used to study farmers' decision-making processes and the factors influencing the adoption of live hedges. This study also includes a quantitative assessment of farmers' perceptions of the advantages and disadvantages of live hedges and their criteria for the choice of species.

175 **Ayuk, E.T., Duguma, B. *et al.*** 1999. Uses, management and economic potential of *Irvingia gabonensis* in the humid lowlands of Cameroon. *Forest Ecology and Management,* 113: 1-9.
Irvingia gabonensis is one of the tree species preferred by farmers in the humid lowlands of Cameroon, as well as having a major place in international trade in West Africa. Although empirical data do exist on the volume of international trade, no data are available regarding production on the farm level. The species generally grows in the wild, and very little effort has been made to domesticate it. A survey was carried out in three regions of Cameroon with different infrastructures and population characteristics, in order to evaluate the economic importance of the species on the farm level. The uses, management and improvement objectives of farmers were also identified. The results of this survey indicate that *Irvingia gabonensis* is found mainly in fields where trees, for example cocoa and coffee, are cultivated. The kernel trade is large. Kernels are processed into a paste used in sauces, but also have medicinal uses and are a source of oil. The pulp of the fruit is edible. The wood is used for building, dead branches for firewood, and the bark for medicine. The annual value of *Irvingia* fruit and seed production is between $US28 and 93 per farmer/collector for the three regions. Improvement objectives include increasing the size of fruit, improving taste, increasing yields and reducing the height of trees.

176 **Bagnoud, N.** 1991. *Inventaire des systèmes agroforestiers traditionnels*. Sikasso, Mali, Ministère du Développement Rural, 45 pp.
This report is the result of agroforestry surveys in the Sikasso region of Mali. It is based on an *ad hoc* field survey in villages likely to provide a varied sampling of practices, and is intended to provide examples and highlight trends in management of the rural environment.

177 **Bagnoud, N., Schmithüsen, F. *et al.*** 1995. Les parcs à Karité et Néré au Sud-Mali: analyse du bilan économique des arbres associés aux cultures. *Bois et Forêts des Tropiques,* 244: 9-23.
In West Africa, where one of the features of agriculture over vast areas is a close linking of cover trees and cash or food crops, the question of the advantages and disadvantages of trees is widely discussed. This study furthers knowledge of the contributions of trees and also of the losses they cause to crops. It is based on analysis of 22 farms in three villages in southern Mali. The species considered, karité (*Vitallaria paradoxa,* Gaertn. f., Hepper) and locust bean (*Parkia biglobosa* [Jacq.] Benth.), provide a wide range of goods and services. The study assesses their contributions and consequent losses in monetary terms on the basis of a series of models. The balance is very positive on almost all the farms, with the best results being obtained on farms with a high density of trees, particularly locust bean.

178 **Banana, A.Y., Obua, J. *et al.*** 1999. *Special regional study report on trees outside forests for Eastern Africa*. Kampala & Rome, Makerere University & FAO, 30 pp. + annex (unpublished).
This report deals with trees outside forests in different countries in East Africa: Kenya, Uganda, Tanzania, Ethiopia, Eritrea, Sudan and Djibouti. The authors seek to offer a review of this resource throughout the whole region, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review, and refer especially to trees contained in silvopastoral and agrosilvicultural systems.

179 **Baudu, M.** 1998. *Mise au point d'une méthode d'évaluation de la ressource diffuse*

des jachères au Mali. Paris, Institut National Agronomique Paris-Grignon, 51 pp.
Mali's fuelwood production sector meets 91% of the country's energy needs. The wood comes from natural forest stands and off-forest formations—trees scattered on agrosilvopastoral land. The scattered stands are strongly affected by human factors, are spread over village land, and are subject to rapid transformation. Even the distribution of woody species within these stands is nuclear, with bare soil alternating with islands of dense vegetation, and appropriate methods are needed in order to assess them. This document focuses on wood resources on fallows, and gives the results and conclusions of a method tested in eight villages in Mali. It would seem that definition of a method to assess wood resources in these stands cannot confine itself to a simple adaptation of the sampling methods used for forest stands, but must incorporate a strong socio-economic component.

180 **Beer, J., Bonnemann, A. *et al.*** 1990. Modelling agroforestry systems of cacao *(Theobroma cacao)* with laurel *(Cordia alliodora)* or poro *(Erythrina peoppigiana)* in Costa Rica. V. Productivity indices, organic material models and sustainability over ten years. *Agroforestry Systems,* 12: 229-249.
This study focuses on production from crops and shade trees and the distribution of organic matter in the system. The parameters studied are: standing biomass, the production of cocoa trees and shade trees, leaf litter production, root biomass, total biomass, total organic matter, soil organic matter, net primary productivity, and productivity indices. These values are then synthesized in models. In the experimental conditions of this study, which included moderate applications of fertilizer, the agroforestry systems of *Erythrina peoppigiana* or *Cordia alliodora* with *Theobroma cacao* increased agricultural production as well as net primary production during the second five-year period. The use of *C. alliodora* is recommended in the conditions studied, and that of *E. peoppigiana* on less fertile soils without fertilizer.

181 **Beer, J., Ibrahim, M. *et al.*** 2000. Timber production in tropical agroforestry systems of Central America. *In* B. Krishnapillay, E. Soepadmo, N.L. Arshad *et al.*, eds. *Forest and Society: the role of research,* 1: 777-786. 21st IUFRO World Congress, Kuala Lumpur, 7-12 August 2000. Kuala Lumpur, IUFRO World Congress Organising Committee.
This paper gives three examples of timber-producing tropical agroforestry systems: multilevel systems with permanent crops (e.g. coffee or cocoa), small woodlots on private farms set up using the *taungya* system, and silvopastoral systems incorporating a timber component. After giving data taken from case studies, which also show the regional importance of timber production, some of the medium- and long-term lessons drawn from this experience are discussed, including research methods and the selection of components and systems. The combination of socio-economic and biophysical research results with results obtained on different levels is also discussed.

182 **Béliard, C.A.** 1983. *Resultados preliminares de la producción de biomasa en cercos vivos de* Gliricida sepium *bajo dos frecuencias de poda en la región de la Palmera, San Carlos, Costa Rica.* Turrialba, Costa Rica, CATIE, 11 pp.
This document gives the preliminary results of a study on the biomass production of living *Gliricidia sepium* fences on a livestock farm at Palmera, San Carlos, Costa Rica. These saplings are five years old, between 2 and 2.5 m tall, and planted 1.5 m apart. Pruning at three- and six-month intervals was compared, using a method of random blocks of ten posts per plot and four repetitions. One pruning after six months offers a better overall production (dry weight) than two prunings with a three-month interval. The total biomass produced is 4.4 against 2.1 metric tons/km of fence at six and three months respectively. However, there is no significant difference in the quantity of fodder produced (1.6 and 1.4 metric tons/km at six and three months respectively).

183 **Bergez, J.E., Msika, B. *et al.*** 1997. Modélisation des systèmes agroforestiers

basée sur des données biologiques. *In* F. Blasco, ed. *Tendances nouvelles en modélisation pour l'environnement,* p. 215-222. Paris, Elsevier.
The "biophysical" model presented here, based on multidisciplinary research carried out jointly by many European research institutes, concerns the description of a silvopastoral plot. One of the main problems in validating this model is the absence of data on real cases over a long enough time span. The biophysical model now works on the plot level. Simulation of geobiochemical cycles, which is needed to calculate production, also contributes to scientific knowledge of the ecological functioning of a complex system.

184 **Bernard, C. & Depommier, D.** 1997. Approche systémique et place du SIG dans la caractérisation et le suivi des parcs agroforestiers. In *11ème congrès forestier mondial. Synthèse "après-congrès*", p. 10. Antalya, Turkey. Montpellier, France, CIRAD.
The traditional combination of trees and crops plays a considerable role on village land. These agroforestry systems, which appear to be sustainable, produce a variety of products and services for those managing them. Through studies carried out on *Faidherbia albida, Parkia biglobosa* and *Vitellaria paradoxa* parklands in western Burkina Faso and northern Côte d'Ivoire, a systematic, multidisciplinary approach was adopted in order to identify how these parklands function and their dynamics. Analysis was carried out on different levels, from that of the village land as a whole, through the individual plot as the site of human management, right down to the tree. The use of a geographical information system meant that for both plots and trees, georeferenced data (obtained with topographical surveys) could be combined with the results of field surveys. When thematic maps were redrawn by intersecting human factors with the distribution of the main tree species, the most typical effects of parkland management and development were seen. On the village land or general parkland, the overall heterogeneity of agroforestry species is a result of morphological and soil conditions, but analysis of stands on the plot level shows that human factors are far more determining.

185 **Bernard, C. & Peltier, R.** 1994. Etude du parc agroforestier d'un terroir Sénoufo au Nord de la Côte d'Ivoire. Utilisation d'un SIG pour cartographier les parcelles cultivées et corréler le type d'arbre avec différentes données agronomiques et socioéconomiques. *In* M. Sébillotte, ed. *Recherches-Système en Agriculture et Développement Rural,* p. 404-410. International symposium, Montpellier, France, 21-25 November 1994. Montpellier, France, CIRAD-SAR.
After carrying out a demographic census and a short sociological study in the village of Dolekaha, the boundaries of the village's land were surveyed, together with the location of large trees. Maps were drawn up, using a geographical information system, and two distinct types of tree system were defined. Around the village is a *Faidherbia albida* parkland, the extent and composition of which have varied little over the past 30 years. The fertility transfer carried out by livestock means that mixed crops (cereals and pulses) can be grown under the *Faidherbia* trees without any need for a fallow. The second type of parkland is found nearer the boundaries of the village land and is dominated by locust bean and karité. The authors show the importance of trees on rural land in numerical and economic terms.

186 **Besse, F.** 1989. Enquête agroforestière. *In* F. Besse, L.A. De & P. Guizol, eds. *L'Agroforesterie au Burundi.* National seminar, Bujumbura, 28-31 March 1989. Bujumbura, Forestry Department.
The survey carried out in 1986 had a variety of aims: (i) to learn more about the woody species used by farmers, how they are treated, and their needs, in order to adapt seedling production policy; (ii) to study and define crop combinations and systems; and (iii) to draw up a questionnaire that can be applied widely. The whole process took 18 months, and the main results are described and commented on here.

187 **Bird, P.R., Bicknell, D. *et al.*** 1992. The role of shelter in Australia for protecting soils, plants and livestock. *Agroforestry systems,* 20: 59-86.
This study had the aim of examining the present state of knowledge on the roles of trees as shelter for grasslands, crops and livestock, in controlling soil erosion, and in improving the productivity and sustainability of crop production in Australia. Soil degradation (the loss of trees and the associated salinity, wind and water erosion, acidification, and structural and nutritional degradation) in Australia are proof that the primary production systems being used are not sustainable. About half the farmland and rangeland in Victoria is affected or under threat. In Western Australia, about 25% of farmland is suffering from erosion and 60% is potentially vulnerable, while 430 000 ha of land and over half the surface water are affected by salinity. Similar problems are found in other states. At least 43 million ha, or 13% of the rangeland, have been seriously degraded by wind erosion as a result of overgrazing, often coinciding with drought or a series of dry years. One of the main focuses of Australian agricultural research has been minimal tillage and the use of stubble to control erosion. A harsh climate and the imperfect adoption of appropriate harvesting and grazing management systems show the weakness of these erosion control methods. However, the complementary use of windbreaks to reduce gulleying is rare, and there has been no campaign to promote their establishment, despite widespread adoption of this technique in other countries. The systematic planting of 10% of the land with a network of shelterbelts and patches of trees could cut wind speed by 50%, which would considerably improve pasture production in both the short and long terms. Wind erosion could be radically reduced and harvest yields probably increased through the use of windbreaks. For example, studies of wheat and oat harvests at Rutherglen, Victoria, and lupins at Esperance, Western Australia, have shown that yields increased by 22, 47 and 30% respectively in areas with such shelter. In semi-arid and dry temperate zones, planting 5% of the land could reduce wind speeds by 30 to 50% and soil loss by up to 80%. Such planting would also contribute considerably to meeting other objectives of sustainable agriculture. Agroforestry will be important in the long-term replanting strategy.

188 **Bracco, I. & Legard, L.** 1996. La place et l'avenir de l'arbre dans le système d'exploitation paysan. Fenoarivo-Atsinanana, Côte Est de Madagascar. *Schweizerische Zeitschrift für Forstwesen,* 147: 121-134.
Deforestation has reached an alarming level on the eastern coast of Madagascar, mainly as a result of the change in crops. The authors assess present and future timber resources and the timber requirements of the inhabitants of a specific area. Trees are extremely important to rural communities, providing construction timber, fuelwood, edible fruit, shade, medicines and hedges. *Eucalyptus* spp., *Pinus caribaea* and *Dracaena* spp. are the species most commonly planted.

189 **Bradley, P.N.** 1988. Survey of woody biomass on farms in western Kenya. *Ambio,* 17: 40-48.
Development projects aimed at increasing the number of trees for fuelwood first of all need a solid picture of the quantity, form and function of existing stocks of woody biomass. The author describes the methods and results of a study undertaken in Kenya to assess wood stocks on individual farms on the basis of certain hypotheses as to consumption. He then tries to assess the shortfall in domestic fuelwood.

190 **Budowski, G. & Russo, R.O.** 1993. Live fence posts in Costa Rica: a compilation of the farmer's beliefs and technologies. *Journal of Sustainable Agriculture,* 3: 65-87.
Living fences are widely used in Costa Rica and other Central American countries as a sustainable agricultural (silvopastoral) practice. Data on Costa Rican farmers' empirical knowledge of this subject were assembled through a questionnaire, field measurements and a bibliographical review. Ninety-two multipurpose species used for living fences were identified, and data were

recorded on propagation, uses (fodder, fuelwood, medicines, nitrogen fixation, honey production and ornamentation) and environmental features. Management practices (preparation of posts, planting, cutting) and uses are discussed in general and for specific species. Biomass production data are given for a kilometre of *Erythrina berteroana* living fence cut back every four, six and eight months. It is concluded that the use of such fences is a very promising sustainable practice and deserves further research and development.

191 **Cabanettes, A., Auclair, D. *et al.*** 1997. Tree height and diameter growth models in agroforestry situations. In *Agroforestry for sustainable land-use,* p. 401-406. Montpellier, France, CIRAD.
Measurements taken on a network of young agroforestry plantations in France and the United Kingdom supplied the initial elements for building a model of forest tree growth in agroforestry situations. On the basis of analysis of the collected data, the growth models used in a classical forest measurement method were adapted in order to take into account the absence of competition between trees in the first years and of competition with grassy vegetation. Account was also taken of modifications in growth in height resulting from the presence of individual protection tubes and the absence of competition between crowns. Variability between individuals was also incorporated into the model.

192 **Cameron, D.M., Rance, S.J. *et al.*** 1991. Arbres et pâturages. Une étude sur les effets de l'espacement. *L'agroforesterie aujourd'hui,* 3: 8-9.
In many parts of Australia, the destruction of woody vegetation on rangelands has led to soil degradation. Although agroforestry could represent a solution to the resulting problems, it has often been identified with the introduction of livestock into natural forests or plantations of trees for grazing, while little study and few experiments have been dedicated to the reverse process—planting trees on grazing land. The Soil, Trees and Grass Project was drawn up to examine the possibilities of designing a wooded pasture system suited to the subtropical environment. This article gives the results of experiments carried out on a plantation of eucalyptus grown on *Setaria sphacelata* grassland, in order to discover the effects of spacing on above-ground and total biomass production and on the growth of the grassy cover.

193 **Campbell, B., Clarke, J. *et al.*** 1995. *The hidden harvest: the role of wild foods in agricultural systems. Local-level economic valuation of savanna woodland resources: village cases from Zimbabwe.* UK, IIED.
The project described here focused on evaluation (including participatory rural appraisal techniques) of wild food resources and tree resources within the context of two research programmes, the Hidden Harvest Project and the Value of Trees Project. The work was carried out in a workshop attended by experts from different disciplines: resource economics, human ecology, sociology, energy, silviculture, environmental policies and ecology. The different sectors of the report consider the study zone, the methodology, the description and evaluation of resources, production flows from woodland, tenure and institutional issues involved in the control of resources, evaluation of products, commercial and non-commercial aspects of local perceptions of value, and, lastly, sustainability.

194 **Chacalo Hilu, A., Grabinsky, J. *et al.*** 1996. Inventario del arbolado de alineación de la ciudad de México. *Ciencia Forestal en México,* 21: 101-119.
This article continues analysis of data on line-planted trees in Mexico City carried out in 1994. It describes the situation of street trees in different sections of the city, including the precise number of trees per block. Relations between the features of the different sites, the health status of the trees, their dimensions and the characteristics of the various species are also analysed.

195 **Chevrou, R.** 1973. Inventaire forestier national: inventaire des haies. *Revue forestière française,* 25: 47-53.

One of the objectives of the French National Forestry Inventory is to assess the volumes of wood contained in linear elements, particularly hedges. Hedges have been defined as irregular, linear, wooded elements with a minimum length of 25 m and a maximum breadth of 10 m, containing at least three trees to be inventored, and an average of one every 10 m. Various methods were used — the intersection method (squares and crosses) and the associated strip method. Only the latter is now being used, because of its advantages in terms of simplicity both for the interpretation of photographs and for taking field measurements and making calculations.

196 **Chundamannil, M., Krishnankutty, C. *et al.*** 1993. *Socio-economic study of farm forestry: a survey of four villages in Kerala.* Kerala Forest Research Institute, 66 pp.
This study examines variations in the cutting of trees in home gardens in four Kerala villages. A socio-economic and land-use survey was made of 247 households, recording harvesting models and details of tree growth. A harvesting intensity index was developed in order to compare various types of mixed farming, and different intensities were refined for seasonal and annual harvesting, permanent harvesting, tree harvesting and harvesting of various other products. Using the size of plot as an indication of economic status, comparisons were made between the households in each village and between different villages. No difference was observed in the intensity of tree harvesting between different-sized plots in any of the villages. However, the tree density varied considerably. The intensity of tree harvesting has decreased while the intensity of permanent harvesting has increased. When the combined intensity of permanent harvesting and tree harvesting was considered, the highest intensity was found on the smallest plots in three of the four villages. Considering the intensity of all harvests taken together, the smaller plots had higher harvesting intensities. Multipurpose trees accounted for 50 to 70% of the trees in home gardens in the different villages. The average number of trees per hectare varied considerably from village to village and between different plot sizes. In all the villages, a reduction in the variety of trees went together with a reduction of the plots' area. Socio-economic factors - such as plot size - leveled out, and many other factors – such as the source of income, the number of sub-systems found in the home garden and their period of development,… - contributed to crop intensification in home gardens, within agroclimatic limitations and soil conditions. Multipurpose or high-value trees were preferred when planting afresh.

197 **Coe, R.D.** 1998. Participatory on-farm experimentation in agroforestry: experiences and the role of biometrics. In *XIX International Biometric Conference.* Cape Town, 14-18 December 1998. Cape Town.
This paper discusses the fact that in most cases new methods for a model and analysis of agroforestry experiments are not needed. Tried and tested approaches and methods are already available but are often not used.

198 **Conforti, J., Mahamoud, O.B. *et al.*** 1995. *Zonage des oasis du Jérid.* Montpellier, France, CIRAD, 165 pp.
Zoning is a tool that should allow agricultural services to adapt their lines of action to differences in production conditions. It aims at highlighting these differences in spatial terms by identifying areas within which the problems are the same. On the basis of analysis of the features of each of the oases in the region, seven groups of oases were identified. The land inheritance system, investment capacities and the efficiency of tillage systems were the main discriminating criteria. It seems that the farms making up these different groups have widely varying capacities for development and adaptation to the market economy. Recommendations are made for each of the groups identified.

199 **Cotler, H. & Maass, J.M.** 1999. Tree management in the northwestern Andean Cordillera of Peru. *Mountain Research and Development,* 19: 153-160.
Farming communities in the Andean Cordillera in northwestern Peru use an efficient tree management strategy that helps

to meet their main needs. Trees supply many types of goods for the farmers, including timber for building and making furniture, glue, rope, medicines, soap and poison. Despite this, the weakness of common tenure rights means that there is inadequate control over access to forest zones, leading to an overexploitation of forest resources, overgrazing and soil erosion. An inventory of the main tree and shrub species in the catchment area of the Mangas waters (an area of 173 km^2) was compiled in order to provide a basis for more sustainable management, and also to allow better planning of future reforestation in the region. Priority was given to the description of each species in terms of its local use, applicability for agroforestry, and position in the soil and in the context of the landscape in which it has grown. There are eight vegetation formations in the area: tropical montane forest, secondary shrubby formations, woodland, wooded savannah (two types), semi-desert shrubland with cacti, shrubby steppe, and gallery forest. Forty-seven of the seventy-one species of tree and shrub identified have several uses. The genera *Acacia, Alnus, Cordia, Erythrina* and *Prosopis* are considered the most effective in improving those forest zones that are used for grazing.

200 **Croze, H. & Gwynn, M.D.** 1983. The global environment monitoring system: its value for analysis and development of agroforestry land use systems. *In* P.A. Huxley, ed. *Plant research and agroforestry,* p. 291-296. Proceedings of a consultative meeting held in Nairobi, 8-15 April 1981. Nairobi, ICRAF.
The Global Environment Monitoring System is a worldwide collection of networks focusing on the environment and dedicated to coordinating data collection and analysis methods. The main function of the network is that of providing managers and planners with an assessment on the state of the environment and on trends, so that such information can be taken into account in decisions.

201 **Daget, P.** 1996. Mésurer le recouvrement des ligneux dans les végétations ouvertes des pâturages. *Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux,* 49: 76-78.
Precise measurement of the covering of woody species in open vegetation is vital, particularly in studies of dynamics. It is made much easier through the use of Cooper's gauge, based on the principles of Bitterlich's relascope.

202 **Daget, P.** 1996. La mesure des biomasses au pâturage. *Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux,* 49: 70-71.
Since vegetation on grazing land is by nature mixed, analysis of its biomass with the classic methods is inadequate, since they are based on the hypothesis of the Gaussian distribution of measurements made on samples taken from a homogeneous population. It is better to define biomass through observation and to use non-parametric tests for comparisons.

203 **Das, P.K.** 1991. Coconut intercropping with cassava: an economic analysis. *Coconut Research and Development,* 7: 58-65.
An evaluation of the impact of coconut intercropping with cassava reveals many advantages. As opposed to the general belief, intercropping with cassava is beneficial to coconuts, and the yields on intercropped plots are better than those on plots planted solely to coconuts.

204 **Daus, S.J. & Guero, M.** 1986. A remote sensing aided inventory of fuelwood volumes in the Sahel region of West Africa: a case study of five urban zones in Republic of Niger. *Remote sensing for Resources Development and Environmental Management,* p. 403-414. Symposium held in Enschede, Netherlands, August 1986. Enschede, Netherlands.
An inventory of wood volumes was made in five urban zones in the Republic of Niger, using the interpretation of Landsat satellite images and medium-range aerial photographs. The aim was to provide the Government with information on the amount of available fuelwood for the population in the five zones—a total area of about 150 000 km^2—for planning purposes. With the aid of a soil/vegetation/landform map, a total of 349 field sites were divided for data collection. The sites were chosen using a multi-level list

sampling method, and the choice was weighted towards forested areas. Quantitative data were collected through a transect system, and the volume of fuelwood was calculated through a multiple regression process.

205 **De Gier, A.** 2000. Woody biomass assessment in woodlands and shrublands. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 89-98. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
There are a certain number of difficulties in assessing the woody biomass of individual trees and shrublands. From the point of view of measurements, differences in the form of the stems and crowns and variations between species pose problems. Carrying out such an assessment then comes up against constraints connected with cost, time and labour. From the point of view of statistics, questions arise as to the model to be used in regression analyses. This paper discusses some of the approaches adopted, and a recently developed method of subsampling trees, which solves some of the above-mentioned problems, is described. Regression analysis approaches are also discussed, and examples are given for a number of countries in different climatic zones.

206 **Den Biggelaar, C. & Gold, M.** 1996. Development of utility and location indices for classifying agroforestry species: the case of Rwanda. *Agroforestry Systems,* 34: 229-246.
In a study of farmers' knowledge and experiments on trees and tree planting, two categories of farmer were identified: tree experts (44 in number) and control farmers (70), through a two-stage classification process of acquaintance and community interviews in three southern Rwandan communes in 1992. A detailed inventory of tree species was made, revealing two key features of trees on farmland: their multipurpose character and their high flexibility as to location. In order to organize the inventory of species logically, two indices—a utility index (UI) and a locational flexibility index (LFI)—were developed. Values according to the two indices were calculated for each species and then transferred as axes onto a bivariate chart. While few exotic species had both high utility and high locational flexibility values, most indigenous species did. These are species that have been used in agroforestry systems for many years (for example *Euphorbia tirucalli, Vernonia amygdalina* and *Erythrina abyssinica*). Some naturalized exotic species introduced in the 1930s (for example *Grevillea robustsa, Eucalyptus camaldulensis, E. saligna, E. maideni, Cupressus lusitanica* and *Persea gratissima*) were also appreciated for their multiple uses and their locational flexibility. Farm sizes vary, with an average of 1.27 ha among the tree-expert farmers and 0.18 ha among the control group. The average number of species cultivated was significantly higher on the tree-experts' farms, although the tree density was much lower there (731 trees per ha) than on the control farmers' land (1 689 trees per ha). Competitive species were found mainly on larger farms, while the smaller ones had more species with high UI and LFI values. The farmers showed well thought-out and reasoned choices of species, taking into account their utility and flexibility, as well as the availability of land.

207 **Diallo,T.S., Soumah, O.K. *et al.*** 1998. *Enquête composition des vergers de la moyenne Guinée.* Conakry, CIRAD-FLHOR, 36 pp.
In a concern to learn more about the fruit tree potential of central Guinea, a survey entitled Orchard Composition was carried out in May 1997 by research experts from the Citrus and Fruit Tree Programmes of the Guinean Agricultural Research Institute, with the aims of: (i) identifying fruit tree species with economic potential found in farmers' orchards, in order to draw conclusions for fruit diversification in the region; (ii) surveying and categorizing the major constraints on the progress and promotion of fruit tree cultivation in the region; and (iii) working out how much potential exists, with a view to forecasting trends and providing guidelines for forthcoming years.

208 **Dunn, W.W., Lynch, A.M. *et al.*** 1990. Surveying farmers' agroforestry plots: experiences in evaluating alley-cropping and tree border technologies in Western Kenya. *Agroforestry Systems,* 11: 141-173.
Evaluation of agroforestry plots on farms should provide further useful information for the design of improved agroforestry systems in research and development projects. Little such evaluation has been carried out, however, because of methodological problems in examining plots on farmland, which vary considerably, and difficulties in identifying the key variables for measurement. This paper describes a range of methods and tools used in evaluating alley-cropped plots and tree borders around cultivated fields established by farmers working with the Agroforestry Extension Project of CARE in western Kenya. Details of the design of surveys, sampling methods and implementation are discussed, and suggestions are made for agroforestry evaluations in other projects. A condensed version of the questionnaire used in the survey is given in the annexes.

209 **Dury, S., Vilcosqui, L. *et al.*** 1996. Durian trees (*Durio zibenthinus* Murr.) in Javanese home gardens: their importance in informal financial systems. *Agroforestry Systems,* 33: 215-230.
The place of Javanese agroforests or home gardens in household budgets is declining, following global development and the growing diversification of activities. A phenomenon of concentration can be observed, with only the richer households with more land now having home gardens. Even many of these households are having financial problems. One of the solutions to such constraints is that of pawning (*gadai*) trees from the home gardens. The cost of the loan corresponds to the production of the tree, which goes to the lender until the loan is repaid. Analysis of 80 oral *gadai* loan contracts involving durians (*Durio zibethinus* Murr.) indicates that the real cost of such loans is not excessively high compared with the costs of formal loans. It also appears that the purpose of the loan (consumption or investment) or the degree of relationship between the two parties to the transaction makes no difference to the prices and sizes of loans.

210 **Dwyer, J.F., Nowak, D.J. *et al.*** 2000. *Connecting people with ecosystems in the 21st century: an assessment of our nation's urban forests.* Gen. Technical Report PNW-GTR-490. Portland, Oreg., USA, Department of Agriculture, Forest Service, 483 pp.
Urban zones (towns, villages, etc.) cover 3.5% of the 48 states and contain over 75% of the population. Within these urban areas, about 3 800 million trees cover 27.1% of the land. On a broader scale, metropolitan zones (counties) cover 24.5% of the United States and contain 74 000 million trees, which cover 33.4% of these counties. Between 1950 and 1990, the metropolitan zones almost tripled in size, while urban zones have doubled in size over the past 20 to 25 years. This report is the first national assessment of the urban forest resources of the United States, and details are given by state, county and individual urban area. It shows local-level variations, the complexity of the resource, and how it has changed over the years. The report ends with a description of sectors for future investment in order to facilitate an integrated, flexible and sustainable management of urban forests and improve the quality of the environment and human health.

211 **Eshete, G. & Stahl, G.** 1998. Functions for multi-phase assessment of biomass in acacia woodlands of the Rift Valley of Ethiopia. *Forest Ecology and Management,* 105: 79-90.
This article describes the functions of individual trees in the biomass in acacia woodlands. The main aim here is to use these functions for multi-phase sampling, in order to assess the biomass of acacia woodlands in the Ethiopian Rift Valley.

212 **Etienne, M. & Auclair, D.** 1995. Modélisation de systèmes agroforestiers. In *Agriculteurs, Agricultures et Forêts,* p. 203-207. Meeting held in Paris, 12-13 December 1994. Paris, Antony, CEMAGREF.
This paper briefly summarizes a research programme funded by the European

Commission. After describing the general framework of the programme, which aims on the one hand at reducing intensive agricultural production, and on the other hand at increasing high-quality timber production, it discusses various aspects of model building. Biological mechanisms, especially interactions between agricultural and forestry components, are also described. Medium- and long-term consequences are forecast. Social and environmental aspects are also taken into account.

213 **Fresco, L.** 1984. *Approaches to the study of farming and cropping systems.* Wageningen, Netherlands, Agricultural University of Leeuwenborch, 33 pp.
This work describes the systems approaches that appeared between the late 1950s and the 1970s and that are still in use today. A large part is dedicated to describing the French and Belgian approaches to study of farming systems.

214 **Fuwape, J.A.** 1993. Charcoal and fuel value of agroforestry tree crops. *Agroforestry Systems,* 22: 175-179.
Wood charcoal is produced from a short rotation of the tropical species *Leucaena leucocephala* and *Tectona grandis*. Combustion-linked properties, moisture content and the percentage of carbon, hydrogen, oxygen, etc. and ash in wood and charcoal were determined for each of the species, as well as their combustion heat.

215 **Gladwin, C.H.** 1989. *Ethnographic decision tree modelling.* Sage Publications, 90 pp.
Econometric models explain how variables linked to households and farms affect the adoption of decisions. Decision tree modelling takes the perceptions used by farmers in deciding on a technology and examines them from another angle.

216 **Glen, W.M.** 1999. *Trees outside forests assessment in Sudan: a contribution to the Forest Resources Assessment 2000 report.* Rome, FAO, 14 pp. (unpublished). Internet: http://www.fao.org/forestry/fo/country/nav_world.jsp
This report examines studies concerned with trees outside forests in Sudan, providing quantitative field data as well as statistics available within the country.

217 **Godard, V.** 1991. *Utilisation conjointe de la télédétection de l'enquête de terrain lors des inventaires d'occupation du sol. Recherche méthodologique appliquée au Sahel Sud-mauritanien.* CIRAD, 441 pp.
This study adapts land cover analysis to a dry tropical natural environment through the combined use of remote sensing and field surveys in land cover inventories. The inventory method proposed is based on the principle of random circular plot sampling in the study area. The survey segments are all the same size, and they are divided up by a non-aligned systematic selection that can be described as systematic and random. Environmental observations are then carried out within the segments, with the aim of rationalizing the preparation and collection of satellite data as well as the production of land cover maps and statistics for dry zones. The areas falling into different categories of land cover are estimated, and the precision of these estimates is also estimated. These estimates are carried out with and without the input of satellite data, and the results are then compared. The contribution of remote sensing, produced by correcting estimates with the help of a regression estimator method, increases the precision of the estimates and the efficiency of the field survey.

218 **Godard, V., Dollé, V. *et al.*** 1990. Un outil de diagnostic rapide pour l'agriculture oasienne: mise au point méthodologique pour l'utilisation de données satellitaires SPOT dans la région de l'Assaba Maurtanien. *In* V. Dollé & G. Toutain, eds. *Les systèmes agricoles oasiens,* p. 91-102. Acts of a meeting held in Tozeur, Tunisia, 19-21 November 1988. Paris, CIHEAM.
This study reviews work undertaken to produce a diagnosis concerning oasis agriculture in the Kiffa (Asaba) region of Mauritania on the basis of SPOT remote sensing material from December 1987 and its numerical processing. A specific survey

methodology is tested for mapping land cover, in correlation with field work. Various oasis sites were identified and pinpointed in order to establish a correspondence between land cover and the representation of this cover on printed colour documents resulting from numerical processing. The first tests using high-resolution satellite imaging have given promising results, with the selected subjects being satisfactorily represented. Complementary tests carried out on the basis of images taken in February-March (off-season crops in oases and the end of grazing in neighbouring rangelands) will allow validation of the initial work and confirm the possibility of assessing cover in the palm grove, identifying date palm zones and hyphenae (or doum) palm zones. It would then perhaps be possible to make a quick estimate of the area of palm groves of different densities.

219 **Grewal, S.S., Mittal, S.P. *et al.*** 1992. Agroforestry systems for soil and water conservation and sustainable production from foothill areas of north India. *Agroforestry Systems,* 17: 183-191.
Conservation based on agroforestry systems has been developed for possible adoption in place of a high-risk agriculture on land capacity classes I to IV in buttress zones of 2 million ha in northern India (Punjab, Haryana and Himachal Pradesh). The field studies described in this paper were carried out in the 1980s and used a typical toposequence of four land capacity classes from the valley bottom to the top of the foothills on the Water and Soil Conservation Research Farm and the Chandigarh Training Institute in the state of Haryana. The sequence covered a horizontal distance of 900 m and a vertical distance of 117 m. Class I of the system (the irrigated valley bottom) was agrosilvohorticultural, combining *Leucaena leucocephala*, lemon (*Citrus auranti* [I] *folia*) and papaya (*Carica papaya*) in the upper storey, and *Curcuma domestica* (*C. longa*) and okra (*Abelmoschus esculentus*) in the understorey. The average sustainable net return is 17 006 rupees per ha per year (against 7 852 rupees for a double-crop agricultural system). Class II of the system (the lower terraces) is agrosilvicultural and consists of *L. leucocephala* var. K8 intercropped with maize (*Zea mays*), *Vigna Mungo* and *Cyamopsis te (t) ragonoloba*; the latter has given the highest net annual returns (3 540 rupees per ha). Class III of the system (the middle terraces) is silvopastoral, with *Eucalyptus tereticornis* and *Eulaliopsis binata* in the understorey. After four years (1985-1988), the average annual above-ground dry grass yield is 4.2 for the October cutting (used for paper paste) and 1.19 for the June cutting (used for fodder). The annual net returns from the grass component is 4 672 rupees per ha. Class IV of the system (marginal sloping ground) is also silvopastoral and is made up of bhabbar grass under five drought-resistant species of acacia. Grass yields and net returns are highest under *A. senegal* and fall under the other four species in descending order: *A. tortilis, A. modesta, A. suma* and *A. lenticularis*. The average annual grass yield and net returns (after six years, all species) are 3.9 and 2 402 rupees per ha respectively. All four of the agroforestry systems described are better than traditional farming systems in each land capacity class.

220 **Lund, G.H.** 2000. Off-in, in-out: concepts for inventorying trees off-forest. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 1-20. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
Data concerning trees outside forests are inadequate for Africa. Inventories of this resource must be made with forestry and agricultural inventories if they are to be economically viable. In most areas, a systematic sampling is the simplest type of inventory to implement. If mapping and remote sensing data are available, a multiphase sampling could bring greater precision. Permanent plots are recommended for measuring growth and trends. Species, heights and crown and stem diameters are most often used in biomass equations.

221 **Hasenauer, H.** 1997. Dimensional relationships of open-grown trees in Austria.

Forest Ecology and Management, 96: 197-206.
This article studies the breadth of crowns, the diameter at breast height, the height of the base of the crown, and the conicity of trees without competition from other trees throughout their lives. Such trees represent the empirical maximum for tree dimensions, and this can be used to work out management guidelines and construct models of the competition and closedness of tree cover.

222 **Herzog, F. & Gotsch, N.** 1998. Assessing the sustainability of smallholder tree crop production in the tropics: a methodological outline. *Journal of Sustainable Agriculture,* 11: 13-37.
Tropical trees are planted on commercial plantations or smallholdings. This article describes a method for assessing the sustainability of smallholder cocoa production in West Africa, proposing a procedure to evaluate the hypothesis that cocoa plantations under shade and less intensively cultivated are more sustainable than non-shaded and more intensive ones. The approach is based on environmental, economic and social indicators of sustainability and takes account of the demands of experimental design to allow statistical evaluation. The research is structured according to several research hypotheses: assessment of sustainability in time and space; and the survey design (sampling, data collection, data analysis and institutional set-up).

223 **Morales-Hidalgo, D. & Kleinn, C.** 2000. *Arboles fuera de bosque en Costa Rica. Trees outside of forest: the case of Costa Rica.* Costa Rice & Rome, CATIE & FAO, 20 pp. (unpublished). Internet: http://www.fao.org/forestry/for/country/nav_world.jsp
This report gives an overview and appraisal of studies regarding trees outside forests in Costa Rica, providing quantitative field data, as well as statistics existing within the country.

224 **Holmgren, P., Masakha, E. *et al.*** 1994. Not all African land is being degraded: a recent survey of trees on farms in Kenya reveals rapidly increasing forest resources. *Ambio,* 23: 390-395.
This article gives the results of a woody biomass survey on farmland in Kenya, which is part of the FINNIDA Kenya Forestry Master Plan Project. The survey covered 10 million ha of high-potential land (20% of the country) inhabited by 80% of the country's population. A two-phase sampling was made, the first phase based on low-altitude aerial photographs following a systematic grid, and the second on field measurements of a subsample. Woody biomass was classified as planted (hedges, demarcation planting and woodlots), riparian (degraded and undegraded) or natural woodland. Contrary to widespread belief, the survey discovered a rapid increase in planted woody biomass between 1986 and 1992, with an estimated annual increase of 4.7%, the dominant planted species being eucalyptus. The survey also showed that wood on cultivated land can become a major source of raw material for the timber industry, since the volume is greater than that found in conventional forests. The previous conclusions, i.e. that population density is positively correlated to the volume of planted woody biomass, were confirmed by the results of a high correlation survey (r2=0.64) on the district level. The results indicate that pessimistic views regarding the extension of land use in Kenya are unjustified. Instead of an increase in the shortfall in fuelwood and a degradation of land following rapid population growth, Kenyan farmers seem to be applying wise and sustainable management practices, including the planting of trees. It is suggested that the tenure system—most farmland in Kenya is privately owned—is a major factor in this recent development.

225 **Ichaou, A.** 1993. *Synthèse bibliographique des inventaires de ressources ligneuses réalisés dans les terroirs agricoles de la zone SDAN.* Niamey, Projet Energie II.
This document is a summary of wood resource inventory work carried out on agricultural land in the SDAN zone. The study is based on the sparse documentary sources and on interviews with researchers and field workers in the study

zone. It helps in assessing forestry potential in terms of the fuelwood used by rural inhabitants, and aims at producing an estimate of the area of cultivated land involved and at gaining an overall picture of the productivity of this wooded resource.

226 **Ichaou, A.** 1998. *Contribution à l'étude de la végétation contractée des plateaux le long d'un gradient pluviométrique et latitudinal de la zone ouest du Niger.* Ouagadougou, Université de Ouagadougou & ORSTOM, 126 pp.
Using a combination of remote sensing and mapping as a background in studying the contracted vegetation known as striped bush on lateritic uplands, the idea of its origin as linked exclusively to the uni-directional flow of runoff is not enough to explain the existence of a contracted structure. The study highlights consideration of the nature of the substratum in terms of both geology and soil science. This form of contracted vegetation is a far from fragile ecosystem, representing a natural balance attained by nature. The hydrology of these systems concentrates the little rain that falls towards clearly defined production sites for woody and grassy species, which reach a level comparable to, or even better than those in zones where the vegetation is uniformly distributed. These highland ecosystems thus represent landholding, pastoral and forestry reserves for the Sahelian inhabitants of towns and countryside, and better knowledge of them is needed with a view to correct long-term management.

227 **Jacqueminet, C.** 1990. Caractérisation quantitative de l'organisation spatiale des aires de ligneux en milieu sahélien à partir des images satellitaires SPOT. *In* M. Pouget, C. Mering & H. Andrianasolo, eds. *Images satellite et milieux terrestres en régions arides et tropicales. Journées Télédétection,* p. 213-224. Bondy, France, 13-17 November 1988. Paris, ORSTOM.
This study analyses the dynamics of plant cover in a Sahelian environment, making use of a quantifiable indicator that can be picked out on satellite images: the spatial distribution of woody species. The idea underlying this research, which is above all methodological, is based on observed changes in plant cover in a Sahelian dune environment over the past thirty years.

228 **Jacqueminet, C.** 1992. *Analyse de la structure spatiale du couvert ligneux en milieu sahélien sur images satellitaires SPOT: étude appliquée au secteur dunaire d'Oursi au Burkina-Faso et au Ferlo sableux du Sénégal.* Paris, Ecole des Hautes Etudes en Sciences Sociales, 227 pp.
This study was made in the framework of the programme concerning fragile Sahelian zones and had the aims of (i) defining a medium-term indicator of the state and changes in Sahelian environments, which should be perceptible and quantifiable on satellite images, and (ii) developing a reproducible method of using satellite data in order to monitor Sahelian environments in space and time. The combined analysis of the distribution of the woody cover and of landscape units was carried out on the basis of SPOT images and field data for the dune area of Oursi in Burkina Faso and the sandy Ferlo area in Senegal. It led to development of a method using both radiometric and morphological data from satellite images. Identification of the distribution of woody cover on SPOT images, with the help of morphological indices, showed the variety of ways woody species are distributed in different dune environments. This variation in structures is closely related to differences in the topography, soil and water of the environments occupied by woody species.

229 **Jewell, N.** 1995. The use of Landsat TM data for estimating the area of "home gardens". *Sri Lanka Forester,* 79-86.
This application of Landsat thematic mapping (TM) data was urged by the pressing need of the Sri Lankan 1995 Silviculture Masterplan to update information on the area occupied by trees outside forests, a sector in which home gardens—a highly developed agroforestry system incorporating crops and forest trees—play a major role. The area of these gardens was estimated by using a combination of image classification and visual interpretation

techniques. While image classification is a very quick way of extracting information and is hence appropriate when information is needed in a hurry, it is unsatisfactory for obtaining a good distinction between types of forest. The trial described in this document showed that greater precision can be obtained for a simple classification of ground cover as "forest" and "non-forest". This broad classification is made by subsuming the large number of land use classes identified on the satellite image into one of these two categories. Home gardens are then placed under "forest", and their area can then be discovered by taking the total "forest" figure and subtracting estimates from 1992 satellite images of natural, sparse and planted forest, as well as estimates from the recent departmental survey of rubber, coconut and other cultivated trees.

230 **Jim, C.Y.** 1989. Tree-canopy characteristics and urban development in Hong Kong. *Geographical review,* 79: 210-225.
This study examines tree cover in the context of urban growth in Hong Kong, and its classification according to geometric criteria of massiveness, connectivity and closeness. Three main types were distinguished on the basis of these three variables: isolated, linear and grouped. Their uneven distribution shows a predominance of small, sparse, disjointed patches of tree cover. A concerted effort seems to be needed in order to improve the quality of the urban landscape.

231 **Joffre, R. & Lacaze, B.** 1993. Estimating tree density in oak savanna-like "dehesa" of southern Spain from SPOT data. *International Journal of Remote Sensing,* 14: 685-597.
The main aim of this study was to establish a method for estimating tree densities in savannah-type vegetation systems by using the highest possible spatial resolution on the basis of satellite data (SPOT-1 panchromatic = 10 m resolution), on the hypothesis that for trees scattered on grassy cover, spatial filters can provide a direct mapping of the tree cover. This study was carried out in *dehesa* systems—woodland in southern Spain marked by the presence of oaks.

232 **Joffre, R. & Rambal, S.** 1993. How tree cover influences the water balance of Mediterranean rangeland. *Ecology,* 74: 570-582.
The *dehesa* ecosystems in the southwest of the Iberian peninsula are considered a type of savannah grassland and are dominated by scattered evergreen oaks. This article presents the results of a study on how these isolated trees affect the water balance of these ecosystems, as well as the implications for models that assume that soil water resources are always the same.

233 **Kaire, M.** 1996. Production ligneuse des jachères et son utilisation par l'homme en zones soudanienne et soudano-sahélienne du Sénégal. In *La Jachère, Lieu de production,* p. 1-8. Meeting held at Bobo Dioulasso, Burkina Faso, 2-4 October 1996. Bobo Dioulasso, Burkina Faso, CNRT.
This study focuses on the wood production of fallows and its uses in Sudanian and Sudano-Sahelian zones. The aim is to assess the woody biomass production level of fallows and the fallow period needed for an optimal production, taking account of the present uses of this resource. It also seeks to determine how human pressure has affected the woodland on these fallows.

234 **Kiepe, P.** 1995. *No runoff, no soil loss: soil and water conservation in hedgerow barrier systems.* Wageningen, Netherlands, Agricultural University of Wageningen, 156 pp.
This work is based on a doctoral thesis for Wageningen University, which developed a soil loss and runoff model for hedgerow barrier systems, based on data from the ICRAF Machakos field station in Kenya, where measurements were taken on *Cassia siamea* hedgerow systems (alley cropping) between 1987 and 1992. Chapters 1 to 5 and 7 to 8 of the paper describe the system, representing and discussing the collected data. The barriers constituted by hedges control water erosion thanks to the presence of trees and an increase in infiltration beneath the hedges. The infiltration rate below hedges is

three to eight times greater than in the alleys where crops are grown. Measurements of the water content of the soil in hedgerow systems indicate that water penetrates the soil beneath the hedges to a greater depth than soil beneath the alleys and on the control plot. An analytical framework is given in Chapter 6 to calculate the impact of hedges and mulch on infiltration, runoff and soil loss. The framework was extended with algorhythms in order to calculate the impact of hedges of varying thicknesses and in one to four lines. It was applied on a seasonal basis, and the forecasts were satisfactory. A dynamic simulation model known as SHIELD (Simulation of Hedgerow Intervention against Erosion and Land Degradation) was developed, and was used to explain experimental observations concerning runoff, soil loss and crop yields, using daily measurements. This is described in Chapter 9. The application of the model (Chapter 10) shows the importance of the conditions of soil dynamics and of plants connected with soil loss, and demonstrates that SHIELD can be used to calculate the maximum distance between hedgerows while keeping soil loss within acceptable levels.

235 **Kiyiapi, J.L.** 2000. Tree resources assessment, anthropogenic influences and monitoring strategies in medium to low agricultural areas: some examples from Tharaka Central and Transmara Districts, Kenya. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 22-43. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
In low-intensity agricultural zones in Kenya, the predominant land use is pastoralism and small-scale subsistence agriculture. The landscape is composed of a mosaic of isolated trees, clumps of trees and a remaining complex natural vegetation. Assessment of resources must take this complexity into account, combining a forest inventory with simple participatory methods. The transect sampling technique seems the most effective when trees are scattered. Assessment of trees outside forests must take into account the continuum of different uses of woodland, ranging from farms to the edges of forests.

236 **Kleinn, C.** 1999. *Compilation of information on trees outside the forest: a contribution to the forest resource assessment 2000-FAO. Regional study for Latin America (including also Haiti).* In collaboration with C.G. Baker, D. Bolivar, J. Botero, L. Girón, J. Morales, R. Muschler, C. Schneider, C. Soihed & A. Skorupa. Costa Rica & Rome, CATIE & FAO, 89 pp. + 7 annexes (unpublished).
This report summarizes and synthesizes information collected by different countries in Latin America—Brazil, Colombia, Costa Rica, Guatemala, Haiti, Honduras and Peru. It gives various types of classification and definition, together with available statistics on trees outside forests in these countries.

237 **Kleinn, C.** 2000. On large-area inventory and assessment of trees outside forests. *Unasylva,* 51(1): 3-10.
This article first seeks to define and classify the resource to be inventoried, then focuses on an inventory and assessment of trees outside forests. It concentrates on inventories made of large areas, and particularly on the different forms of survey possible, offering some examples and experiences from Latin America.

238 **Kleinn, C.** 2000. Tree resources outside the forest in Central America: a regional assessment approach based on remote sensing and field survey. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 44-53. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This paper describes the structure and relevance of a project to develop an assessment and mapping method for trees outside forests in Central America. The research methods used are also described, and the initial experiences discussed. The method chosen is a combination of remote sensing and sampling. The main aim of the project is to identify an optimal use and combination of

these information sources, together with an adequate presentation in a geographical information system.

239 **Kojwang, H.O. & Chakanga, M.** 1999. *Trees outside forests assessment in Namibia: a contribution to the forest resources assessment 2000 report*. Windhoek, Namibia & Rome, Ministry of Environment and Tourism & FAO, 30 pp. (unpublished). Internet: http://www.fao.org/forestry/for/country/nav_world.jsp
In this report on trees outside forests in Namibia, the authors offer a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review.

240 **Kumar, B., George, S. *et al.*** 1994. Diversity, structure and standing stock of wood in the homegardens of Kerala in peninsular India. *Agroforestry Systems,* 25: 243-262.
A survey was carried out in 17 selected sub-districts in the state of Kerala to discover the floristic structure and composition of home gardens and to measure the similarities and diversities in their composition, with particular reference to their size—small (under 0.4 ha), medium (0.4 to 2 ha) and large (over 2 ha). The potential of home gardens to supply commercial timber and fuelwood was also assessed. About 250 farmers were chosen through a stratified random process. Apart from the collection of general information on agricultural and livestock farms, all the scattered trees and shrubs (with a diameter at breast height of at least 15 cm) on the farm, as well as demarcation trees (apart from palms and rubber trees) were recorded. There were differences in the numbers of trees and shrubs and in species on the farms chosen in the different sub-districts. All the various size categories also showed major variations in the number of woody species and individuals found. In all, 127 woody species with a DBH of at least 15 cm were found. The average number of woody species found in home gardens ranged from 11 to 39. The floristic diversity was greatest on small plots and fell in larger ones. The main Simpson diversity index for plots ranged from 0.251 to 0.739, suggesting that floristic diversity is moderate to low (compared with a value of over 0.9 for species-rich evergreen forests in the Western Ghats). The Sorensen similarity index suggested a moderate to high degree of similarity for the different tree species found. Trees and shrubs were scattered all over home gardens or around their edges. Farmers tend to prefer trees for construction timber, such as tree of heaven or Chinese sumac (*Ailanthus triphysa*, the most frequently found) and teak (*Tectona grandis*), and fruit trees such as mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyullus*) and cashew (*Anacardium occidentale*). The main home garden species is found in every class of diameter. So far as diameter is concerned, however, there was a slight bias (+) in the distribution model, with the highest frequency in the 20 to 30 cm classes, thus assuring an adequate regeneration status and making home gardens a sustainable and dynamic land-use system. The average permanent commercial standing stock for construction timber in home gardens ranged from 6.6 to 50.8 m^3/ha, while the volume of fuelwood ranged from 23 to 86 m^3/ha. The fact implicitly shown by these large volumes is that a substantial proportion of society's wood demands is met from home gardens. However, palms constitute the dominant component of commercial construction timber and fuelwood—63% and 72% respectively of the total wood in these categories.

241 **Lachenaud, P.** 1988. La plantation en haies fruitières: une technique permettant l'association avec les cultures vivrières et leur stabilisation. In: *Conférence Internationale sur la Recherche Cacaoyère. 10,* p. 45-50. Santo Domingo, 17-23 May 1987. Lagos, Cocoa Producers' Alliance.
An intercropping trial was set up in 1980 at the Divo station in Côte d'Ivoire, combining cocoa trees and food crops within fruit hedges, with the following experimental lay-out: 3 lines of cocoa trees, 10 x 1 m (A); 3 double lines of cocoa trees (2 m + 8 m) x 2 m (B); 3

lines of cocoa trees (10 x 2 m) x 2 m(C); control plot 3 x 2.5 m (T). The cocoa trees were Upper-Amazonian, and various food crops were planted between them. The first two harvests showed no significant difference between plots, but in the third harvest, A, B and T produced more healthy pods than C. The food plants showed no incompatibility with the cocoa trees. Soil analysis after four years showed a significant impoverishment in phosphorus between the lines in the space intended for food crops, and this would have to be compensated for with a mineral fertilizer.

242 **Lamers, J., Michels, K. *et al.*** 1994. Trees and windbreaks in the Sahel: establishment, growth, nutritive and calorific values. *Agroforestry Systems,* 26: 171-184.
Tree species for windbreaks in the southern Sahelian zone of West Africa were assessed according to a number of criteria: rapid establishment, effectiveness, fodder production for livestock, and fuelwood production. Trials were carried out in Niger between 1988 and 1993 to assess these criteria for seven species used in planting windbreaks. This article gives details of these trials and their results.

243 **Laverne, R.J. & Lewis, G.M.** 1996. The effect of vegetation on residential energy use in Ann Arbor, Michigan. *Journal of Arboriculture,* 22: 234-243.
Computer models have shown that the appropriate placing of trees around buildings can make a significant contribution to energy savings through a cooling effect in the summer months and a heating effect in winter. A study carried out in a residential neighbourhood of Ann Arbor, Michigan, used the statistics of the electricity and natural gas companies to examine the energy demands of homes in three sectors with very different tree densities. Field measurements assessed the density of vegetation that provides direct shade for the buildings, and aerial photographs were interpreted to assess the potential protective effect of vegetation against wind and adjacent buildings. Statistical analysis of the data showed that the effectiveness of air conditions and the variability of structures, including the level of insulation, masks the effects of the vegetation on energy consumption. Analysis is complicated by the wide variety of energy consumption habits of individual owners. Nevertheless, the trends discerned suggest that the appropriate placing of trees, with regard to gains in sunlight depending on the season and the direction of winds, can bring substantial savings in energy.

244 **Mary, F. & Besse, F.** 1996. *Guide d'aide à la décision en agroforesterie,* vol. 1. Paris, 301 pp.
This volume provides an overview, giving methodological pointers, both on problems specific to the intercropping of trees with crops, and on the organization of nurseries or the design and participatory implementation of projects with the rural population. It gives an overview of agroforestry and its uses, and follows the progress of an agroforestry intervention, from diagnosis, through the choice of methods and the production of plant material, to evaluation. It also examines the main methodological approaches used in agroforestry, as well as the links between agroforestry and research.

245 **Mary, F. & Besse, F.** 1996. *Guide d'aide à la décision en agroforesterie,* vol. 2, *Fiches techniques*. Paris, 284 pp.
This volume is composed of technical instruction notes on agroforestry, giving practical, operational form to the technical and methodological information found in volume 1 on the design and implementation of agroforestry programmes and projects. The instruction notes explain the main techniques for collecting the data needed to draw up a diagnosis, specifications or an assessment. They also describe the tools for implementing a project, from organization to management and from communication to the choice of species.

246 **McGregor, J.** 1994. Woodland pattern and structure in a peasant farming area of Zimbabwe: ecological determinants and present and past use. *Forest Ecology and Management,* 63: 97-133.

The distribution of woody species and the structure of *miombos* were studied in a deforested agricultural area of central Zimbabwe (Ward 2, Shurugwi), and the plant ecology was examined in relation to the past use of this wooded region. The area is classified as moist dystrophic savannah, with an average annual rainfall of 675 mm and soils of granite or dolerite origin. Data on the specific composition, land area, height and features of the woody vegetation are given for 11 different landscape zones (divided on the basis of soil type, proximity to villages or water sources, and geology). The nature and degree of disturbance caused by the extraction of fuelwood and construction timber are evaluated. Fruit trees, other trees with cultural functions, and species that rapidly invade modified ground (these last may be extremely productive in terms of woody biomass) tend to dominate wooded regions in arable sectors close to villages. Grasslands occupy the main wooded areas in the sector under study. On deeper soils that have been cultivated in the past, an open wooded formation remains, which has had a tendency to be dominated by coppices of *Brachystegia spiciformis* and *Combretum molle* (both of which are also predominant in the less modified *miombos*). On rocky soils that have not been deforested in the past, coppices also dominate through climax species. Woody vegetation on *kopjes* and along streams is less disturbed in terms of distribution, species composition, density and height, than in wooded zones in other parts of the landscape. It is shown that the spatial model and the nature of felling vary depending on land-use category, species and the dimension of individual stems. The *miombos* show a relatively high degree of stability in species composition under the disturbance caused by felling: of the 94 species included in the analysis, relatively few are significantly associated with a particular soil type or a particular land-use category.

247 **Mehl, C.B.** 1991. *Trees and farms in Asia: an analysis of farm and village forest use practices in south and southeast Asia.* Arlington, USA, Winrock International Institute for Agricultural Development, 82 pp.

This report analyses the forestry practices of farms and villages in six countries in South and Southeast Asia—Bangladesh, Indonesia, Nepal, Philippines, Sri Lanka and Thailand—and studies the use of tree products from farms of different sizes. At least 50 households in 26 villages, including landless families, were surveyed. Four general trends were found: (i) farm size affects the way a household uses tree products; for example, households on medium and large farms use these products as a primary source of fodder more often than those on small farms; the latter use State-owned forests as a major source of fuelwood more often than the others, while charcoal is used more by households on large farms; households on medium and large farms are more similar to one another and use wood regularly; (ii) although the extension of government facilities contributes to agroforestry practices, socio-economic and other factors are also important; (iii) the most common place for cultivating trees is the garden, while the second most common source of wood is trees scattered among crops; and (iv) trees provide food in general, and fruit trees are the most popular, especially multipurpose trees, whatever the size of farm.

248 **M'Hirit, O. & Et-Tobi, M.** 2000. *Evaluation des arbres hors forêt au Maroc. Une contribution au rapport sur l'évaluation des ressources forestières 2000.* Ecole nationale forestière d'ingénieurs & Rome, FAO, 29 pp. + annexes (unpublished). Summarized in *Les arbres hors forêt—Vers une meilleure prise en compte.* FAO Conservation Guide. Rome, FAO, 6 pp. (in press).

The authors of this report on trees outside forests in Morocco offer a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review. The report also contains a detailed study of the carob (*Ceratonia siliqua* L.), a multipurpose forest fruit species.

249 **Moyo, S.** 1999. *Trees outside forests. Zimbabwe country report.* EC-FAO

Partnership Programme (1998-2000), Project GCP/INT/679/EC. Rome, FAO, 35 pp. (unpublished).
In this report on trees outside forests in Zimbabwe, the author offers a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review.

250 **Mussak, M.F. & Laarman, J.G.** 1989. Farmers' production of timber trees in the cacao-coffee region of coastal Ecuador. *Agroforestry Systems,* 9: 155-170.
The coastal region of Ecuador produces considerable quantities of coffee and cocoa. The farms and ranches in the region also produce industrial timber for sawmills, with most of the timber coming from shade trees and trees on rangeland. Since little is known about the supplies of timber from these farms, a survey was carried out, taking a sample of 122 farmers in different subregions. The results show an abundance of land suitable for planting trees and an excellent regeneration of many species on most farms. Despite this, present tree stocks are well below the potential, and less than half the farmers interviewed manage trees with timber sales in view. Only 2.2% of farm income comes from the sale of timber, although over half those interviewed had sold trees to industrial purchasers at least once. The constraints on the production and sale of trees include the risk of damage to the coffee or cocoa, the belief of incompatibility with present farming practices, inadequate classification methods, the low price of trees, and, lastly, insufficient knowledge of the industrial uses of trees by developers. These limitations should be countered by a research, development and information strategy on selected demonstration farms.

251 **Ndione, P.D.** 1999. *Estimation et évaluation des arbres hors forêts: première partie de la contribution au projet FRA 2000 et à l'identification des thèmes. Etude spéciale pour la région soudano-sahélienne: cas du Sénégal.* Dakar & Rome, Direction des eaux et forêts & FAO, 107 pp. (unpublished).
This document summarizes knowledge on trees outside forests in Senegal, defining this resource and discussing its roles and functions, as well as the management methods adopted. Evaluation methods are also suggested.

252 **Nguyen, H., Lachenaud, P. *et al.*** 1997. *Cartographie analytique et statistique des vergers cacao et café de deux zones pilotes Daloa et Soubré de Côte d'Ivoire.* Montpellier, France, CIRAD, 60 pp.
This study seeks to determine the environmental and human factors affecting coffee and cocoa yields in Côte d'Ivoire. It presents the results within a geographical information system (GIS) in order to show the causes and effects obtained on the plots surveyed. The field study and the established GIS show that in the Daloa pilot zone, cocoa and coffee yields are linked to the condition and upkeep of the plantation. The cocoa trees from hybrid plant material have a considerably higher yield than those from *amelonado* material. In the case of coffee bushes, shade has a negative effect on yields. In the Soubré zone, cocoa and coffee yields are closely linked not only to condition, upkeep and plant material, but also to the amount of insect damage and shade. This information and satellite image processing should show how yield levels can be classified, together with the corresponding inputs.

253 **Nihero, D.A.** 1999. *A study on trees outside forests in Malawi.* EC-FAO Partnership Programme (1998-2000), Project GCP/INT/679/EC. Rome, FAO, 36 pp.
In this report on trees outside forests in Malawi, the author offers a country-wide review of this resource, together with data based on field observations and a bibliographical review. He also attempts to define this term and other terminology used with it, and suggests classification systems for trees outside forests.

254 **Njuguna, P.M., Holding, C. *et al.*** 2000. On-farm woody biomass survey (1993 and 1998):

a case study from Nakuru and Nyandarua districts in Kenya. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 54-77. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This document describes woody biomass survey activities undertaken in 1993, 1996 and 1998 in two districts of Kenya. The 1993 inventory used aerial photographs and field inventories, in which all the trees were counted, in order to provide a basis for assessment of the tree cover on 62 farms in the two districts. In 1995, the Kenyan Forestry Plan estimated that 65% of the total timber produced in the high- and medium-potential districts came from farms, and planned to increase this to 80% by 2020. The 1996 inventory was thus carried out on the same farms, and it gave encouraging results regarding the increased tree potential in these areas.

255 **Nowak, D.J. & McPherson, E.G.** 1993. Quantifying the impact of trees: the Chicago Urban Forest Climate Project. *Unasylva,* 44(2): 39-44.
This article describes the methods and first results of a research project on urban forestry set up in Chicago, Illinois. It examines the interdependent functions of the urban forestry ecosystem now under study—climate change, energy savings, air quality and carbon dioxide retention—and analyses the costs and advantages of urban vegetation.

256 **Oladokun, M.A.O. & Egbe, N.E.** 1990. Yields of cocoa/kola intercrops in Nigeria. *Agroforestry Systems,* 10: 153-160.
The yields from two intercropped cocoa/kola plots at the Cocoa Research Institute were compared with those from two monocropped plots, one under cocoa and the other under kola. A monocropped plot of 1.75 ha gave the same yield (in kg/ha) as 1 ha of mixed crops. The cocoa trees fruit earlier than the kolas and continue to produce each year. Intercropping cocoa and kola is practical and economically attractive.

257 **Olsson, K.** 1985. *Remote sensing for fuelwood resources and land degradation studies in Kordofan, the Sudan.* Lund, Sweden, Royal University of Lund, 182 pp.
The Monitoring Wood Resources and Land Degradation in Kordofan, Sudan, Project was launched by the Physical Geography Department of Lund University in 1981/1982. One of the aims was to develop a methodology, based mainly on remote sensing, to estimate the volume of woody biomass in arid and semi-arid environments. A second aim was to study the fuelwood consumption model in the study zone in order to relate it to the desertification process. Knowledge of the history of the landscape is needed in order to understand its contemporary state, so this aspect was also included in the study. The results indicate that canopy cover and woody biomass can be linked to Landsat multispectral scanner system (MSS) data in a given physical environment. No serious fuelwood supply problem appears to exist, although the situation in certain zones seems to be deteriorating, with shortfall pockets being indicated, especially around villages. The most serious treatment for woody vegetation seems to be a reduction in the crop/fallow cycle, which can create problems by increasing wind erosion and decreasing soil fertility.

258 **Onana, J.** 1995. Les ligneux fourragers du Nord-Cameroun. I. Inventaire et phénologie. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux,* 48: 213-219.
About 60 woody species have been recorded in the savannah of northern Cameroon as playing a part in the food of domestic ruminants. The phenology of some of these species was monitored for four years both on natural rangelands and on plantations. The study showed that the trees and shrubs most widely used are, in order of preference: *Ficus sycomorus, Daniellia oliveri* and *Afzelia africana* for their leaves, and *Acacia albida, Dichrostachys cinerea* and *Prosopis africana* for their fruit. The flowers of *Daniellia oliveri, Pterocarpus erinaceus* and *Bombax costatum* are also widely appreciated. *Ficus sycomorus, Pericopsis laxiflora, Daniellia oliveri* and

Detarium microcarpus also have a phenology in the natural environment compatible with optimal use of their leaves during the lean period.

259 **Pandey, D.N.** 2000. *Ethnoforestry and trees outside forests in India.* INEF Occasional Paper. Bhopal, India, Indian Institute of Forest Management.
This study seeks to assess officially designated trees outside forests in India. The study reveals a total of 18 397 120 000 trees, covering the equivalent of 22 980 000 ha, of 7% of the land area of the country. It would cost 427 542 900 000 rupees, or $US 6 607 700 000, to plant 22 980 000 ha at current reforestation costs. This is thus the present minimum value of trees outside forests in the country.

260 **Pauleit, S. & Duhme, F.** 2000. GIS assessment on Munich's urban forest structure for urban planning. *Journal of Arboriculture*, 26.
A geographical information system (GIS) was developed and applied in order to assess the spatial model and environmental functions of Munich's urban forest. Urban land types were defined as spatial units, distinguished by such physical and land-use attributes as percentage cover by construction and vegetation. Urban forests are described on the basis of the cover provided by trees and shrubs and their maximal age. The survey is coupled with statistical databases and environmental data such as those from habitat surveys and thermal infrared photography. Trees and shrubs cover approximately 5 400 ha, or 18% of Munich's total area. The spatial model of the urban forest was closely linked to the division into land-use zones and the density of the buildings. The relationship between cover, size and age of the woody vegetation and the presence of birds as indicators of wooded regions was used to assess the role of the urban forest in nature conservation. Moreover, it was shown that the urban forest can effectively reduce temperatures during warm summer days. Specific urban silviculture programmes are proposed, which would increase forest cover to 22% of the city's area. An estimate of the overall costs of establishing further forested zones is given.

261 **Peltier, R., Lawali, E.M.** ***et al.*** 1994. Aménagement villageois des brousses tachetées au Niger. 1ère partie: le milieu: potential et contraintes. *Bois et Forêts des Tropiques,* 242: 59-76.
The city of Niamey depends on wood for 95% of its domestic energy supply. This represents about 150 000 metric tons of wood per year at present, while the production of forests in the region is estimated at 300 000 metric tons per year. It appears that these forests would be capable of covering annual urban and rural needs if the pressure of felling were properly distributed (whereas it is at present concentrated around the capital) and if forestry management assured renewal of the resource. The "offer component" of the Energy II Project hopes to contribute to the development of 250 000 ha of bushland in ten years, with the support of other projects. Between 1991 and 1992 the Say district development team thus chose nine villages that wanted to develop a sector of uplands of about 10 000 ha, located around the village of Tientiergou. The authors describe how the region functions in socio-economic terms (including agricultural and pastoral practices), the ecology of striped and leopard bush, and the failures and successes of the first forestry development trials carried out in the country. With the help of a forestry and pastoral inventory, they try to work out the potential of the zone and the reaction of the environment to felling combined with grazing.

262 **Penot, E. & Wibawa, G.** 1997. Complex rubber agroforestry systems in Indonesia: an alternative to low productivity of jungle rubber conserving agroforestry practices and benefits. In *Symposium on Farming System Aspects of the Cultivation of Natural Rubber,* p. 56-80. Beruwala, Sri Lanka, 6 November 1996. Brickendonbury, IRRDB.
The major constraint for the agroforestry system known as jungle rubber, which is an indigenous alternative to shifting cultivation, is its low productivity. Rubber-based agroforestry systems tested in the framework

of the project are based on the use of improved genetic material (clones). A low to medium level of inputs and labour are features of these systems. A preliminary cost-benefit analysis of rubber-based agroforestry techniques was carried out in comparison with jungle rubber and with the monocropping system advocated by the TCSDP (a World Bank project), taking labour productivity into account. This analysis gives an idea of the improvement in economic results brought about by using clones. Rubber-based agroforestry systems, which show a good labour productivity for a limited initial investment, are particularly suitable for planters with little money available.

263 **Pointereau, P.** 1996. Le bois-énergie dans les exploitations agricoles en région Midi-Pyrénées. *In* G. Balent, ed. *La forêt paysanne dans l'espace rural: biodiversité, paysages, produits,* p. 229-243. Etudes et Recherches sur les Systèmes Agraires et le Développement No. 29. Paris, INRA.
Precise information on fuelwood flows in France is hard to come by because declared sales represent only a small part of the volume actually consumed. This difficulty can be overcome by using a number of surveys and cross-checking them. This document describes the results of such surveys carried out in the Midi-Pyrénées region.

264 **Price, C.** 1995. Economic evaluation of financial and non-financial costs and benefits in agroforestry development and the value of sustainability. *Agroforestry Systems,* 30: 75-86.
Financial apparisal of agroforestry is not different in kind from appraisals applied to pure forestry. Existing techniques for valuing non-market effects may also be applied. Effects on hydrological and carbon fluxes might be less favourable than those of pure forests. In the confusing field of biodiversity valuation too, only limited and specific claims can be made for agroforestry. Amenity valuation techniques developed for trees and woodlands encounter additional problems of interpretation in an agroforestry context. Agroforestry may offer a quantifiable value in short-term sustainability, and might meet recent economic definitions of long-term sustainable development, without encountering the full dangers to future generations embodied in conversion of natural to human capital.

265 **Raintree, J.B.** 1987. *D&D user's manual: an introduction to agroforestry diagnosis and design.* Nairobi, ICRAF, 110 pp.
This work is a new overview of the procedures involved in practical applications of the diagnosis and design (D&D) method. The elementary concepts are described in the first section of the work, together with the main lines of the D&D method. More detailed suggestions are then given on procedures to be followed in national research programmes. The following section examines case studies, while the final section deals with the use of this method in national agroforestry research programmes.

266 **Rao, M.R., Sharma, M.M. *et al.*** 1991. A tree/crop interface design and its use for evaluating the potential of hedgerow intercropping. *Agroforestry Systems,* 13: 143-158.
This article describes a tree/crop interface (TCI) experiment undertaken at the ICRISAT Center at Patancheru in India, designed to examine the effects of the orientation of lines of *Leucaena leucocephala*. Each TCI plot consisted of regularly pruned *L. leucocephala* hedges in the centre, with 12 rows of crops on each side. Eight plots were set up, arranged at 45º around a single plot of *L. leucocephala* with rows oriented in four directions: North-South, East-West, Northeast-Southwest and Northwest-Southeast. Either sorghum or sunflower was grown as an annual crop. The *L. leucocephala* was first pruned five months after planting (at a height of 0.75 m) and then whenever the regrowth reached 1.5 to 1.8 m in height—usually four times a year. After pruning, the wood and leaves were separated, dried and weighed. Harvest yields over four years (1984-1987) showed no effect from the orientation of the rows, nor from location to windward or leeward of the hedge. The effect of the TCI was positive on the first row of

crops in the first year, because the *L. leucocephala* grew slowly, but in the following years, the yields of the first four to six rows of crops (1.8 to 2.7 m from the hedge) were lower. The negative effect of *L. leucocephala* was greater for the sunflowers (grown in 1985) in a relatively dry year than for the sorghum, which was grown in the other years. The results from the TCI plots were used to evaluate the yields of five intercropping systems of hedges with alleys of varying breadths (2.7, 3.6, 4.5, 6.4 and 9.9 m). Comparison with plots of *L. leucocephala* alone and crops alone indicated that hedgerow intercropping systems are more productive, particularly when alleys are narrower.

267 **Rapey, H.** 1997. Evaluation économique à l'échelle d'un ménage des systèmes agroforestiers de régions tempérées: problématiques et méthodes. In *Agroforestry for sustainable land-use: fundamental research and modelling temperate and Mediterranean application,* p. 231-236. International workshop held in Montpellier, France, 23-29 June 1997. Montpellier, France, CIRAD.
An economic evaluation of tree/grassland/livestock combinations requires the use of an economic method that takes account of the non-commercial concerns of owners and the specific technical and temporal constraints of the farming systems in question. A model was designed based on the economic concept of "utility" and the results of technical experiments. The result of the planting of trees was assessed on the individual farm level in terms of consumption, inheritance and the use of non-commercial goods throughout one life cycle. First a survey was carried out and an estimation made of changes in the plot, farm production and household budget brought about by the introduction of agroforestry. The tool developed during this work can encourage the adoption of agroforestry in temperate zones under certain conditions.

268 **Satin, M.S.** 1998. *A socioeconomic evaluation of live fencing and windbreak agroforestry technologies in Kaolack, Senegal.* Morgantown, USA, West Virginia University, 452 pp.
This thesis includes a cost-benefit analysis and a model to assess the influence of selected socio-economic factors on the adoption of live fencing and windbreaks in Senegal.

269 **Seiter, S., William, R.D. *et al.*** 1997. Alley cropping in temperate climate: evaluation of potential planting arrangements and tree species. In *Agroforestry for sustainable land-use: fundamental research and modelling temperate and Mediterranean application,* p. 91-96. International workshop held in Montpellier, France, 23-29 June 1997. Montpellier, France, CIRAD.
A number of different alley-cropped plantations with sweet maize (*Zea mais*), *Alnus rubra* and *Robinia pseudoacacia* were evaluated over a period of four years. The highest cereal yields correspond to the lowest compost mass production from trees. The area devoted to maize is a significant parameter in forecasting cereal yields. Although maize yields were higher on the single-crop control plot, the reduction in yields owing to the planting of trees between the lines of maize was proportionally lower than the reduction in area under maize owing to the presence of the trees. *Alnus rubra* and *Robinia pseudoacacia* are thus suitable species for alley cropping. *Alnus rubra* biomass production rose constantly throughout the study, whereas the capacity of *Robinia pseudoacacia* to form biomass fell after each cutting. A comprehensive approach was adopted, taking into consideration outputs (cereal yields and biomass production from the trees) and their interactions, total performance and feasibility.

270 **Selme, M.A.O.** 1999. *"Arbres hors forêt" dans le contexte mauritanien.* EC-FAO Partnership Programme (1998-2000), Project GCP/INT/697/EC. Rome, FAO, 25 pp. + annexes (unpublished)
In this report on trees outside forests in Mauritania, the authors offer a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees

outside forests). The data are based on field observations and a bibliographical review.

271 **Shah, H., Bakhsh, M. *et al.*** 1991. Tree growth on farmlands of NWFP. *Pakistan Journal of Forestry,* 41: 74-81.
Farmland in the North-West Frontier Province carries about 80 million trees, two thirds of them on irrigated land. The average number of trees per hectare is 46 for all types of land, 72 for irrigated land, and 27 for non-irrigated land. The poplar (*Populus*, 24%), China berry or Persian lilac (*Melia azedarach*, 18%), palisander (*Dalbergia sissoo*, 15%), tree of heaven or Chinese sumac (*Ailanthus glandulosa [A. altissima]*, 13%) and mulberry (*Morus alba*, 10%) are the commonest species on irrigated land, while the jujube (*Zizyphus jujuba [Zizyphus mauritania]*, 23%) and tree of heaven (14%) are the commonest on non-irrigated land. Most of the trees are of small diameters, with diameters of 5-9, 10-14 and 15-19 cm accounting for 42, 14 and 13% of the total number of trees respectively The estimated volume of growing stock is 14 million m^3, with 10.6 million m^3 (76%) of this being found on irrigated land. The volume of growing stock per hectare is 8.0, 13.8 and 5.3 m^3 on lands of every type, irrigated land and non-irrigated land respectively. The growing stock on irrigated land is mainly made up of silver date palm (*Phoenix sylvestris*, 27%), palisander (19%), mulberry (13%) and poplar (12%). On non-irrigated land, the growing stock is made up of tree of heaven (21%), jujube (15%), mulberry and fig (*Ficus palmate*, 9%). In 1989, farmers felled about 10.8 million trees (13.5% of the total) and extracted 2.9 million m^3 (21% of the total growing stock) to meet their own needs and for sale. The other species for which data are given are: willow (*Salix tetrasperma*), Indian olive (*Olea cuspidate*), prickly acacia (*Acacia nilotica*), *Eucalyuptus camaldulensis*, *Acacia modesta*, *Celtis australis, Robinia pseudoacacia*, *Debregeasia hypoleuca*, *Tamarix articulata (T. aphylla)*, Russian olive (*Elaeagnus angustifolia*), chir pine (*Pinus roxburghii*), oriental plane (*Platanus orientalis*) and walnut (*Juglans regia*).

272 **Sharma, S.K.** 2000. *Valuation and evaluation of trees-outside-forests of Sri Lanka. Regional special study for Asia and Pacific.* Dehradun, India & Rome, Forest Survey of India & FAO, 46 pp. + annexes (unpublished).
In this report on trees outside forests in Sri Lanka, the author offers a country-wide review of this resource, together with data as to quantities (production, area, etc.) and quality (goods and services provided by trees outside forests). The data are based on field observations and a bibliographical review.

273 **Singh, N.** 1997. Analysis of wood fuel supply from non-forest areas. *In* N. Singh, R.C. Maheshwari & P. Chaturvedi, eds. *Bio-energy for rural energisation,* p. 43-48. Proceedings of the National Bio-energy Convention-95 on Bio-energy for Rural Energisation, organised by the Bio-energy Society of India, 14-15 December 1995, New Delhi. New Delhi, Concept Publishing Company.
The author presents and analyses different results concerning the demand, consumption and supply of fuelwood from non-forest areas of India.

274 **Sola, P.** 2000. Participatory assessment of communal tree resources. Experience from Zimbabwe. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 195-206. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
As part of the Managing Our Indigenous Tree Inheritance Project, the Southern Alliance for Indigenous Resources (SAFIRE) has developed a range of methods for participatory appraisal of resources, with the aim of involving rural communities in assessing the quantity and value of their natural tree resources. Using a combination of participatory rural appraisal and forest evaluation methods, the information collected by SAFIRE and the communities focused on the volume of harvestable wood, the potential production of fruit, the structure of the tree population, its ecological distribution and the density of tree species.

275 **Somarriba, E.** 1990. Sustainable timber production from uneven-aged shade stands of *Cordia alliodora* in small coffee farms. *Agroforestry Systems,* 10: 253-263.
A model was developed in order to estimate the wood production of a shade giving plantation of *Cordia alliodora* on coffee farms. The model envisages timber production of 9 to 24 m^3 / ha / year of total volume and 6 to 15 m^3 / ha / year of stripped volume for a planting density of 120 to 190 trees / ha. Current production on four sample farms are below these figures. The model is used to show the transitory trajectory of *Cordia alliodora* stands with different DBH distributions at the outset. The main recommendations concern how farmers should manage their trees in order to obtain a stable output of timber in the shortest possible time.

276 **Stahl, G., Ringwall, A. *et al.*** 2000. Guided transect sampling for assessing sparse populations. *Forest Science,* 46: 108-115.
Guided transect sampling is suggested for assessments based on transects of sparse and geographically scattered populations. This is a two-stage model, with broad strips being selected in the first stage, followed by a subsampling procedure in the second stage on the basis of the previous information. This article compares the method with a traditional strip assessment under various simulated forest conditions. This comparison shows that the proposed method can improve the precision of transect-based inventories of sparse populations.

277 **Stewart, J.L.** 1989. Aspects of biomass estimation in multipurpose trees. In *Proceedings of a conference on breeding tropical trees: population structure and genetic improvement strategies in clonal and seedling forestry,* p. 311-324. Proceedings of a conference held in Pattaya, Thailand, 28 November-3 December 1988. Oxford, UK, Oxford Forestry Institute.
In the recent proliferation of research on multipurpose trees, insufficient attention has so far been paid to the development of rational, reproducible methods for evaluating them. Even the measurement of such variables as height and diameter can be ambiguous and confused. Standardized evaluation methods for trials concerning hardwood species in the dry zone of Central America were developed at the Oxford Forestry Institute in order to solve this problem. The various aspects of the methodology are discussed with specific reference to one of these trials, including methods for measuring height and diameter and the use of these variables to forecast the production of dry woody biomass.

278 **Stewart, J.L. & Salazar, R.** 1992. A review of measurement options for multipurpose trees. *Agroforestry Systems,* 19: 173-183.
There is an urgent need to standardize the methods used in assessing the growth of multipurpose trees. Most of the standard methods described until now were developed specifically for use in trial networks in different places. This article makes a critical review of these methods for measuring heights and diameters and assessing biomass, in order to provide researchers with a series of methodological choices, while stressing the need to define clear evaluation methods.

279 **Sturmheit, P., Kaonga, Y. *et al.*** 1988. Evaluation of a soil conservation and agroforestry needs assessment study conducted in Mazabuka district of Zambia. In *Agroforestry, the efficiency of trees in African agrarian production and rural landscapes,* p. 351-382. Meeting held in Kigali, 11-16 June 1991. Wageningen, Netherlands, CTA.
This paper describes the method and results of a study on soil conservation and agroforestry needs in Zambia's Mazabuka district between 1986 and 1987. The aim was to gather information on conservation and agroforestry problems, constraints and needs, and on indigenous and traditional knowledge. The study also offers recommendations for appropriate soil conservation and future agroforestry extension strategies.

280 **Sylla, M.L.** 1998. *Méthodologie d'évaluation rapide de la production des formations savanicoles.* Ouagadougou.
This work is a response to ongoing concern to provide the Malian Forestry Service,

particularly the Woodfuel Unit, with a practical tool for evaluating fuelwood production in felling zones. After field survey / identification with the local population, a transect is opened with felling units of four trees every 100 paces being set up along the transect. The inventory covers not only the four trees, but any other woody stems that could be used as fuelwood (a minimum circumference of 10 cm. at breast height).

281 **Thomas, T.H. & Bright, G.A.** 1990. A spreadsheet approach to the economic modelling of agroforestry systems. *In* R.T. Prinsley, ed. *Agroforestry for sustainable production. Economic implications,* p. 353-383. London, Commonwealth Science Council.
This article is divided into two parts. The first concerns methodological aspects of an economic evaluation of a multiple land-use system in which the same piece of land is put to both forestry and agricultural uses. The second gives the results of application of this method to a mixed poplar/cereal/sheep agroforestry system.

282 **Tourret, V.** 2000. *Coûts de gestion de quelques modèles de haies.* Lyon, France, IDF.
In 1999, the IDF described technical aspects (together with statistical data) of the planting and maintenance of various distinct types of hedgerow, within the framework of studies on lines of trees in the Midi-Pyrénées region of France, with the collaboration of the Forestry and Wood Service of the Regional Agriculture and Forestry Directorate.

283 **Unruh, J.D. & Lefebvre, P.A.** 1995. A spatial database approach for estimating areas suitable for agroforestry in SubSaharan Africa: aggregation and use of agroforestry case studies. *Agroforestry Systems,* 32: 81-96.
Growing awareness of the importance and potential of agroforestry has led to a proliferation of site specific case studies. There are now enough good-quality studies of this type for use in research on a broader scale. This article describes an approach for the aggregation and use of agroforestry case studies in agroforestry research on a broader scale than the local site. It shows how the ICRAF agroforestry database can be used in combination with satellite images and additional information, by way of cross classification and a geographical information system (GIS), in order to produce a GIS-based agroforestry research tool for sub-Saharan Africa. This tool is used on a broad scale and as an initial step in estimating areas where appropriate agroforestry systems could be developed in Africa.

284 **Vabi, M.B. & Mala'a, D.** 1998. Community knowledge and traditional uses of trees in some village communities of Cameroon and the Central African Republic. *In* B. Duguma & B. Mallet, eds. *Recherche et Développement dans les Zones Tropicales Humides d'Afrique Centrale et de l'Ouest,* p. 427-435. Regional symposium held in Yaoundé, 4-7 December 1995. Montpellier, France, CIRAD.
Since the early 1980s, development experts have focused their attention on improving methodological approaches to producing information on the village communities in which their institutions will be established or their activities carried out. Such methodological improvements are still continuing through the farmer participatory research (FPR) and participatory rural appraisal (PRA) methods, which are increasingly being used to produce information on village communities. PRA tools and techniques include in particular: configuration, participatory diagrams, interviews, classification, transects and institutional analyses. One of the features of PRA is that it stresses visual expression, allowing local people to participate directly in the creation and analysis of the information gathered. The main focus of this paper is the use of certain PRA tools and techniques in producing information on community knowledge and traditional uses of different tree species. It makes a synthesis of the results of PRA surveys carried out by the German Agency for Technical Cooperation and the United States Agency for International Development in five villages in Cameroon and

three in the Central African Republic. The figure of 444 known uses of tree species in the eight village communities involved in the study justifies the development of agroforestry activities and of research to show the service and production functions of trees as well as throwing light on gender issues. The paper holds that the use of PRA tools and techniques produces the most appropriate and useful tools for the initial information and for agroforestry research and development interventions.

285 **Varjo, H., Mäkelä, H. *et al.*** 2000. Monitoring land use changes by remote sensing in Eastern Africa with emphasis on forest and off-forest tree resources. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 78-88. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This paper examines (i) the present results concerning the development of a change detection method, (ii) the sensing of changes in land use and forest cover with present methods, and (iii) the applicability of these methods in East Africa.

286 **Vergara, N.T.** 1997. *Wood material from non-forest areas. Asia-Pacific forestry towards 2010.* Asia-Pacific Forestry Sector Outlook Study Working Paper Series No. 19. Rome, FAO, 64 pp.
A high population density and a rapid human expansion, coupled with an accelerated economic growth, have led to heavy pressure on forest resources in the Asia-Pacific region. The remaining forests seem incapable of meeting fuelwood and industrial raw material needs. Most countries will have to turn increasingly to trees outside forests in order to make up the shortfall. This document assembles and analyses data on wood material from trees in non-forest areas of this region.

287 **Von Carlowitz, P.G.** 1987. *Multipurpose tree yield data. Their relevance to agroforestry research and development and the current state of knowledge.* Nairobi, ICRAF, 23 pp.
This article shows how little is known about perennial plants in comparison with agricultural crops, a situation that represents a serious obstacle in the analysis of agroforestry systems and their future development. This lack of knowledge applies particularly to quantitative data on the production of trees and shrubs used in agroforestry systems. The article also makes preliminary suggestions on how yield evaluation parameters could be standardized in order to improve their comparability, and also on how this type of data could be made more accessible by establishing supplementary databases.

288 **Sanchez, M.D. & Rosales-Mendez, M.** 1999. Agroforestry systems for intensifying sustainable livestock production in tropical Latin America. In *Agroforestry for animal production in Latin America,* p. 1-13. Proceedings of an electronic conference, April-September 1998. FAO Animal Production and Health Paper No. 143. Rome, FAO.
Animal production in the Latin American tropics has developed by incomplete adaptation of temperate systems. Extensive cattle production based on grass has caused ecological damage and loss of biodiversity, and has not contributed to rural employment and development. Agroforestry systems are alternatives to intensify animal production, while promoting plant and animal biodiversity and environmental conservation. Agroforestry implies the presence of trees and shrubs. It includes silvopastoral systems with grazing beneath or among trees in natural or planted forests; industrial and fruit tree plantations; pastures with forage and multipurpose trees (in fences, banks and throughout the area); and integration of animals (in confinement) within mixed farming, and intensive cut-and-carry systems. Specialized silvopastoral systems have the following advantages over grass monocultures: greater amount and higher quality of fodder distributed in various plant strata; better micro-environment for animals; greater plant and animal biodiversity; larger carbon reservoir (counteracting CO2 emissions); and various other benefits at farm level (provision of fuelwood, posts, wind barriers, watershed protection, landscape improvement). Constraints to the development

and extension of silvopastoral systems include: identification of suitable plant species for each stratum and location; technologies for plant introduction; methodologies for farm conversion to silvopastoral systems; financial support; availability of labour; and land tenure aspects. Key factors for the success of agroforestry systems are re-training of technical people and setting up demonstration units.

289 **Penot, E.** 1998. Jungle rubber improvement in Indonesia. *Plantations, Recherche, Développement,* 5: 99-106.
The SRAP research programme, launched by CIRAD-CP and ICRAF, is developing complex rubber based agroforestry systems in Indonesia that conserve biodiversity and maintain the ecological environment. The purpose is to generate sufficient income for smallholders from the production of rubber and agroforestry products (fruits, wood, rattan and other non-woody products), whilst rehabilitating severely degraded environments. The programme consists of testing rubber agroforestry systems in the smallholder environment (hands-on approach involving 100 smallholders in a network covering 3 provinces in Kalimantan and Sumatra), involving high-yielding Hevea clones with other tree crops (wood and fruits, rattan, etc.) and annual crops (while Hevea is immature). Exogenous technical innovations (clones, fertilizer application, tapping techniques, weeding, etc.) are combined with indigenous innovations.

290 **Sène, E.H.** 2000. Forests and food security in Africa: the place of forestry in FAO's Special Programme for Food Security. *Unasylva,* 51(3): 13-18.
The role of forests and trees in FAO's Special Programme for Food Security (SPFS) launched in 1994 to help farmers in low-income food-deficit countries (LIFDCs) increase food production to meet growing market demand, and eradicate food security, is discussed with reference to Africa. Aspects addressed include the direct contribution of forests to food security and ways to improve it (with examples of edible forest species), forests, jobs and income in relation to sustainable forest management, and improving agricultural production by exploiting the role of trees (agroforestry parklands and modern agroforestry systems) and diversifying farming systems through tree planting and agroforestry (the SPFS programme started a diversification component in 1998, specifically to address these issues). The energy contribution of forest and tree resources to household energy supply, and the contribution of wild animal resources are also discussed.

2.3 RESOURCE DYNAMICS

300 **Arnold, J.E.M. & Dewees, P.A.** 1995. *Farms, trees and farmers, response to agricultural intensification.* London, Earthscan, 292 pp.
This is a collection of articles focusing on why farmers do or do not plant trees. Four case studies examine trends in tree-growing on farms, examining farmers' increasing efforts to plant and manage trees in the hills of Nepal and on overexploited common land under the influence of rapid social and economic change in Rajasthan in India. The factors affecting farmers' choices are also analysed.

301 **Bazin, P. & Schmutz, T.** 1994. La mise en place de nos bocages en Europe et leurs déclins. *Revue Forestière Française,* special issue 1994: 115-118.
Wherever we may be in a rural landscape in Europe, we recognize the type of region thanks to an identification process that is based in large part on the form and arrangement of forest shelterbelts within the landscape. People tend to think that these landscapes are thousands of years old, but most of the hedges in fact date back less than 150 years. Historians and geographers of bocage landscapes identify several major periods in the constitution of these networks. Although we may think that hedges have always had a whole series of roles, it is striking that in any given period only a few of these functions were actually taken into account.

302 **Bernard, C.** 1999. *Structure, dynamique et fonctionnement des parcs agroforestiers traditionnels. Cas de Dolékaha, Nord Côte d'Ivoire, et Holom, Nord Cameroun.* Paris, Sorbonne, Université Panthéon, 387 pp.
Since the great droughts of the early 1980s, many projects have focused on reforestation of Sahelian zones. In view of the failure of many government plantations, which were often composed of exotic species, research experts and developers started paying more attention to the local species cultivated by farmers. Attempts to enrich tree systems were carried out in many countries, but unfortunately, and for no apparent reason, the attention and care given to these trees by the farmers varied widely depending on individual, ethnic group, region and agrarian system. The CIRAD agroforestry programme therefore decided to focus its research on the development and future of traditional tree systems, taking social, land tenure and economic issues into account. Against this background, a study was carried out on the analysis of agroforestry systems on the village lands of two villages, not just examining the tree systems themselves, but placing them in the context of the wider area managed by a whole village community. The aim of this research was to show how different factors explained the dynamics of the various components of a tree system, with a view to being able to offer guidance in due course.

303 **Blanc-Pamard, C. & Lericollais, A.** 1991. *Dynamique des systèmes agraires à travers champs: agronomes et géographes.* Paris, ORSTOM, 297 pp.
This publication is a collection of texts concerning the dynamics of agrarian systems from the viewpoint of rural engineers, agronomists and geographers. The agrarian situation—or more specially the relations between rural societies and their environment—can be interpreted in a number of ways, with geographers focusing on landscapes, village land, agrarian structures, etc., while agronomists are concerned with technical factors, production processes, etc. These complementary approaches lead to some mutual questioning.

304 **Clouet, Y. & Dollé, V.** 1998. Aridité, oasis et petite production, exigences hydrauliques et fragilité sociale: une approche par analyse spatiale et socio-économique. *Sécheresse,* 9: 83-94.
The future of small-scale producers in the oases scattered from the Sahara to Central Asia is of major concern today. A combined historical and spatial approach is proposed in order to throw light on the issue. Identification of major

changes in oases over the long term shows fairly similar social situations, despite differences in water management approaches. Under the pressure of strong internal constraints (unequal distribution of land, exploitation of their labour force, economic and social exclusion, etc.), most of the inhabitants, especially small-scale producers, have to find their place in newly emerging economic and geographic spaces. The article describes the approach adopted and draws some operational conclusions. The latter represent a possible way of developing the outlying arid spaces where each State has its own way of managing a piece of the magnificent heritage of the great oasis networks that have been on the wane since the 16th century as a result of mastery of the oceans, the rise of capitalism, the rural exodus, urbanization and burgeoning oil revenues.

305 **Depommier, D.** 1996. *Structure, dynamique et fonctionnement des parcs à* Faidherbia albida *(Del.) A. Chev. Caractérisation et incidence des facteurs biophysiques et anthropiques sur l'aménagement et le devenir des parcs de Dossi et de Watinoma, Burkina Faso.* Vol. 2, *Photographies, annexes et listes des cartes, figures, graphiques et tableaux.* Paris, Université Pierre et Marie Curie, 662 pp.

This work uses a comparative analysis of parkland in Dossi (Sudanian zone) and in Watinoma (sub-Sahelian zone), to study *Faidherbia albida* (Del.) A. Chev. parklands in Burkina Faso. The aim is to reach a diagnosis and define the features of these tree systems (floristic composition, structure, dynamics and functioning) by assessing the role of biophysical and human factors that affect these parkland development and future. Surveys and inventories have identified the following features: a high social and land tenure stability; management by men, who are often old; crops dominated by cereals, which are continuous on miniplots and are fairly well manured close to the settlement. However, the parkland in Dossi, a long-established and almost single-species parkland, homogeneous in structure and in distribution over more than 300 ha, is shrinking. Regeneration is more abundant than in Watinoma and fallows increasingly long. The change is a result of the development of cotton in the parkland, to which all investment is devoted. On the other hand, the Watinoma parkland is broken up, composite and multilayered. Although cutting back, seed-eating insects and livestock affect the seed potential, while hoeing and environmental conditions act as constraints on regeneration, this tree system has been expanding over the past generation. Most of the trees are young, with an average age of 20 years in Watinoma, against the 40 year average in Dossi. Watinoma, a poor and overpopulated area, shows a certain interest in *Faidherbia*, but prefers a more diversified parkland. The species grows faster here, however—roughly 1 cm on the rays—with the cutting back extending its foliation into the middle of the rainy season. While cutting back is only very moderate in Dossi, it tends to be much more drastic in Watinoma and to affect most of the trees, which then throw out new shoots from the top. The leaf production from total cutting is constant from one season to another. It ranges from 5 to 40 kg of dry matter depending on the size of the tree, as well as 40 to 100 kg of wood. However, the cutting reduces fruit production, which is only a few kg of MS per tree in Watinoma, as against 20 to 25 kg in Dossi. The pods are two to three times more digestible than the leaves, but the latter are an indispensable fodder complement for livestock at the end of the dry season. The trees improve soil fertility right to the edges of the crown, increasing MO, C and N by 50% and P, K, Ca and Mg to varying degrees. The effect of this rises with the size of the tree. It is less on the more fertile soils of Dossi. In all places, it is linked to the fact that livestock halt beneath the trees. The trees also raise the moisture content of the surface horizon on the driest site in Watinoma. The improvement in crop grain yields is greatest in the most extreme site and climate conditions, with an increase of over 150% beneath the crowns. The effect increases with the size of the tree, with the grain yield peak found at the inner edges of the crown, while stem production is greatest close to the trunk—the most shaded area. In Dossi, maize seems more sensitive than sorghum to the improving effect of trees, giving yields of over 4 000 kg per hectare. The cardinal orientation of trees appears to have no

significant effect. In conclusion, it is shown that on the plot level, an improvement of 25% in productivity is a decisive advantage for Watinoma farmers, guaranteeing a food self-sufficiency that the Dossi parkland no longer provides.

306 **Diallo, M., De La Rocque, S. *et al.*** 1998. *Evolution des formations ligneuses riveraines dans la zone agro-pastorale de Sidéradougou, Burkina Faso, et recherche des causes anthropiques.* Bobo Dioulasso, Burkina Faso, CIRAD, 41 pp.
Recent studies carried out in the agropastoral zone of Sideradougou, south of Bobo Dioulasso in Burkina Faso, have shown a close link between a decrease in populations of tsetse flies, insects with narrow environmental requirements, and the amount of human activity carried on close to their biotopes—gallery forests. The present work seeks to assess changes in gallery forests in this area, particularly the impact of processes of human origin. The results confirm the importance of agricultural activities carried on close to gallery forests (less than 100 or 150 m away). Cultivated plots close to watercourses give rise to water processes that accelerate erosion of the banks. The felling of fuelwood is also very detrimental to gallery forests, while other activities such as hunting or fishing have a lesser impact. Animal husbandry does not seem to be a factor in degradation, except perhaps in very localized terms at watering points.

307 **Gautier, D.** 1992. Haies Bamilèke et systèmes de production: l'exemple de la chefferie Bafou, Ouest Cameroun. *Cahiers de la Recherche Développement,* 31: 65-78.
The Bamiléké country in the highlands of western Cameroon is famous for its bocage landscape. The typical hedge forming this landscape is multifunctional, made up of a number of species, and horizontally belted with raffia "bamboos". Set out around the edges of farms, marking property boundaries, or in the form of enclosures, these traditional hedges evolve parallel with production systems, the factors in any change being: the introduction of monetarized agriculture, a decrease in small animal husbandry, pressure on land, and a shortage of labour. Hedges can thus be considered a good indicator of the dynamics of the Bamiléké landscape and of changes in agrarian systems.

308 **Gilmour, D.A. & Nurse, M.C.** 1991. Farmer initiatives in increasing tree cover in central Nepal. *Mountain Research and Development,* 11: 329-337.
Farmers in the central hills of Nepal depend to a large degree on tree products as back-up to their agricultural systems. They manipulate the plant cover on their farmland, in general on the edges of terraces and on uncultivated plots within their farmland. Trees are also found on public land around villages, and their use is also managed by the farmers, even if the land falls under the legal authority of the Water and Forestry Department. This article examines changes in the plant cover on different types of land in a drainage basin of 14 000 ha near Kathmandu. Comparisons were made with the help of aerial photographs taken in 1972 and 1989. The area of each category of land use was determined for eight study sites, and the percentage of plant cover was calculated for each category. The results indicate that there has been no change of public land (forests and grasslands) into farmland between these two dates. The percentage of plant cover on the main agricultural land use category (hillside terraces) and on public land increased considerably between the two dates. Inasmuch as these two categories account for 86% of the study sites, it would seem that the landscape has as a whole been the object of continuous afforestation, which can be attributed to farmers.

309 **Guyon, J.P.** 1996. Evolution des formations boisées sur le territoire de deux communes du canton d'Aurignac, Haute-Garonne, de 1942 à 1992. *In* G. Balent, ed. *La forêt paysanne dans l'espace rural: biodiversité, paysages, produits,* p. 267. Etudes et Recherches sur les Systèmes Agraires et le Développment No. 29. Paris, INRA.
Tree systems linked to agricultural activities are subject to management conditions and uses that lead to a wider variety of structures, both internal and external, than are found in public

forests. This article describes the methodology adopted to study two communes in the Aurignac region of France. First, a photo-interpretation of wooded and pre-wooded structures and their evolution between 1942 and 1992 was made on the cadastral plot level, after which surveys were carried out to confirm the management approach adopted and define farmers' uses and aims. The first results show a remarkable stability in wooded area over the past 50 years, interpreted as a balance between natural woodland and artificial, agriculture-linked woodland. These stands are almost exclusively coppices, often in the form of small sub-plots of one or a few hectares, which are felled at least every 20 years. A clear decrease in the lengths of linear elements (hedges and lines of trees along watercourses) and in the number of isolated trees can also be seen.

310 **Hsiung, W., Yang, S. *et al.*** 1995. Historical development of agroforestry in China. *Agroforestry Systems,* 30: 277-287.
Agriculture and agroforestry have been carried on in China in forests, developing side by side since their start. Archaeological evidence shows that the Chinese settled in forests, where they sought shelter from outside dangers and lived on the edible parts of plants and animals, thanks to hunting and gathering activities. Starting in the Neolithic Age (7000 to 8000 BC), fire was generally used to burn forests for shifting cultivation, which is a primitive form of agroforestry. With rapid population growth, the annexation of tribes, the collapse of clan-based societies and the development of the slavery system, the nomadic system of shifting cultivation gave way to sedentary agriculture during the Xia Dynasty (2000 to 1600 BC). During the Shang and West Zhou Dynasties (1600 to 800 BC), sedentary agriculture encouraged the development of private land ownership. Farmers planted trees in or around cultivated fields, grew fruit-bearing plants and vegetables, and reared domestic animals for self-sufficiency. After this, various forms of agroforestry gradually developed, providing the fundamental framework of the Chinese small farming economy for over 3000 years. The Chinese population has grown rapidly since the 1950s. During the same period, the area of arable land has shrunk drastically, and the environment has suffered from rapid degradation with industrial development. Traditional working methods and inefficient agroforestry management practices have not been adapted to the present situation. In view of the economic, environmental and social potential, it is suggested that a simple biological production system for crops, trees and livestock should be converted into a system combining agricultural production, trees and livestock, and including processing and marketing. Such a management system—modern agroforestry, in fact—could be very helpful in development of the rural economy of modern-day China and in environmental conservation.

311 **Huang-WenDing, Kanninen, M. *et al.*** 1997. Agroforestry in China: present state and future potential. *Ambio,* 26: 394-398.
In China, major agroforestry systems are estimated to cover 45 million ha. Agrosilviculture is a dominant practice. Aquasilvicultural systems, e.g. tree-fish-arable crop and tree-fish-livestock systems, are alternatives for land use in the wetlands. Silvopastoral systems are popular in the northern and western regions. Compared with a monoculture, well-managed systems have many benefits. The recycling of residues is expected to increase the efficient use of natural resources. The C sink in the vegetation of major agroforestry systems in China was 179 Tg yr-1, and agroforestry is reported to have a positive effect on soil conservation and biodiversity. The major constraint on agroforestry is that most of the systems are on a low level of management, primarily resulting from a shortage of technical support. However, there is a great potential for the development of agroforestry in China. This paper presents recommendations concerning policy options, technical support, extension, and marketing in agroforestry.

312 **Lauga, C.** 1992. *Quelques réflexions sur les bocages africains à partir de l'exemple Bamiléké.* Paris, GRET, 88 pp.
This working document for the bocaging project initiated in 1991 by the Technological Research and Exchange Group (GRET) consists

of a bibliographical synthesis, providing very full details on African bocage landscapes, especially in the Bamiléké country. This example is helpful in showing not only the knowledge of bocage dynamics in Africa, but also the methods that have already been used in studying it.

313 **Lauga, S.C. & Sibelet, N.** 1998. Là où il n'y a pas de forêt … Dynamiques bocagères et environnement au Fouta-Djalon, Guinée, et au Niumakélé, Comores. In *Dynamiques socials et environnement: pour un dialogue entre chercheurs, opérateurs et bailleurs de fonds,* p. 143-149. Contributions to a meeting held in Talence, France, 9-11 September 1998. Talence, France, CNRS/ORSTOM.
African societies could well be more capable of offering solutions to the problem of environmental protection than the outside experts working alongside them. Examples of bocage systems taken from Fouta-Djalon in Guinea and Niumakélé in the Comoros help to show that, contrary to common belief, farmers' practices do in fact help to preserve the environment. In these two tropical highland regions, the extension of cultivated land, crop diversification and the intensification of production systems rely on the use of live enclosures intended to protect crops from livestock. On the edges of reserved or protected forests, the establishment of bocage systems on the part of farmers shows that an increase in farm production can help to preserve and enrich an environmental heritage.

314 **Lauga-Sallenave, C.** 1996. La clôture, une signature au pays de Peuls de Guinée. *Cahiers des Sciences Humaines,* 32: 335-359.
In the central Fouta-Djalon highlands of Guinea, the Timbis plateau is densely populated by the Fulani, who practise a semi-intensive, sedentary form of agriculture based on cattle, goats and sheep. Belts of trees separate their land from the large open lands managed collectively for cereal cultivation. The Fulani's farming systems are examined in this document, looking at how this land-use model, based on the establishment of hedges and demarcation trees, developed. Changes at present taking place are also examined. Constant population growth, leading to increasingly intensive agricultural methods and an expansion of demarcated plots, increases the pressure on land resources and also the risk of crop destruction by livestock. This pressure on resources, combined with migration, has increased the need for demarcation and the development of enclosures. Coupled with a changing economic and political environment, these factors are probably having a major effect on traditional farming systems in this region.

315 **Levang, P. & Gouyon, A.** 1999. De la retouche à la rupture. L'introduction de l'hévéa dans les systèmes de riziculture sur brûlis à Sumatra. *In* J.P. Chauveau, M.C. Cormier-Salem & E. Mollard, eds. *L'innovation en agriculture: questions de méthodes et terrains d'observation,* p. 287-301. Paris, IRD.
Although small farmers live in traditional societies ruled by custom and routine, this does not prevent them from receiving and accepting innovations, which then gradually lead to changes. The adoption of rubber cultivation led farmers in Sumatra to make radical changes to their whole agrarian system—and in a remarkably short period of time. By introducing rubber on their freshly cleared land, Sumatran farmers have replaced the gathering of products scattered through the forest with that of a species that is artificially concentrated within the plant cover and more commercially developed. The high prices of rubber and the active role of traders encourage the introduction of innovations. The remarkable adaptation of the plant to the physical and socio-economic conditions of the region works in favour of its spread. The development of individual land appropriation forces even the more reluctant to join the general trend. The accumulation of productive capital allows the farmers to look to a future well beyond the next rainfed rice harvest. Rubber, a real miracle plant, is the source of wealth, but also of social division.

316 **Leveau, P., Heinz, C. *et al.*** 1991. Les origines de l'oléiculture en Gaule du Sud. Données historiques, archéologiques et botaniques. *Revue d'Archéométrie,* 15: 83-94.
This work seeks to throw light on the origins of olive cultivation. Examination of

palaeobotanical data gathered both outside archaeological sites (pollen diagrams from core-drilling) and on such sites (olive stones and charcoal), together with historical data, indicate major local variations since 2000 BC. These variations can very plausibly be explained by arboriculture, an arboriculture that saw periods of expansion and contraction between the introduction of the cultivated species by the Greeks and the present-day olive fever.

317 **Ould, S.C.** 1999. Présentation des oasis mauritaniennes. *In* M. Ferry, S. Bedrani & D. Greiner, eds. *Agroéconomie des oasis,* p. 49-51. Montpellier, France, CIRAD.
The total area of oases occupied by date palms in Mauritania was estimated at 10 000 ha in 1972, whereas according to recent statistics, the figure is now no more than 4 700 ha. In 20 years, 52% of the palm heritage of the country has vanished. Several oases found in the Adrar region in the 1960s have completely disappeared, either buried beneath dunes, or abandoned on account of desertification, or attacked by undiagnosed disease.

318 **Seignobos, C.** 1980. Des fortifications végétales dans la zone soudano-sahélienne (Tchad et Nord-Cameroun). *Cahiers de l'ORSTOM,* 17: 191-222.
From Sudan to Senegal, the widespread conversion of crop defence hedges into enclosures has very often disguised the past function of these elements. However, villages and cultivated land were in many places protected by live ramparts combining a variety of species. Certain natural, historical or geo-strategic conditions—particularly an endemic insecurity—led to the establishment of such systems. In northern Cameroon, for example, the Mandara mountains and their approaches suffered pressure not only from the Bornu and Wandala empires, but also from lowland ethnic groups, which had been in turn driven out by these empires or to a greater or lesser extent fallen under their yoke. Lastly, the establishment of Peul *lamidats* (territory under the authority of a chief called Lamidé) in the 19th century simply reinforced the already existing defence structures. These plant installations made up for the relative absence of buffer zones and of natural bushland. They did well at a latitude where woody vegetation was fairly sparse, as well as in the foothills of mountain massifs where it was hard to build earth walls. They were always established in relatively densely populated regions, and, on the whole, within the context of individualized ethnic groups and not in that of multi-ethnic empires where the capital was the only place with the right to fortify itself. Undoubtedly facilitated by a particularly favourable terrain, northern Cameroon has a considerable wealth and a great variety of plant defence systems, in contrast to a certain poverty in Chad, where the great empires in the North and vegetation along watercourses in the South have restricted the development of such structures.

319 **Simons, A.J., Jaenicke, H. *et al.*** 2000. The future of trees is on farm: tree domestication in Africa. *In* B. Krishnapillay, E. Soepadmo, N.L. Arshad *et al.*, eds. *Forest and Society: the role of research,* 1: 752-760. 21st IUFRO World Congress, Kuala Lumpur, 7-12 August 2000. Kuala Lumpur, IUFRO World Congress Organising Committee.
Present deforestation levels indicate that the growing demand for tree products should be mirrored by the planting of trees. Although traditional forest planting will meet some of this demand, there will certainly be an increase in the trees planted on agricultural land. Farmers in zones with growing population levels already have an incentive to plant trees on their land because of the benefits they bring, and this trend will continue. However, the tree species cultivated need to be improved by domesticating high-value tree species (timber, fruit, medicinal products).

320 **Tersen, G.** 1994. Les arbres d'alignement. *Arbre Actuel,* 14: 28-44.
This article provides an overview of line-planted trees in France—their origin, their history, the question of their validity, and the recent wave of planting, using new techniques and new species.

321 **White, R., Adikari, S.B. *et al.*** 1995. Land-use change in the Upper Mahaweli catchment. *Sri Lanka Forester,* 63-68.
Land use in three types of zone is compared, covering 571 km^2 or 18% of the Upper Mahaweli Catchment in Sri Lanka, on the basis of data from 1956 and 1979-1981 and from 1991 land-use maps. The results indicate that in the space of 35 years, there has been a 59% increase in forest cover. There has been a considerable shift in crop cultivation toward home gardens, with a decrease in tea and the almost total disappearance of rubber. Natural forests have been maintained or increased, and man-made forests have increased enormously.

CHAPTER 3 : MANAGEMENT AND DEVELOPMENT OF TREES OUTSIDE FORESTS

3.1 TECHNICAL ASPECTS

340 **Adlard, P.G.** 1990. *Procedures for monitoring tree growth and site change. A field manual.* Oxford, UK, Oxford Forestry Institute, 184 pp.
This work describes procedures for monitoring forest plantations and field trials, mainly in the tropics. The subjects include: provisional and permanent types of plot; experiments to assess the effects of different types of forest management on trees and growth models; volume and yield tables, and functions, seen as the basis for plantation management and for detection of site change; data collection and processing; biomass evaluation; conventional tree measurement and site-linked variables; planning of ongoing inventories; and experiments to assess the effects of plot density, fertilizer use and other treatments.

341 **Alrefai, R.H. & Korban, S.S.** 1995. Cross protection against virus diseases in fruit trees. *Fruit Varieties Journal,* 49: 21-30.
Fruit **trees** are commonly infected with plant viruses. Genetic engineering of virus resistance into plants has been accomplished using several strategies including satellite-RNA-mediated resistance, antisense-RNA-mediated resistance and coat protein mediated resistance, among others. Current advances in using coat protein mediated resistance have proven promising in protecting several agronomic crops against virus infection. More recently, a number of fruit crop species have been transformed with coat protein genes of important plant viruses and promising results have been obtained. The subject is reviewed under the headings; importance of control of virus diseases in fruit **trees**; current methods for controlling virus diseases in fruit **trees**; and outlook for genetically engineered virus resistance in fruit crops.

342 **Arnold, H.F.** 1993. *Trees in urban design.* New York, NY, Van Nostrand Reinhold, 197 pp.
This work describes the technical and economic aspects of trees in urban design.

343 **Balandier, P.** 1999. Analyse et modélisation de l'interaction arbre-culture. In *Bois et forêts des agriculteurs,* p. 10-12. Acts of meeting held in Clermont-Ferrand, France, 20-21 October 1999. Clermont-Ferrand, France, INRA/Cemagref/Ministère de l'Agriculture et de la Pêche.
This document gives a summary of experiments undertaken to acquire technical and economic points of reference on how agroforestry systems work. Different combinations were studied (tree/crop, tree/rangeland, tree/spontaneous or introduced vegetation) in order to gain a better understanding of the mechanisms brought into play by the interaction between a tree and a crop, to build models of these interactions in order to gain a long-term picture of how the system develops, and thus to choose the complementary species suitable for these types of combination.

344 **Baldy, C. Dupraz, C.** ***et al.*** 1993. Vers de nouvelles agroforesteries en climats tempérés et méditerranéens. 1: Aspects agronomiques. *Cahiers Agricultures,* 2: 375-386.
This article describes an overview study of the plot-level effects on microclimate, water and agriculture of combinations of trees and leafy plants in climates with a marked water shortage in the summer. The impact of agroforestry plots on zonal climates was also examined. It was seen that agroforestry practices can very favourably meet the demands for expansion and respect for the environment, which are priorities for agriculture today. In this perspective, new

agroforestry combinations are then proposed, ranging from putting woody fruit crops (grape vines, fruit trees) permanently under grass, to new combinations of multipurpose trees (quality wood, fodder) and crops. The trees chosen are broad-leaved deciduous species, which lend themselves better than conifers to combination with crops. The criteria for the choice of woody and leafy species are defined in order to obtain agroforestry combinations that will grow well together and perform well in a Mediterranean climate.

345 **Baudry, J. & Roulleau, J.N.** 1994. Les routes et autoroutes: du verdissement à l'écosystème. In *Recréer la Nature. Réhabilitation, restauration et création d'écosystèmes,* p. 41-45. Meeting held in Paris, 17-19 May 1994. Paris, Ministère de l'Environnement, p. 41-45.
Some years ago, the environmental aims for the green strips along motorways changed from the fastest possible greening in order to disguise the bare ground that had been exposed on embankments, to extensive management of all bordering areas. This article discusses possible ways of incorporating broader environmental concerns when designing motorways, with a view to restoring or recreating the environmental functions of the green areas along them. The proposed approach must take account of technical constraints and security concerns in connection with motorway building.

346 **Baumer, M.** 1989. *Watershed management: the potential role of agroforestry.* Course notes for the international training session *Integration of the concept of environment in the management of water resources* organised by OEFIGRE and UNEP at Bujumbura, 2-13 November 1987. Nairobi, ICRAF, 50 pp.
Erosion in watersheds is discussed, with particular reference to its measurement, the role of trees and vegetation in its control, appropriate management and development methods, and direct and indirect erosion control measures.

347 **Bazin, P.** 1999. Les haies et la faune: entretenir sans détruire. *Forêt Entreprise,* 125: 16-21.
Most hedges are maintained by farmers, who try to keep the ground clear. There are ways of avoiding getting caught up in a vicious circle of endless treatment processes. A little attention, combined with respect for some simple rules, would be enough to maintain a habitat favourable to the wild guests of hedges, for example being willing to lose a little land rather than seeking at any price to maintain the last centimetre, or admitting that vegetation favourable to wildlife appears more easily when the ground is "dirty".

348 **Bazin, P., Jégat, R. *et al.*** 1996. *L'entretien courant des haies bocagères. Les grands modèles d'entretien des haies.* Paris, 68 pp.
The functions of hedgerows have changed over time, and particularly in the past 15 years. New stakeholders have appeared. How should hedges be maintained today? What technical models should be chosen, and what is their cost? How can they be developed?

349 **Bennet, A.F.** 1999. *Linkages in the landscape. The role of corridors and connectivity in wildlife conservation.* Gland, Switzerland, World Conservation Union (IUCN), 254 pp.
This book reviews international literature on the theme of corridors, landscape connectivity and wildlife conservation. It was prepared in response to a request from the IUCN Forest Conservation Programme for a book that would provide information and guidelines on the subject. Indicative of the intense interest and activity in this area of conservation biology, there has been a wealth of new material over the last decade. This includes several published conference proceedings, critical reviews, and a variety of papers reporting field studies, computer simulations and the application of conceptual principles to land-use planning. There is also a rapidly growing number of situations in which 'corridors' of various types are being incorporated into conservation strategies and land uses. Two particular challenges were evident during the preparation of the book.

First, those reading this book will approach the topic from a number of viewpoints. Those that might be described as having a primarily scientific perspective are likely to be most interested in a theoretical understanding of the role of corridors in the dynamics of species populations in heterogeneous environments, and in the scientific evidence in support of their function. Others, whose perspective is primarily that of conservation, may have greater interest in the conservation values of linkages and information pertaining to practical issues of design, management and land-use planning. The structure and content of the book have been planned to encompass both theoretical and applied aspects of this topic, but with particular emphasis given to the role of linkages in the conservation of biodiversity. A second challenge relates to the differing spatial scales at which linkages are incorporated in conservation plans. In intensively-developed landscapes, attention is often directed to local networks of habitat corridors that link small natural areas. In other situations, the focus of those involved in conservation planning is on major links between conservation reserves and on the maintenance of connectivity within large geographic areas. At a broader scale, others are concerned with protecting national and continental networks for conservation. Recognizing these diverse levels of application, examples and case studies have been selected to illustrate the role of linkages at both local and broad spatial scales, and principles that are relevant across a range of spatial scales have been sought. The book is arranged in 3 parts, each with 3 chapters. The chapters in Part 1, Defining the issues, are: (1) Responding to an issue of global concern; (2) Habitat fragmentation and the consequences for wildlife; and (3) Approaches to understanding the benefits of connectivity. The chapters in Part 2, Values of linkages, are: (4) Connectivity and wildlife conservation; (5) Movements of animals through linkages; and (6) Linkages as ecological elements in the landscape (including landscape linkages, riparian vegetation, hedgerows and fence rows, roadside vegetation and forest linkages). The chapters in Part 3, Linkages and conservation strategy, are: (7) Design and management of linkages for conservation; (8) Connectivity and conservation strategy; and (9) Case studies of linkages in land-use planning and conservation (including landscape linkages between reserves or large natural areas, linked systems of habitat at the regional scale, linkages in forest conservation and management, linkages for the conservation of large mammals, and local networks of linear habitats). An appendix of common and scientific names of species cited in the text, and a subject index, are included.

350 **Bentley, J.M. & Catterall, C.P.** 1997. The use of bushland, corridors, and linear remnants by birds in southeastern Queensland, Australia. *Conservation Biology,* 11: 1173-1189.

A field study was conducted during December 1992 to March 1993 and late May to early August 1993 in a 3100 km2 area of southeastern Queensland, to investigate bird use of riparian corridors in pastoral and urban surroundings and riparian linear remnants within an urban context. Vegetation types included Acacia, Eucalyptus, Melaleuca, Banksia and Casuarina in addition to rain forest species, shrubs, grass and bracken. The avifauna of these remnants was compared with dryland and riparian sites within continuous bushland, and their use by previously derived response-guilds of birds to bushland clearing was also assessed. 3567 individuals of 102 bird species were recorded. Riparian bushland supported more species and had greater bird abundances than dryland bushland. Corridors and linear remnants supported densities of many bushland-dependent species similar to those in bushland; this varied with species' patterns of large-scale migration and residency. Bushland-dependent winter migrants used both corridors and linear remnants extensively. Bushland-dependent residents were most abundant in continuous bushland and least abundant in linear remnants, possibly reflecting the constraints of central place foraging. The effects of isolation were only evident in resident bushland-dependent

species. Local habitat variables were significantly associated with variation in abundance of some types of birds within corridors and linear remnants; however, the differences in bird abundances attributable to spatial characteristics were greater than those attributable to habitat characteristics. The effects of bushland fragmentation and isolation were mediated by the extent to which species were dependent upon bushland and their patterns of large-scale migration or residency. It is concluded that local habitat, and possibly more importantly altitude, may influence site use by winter migrants and generalist species.

351 **Besse, F., Sarrailh, J.M. *et al.*** 1997. Conservation des sols et agroforesterie. *Bois et Forêts des Tropiques,* 252: 30-33.
This article gives an overview of the different erosion control techniques used in fragile forestry development zones in combination with agroforestry.

352 **Booth, T.H. & Booth, W.D. *et al.*** 1994. Determining the climatic requirements of trees suitable for agroforestry. In *Climatic change: significance for agriculture and forestry: systems approaches arising from an IPCC meeting,* 27: 93-102.
After fossil fuel burning, clearing of forests for agriculture is the second most significant factor increasing levels of atmospheric carbon dioxide. Replanting trees on previously cleared land around the world could reduce the buildup of atmospheric carbon dioxide. However, forests were usually cleared to grow crops or graze animals, so there is no possibility of completely restoring forests on most cleared lands. There is a need to develop agroforestry systems which integrate trees with agricultural activities. One of the key problems in developing successful agroforestry systems is identifying which trees can be successfully grown in different areas. This problem will become even greater as tree breeding produces a wider variety of genotypes available for planting. General methods are described to identify where a particular tree (species, provenance or clone) with potential for use in agroforestry systems can be grown. The methods also help to identify locations where particular trees are growing under relatively extreme climatic conditions for that taxon. Conditions at these locations should be carefully evaluated as more reliable future climatic scenarios are developed. In the meantime they could be monitored to provide early warning of the effects of climatic and atmospheric change.

353 **Brandle, J.R., Hintz, D.L. & Sturrock, J.W., eds.** 1988. *Proceedings of the International Symposium on Windbreak Technology*. Lincoln, Nebr., USA, 23-27 June 1986. Amsterdam, Elsevier Science Publishers, 598 pp.
This publication contains a selection of papers from the first International Symposium on Windbreak Technology, which was attended by researchers, managers and specialists from different disciplines in order to discuss the present state of knowledge on windbreak technology. The ten sections, containing 34 articles in all, deal with the following subjects: “Windbreak basics”, “Wind erosion”, “Non-woody windbreaks”, “Crops response to windbreaks”, “Livestock and windbreaks”, “Windbreaks and energy”, “Windbreaks and wildlife”, “Windbreaks, snow and water use”, “Windbreak planting and establishment”, and “Windbreak management”.

354 **Bridgeman, P.** 1983. Computerised street tree management in the United Kingdom. *In* C.J. Bickmore & T.H.R. Hall, eds. *Computerisation of tree inventories,* p. 32-38. Herts, UK, Academic Publishers.
Each local authority in the United Kingdom is responsible for caring for the trees on its property—motorways, parks, schools, etc. It is also expected to apply legislation concerning these trees. Planned management of these trees needs data, and obtaining such data in turn requires expertise and funding. Most local authorities do not have any precise idea of the location of the trees, the types of species and their condition. The only solution is to make a full inventory of all these trees and computerize the data, so that an

appropriate development plan can be drawn up and implemented.

355 **Carucci, R.** 2000. Trees outside forests: an essential tool for desertification control in the Sahel. *Unasylva,* 51(1): 18-24.
The author describes the potential of trees for combating and preventing desertification. The data are taken from an integrated rural development project at Keita in Niger, which was launched in 1984, funded by the Italian Government and executed by FAO, with the support of the World Food Programme. The project was initially based at Keita, but then expanded to other administrative areas (Abalak to the north and Bouza to the southeast). Under this project, a strategic approach was drawn up for planting trees as one of many other components, in order to stop the degradation of catchment areas, strengthen the banks of water courses, install windbreaks, fix moving sand dunes, and help the regeneration of agroforestry parkland. For each of these objectives, the author gives information on the techniques and species used. The conclusions drawn from the experience of this project seem to indicate that desertification can be combated.

356 **CIRAD** 1993. *FLHOR seminar on tropical orchards.* Annual meeting of CIRAD-FLHOR, Montpellier, France, 30 August-5 September 1993. Montpellier, France, CIRAD-FLHOR, 135 pp.
This publication contains a summary in English, French and Spanish of the papers given at the annual meeting on tropical orchards. A major place is given to citrus fruit and mangos. Stress is also laid on agroeconomics, post-harvest technology and processing, crop protection, ecophysiology, genetics and biotechnology.

357 **Cuttle, S.P. & Gill, E.K.** 1991. Technology impact evaluation in agroforestry projects. *Agroforestry Systems,* 13: 235-257.
In 1988 and 1989, ICRAF contacted 166 projects throughout the world, asking about their activities in monitoring and evaluating agroforestry technology, with a view to identifying appropriate methods for evaluating the impact of new agroforestry technology. Forty-five percent of the 108 that answered were involved in impact evaluation processes. This study revealed generalized difficulties encountered in selecting impact indicators and evaluation methods. Until now, stress has been laid on assessing the number of trees planted and the size of agroforestry areas, rather than on socio-economic impact. It was hard to define the adoption of agroforestry and to distinguish intermediate and final impacts. Impact studies were often hard to interpret or compare, which limited their value for the rest of the agroforestry community. On the basis of lessons learned from this study, an analytical framework is proposed for planning impact evaluation in agroforestry projects. The choice of indicators should depend on project objectives, taking account of certain variables: the number and type of trees cultivated; land use; farmer knowledge and attitudes; availability of agroforestry projects and services, and/or socio-economic well-being. Data collection tools could include sequential photography or mapping, informal or formal surveys, meetings of farmers, workshops, analysis of trends in projects, and case studies of households or communities.

358 **Delahaye, T. & Vin, P.** 1994. *Le jardin fruitier.* Paris, Nathan, 159 pp.
This book considers all the aspects of fruit trees: biology, planting, grafting, pruning, diseases and parasites, harvesting, and the conservation of fruit. It describes 25 fruit species and over 250 varieties.

359 **Dhillon, M.S., Singh, B. *et al.*** 1996. Organic farming through agroforestry. In *Resource inventory techniques to support agroforestry and environment.* Proceedings of IUFRO-DNAES international meeting, Chandigarh, India, 1-3 October 1996. Chandigarh, India, HKT Publications.
The paper explores the possibilities available for increasing soil organic matter through agroforestry and other means, for a sustainable environment and agricultural production in the Indian Punjab. These include the use of nitrogen fixing trees, green

manures, alley cropping, forest litter, and organic manures.

360 **Dupraz, C.** 1994. Prospects for easing land tenure conflicts with agroforestry in Mediterranean France: a research approach for intercropped timber orchards. *Agroforestry Systems,* 25: 181-192.
Agroforestry allows the combination of annual agricultural production and the long-term capitalization of timber. In Europe today, the policy of fallows is intended to reduce the excess of agricultural produce. Agroforestry management could be an alternative to fallows or to setting up tree plantations on farmland. Agroforestry is attractive to the owners of farmland in the French Mediterranean region, since agroforestry plots cost less than forestry plantations, are less prone to fire, supply agricultural products from companion crops for the first twenty years, and bring many environmental benefits. An experimental network of agroforestry plots within farms was set up in this region in 1988. These plots include seven grazed enclosures (silvopastoral systems with sheep or cows) and two non-grazed fields (silvicultural systems) set up with best-choice species: walnut (*Juglans regia*) on deep soils in lowland areas, wild cherry (*Prunus avium*) on hills and lower mountain areas, and red oak (*Quercus rubra*) in higher areas. Stocking levels on agroforestry plots are between 100 and 400 stems per hectare, and on traditional ones 1 100 stems per hectare. The trees were protected with plastic sleeves, and the ground was hoed with glyphosate for the first three years, and intercropped with a fodder species. The more densely stocked plots were soon thinned out. The trials were supported by landowners and tenants, the former hoping for a good profit from the timber, and the latter for free use of the space between the lines of trees. The planting was planned for ease of mechanization of the companion crop. The first results from two experimental sites (at Pomy and Ports, both in the Montpellier region) are discussed. These sites were grazed by sheep and planted with a certain number of tree species (including multipurpose trees). The main tree species was *P. avium* at Pomy, with grass between the lines, and *Q. rubra* at Ports, with *Dactylis glomerata* between the lines. The trees on the agroforestry plots grew much faster than those on the control forestry plots. An annex is given, describing the tree species used on all the experimental plots and indicating their uses (fruit, timber, apiculture, fodder, food).

361 **Epila, J.S.O.** 1988. Wind, crop pests and agroforest design. *Agricultural Systems,* 26: 99-110.
The influence of wind on insect flight performance, dispersal and resource exploitation is reviewed. Many insect species respond to chemical messages emanating from resources and are passively transported to target habitats by the wind. Because flying insects are generally poor aeronauts, the majority of them “rely” on natural windbreaks to effect physical contact with perceived target resources. These natural barriers obstruct airflow and subsequently reduce wind speeds, thus creating wind-shadows which enable insects to land on, or near, the resources. The effects of windbreaks of woody plants on primary insect infestation patterns on crop plant components of agroforestry are discussed in relation to agroforest design.

362 **Etienne, M., Hubert, B. *et al.*** 1994. Sylvopastoralisme en région méditerranéenne. *Revue Forestière Française,* Special issue 1994: 30-42.
After a review of the ideas underlying a silvopastoral development, three Mediterranean-region examples of the application to different situations (reforestation, coppicing, forest) show how a silvopastoral project must be adapted to the specific objectives of a given environment, and how this adaptation is the viable result of close coordination between two projects—one for a livestock system and one for forestry development.

363 **FAO** 1986. *Brise-vent et rideaux abris avec référence particulière aux zones sèches.* Rome, FAO, 385 pp.

This work seeks to gather together all the available information on the results of work carried out over the previous 20 years in the field of wind erosion control, and provides basic theoretical and practical elements for the design, installation and management of windbreak networks. The work is addressed to three types of reader: forestry and agricultural experts who hope to make practical use of the results of windbreak research, teachers who seek a reference work to help them to design a training course, and research experts who want to study windbreaks and need theoretical and practical data to help them in the choice of research topics. The information presented in this work is based to a considerable extent on work carried out in the Mediterranean region, but most of it can be applied to environmental conditions in other parts of the world.

364 **Fernandez-Juricic, E.** 2000. The role of arborists in providing wildlife habitat and landscape linkages throughout the urban forest. *Avifaunal use of wooded streets in an urban landscape,* 24: 513-521.
Birds in urban landscapes primarily occupy parks (forest fragments), wooded streets (linear strips connecting fragments), or the urban matrix. In this study, which was carried out in Madrid (Spain) during two consecutive breeding seasons (1997-98), the effects of street location in the landscape, vegetation structure, and human disturbance (pedestrian and automobile load) within wooded streets were investigated on bird species richness, temporal persistence, and density of feeding and nesting guilds, and on the probability of street occupation by individual species. The number of species recorded increased from the least suitable (control streets without vegetation) to the most suitable habitats (urban parks), with wooded streets being intermediate landscape elements. Fourteen species, belonging to 4 of the 8 guilds identified in this system, were recorded in wooded streets in both years. Streets that connected urban parks, along with vegetation structure, positively influenced the number of species within wooded streets, species persistence, guild density, and probability of occupation of streets by individual species. Human disturbance exerted a negative influence on the same variables. Wooded streets potentially could function as corridors, allowing certain species (particularly those feeding on the ground and breeding in trees or tree holes) to fare well by supporting alternative habitat for feeding and nesting. It is concluded that local improvements in corridor quality, through increased vegetation complexity and reduced human disturbance, could exert a positive influence on the regional connectivity of the system. Because of differential use of corridors by species with different habitat requirements, however, corridor implementation should also take into account the target species of management.

366 **Folly, A.** 1997. *Land use planning to minimize soil erosion. A case study from the Upper East Region in Ghana.* Copenhagen, Institute of Geography, University of Copenhagen, 207 pp.
An examination is presented of soil erosion in the Upper East Region of Ghana, focusing on the symbiosis between the biophysical parameters and the socio-economic parameters. The paper is divided into nine chapters. Chapter 1 introduces the soil erosion problem in general and in Ghana in particular, and presents the overall research questions. The chapter also provides a general description of the study area. In chapter 2 discussing land use planning, different ways of assessing erosion risk and estimating soil loss is presented providing the basis for the choice of the Universal Soil Loss Equation (USLE). The assessment of erosivity is discussed in chapter 3, with an investigation of the spatial variability of erodibility in chapter 4. A determination of topographic characteristics using digital terrain models is presented in chapter 5. Land cover mapping is presented in chapter 6 using Landsat TM images analysed through a knowledge-based approach providing the basis for an assessment of the land cover and crop management factor in the USLE. The spatial distribution of erosion-control practices is mapped followed by an erosion risk assessment indicating the mean, annual soil

loss within the study area. A discussion is presented in chapter 7 of the various errors associated with the use of GIS and perspectives on how to make the method more universal. Chapter 8 describes the socio-economic setting ranging from household, farm and market characteristics to an identification of the perception of erosion and the use of conservation measures. This provides data for a simplified linear programming example in chapter 9, which enables an identification of areas in which grass hedges minimizing soil erosion are to be introduced.

367 ***Fruits*** 1994. Special issue on tropical orchards. *Fruits,* 49: 503 pp.
This special issue of the journal *Fruits* contains some of the papers from the tropical orchards seminar held in September 1993. It reviews a whole series of scientific and technical information that may be of interest to both professionals and researchers. Some of the information is in the form of short updating notes (new cropping and propagation techniques), while some is in the form of clear but sufficiently detailed summaries (germplasm management, hybridization and selection work, genetic studies, identification and control of new parasites and pests). The introduction contains an economic reflection, reviewing the main trends and consumer demands.

368 **Galvin, M.F.** 1999. A methodology for assessing and managing biodiversity in street tree populations: a case study. *Journal of Arboriculture,* 25: 124-128.
As a consequence of compacted soils, impervious surfaces, heat irradiation, pollution, and other stresses, urban trees have an average expected service life of 10 to 25 years. Most US public agency budgets for street tree replacement and maintenance are declining. Public tree managers need tools to prolong the service life of street tree populations while reducing the need for maintenance activities (including pruning and pest management). Many jurisdictions rely on "approved tree" lists, but these often contain large numbers of species generally unavailable in a given area, and filters for diversity are seldom part of these documents. To avoid catastrophic losses and pest outbreaks associated with virtual monocultures, the Maryland Department of Natural Resources has developed a methodology for assessing biodiversity in existing populations. An inventory is taken. The results of the inventory are broken down taxonomically by family, genus, and species. The results are then analysed, with target levels established as follows: no more than 30% of any one family, 20% of one genus, or 10% of one species should be present. Based on the results of the assessment, recommendations are made as a tool for use in future replacement contracts to bring about the desired species composition.

369 **Georgofili, Accademia dei.** Study days on "global change". Open spaces for protection and improvement of the environment. The compatibility of agroforestry activities in protected areas. In *Giornate di studio sul global change.* Accademia dei Georgofili.
Papers given at a conference held in Teramo, Italy, 25-26 November 1994, are presented. The conference focused on land use in national parks and protected areas (in Italy). Included in the 14 contributions are papers on legislation, sustainable development and land use planning, agroforestry (particularly livestock husbandry in upland forest and grassland areas) and its role in reducing erosion and preserving the landscape, management of game animals, wildlife and forests in protected areas, recreation, arable farming and grazing in protected areas, and conflicts between local and national interests in land use and conservation policies. Two papers outline the development and present situation in national parks in the Abruzzi.

370 **Gilla, A.S., Lal, B. *et al.*** 1995. Erosion control in steeplands through agroforestry. In *Sustainable reconstruction of highland and headwater regions.* Proceedings of the 3rd International Symposium on Headwater Control, New Delhi. New Delhi.
Soil erosion is a major problem in hilly and mountainous regions of India. It results in

reduced soil fertility, floods, landslides, sedimentation of reservoirs, and damage to roads. Surface erosion control through agroforestry is discussed. The two most significant soil characteristics influencing erosion on steep lands are infiltration capacity and structural stability. The role of trees and shrubs in erosion control on hillsides is considered. Rotational practices are described: shifting cultivation, improved tree fallow, *taungya*. Plantation crop combinations, multistorey tree gardens, hedgerow intercropping and barrier hedges, and plant spacing in hedgerows are discussed.

371 **Godon, P. & Nguyen, G.Q.** 1997. Rubber and cashew intercropping systems. *Agriculture et Développement,* Special issue, Vietnam: 169-174.
Present economic changes encourage the development of permanent plantations and intercropping. On red soils that have been cultivated in the past, the correction of aluminium toxicity leads to a major increase in yields. More extensive tillage improves the results very little. On undegraded red upland soils, harrowing has proved very productive. Good initial fertility is improved by a massive application of thermophosphate. On degraded red soils on slopes, sod seeding lets rainfed rice make the best use of manure. The first tested fertilizer dose restores the fertility of these soils. These propositions allow optimization of companion crops and contribute to the success of village plantations of rubber, cashew or coffee. The joint cultivation of export crops and food crops can ensure sustainable development.

372 **Groppali, R.** 1994. The importance of hedges and tree rows for breeding and overwintering birds in the Po valley: proposals for protection and restoration. *Monti e Boschi,* 45: 12-16.
A survey of breeding bird species (in 1990) and overwintering bird species (in 1990-91) was carried out in 250-m lengths of four types of hedge in Cremona province, N. Italy: (1) a coppiced hedge (height 6 to 10 m) composed of hybrid plane (Platanus acerifolia); (2) a line of pollarded mulberry (Morus alba) trees, height 5 to 6 m; (3) a line of black poplar (Populus X euramericana [P. canadensis]) with sparse shrub understorey; and (4) a mixed hedge, with a rich shrub component, dominated by Quercus robur. Hedge type (4) contained the greatest number of breeding (45-48 pairs, 16 species) and overwintering (20-40 individuals, 12 species) birds. Enrichment of tree rows with shrub and tree species is suggested as a means of enhancing the habitat for birds in this intensively farmed area.

373 **Guofang, S. & Xian, W.** 1991. Techniques for rehabilitation of sylvo-pastoral ecosystems in arid zones. *Revue Forestière Française,* 3: 265-271.
After reviewing the present situation and recalling the problems encountered in combating desertification in arid zones, this article describes four techniques for the rehabilitation of silvopastoral systems: the erection of shelterbelts and the planting of trees on grazing land; the introduction of fodder plantations, by planting arborescent species; the stabilization of sand in order to improve grazing land; and the protection and rehabilitation of natural forests in arid zones. These techniques should be used in combination, taking local conditions into account.

374 **Harmand, J.M., Njiti, C.F. *et al.*** 1997. Gestion de l'arbre et des formations naturelles de savane en zone soudanienne. *In* L. Seiny Boukar, J.F. Poulain & G. Faure, eds. *Agricultures des savanes du Nord-Cameroun. Vers un développement solidaire des savanes d'Afrique Centrale,* p. 71-87. Acts of an exchange workshop, Garoua, Cameroon, 25-29 November 1996. Montpellier, France, CIRAD.
This paper discusses the results of agroforestry research, focusing on the sustainable management of natural resources and inputs, carried out by the Cameroon Institute of Agronomic Research in the context of the Garoua project. Various management approaches for trees and their environment are examined on the basis of experimental work in full-scale environments and of studies in a small-farmer environment.

Study of the growth dynamics of natural savannah formations in the Sudano-Sahelian zone allowed assessment of various savannah management methods. Observations on private woodlots showed how useful grasslands can be in ensuring the sustainability of these stands. Study of the functioning of *Faidherbia albida* parkland focused on the behaviour of cotton under trees and on the water balance of the soil system and the cultivated plant. In a situation where soil fertility is a problem, alley cropping trials allowed a view of interactions between hedges of trees and cultivated plants. The impact of different fallows on the characteristics of ferruginous soils was also studied, and the organic and mineral status of the soil was best conserved by planting *Acacia polyacantha*. Trial results are also available on installation and coppicing techniques for the species most suitable for use in rural development. Some possible topics for future research and development are listed, such as reorganization of the timber sector, or development of gum arabic acacia (*A. senegal*) fallows to restore soil fertility and improve producers' income.

375 **Henniger, J., Fatcha, H.H. *et al.*** 1989. Arborización urbana. Especies adecuadas y su plantación en el Paraguay. *Revista Forestal,* 1: 31-39.
This article summarizes and evaluates the features of the indigenous and exotic trees most suitable for planting in urban areas in eastern Paraguay. A list of 30 selected tree species is given in order to facilitate the choice of the species best suited for each situation and condition.

376 **Hodge, S.J.** 1995. *Creating and managing woodlands around towns.* London, HMSO Publications Centre, 176 pp.
The handbook presents practical information on the process of urban woodland planting, establishment and management in the UK, including community involvement and planning multipurpose woodlands. The 10 chapters describe: opting for woodland; issues affecting the decision to plant; working with local people; the right specification; establishing successful woodlands; woodland creation from seed (natural regeneration, direct sowing); managing existing woodlands; woodlands for particular uses (recreation and amenity, wildlife, timber production); and two case studies - Freckland Wood, a new woodland and Belvoir Park Forest, an existing woodland.

377 **IDF** 1978. *Les terrains boisés et leur mise en valeur.* Paris, IDF, 200 pp.
This work offers simple, clear answers to each of the following questions: Is it better to produce small-diameter timber of high quality or large trees of middling quality? If it is possible, what should be done, how, and with whom? How much would it cost? Is it cost-effective? The aim of this work is not merely utilitarian, for it also offers the reader the basic concepts underlying the various methods of cultivation and management of forest stands.

378 **IDF** 1995. *Les bourses d'arbres. Remembrer sans déboiser.* Paris, IDF, 47 pp.
The movement to plant new hedges is steadily growing. At the same time, many trees are still being uprooted during private or public land regrouping operations. How can the community's tree heritage—formed over previous centuries—be preserved during regrouping operations? One solution is the establishment of "tree grants", but how are they to be set up, organized and successfully run? The IDF gives an overview of the situation and future prospects on the basis of French experience.

379 **Ingram, J.** 1990. The role of trees in maintaining and improving soil productivity: a review of the literature. *In* R.T.L. Prinsley, ed. *Agroforestry for sustainable production. Economic implications,* p. 243-303. London, Commonwealth Science Council.
Topics covered include: definition and measurement of benefits (soil fertility, soil productivity, soil conservation, degradation, sustainable agriculture); reviews to date; evidence for improvement of soils by trees; effects of individual trees and shrubs on soils and crops beneath them (Acacia albida, Prosopis spp., and other examples of microsite

enrichment under tree/shrub canopies); agroforestry systems research; processes by which tree**s** affect soils (protection, conservation and increase of soil **organic** matter (SOM), above ground litter, below ground litter, factors affecting SOM decomposition and mineralization, increase in nutrient status, nutrient cycling, improved moisture status); tree selection and management; crop response; time; and levels of impact.

380 **Jaenicke, H., Simons, A.J.** ***et al.*** 2000. Domesticating indigenous fruit trees for agroforestry. *Acta-Horticulturae: Proceedings of the 15th International Horticultural Congress. Part 13: New and specialized crops and products, botanic gardens, and human-horticulture relationship,* 523: 45-51.
As new exotic fruits are being introduced to consumers in the North, **domestication** of lesser-known, indigenous fruits for tropical subsistence farmers receives an additional perspective. **Domestication** of indigenous fruits is part of a strategy to improve human nutrition in rural areas and to "put money into farmers' pockets" in order to improve their living conditions. It is an integrated strategy that involves dissemination of information and **germplasm** following research on identification, production, management and adoption of desirable **germplasm**. The different strategies for two species, Uapaca kirkiana and Bactris gasipaes, are presented. U. kirkiana is a dioecious tree whose fruits are widely eaten throughout southern Africa, but are only traded locally. B. gasipaes is a palm species with considerable importance in Central and South America. Through a long history of use by indigenous people, the species now has a complex of distinct landraces. Its market is mainly regional, but two of its products, fresh and canned heart-of-palm, are being commercialized in North America and Europe. With growing markets, improved production of both species could help improve the local farmers' conditions. **Germplasm** collections of both species have been conducted and genetic trials established in a number of countries. Vegetative propagation is a key technique to support the genetic selection. Current research on grafting of U. kirkiana and on the induction of adventitious shoot production in B. gasipaes is presented.

381 **Jong, B.H.J. de, Montoya-Gomez, G.** ***et al.*** 1995. Community forest management and carbon sequestration: a feasibility study from Chiapas, Mexico. *Interciencia*, 20: 429-436.
Results are presented from a feasibility study to: (1) evaluate the interest of local communities in, and how they would organize themselves for, a forestry carbon sequestration project; (2) identify the carbon sequestration potential of the agroforestry/forestry systems that are both ecologically viable and preferred by local farmers; (3) determine the social constraints of, and potential for, such projects; and (4) assess the economic potential of the carbon offsets estimated for such systems. The project was carried out in 2 ecological regions: the Tojolabal and Tzeltal zones of Chiapas, Mexico. Five systems with high carbon sequestration potential were considered technically and socially viable for each region. Initially, all participants will plant trees on an individual basis in their coffee plantation, fallow and pasture lands, or in their maize fields. The estimated amount of carbon sequestered ranged from 46.7 to 236.7 t/ha. Net income benefits due to converting fields from maize cultivation to farm forestry were estimated at $500-1000/ha. Forests and farm woodlands that are sustainably managed have substantial economic and carbon sequestration potential. The principal barrier to communal forest management appears to be socio-political rather than economic. Because forest management requires long-term investments, good planning is essential and includes community control of projects, selection of appropriate tree species, and management techniques that are specific to the ecological and social conditions of the area.

382 **Kang, B.T. & Reynolds, L.** 1986. *La culture en couloirs dans les tropiques humides et subhumides.* Acts of an international workshop on alley farming in humid and

subhumid tropics, Ibadan, Nigeria, 10-14 March 1986. Ottawa, CRDI, 271 pp.
Scientists studying food crops in high-altitude areas in many humid and sub-humid tropical regions have an urgent task: that of finding viable, sustainable and environmentally sound replacements for the old systems of crop rotation, fallow and shifting cultivation. As an agricultural and animal husbandry technique, alley farming requires few inputs and helps in soil conservation, while boosting long-term agricultural productivity. This publication contains the results of an international workshop on alley farming in humid and sub-humid tropical areas, attended by 100 people from 21 countries. The workshop focused on the development of more productive and sustainable cultivation methods needing few inputs for humid and sub-humid tropical regions, thanks to alley cropping techniques. It gives an overview of present research on alley farming and its applications, discusses the use of trees in tropical farming systems, highlights training and research needs, and suggests the establishment of networks for collaboration on research.

383 **Kang, B.T., Reynolds, L. *et al.*** 1990. Alley farming. *Advances in Agronomy,* 43: 315-359.
This article assesses alley farming for foodcrop and livestock production. The use of trees and shrubs in fallow systems and the development of alley farming is briefly discussed, before moving on to the importance of establishing and managing hedges (choice of species, and management for mulch and fodder production), the benefits in terms of crop production (soil yield, properties and conservation, suppression of weeds, and crop yields) and the benefits for livestock (quality and availability of food, effect on consumption, digestibility and livestock production). Economic and social aspects of alley farming are also identified and briefly examined, as well as research needs.

384 **Kendle, T., Forbes, S. *et al.*** 1997. *Urban nature conservation: landscape management in the urban countryside.* London, E. & F.N. Spon, 352 pp.
This book attempts a synthesis of principles which will guide urban landscape management and policy formulation at a strategic level which allows the integration of conservation into a wider management or urban planning framework. This a complex technical area which requires professional management understanding of ecological, traditional horticultural and arboricultural approaches to green space development. The resulting text is a comprehensive overview aimed at the working professional and students. After a preface, there are 9 chapters: The urban estate and the 'urban countryside'; The urban environment and urban species; The history and development of ecological landscape styles (with Cooper, D.) - with particular reference to the UK, but including discussion of Germany, the Netherlands and the USA; The objectives of urban nature conservation; Biogeography and conservation planning in the urban countryside; Ecological restoration and habitat creation; Restoration and creation of the main biome types - grassland, heath, annuals, wetland, trees, woodland; Strategic management issues in the urban countryside - including vegetation management and weed control; and Nature for people. A subject index is included.

385 **Kepner, W.G., Watts, C.J. *et al.*** 1999. A landscape approach for detecting and evaluating change in a semi-arid environment. In *Fourth Symposium on the Environmental Monitoring and Assessment Program.* San Francisco, Calif., 6-8 April 1999.
Trends in ecological and hydrological conditions are being monitored in a community-based watershed in southeast Arizona, USA and northeast Sonora, Mexico using a system of landscape pattern measurements derived from satellite remote sensing, spatial statistics, process modelling, and geographic information systems technology. These technologies provide the basis for developing landscape composition and pattern indicators as sensitive measures of large-scale environmental change and may provide an effective and economical method for evaluating watershed condition related to disturbance from human and natural stresses.

The project utilizes the database from the North American Landscape Characterization (NALC) project which incorporates triplicate Landsat Multi-Spectral Scanner (MSS) imagery from the early 1970s, mid 1980s, and the 1990s. Landscape composition and pattern metrics were generated from digital land cover maps derived from the NALC images and compared across a nearly 20-year period. Results about changes in land cover for the study period show that extensive, highly connected grassland and desert scrub areas are the most vulnerable ecosystems to fragmentation and actual loss due to encroachment of xerophytic mesquite woodland. In the study period, grasslands and desert scrub decreased in extent and became more fragmented. That is, the number of grassland and desert scrub patches increased and their average patch sizes decreased. In contrast, the mesquite woodland patches increased in size, number, and connectivity. These changes have important impact for the hydrology of the region, since the energy and water balance characteristics for these cover types are significantly different.

386 **Khosla, P.K., Uppal, D.K. *et al.*** 1996. *Ecofriendly trees for urban beautification.* Solan, India, Indian Society of Tree Scientists, 329 pp.

This book comprises 33 invited papers from the M.S. Randhawa Memorial National Symposium on Trees for Beautification and Ecofriendly Plantation in Cities, held at DAV College, Chandigarh, on February 10-11, 1996, under the auspices of the Indian Society of Tree Scientists. The papers are arranged in 5 sections. Section I, Landscaping: the past, present and future, has 7 papers on trees for the 21st century, a history of tree growing in India, avenue and garden trees, amenity planting and trees for environmental conservation and landscaping. Section II, Landscaping with native species, has 5 papers. Section III, Tree management and genetic improvement, has 10 papers, on various aspects of tree breeding (including cytology, cytogenetics, vegetative propagation, and genetic improvement for pest and disease resistance), and aspects of the management of urban trees and tree nurseries. Section IV, Architecture and silvics, has 6 papers. Section V, Trees for ecofriendly plantations, has 5 papers on the use of trees for combating air pollution, dust and noise pollution, the need to avoid the use of allergy causing trees in urban plantings, the use of Couroupita guianensis as a pollution indicator, and strategies for ecofriendly planting in cities. There is a species index to the main part of the book. An appendix gives a tabulated list of 210 trees available in India for urban planting, with details of scientific and common names, country/region of origin, mode of propagation, flower colour and flowering season, and possible uses (other than for fuelwood and timber). The appendix it includes an index to the English/common/vernacular names given in the table.

387 **Kort, J., Turnock, R. *et al.*** 1999. Carbon reservoir and biomass in Canadian prairie shelterbelts. *Agroforestry Systems,* 44: 175-186.

Greenhouse gases in the atmosphere, mainly carbon dioxide (CO2), can be mitigated by the planting of trees and shrubs. Appropriate agroforestry practices in Saskatchewan (Canada) include field and farmyard shelterbelts, wildlife plantations, poplar plantations and managed woodlots. A study was conducted to determine the amount of carbon held in prairie shelterbelts. The effect of the soil type and tree/shrub species (12 species in all) on biomass and carbon content was measured in shelterbelts in the brown, dark brown and black soil zones of Saskatchewan, although separate measurements for each soil type were made for only the 5 commonest species: caragana (Caragana arborescens, a shrub); and the deciduous species Manitoba maple (Acer negundo), Siberian elm (Ulmus pumila), hybrid poplar (Populus deltoides) and green ash (Fraxinus pennsylvanica). The other species included in the study were: the conifers white spruce (Picea glauca), Colorado spruce (P. pungens) and Scots pine (Pinus sylvestris), and the shrubs choke cherry (Prunus virginiana var. melanocarpa), villosa

lilac (Syringa villosa), buffaloberry (Shepherdia argentea) and sea buckthorn (Hippophae rhamnoides). Mean above-ground carbon content for the 5 commonest species was: 26 t/km for caragana; 86 kg/tree (34 t/km) for Manitoba maple; 110 kg/tree (40 t/km) for Siberian elm; 260 kg/tree (104 t/km) for hybrid poplar; and 79 kg/tree (31 t/km) for green ash. In the brown and the dark brown soils, which are more arid than the black soil zone, the trees/shrubs had 60.6 and 65.5%, respectively, of the biomass and carbon content than those of trees/shrubs in the black soil zone. Simple equations were developed to calculate the carbon contents of prairie shelterbelts, based on easily measured tree or shrub parameters. The results of this particular study and the broader implications of this work are discussed.

388 **Kotschi, J.** 1990. Ecofarming practices for tropical smallholdings. In *Tropical Agroecology.* Weikersheim, Germany, Verlag Josef Margraf, 5: 185.
This paper contains chapters on: agroforestry for soil maintenance in the semi-arid areas of Zimbabwe; conservation of soil fertility by peasant farmers in Atlantic Province, Benin; green manuring with fast-growing shrub fallow in the tropical highland of Rwanda; investigating possibilities of combining fodder production with erosion control and agroforestry in the West Usambara Mountains of Tanzania; multiple cropping with deciduous trees in the cold tropical highland of Colombia; low-cost soil and water conservation measures for smallholders in the Sudano-Sahelian zone of Burkina Faso; and opportunities for cooperation between scientists and farmers in ecofarming research.

389 **Lagerstrom, T. & Eriksson, G.** 1996. Improvement of trees and shrubs by phenotypic selection for landscaping in urban and rural areas. A Swedish example. *Forest and Landscape Research,* 1: 349-366.
The unfortunate coincidence of a rapid increase in demand of plant material for planting in rural and urban areas in Sweden and lack of hardy and true breeding cultivars during the seventies called for immediate measures. As a response to this an improvement programme started in 1983. According to type of plantation and possible investment costs one or more of five levels of improvement is used for 25 native and 26 exotic species. Approval based on visual examination of phenology, growth characteristics and health in progenies from potential seed stands grown in a commercial nursery is the first level of the improvement programme. Narrowing of the variation in growth habit traits in approved seed stands and establishment of new seed stands are the second level. Delineation of climatic breeding zones based on phenological studies is the third level. Phenotypic selection of individuals with good exterior characteristics is carried out at the fourth level and seed orchards are established. Finally the fifth level is a simple recurrent selection, meaning that selection is carried out over more than one generation without keeping track of the pedigree. Improvement at levels 4-5 can only be carried out for species with high commercial value, such as Acer platanoides and Prunus avium. So far about 70 plantations or wild stands have been appointed as seed stands. Thirty new seed stands and nine seed orchards with selected phenotypes have been established. Information to landscape architects, nurserymen, constructors and managers of parks and amenity forests about the merits of using improved plants is an integrated and important part of the improvement programme.

390 **Lal, R.** 1989. Agroforestry systems and soil surface management of a tropical alfisol. 2: Water runoff, soil erosion, and nutrient loss. *Agroforestry Systems,* 8: 97-111.
Field runoff plots, 70X10 m each, were established on a tropical alfisol at Ibadan, Nigeria, to monitor water runoff, soil erosion and nutrient loss in water runoff. A non-agroforestry control treatment was established with plough-till and no-till systems of seedbed preparation. Agroforestry (alley cropping) systems based on contour hedgerows of Leucaena leucocephala and Gliricidia sepium were established at 4-m and 2-m spacings. Field plots were established in 1982 and

hydrological measurements were made for uniform maize (Zea mays)/cowpea (Vigna unguiculata) rotations for 12 consecutive growing seasons from 1982 to 1987. Once established, hedgerows of L. leucocephala at 2-m spacing were extremely effective in reducing water runoff and controlling erosion. Runoff, erosion and nutrient losses were generally more from maize grown in the first season than from cowpea grown in the second. Mean seasonal erosion from maize was 4.3, 0.10, 0.57, 0.10, 0.64 and 0.60 t/ha for plough-till, no-till, L. leucocephala-4m, L. leucocephala-2m, G. sepium-4m and G. sepium-2m treatments, respectively; mean runoff in the first season was 17.0, 1.3, 4.9, 3.3, 4.3, and 2.4% respectively of rainfall received. There were high losses of Ca and K in water runoff from the plough-till treatment. In contrast to runoff and erosion, losses of bases in water runoff from agroforestry treatments were relatively high, probably because of nutrient recycling by the deep rooted perennials.

391 **Lawton, K. & Wiken, E.B.** 2000. Understanding wildlife habitats in urban areas. *Forestry Chronicle,* 76: 259-262.
A discussion of the attitudes of Canadians to urban wildlife and the need to monitor and manage the wildlife and their habitats.

392 **Lefroy, E.C., Stirzaker, R.J. *et al.*** 1999. Agroforestry for water management in the cropping zone of southern Australia. *Agroforestry Systems,* 45: 277-302.
Agroforestry has been advocated as a means of managing the excess water that has accumulated in the agricultural landscape of southern Australia since the native vegetation was cleared. This article examines the feasibility and profitability of agroforestry systems designed to manage rising saline water tables. A framework for Australian conditions is described that considers the interactions between trees, crops and their below-ground environment and how they influence water use, crop yield and profitability. Data are presented from a study of a commercial-scale agroforestry (alley cropping) system was the fodder tree tagasaste (*Chamaecytisus proliferus* [*C. prolifer*]) at Moora in southwestern Australia, under ideal conditions where trees have access to a shallow fresh water table; water use and productivity data are given for trees alone, crops alone (grain lupins, *Lupinus angustifolius* var. *Gungurru*, followed by oats, *Avena sativa* var. *Toodyay*) and alley cropping treatments. The discussion is then broadened to encompass soil, relief and ground water conditions more typical of the southern Australian cropping zone. The relative merits of segregating, integrating and rotating trees with crops are then examined. It is concluded that, in most cases, trees would need to be widely dispersed over a significant proportion of the landscape to manage deep drainage and salinity. Agroforestry is, therefore, only likely to be an effective solution to water management where trees can compete directly on commercial terms with conventional agriculture. Given the generally low rates of biomass accumulation in semi-arid woody species, this presents a significant challenge for agroforestry in the cropping zone of southern Australia.

393 **Lichou, S.J. & Tronel, C.** 1999. La production raisonnée, intégrée et biologique en arboriculture fruitière: definitions. *Infos-Paris,* 157: 37-39.
This brief paper presents trends in integrated and organic management of orchards in comparison with conventional management. The evolution of the concepts of integrated and organic management are discussed in relation to practical implications, economic and environmental considerations, and fruit quality (customer satisfaction).

394 **Li, H., Gartner, D.I. *et al.*** 1999. A landscape model (LEEMATH) to evaluate effects of management impacts on timber and wildlife habitat. *Computers and Electronics in Agriculture,* 27: 263-292.
Managing forest resources for sustainability requires the successful integration of economic and ecological goals. To attain such integration, land managers need decision support tools that incorporate science, land-use strategies, and policy options to assess

resource sustainability on large scales. LEEMATH (Landscape Evaluation of Effects of Management Activities on Timber and Habitat) is a tool for evaluating alternative management strategies from both economic and ecological perspectives. The current version of LEEMATH emphasizes timber production and wildlife habitat in industrial forest landscapes. LEEMATH provides a framework upon which various models can be integrated. It is generic because it is designed to model stand growth, habitat attributes, and habitat suitability as found generally throughout the American Southeast. It is dynamic because it examines the effects of management strategies on timber production and habitat quality over time, especially the balance between habitat loss and regrowth at the landscape scale. It is spatially explicit because it evaluates landscape configuration for its effects on habitat in terms of adjacency requirements and dispersal potential. It is heuristic because it simulates the dynamics of forest stands under different management scenarios and allows land managers to ask "what-if" questions to explore management alternatives and their possible effects over time. The paper discusses how to integrate different models into a decision-support system, and how to evaluate habitat suitability on the landscape level. Gaps in knowledge of landscape habitat assessment and the limitations of LEEMATH are also discussed. Finally, LEEMATH is applied to a forested landscape (the Woodbury Tract) on the coastal plain of South Carolina, USA, to demonstrate its usefulness in management planning with multiple interests. The landscape is made up of longleaf pine (*Pinus palustris*), loblolly pine (*P. taeda*), cypress/tupelo (*Taxodium* sp./*Nyssa aquatica*), bottomland hardwoods, upland oak (*Quercus* sp.), mixed pine/hardwoods, and non-forest. The effects are shown of two management regimes on timber production, habitat attribute dynamics, and habitat quality of three target wildlife species (the Acadian flycatcher [*Empidonax virescens*], Bachman's sparrow [*Aimophila aestivalis*] and the barking treefrog [*Hyla gratiosa*]) on both the stand and landscape levels.

395 **MacDicken, K.G.** 1997. *A guide to monitoring carbon storage in forestry and agroforestry projects.* Morrilton, Ark., USA, Winrock International Institute for Agricultural Development, 87 pp.

This guide describes a system of cost-effective methods for monitoring, measuring and verifying carbon storage on a commercial basis for three types of land use: forest plantations, managed natural forests, and agroforestry systems. The methods were developed by the Forest Carbon Monitoring Program of Winrock International as a way of providing reliable results using accepted principles and practices of forest inventory, soil science and ecological surveys. The system assesses changes in four main carbon pools: above-ground biomass, below-ground biomass, soils, and standing litter crops. It aims to assess the net change in each pool for project and non-project (or pre-project) areas over a specified time period. Although carbon monitoring requires specialized equipment and trained personnel, the system aims to minimize the associated costs. The components of the system are: (1) baseline determination of pre-project carbon pools in biomass, soils and standing litter crop; (2) establishment of permanent sample plots for periodic measurement of changes in carbon pools; (3) plotless vegetation survey methods (quarter point and quadrant sampling) to measure carbon stored in non-project areas or areas with sparse vegetation; (4) calculation of the net difference in carbon accumulated in project and non-project land uses; (5) use of satellite images and base maps to gauge vegetation changes; (6) development of computer software to calculate minimum sample size; (7) computer modelling of changes in carbon storage for periods between field measurements; and (8) creation of a database of biomass partitioning (roots, wood, foliage) for selected species. There is a companion guide, entitled Field Tests of Carbon Monitoring Methods in Forestry Projects.

396 **Madany, M.H.** 1991. Living fences: Somali farmers adopt an agroforestry technology. *Agroforestry Today,* 3: 4-7.
This document describes a participatory agroforestry project implemented by World Concern in a leprosy colony on Labadaad Island in the River Jubba, in the Jilib region of southern Somalia, between 1984 and 1989. The project was part of a broader programme, which also covered primary medical services, income generation and agriculture. The initial activity, designed to combat falling soil fertility and a wood shortage, was the installation of an alley farming trial, with crops being grown between hedges of *Leucaena leucocephala* and other multipurpose trees. The trial plot was also used to assess intercropping with pigeon peas and other pulses and to evaluate other species of trees, including fruit trees. In the absence of resources to build protection barriers (*Acacia* and *Dichrostachys*), live barriers of *Parkinsonia aculeate* (a new species for the community) were planted around the trial plot. Ten years later, the use of this technique was extended to the protection of agricultural plots (bananas, tobacco, squashes, maize and sesame) on the initiative of communities in the nearby Jubba area. The use of living fences was also suggested as protection against cattle and soil erosion. The development and management of such fences from 1986 onwards are described, and the factors involved in the successful adoption of this new technology are discussed. These factors include population growth, a decrease in available arable land, the fact that a community under pressure is more ready to adopt a new technology, the low amount of labour needed for living fences, and their secondary advantages of fuelwood production. The species used for the fences are: *Parkinsonia aculeate, Caesalphinia pulcherrima, Prosopis chilensis, Acacia nilotica, A. mellifera* and *Zizyphus mauritiana*.

397 **Mailliet, L.** 1989. Approche méthodologique de la gestion de l'arbre en ville. Quelques éléments pour l'inventaire du patrimoine. *Revue Forestière Française,* Special issue, L'arbre en ville: 119-124.
Like other cities and towns in Europe, especially in Switzerland and Germany, French towns are installing the tools and structures needed for a modern management of their tree heritage. The main aim of this article is to offer a methodological framework for professionals.

398 **Masson, P., Papanastasis, V.P., Frame, J. *et al.*** 1999. Shrub management by grazing animals in French cork oak forests. In *International Occasional Symposium of the European Grassland Federation,* p. 199-203. Thessaloniki, Greece, 27-29 May 1999. Thessaloniki, Greece, Hellenic Range and Pasture Society.
In the cork oak (*Quercus suber*) forest of southern France, animal husbandry systems help in fire prevention by reducing the shrub component of the undergrowth. A detailed analysis of the shrub vegetation (cover and height) on an area of 200 ha managed by four livestock systerms (including goats, cattle and horses) was used to determine the role of browsing after a five-year period. The shrubs were well controlled in the cleared and sown paddocks. The species sown were *Trifolium subterraneum*, *Dactylis glomerata* and *Festuca arundinacea*. In the uncleared paddocks, the apparent phytovolume remained high. The canopy cover played a major role in shrub control. In the open forests, control of self-sown *Cistus* spp. was difficult and the optimum tree cover for silvopastoral management appeared to be 30-40% for the cork oak forest. The management of silvopastoral systems by the farmers in relation to production and fire prevention objectives indicated that about half of the grazed territory is well maintained for fire prevention. In the remaining territory, grazing animals maintain a simple opening-up of the forest. Patterns of land use suitable for fire prevention are discussed.

399 **McAdam, J.H., Hoppe, G.M. *et al.*** 1999. The use of wide-spaced trees to enhance faunal diversity in managed grasslands. In *International Occasional Symposium of the*

European Grassland Federation. Thessaloniki, Greece, 27-29 May 1999. Thessaloniki, Greece, Hellenic Range and Pasture Society.
In Northern Ireland, over 92% of farmed land is managed grassland, and tree cover is only 6%. Silvopastoral systems in which widely spaced, protected, broadleaved trees are planted into managed pasture are a sustainable land use system which can reduce agricultural output, enhance the landscape and increase biodiversity. This paper summarizes replicated trials to investigate the effect of silvopastoral systems on birds, invertebrates, flora and earthworms at both a lowland and an upland site. An increase was found in carabid species and numbers when moving from open grassland through agroforestry to woodland conditions. A greater number of birds, although not bird species, visited both upland and lowland silvopasture than either agriculture or woodland controls. Preliminary data have shown that earthworm biomass is greater in silvopasture than grazed pasture. These results all indicate that widely spaced trees can enhance a range of indicators of biodiversity in managed grasslands.

400 **Miller, R.W.** 1997. *Urban forestry. Planning and managing urban greenspaces.* Upper Saddle River, 2nd edition, 502 pp.
This technical work focuses on the planning and management of urban vegetation, with very useful information on the history and uses of such vegetation, its evaluation, inventory methods, planning processes, management and maintenance.

401 **Miller, B.K., Moser, B.C. *et al.*** 1994. Designs for windbreaks and vegetative filterstrips that increase wildlife and provide income. In *Environmentally sound agriculture*. Proceedings of the 2nd conference, Orlando, Fla., USA. St Joseph, USA, American Society of Agricultural Engineers.
This paper outlines a long-term demonstration/research project to evaluate planting designs that met environmental objectives (soil conservation, water quality improvement, provision of a habitat for wildlife) and provided income to landowners equal to or exceeding row crop production on the same acreage. Windbreaks and filterstrips were designed that did not require labour inputs during the planting and harvest season for row crops, provided a better wildlife habitat, and were more aesthetically pleasing than conventional designs. Tree and shrub species providing ornamental cut branches utilized by the florist trade were capable of giving the environmental benefits desired in these plantings and were compatible with most row crop operations, since most labour inputs occurred between December and April. Pussy willow (*Salix discolour*) branches were harvested as early as two years after planting. Preliminary harvest studies indicated that gross returns in excess of $US 13 590/ha were possible.

402 **Misra, R.C. & Behera, G.** 1998. Vegetation type mapping using remote sensing technique. A case study of Koraput district. *Journal of Economic and Taxonomic Botany,* 22: 65-77.
Koraput district, the largest in Orissa, has diversified vegetation resources and a rich floristic composition owing to its wide range of physical features (topographical and altitudinal gradients). The natural vegetation of the district falls under the tropical deciduous forest type, and this is further divided into seven sub-categories depending on local microclimate, species composition and degree of deforestation: tropical semi-evergreen, potential sal (Shorea robusta) forest, tropical dry deciduous, intermediate teak forest (Tectona grandis/Terminalia), dry deciduous scrub, bamboo and grassland. The vegetation as observed from analysis of Indian Remote Sensing Satellite I-A LISS II data exhibits a distinct zonation into 6 belts according to the degree of biotic influence - natural forest vegetation (dense, open and degraded forest), horticultural and forest plantations, and groves (horticultural or amenity trees generally in the plains and foothills). The distribution of these zones in the 6 different phytogeographical zones (6) of Koraput and the smaller locations/blocks within them (63) is described and discussed,

with details of the characteristic species found in each phytogeographical zone.

403 **Moll, G., Young, S. *et al.*** 1992. *Growing greener trees: a tree-planting handbook.* Los Angeles, Calif., Living Planet Press, 126 pp.
This work provides information on trees and the critical roles they play in natural cycles, as well as the different processes involved in planting and maintaining them in an urban environment.

404 **Nasr, N.** 1997. Atouts et contraintes des oasis traditionnelles de Tataouine en Tunisie: étude de l'oasis d'El-Ferch. *Agriculture et Développement,* 14: 31-40.
Although the traditional oases of southeastern Tunisia have some major advantages (the existence of an accessible water table, skilled family labour, considerable non-agricultural income, closeness to markets, etc.), they also have to cope with various constraints (a shortage of water, salinization of water and soil, silting up, land fragmentation, etc.) that hinder their development. This article is a study of production systems in the El Ferch oasis, located in the Matmata mountains in Tataouine governorate. On the basis of a typology of farms and agricultural and socio-economic analysis of the oasis, the author suggests development approaches for the rehabilitation of traditional oases.

405 **Nilsson, K., Konijnendijk, C.C. *et al.*** 2000. Urban forestry: where people meet trees. In *Community forestry: a change for the better,* p. 28-31. Proceedings of a conference held in London, 7-8 December 1999. London, Forestry Commission and Countryside Agency.
In a society in process of urbanization, green spaces are recognized as major elements in the quality of the urban environment, filling a whole series of ecological, economic, cultural and social roles. The potential of urban green spaces is often not fulfilled, owing to pressure, lack of integrated planning and management, and a limited knowledge of these urban forests and trees. In recent decades, "urban silviculture" has seemed to offer the possibility of an integrated approach. Many different disciplines are involved in the planning and management of forests, parks, street trees and other green spaces. This paper offers the example of "COST Action E12" Urban Forests and Trees, a European network of research experts concerned with urban silviculture in 23 countries, which seeks to improve the database on urban silviculture. One of the main activities of this project has been the production of a synthesis of recent and current research on urban forests and trees in Europe. This overview indicates that appropriate research activities are at present fragmented, mono-disciplinary, and mainly carried out on a local or regional level. More coordination is needed, with integration and development of research work, in order to bring about sustainable management of urban green spaces.

406 **Nohr, H. & Jorgensen, A.F.** 1997. Mapping of biological diversity in Sahel by means of satellite image analyses and ornithological surveys. *Biodiversity and Conservation,* 6: 545-566.
The main objective of this study was to develop and test a method for mapping and monitoring biological diversity and stability in the West African Sahel zone (the Ferlo region of northern Senegal) using (1) ornithological survey data (species richness, numbers of individuals, diversity index, and avian biomass per area unit) collected in 1991-93 in transects primarily located within, or overlapping with, earlier study sites used for ground truthing satellite imagery and for analysing the woody vegetation and (2) remote sensing (Landsat Thematic Mapper (TM), and NOAA AVHRR (Advanced Very High Resolution Radiometer)) data from 1990-92. The area is dominated by annual grasses, shrubs and small trees, with the major vegetation types forming mosaics; it has suffered human impact from wood cutting, grazing, subsistence agriculture and intensive rice and groundnut production. Correlations were obtained between different measurements of avian diversity and the combination of a landscape diversity index based on Landsat TM data and yearly biomass expressed by INDVI (the Integrated

Normalized Difference Vegetation Index, derived from the AVHRR data). A multiple regression model based on 10 study site parameters (transect length, N.-S. gradient, Landsat TM landscape diversity index, biomass production, percentage bare ground, woody vegetation production, herbaceous vegetation production, heterogeneity of woody vegetation, diversity of woody vegetation, density of woody vegetation) explained 59-68% of the variation in avian species richness, number of individuals and Simpson diversity index. Based on the positive multivariate regression between avian diversity and Landsat TM and AVHRR images, a biodiversity map was produced for the Ferlo region. Limitations in the interpretation of the map and recommendations for improvement are discussed.

407 **Nor, S.M., Kwan, W.Y. *et al.*** 1990. *The tropical garden city. Its creation and maintenance.* Kuala Lumpur, Forest Research Institute of Malaysia, 99 pp.
Air pollution, overpopulation, the lack of open spaces and the scarcity of green spaces all contribute to the pressures and stresses of urban life. Proper planning and civil action can turn cities into gardens, leading to a better quality of life for their inhabitants. Creating and maintaining gardens in cities in humid tropical zones calls for a different approach from that used in other climates. This work describes the methods used in creating and maintaining such green spaces.

408 **Ohler, J.G.** 1999. *Modern coconut management: palm cultivation and products.* London, Intermediate Technology Publications, 475 pp.
This work presents recent information on the coconut palm and its adaptation to the environment, giving an overview of coconut-based cropping techniques. It discusses coconut products used industrially, such as copra oilcake, active charcoal, coconut oil and coconut sugar. It describes new selection and improvement techniques, and dedicates considerable space to diseases, their agents and the main predatory insects. Since coconut monocropping is no longer financially viable, or only so in marginal areas, various income-boosting intercropping or mixed cropping systems are discussed in some detail, as well as livestock production under coconuts. One chapter is devoted to national and international research and development programmes, and an annex contains a list of international organizations and research centres concerned with the coconut palm. An extensive bibliography completes the work. This handbook is addressed to students, planters and scientists.

409 **Ouedraogo, A.S.** 1995. Parkia biglobosa (Leguminosae) *en Afrique de l'Ouest: biosystématique et amélioration.* Wageningen, Netherlands, Wageningen Agricultural University, 205 pp.
The purpose of the research described here was to strengthen the scientific and technical basis of biodiversity conservation and use of Parkia biglobosa, a multipurpose tree used in agroforestry systems in West and Central Africa. Both technical and ethnobotanical data were collected. More than 1600 trees from 5 countries were sampled and various morphometric and phenological observations used to determine the level of variation extant in P. biglobosa, and the structure of this diversity. Socio-economic and cultural data were obtained through questionnaires filled in by more than 500 people from different ethnic groups in Burkina Faso and Benin. The research results are presented in 6 parts: preliminaries; introduction - taxonomy, botany and architecture; study on morphological and biochemical variation; socio-economic and cultural aspects - the ethnobotanical study; P. biglobosa in Burkina Faso - distribution, phenology, and its variation, pollination, reproductive behaviour and fruiting; and conservation and genetic improvement - the strategy in West Africa.

410 **Picard, O.** 1996. Scenarios technico-économiques de boisement de parcelles d'exploitations agricoles en Midi-Pyrénées. *In* G. Balent, ed. *La forêt paysanne dans l'espace rural: biodiversité, paysages, produits,* p. 213-227. Etudes et Recherches

sur les Systèmes Agraires et le Développement No. 29. Paris, INRA.
Afforestation within a farm can be looked at from two points of view: as a rationalization of production, or as a diversification. In the first case, afforestation replaces a short crop, economizes on labour, and allows capital improvement to landholdings. In the second case, afforestation must either go hand in hand with another activity (hunting, tourism) to bring in short-term income, or else be incorporated into the creation of a "wood workshop" that will encompass management of existing stands. Farmers have a major advantage over traditional foresters, inasmuch as subsidies and self-financing in kind make afforestation less expensive for them. However, the lack of concrete examples of afforestation on farms led to the use of a method based on silviculture scenarios. A number of simulations revealed the most interesting criteria for farmers, including cashflow management, labour time and capital improvements to landholdings.

411 **Race, D.** 1993. *Agroforestry: trees for productive farming.* East Melbourne, Australia, AGMEDIA, 240 pp.
This book is a comprehensive collection of up-to-date practical information on agroforestry practices in southeastern Australia. It has been written by a number of authors, and is the result of cooperation between the Department of Agriculture and the Department of Conservation and Natural Resources of Victoria, Australia, where agroforestry is making an important contribution to productive and sustainable land management. The book contains 38 chapters, a glossary and a subject index. The first 4 chapters are introductory and discuss the need for trees on farms, farm planning, the characteristics of agroforestry, and design options for it. Other chapters cover specific topics with reference to agroforestry and farm forestry. These are: the benefits of shelterbelts on farms; pruning and thinning for improved timber production; coppice systems; harvesting, milling and seasoning timber; timber products and their utilization and marketing; joint venture schemes between farmers and investors/managers; taxation; planning controls; the FARMTREE economic model; minor farm tree products (other than timber and fodder); agroforestry for irrigation farms and for salinity control; managing the agricultural component - crops, pasture and livestock; an overview of agroforestry tree species, and accounts of 8 species/groups (black walnut, Juglans nigra; blackwood, Acacia melanoxylon; Casuarina and Allocasuarina spp.; cypress, Cupressus spp.; Eucalyptus spp.; Paulownia spp.; radiata pine, Pinus radiata; and tagasaste, Chamaecytisus palmensis); tree seed collection; plant propagation; tubestock and open root plants; direct sowing; natural regeneration; pests and diseases; tree planting for erosion control; indigenous plants; trees and shrubs for wildlife; wildlife and the farm dam; and trees for fire protection.

412 **Rao, M.R., Singh, M.P.** ***et al.*** 2000. Insect pest problems in tropical agroforestry systems: contributory factors and strategies for management. *Agroforestry Systems,* 50: 243-277.
Pest management in agroforestry has not received much attention so far, but recent emphasis on producing high value tree products in agroforestry and using improved germplasm in traditional systems, and emergence of serious pest problems in some promising agroforestry systems have increased awareness of risks posed by pests. Insects may attack one or more species within a system and across systems in the landscape, so pest management strategies should depend on the nature of the insect and magnitude of its damage. Although greater plant diversity in agroforestry is expected to increase beneficial arthropods, diversity by itself may not reduce pests. Introduction of tree germplasm from a narrow genetic base and intensive use of trees may lead to pest outbreaks. In simultaneous agroforestry systems, a number of factors governing tree-crop-environment interactions such as diversity of plant species, host range of the pests, microclimate, spatial arrangement and tree management, modify pest infestations by affecting populations of both herbivores and natural enemies. Trees

also affect pest infestations by acting as barriers to movement of insects, masking the odours emitted by other components of the system and sheltering herbivores and natural enemies. In sequential agroforestry systems, it is mostly the soil-borne and diapausing insects that cause and perpetuate damage to the common hosts in tree-crop rotations over seasons or years. An integrated approach combining host-plant resistance to pests, exploiting alternative tree species, measures that prevent pest build up but favour natural enemies and biological control is suggested for managing pests in agroforestry. Species substitution to avoid pests is feasible only if trees are grown for environmental services such as soil conservation and low value products such as fuelwood, but not for trees yielding specific and high value products. For exploiting biological control as a potent, low cost and environmentally safe tool for pest management in agroforestry, research should focus on understanding the influence of environmental and management factors on the dynamics of insect pest-natural enemy populations.

413 **Reiss, D., Onana, J. *et al.*** 1997. Introduction de légumineuses fourragères dans les assolements: gestion des pâturages naturels. *In* L. Seiny Boukar, J.F. Poulain & G. Faure, eds. *Agricultures des savanes du Nord-Cameroun. Vers un développement solidaire des savanes d'Afrique Centrale,* p. 195-209. Acts of a meeting held in Garoua, Cameroon, 25-29 November 1996. Montpellier, France, CIRAD.
Pulses were selected in order to meet various fodder production and soil fertility restoration objectives. These appear compatible, and technical steps to be taken in introducing a fodder rotation cropping system are proposed, either focusing on a single crop or combining it with a main cotton or cereal crop. The role of pulses in improving the grazing value of fallows is assessed, together with the impact of fallows on soil fertility when soils are rested for a short time. The main grassland formations of the northern province of Cameroon are surveyed and classified. Organizational innovations are being implemented so that rangeland management principles can be put into practice.

414 **Rich, T.C.G., Clements, D.K. *et al.*** 1999. A comparison of four methods used to survey hedgerows: the Cardiff Hedgerow Survey 1998. *Journal of Environmental Management,* 60: 91-100.
Four survey methods were compared following the stratified sampling of 211 hedges in Cardiff County, S. Wales, UK: standard 30-m hedgerow lengths; 10X1-m plot lengths; the Hedgerow Evaluation and Grading System (HEGS); and important features, as defined by the 1997 Hedgerow Regulations (HR) of the UK Government. All the methods could identify variation between hedgerow types and hedges in different areas. Surveys of sections were able to indicate overall species richness, although 30-m lengths were more accurate than 10-m lengths. Generally, there was a good relation between HEGS and HR 'importance', but this relation was not predictive for middle-ranking hedges, and the HEGS method cannot be used instead of the HR, or vice versa. However, general hedgerow surveys using both these methods together can be conducted.

415 **Rochette, R.M.** 1989. *Le Sahel en lutte contre la désertification. Leçons d'expériences.* Weikersheim, Germany, CILSS, 592 pp.
On the initiative of CILSS, a regional strategy to combat desertification in the Sahel was adopted at Nouakchott in November 1984. Since then, each member country of CILSS has adopted a national masterplan for desertification control, while action has been taken by village communities in the different countries, with the support and advice of local associations, NGOs, project agents, workers, and government services. This book examines some of these initiatives, discussing their failures, difficulties and successes. It has two main objectives—that of providing information on positive experiences, and that of identifying and explaining the factors involved in failures and obstacles, as well as those involved in progress and success, both technical and social—and these indicate its

intended readership. The structure of the book stresses the field approach, describing 20 actual cases in the first part, while drawing some lessons from these cases in the second part.

416 **Roose, E., Ndayizigiye, F. *et al.*** 1998. Agroforestry, water and soil fertility management to fight erosion in tropical mountains of Rwanda. *Soil Technology,* 11: 109-119.
A strategy (GCES = land husbandry) has been suggested to increase the soil productivity rapidly and protect the rural environment by the efficient management of water, organic matter and soil fertility restoration. This strategy was tested in 9 runoff plots (5 X 20 m) on a 23% slope of a very acid ferrallitic soil (pH 4). Three types of living hedges (Leucaena, Calliandra, Calliandra + Setaria) twice replicated, were compared with the international bare standard plot and with the regional farming system (maize + beans during the first season, and sorghum during the second season). After 2 years, living hedges reduced runoff to <2% and erosion to 2 t/ha per year; they produced firewood and high quality leguminous forage (3 to 8 kg/m) and annually return to the soil as much as 80-120 kg N/ha, 3 kg P/ha, 30-60 kg Ca and K/ha, and 10-20 kg Mg/ha. Agroforestry reduced the erosion hazard but did not restore the soil productivity. Without 2.5 t lime/ha every 3 years to increase the pH up to 5 and reduce the aluminium toxicity, and without 10 t manure/ha every 2 years and mineral fertilizers to nourish the crops, the yield remains very low (800 kg cereals/ha). Agroforestry and mineral fertilizer controlled the erosion hazard and the productivity of soil and labour intensified more than 3 times.

417 **Shi, P., Li, W. *et al.*** 1998. *Rehabilitation of degraded mountain ecosystems in southwestern China: an integrated approach*. Beijing, Commission for Integrated Survey of Natural Resources, Chinese Academy of Sciences.
The degradation of mountain ecosystems in SW China has been unprecedented in speed and scale over the past decades. Deforestation, overgrazing, water and soil erosion, loss of soil fertility and declining or poor crop yields are alarming indicators of unsustainability due to rapid population pressure. Under the conditions of shortage of arable land, more marginal and forest lands are being reclaimed for agricultural use, and this accelerates the degradation of the fragile mountain ecosystems. Moreover, inaccessibility and a low level of education are preventing development in mountain communities. Agroforestry provides a promising resource-centred technology to meet the twin goals of productivity and conservation. This paper discusses the indigenous agroforestry systems practised in SW China, and the promising economic and ecological benefits. People in SW China have accumulated abundant knowledge on the utilization of agroforestry technologies to rehabilitate degraded land and the multiple benefits that follow some indigenous practices. Agroforestry technologies described in the paper are generally based on the use of the wide diversity of multipurpose tree species available. Outlines are given of the systems used: agrosilvicultural systems, including improved shifting cultivation, taungya, various types of homestead gardens (tree gardens with multiple-species multistorey associations of trees, vines and herbaceous species in space and time arrangements; planting trees around houses in forest canopy gaps; fuel plantations; religious forests; and field boundary planting); silvopastoral systems; agrosilvopastoral systems; other silvo-based multipurpose systems (silvo-insect systems - sericulture, apiculture, lac production; silvo-fungi systems - edible fungal resources in forests; silvo-sericulture-fishery-crop-systems; and silvo-livestock-fishery systems). Integrating the agroforestry system and modern agricultural technologies can be an effective approach for the sustainable development and rehabilitation of degraded mountain ecosystems. Aspects of this addressed are: modifying swidden fallow to resettled agroforestry; the return of steep slopes to forest lands (using contour hedgerows with crops cultivated in the strips between them); the rehabilitation of hot-dry

valleys; agroforestry contributions to biodiversity conservation; and environmental protection and poverty alleviation.

418 **Simons, A.J.** 1992. Genetic improvement of non-industrial trees. *Agroforestry Systems,* 18: 197-212.
Improvement strategies applicable to non-industrial (multipurpose) trees are discussed focusing on end use, target group of beneficiaries, amount of planting material required, the biology of the species and the amount and type of variation. Whichever strategy is used it is paramount that material is properly evaluated in trials and that diverse and productive germplasm is released. Cognizance of farmers' needs and criteria should be taken, with particular respect to risk aversion and the requirement for stabilization (rather than maximization) of production. The consequences of release of planting stock need to be considered in relation to whether improvement will be recurrent or a single event. The establishment of breeding seedling orchards that perform the combined functions of resource population, breeding population, progeny testing and seed production would be advantageous. Decision strategies for improvement of non-industrial **trees** are discussed in relation to the features outlined.

419 **Simpfendorfer, K.J.** 1989. *Trees, farms and fires.* Lands and Forests Bulletin No. 30. Victoria, Australia, Department of Conservation, Forests and Lands, 55 pp.
Fire danger and fire effects are discussed, and the design of and selection of species for shelterbelts to protect farm buildings and fields in Victoria from fire are described. A table lists preferred species for fire shelterbelts, and an appendix tabulates the characteristics of recommended species in relation to fire.

420 **Sinclair, F.L.** 1997. *Special issue on the control of soil erosion and fertility on sloping land.* 36 pp.
This issue focuses on contour hedgerows. Nine papers by various authors are included, describing the effectiveness of the system, discussing soil redistribution within the cropped alleys of such systems and its modelling, and reporting studies from the Philippines, the Andean Hills of Bolivia, Latin America and the Caribbean, Nepal, and the tropics and subtropics in general.

421 **Subramanian, K.N., Bedell, P.E. *et al.*** 1992. *Casuarinas: trees of multiple utility.* Dehra Dun, India, Indian Council of Forestry Research and Education, 115 pp.
This treatise is a compilation of information on Casuarina, presented in 6 chapters: (1) Taxonomy - including morphology, classification, phylogeny and details of species (36 ref.); (2) Genetic resources - mapping the genetic spectrum, species distribution and genetic variability, genetic improvement, provenance trials, plus tree selection, germplasm banks, vegetative propagation, seed orchards and genetic engineering (36 ref.); (3) Seed biology - reproductive structures, fruit and seed structure, seeding habits, and seed handling and germination (32 ref.); (4) Silviculture and agroforestry - including nitrogen fixation and nutrient requirements (68 ref.); (5) Pests and diseases - insect pests, and fungal, bacterial, viral and nematode diseases (144 ref.); and (6) Utilization, marketing and economics (34 ref.).

422 **Tchoundjeu, Z, Weber, J. *et al.*** 1997. Germplasm collections of endangered agroforestry tree species: the case of *Prosopis africana* in the semi-arid lowlands of West Africa. *Agroforestry Systems,* 39: 91-100.
The International Centre for Research in Agroforestry (ICRAF) coordinates a research network in the Semi-Arid Lowlands of West Africa (SALWA) in 4 countries - Burkina Faso, Niger, Mali and Senegal. Prosopis africana, an important agroforestry tree species is seriously threatened in this eco-region. ICRAF organized seed collections of this species for long-term conservation and subsequent utilization by small-scale farmers in the West African Sahel. Prior to the collection, ICRAF, the International Plant Genetic Resources Institute (IPGRI) and International Crops Research Institute for Semi-Arid Tropics (ICRISAT) organized a

planning workshop with collaborating national research institutes. Out of this workshop came a consensus on the strategy, logistics and choice of collection sites. To collect as much genetic diversity of P. africana in the SALWA region as possible, 34 collection sites were selected - 15 in Niger, 8 in Mali, 7 in Burkina Faso and 4 in Senegal. The main aim of the collection was to capture the genetic diversity within P. africana before the valuable genetic resources are lost. This paper reviews the methodology and results of the germplasm collection.

423 **Trnka, P., Rozkosny, R. *et al.*** 1990. Importance of windbreaks for ecological diversity in agricultural landscape. *Ekologia-CSFR,* 9: 241-258.
The importance of windbreaks for preserving biota in an intensively utilized agricultural landscape was assessed in southern Moravia. The research focused on a windbreak/field interaction documented by an analysis of quantitative and structural parameters of their partial communities. The importance of windbreaks for preservation and dispersal of the autochthonous plant species has not been proved. The results of study of model animal groups (Lumbricidae, Carabidae, Diptera, Aves, small mammals) show, however, that the existing windbreaks represent a suitable environment for numerous animal species. Species diversity of the studied groups (except for Carabidae) is always greater in the windbreak than in field growth. Marked differences in population density and especially in the value of biomass can be seen with Lumbricidae. A positive role of the ecotone on windbreak/field contact was found with representatives of the Diptera and Aves groups. Man-made forest shelterbelts provide sufficient environmental conditions for various wildlife species, contributing significantly to the strengthening of self-regulating processes in biocoenoses. Windbreaks serve as biocorridors and refuges in agricultural landscapes and thus enable survival of woodland species. These conclusions confirm the need for at least minimum diversification of the uniform pattern of the present agricultural landscape.

424 **United States Department of Agriculture, Forest Service** 1995. *Guidelines for the use of digital imagery for vegetation mapping.* Washington, DC, United States Department of Agriculture.
This guideline describe key steps in creating the vegetation layer from digital imagery and show how to integrate the results into GIS. They are designed to assist FS resource managers with little prior knowledge of remote sensing and GIS technologies.

425 **United States Department of Agriculture, Natural Resources Conservation Service** 1997. *Windbreaks for conservation.* Washington, DC, United States Department of Agriculture, 24 pp.
The bulletin considers the conservation value of windbreaks in reducing wind erosion, for increasing human comfort, in protection of homes, crops and livestock, in orchards, vineyards and gardens, as wildlife habitats and as living snow fences. The effect of soils on windbreak growth is discussed. The planning, establishment and management of windbreaks is described.

426 **United States Society of American Foresters** 1997. Meeting in the middle. In *Society of American Foresters 1997 National Convention.* Memphis, Tennessee, 4-8 October 1997. Bethesda, Md., USA, Society of American Foresters.
Two general initial sessions of the convention considered: populations and demographics, forestry and the new demographic ball-game; emerging information technologies; conservation of the environment, responsibilities of natural resource professionals; forests - supply and demand, global fibre supply; global issues - local solutions, foresters and civic stewardship; and a summary on selected reflections on how to address global concerns and develop local solutions. The working group technical sessions discussed: biometrics (data needs for forest management, and modelling); remote sensing and photogrammetry; urban forestry (perspectives and influences, and measurements and utilization); international

forestry, and economics, policy and law; agroforestry (forest ecology, soils, range ecology, wildlife and fish ecology, physiology, technology assessment and future analysis, wilderness, recreation, education and communication, human resources, philosophy); SAF ethics committee (ecotourism and workshops); silviculture; fire; economics, policy and law; land use and planning design, and forest land organization and management; management science and operations research (wildlife as an objective in forest management, and dealing with risk in forest management); and wilderness management and recreation. A total of 36 posters are presented.

427 **Valor, E. & Caselles, V.** 1996. Mapping land surface emissivity from NDVI: application to European, African and South American areas. *Remote Sensing of Environment,* 57: 167-184.
A number of methods have been developed to determine land surface emissivity from satellite data. A theoretical model linking emissivity to the Normalized Difference Vegetation Index (NDVI) of a given surface is proposed, and can be used to obtain the emissivity of any flow of heat. Attention is concentrated on the regions from 10.5 to 12.5 micrometres, the scale of most heat sensors on satellites now in use. The model can be applied to surfaces covered by different types of vegetation, such as vines, grass, and various species of tree and crop, as well as a variable plant cover. An operational methodology was developed on the basis of the theoretical model in order to obtain the effective emissivity by combining satellite images with field measurements. The general reliability of the model was verified by applying it to different atmospheric environments and to zones with varying topography, in central latitudes (France, Argentina) and the tropics (Sahel, Botswana), and in flat and hilly areas.

428 **Vandermeer, J.H. & Perfecto, I.** 2000. Biodiversity and pest control in agroforestry systems. *Manejo Integrado de Plagas,* 55: 1-5.
An important feature of agricultural intensification is the general topic of biodiversity, both planned and associated. If it is the case that by adding trees to an agroecosystem we are actually adding more biodiversity than just the species of trees that are planted, it is important that we understand the functional role of the biodiversity. One such role has been assumed to be enhanced pest control. However, the relationship between pest control and biodiversity is complicated and not well understood. There is a need for a vision of pest management that promotes ecosystem buffering and autonomous ecosystem management, but at the same time renders the farmer less a technician who applies particular products for particular pests and more an artisan who seeks to maintain the health of the system as a whole.

429 **Washusen, R. & Reid, R.** 1996. *Agroforestry and farm forestry: productive trees for shelter and land protection in North East Victoria.* Benalla, Australia, Benalla Landcare Farm Forestry Group, 188 pp.
Trees are increasingly becoming an integral part of farming in North East Victoria, Australia, as landowners recognize the benefits that trees can bring to their lands and catchment areas. These include shelter, wildlife protection, and the control of land and water degradation - particularly soil erosion, and more recently salinity and waterlogging. However, sufficient tree planting to provide solutions to these problems is unlikely without the involvement of commercial tree growing - a solution which also provides commercial returns. Many parts of NE Victoria are suited to tree growing but the area is at present intensively managed for agriculture, which is facing a continuing decline in profitability. This book discusses agroforestry and farm forestry as a solution to these problems. It has been produced as a result of the National Farm Forestry Program, which started in 1993 with funding from the Department of Primary Industries and Energy, and involved 2 National Farm Forestry projects in NE Victoria - the Benalla Landcare Farm Forestry Group and the North East Farm Forestry

Programme These projects bring together industry, government agencies, landcare groups, a forest growers' cooperative and other farmer representatives. The book is a manual for landowners interested in using agroforestry and farm forestry as a land management tool for shelter for crops and livestock, land degradation control, fire protection, income diversification and amenity value. There are 9 chapters: Agroforestry and farm forestry as the solution; The North East Region; The role of trees on farms; Forestry in the North East; Silviculture: managing trees for timber; Tree species for agroforestry and farm forestry; Local markets for timber; Designing agroforestry and farm forestry systems; and Information and resources. Indexes are included to case studies presented in the book, and to tree species mentioned.

430 **Westley, S.** 1990. Les clôtures vivantes ou haies défensives. *Agroforesterie Aujourd'hui,* 2: 11-14.
This article basically focuses on different types of living fences whose essential function is demarcation and protection. Technical aspects of management of these systems are also discussed.

431 **Wibowo, A., Suharti, M.** ***et al.*** 1996-1997. Fire management on *Imperata* grasslands as part of agroforestry development in Indonesia. *Agroforestry Systems,* 36: 203-217.
Fire is an important factor in the Imperata cylindrica grassland ecosystem. It prevents or slows down the natural succession to shrubs and/or secondary forest vegetation and is a major threat to (agro)forestry options for Imperata grassland rehabilitation. Forest fires can also be a primary cause of the extension of Imperata grasslands. In this review an attempt is made to integrate biophysical and socioeconomic aspects of the causes of fires in a conceptual model. Fire effects on vegetation are examined. The management options at the level of a farmer, a village community and a national government are analysed.

432 **Wiersum, K.F.** 1997. From natural forest to tree crops, co-domestication of forests and tree species, an overview. *Netherlands Journal of Agricultural Science,* 45: 425-438.
Little attention has been paid to the process of domesticating trees, which starts with the protection of natural forests and ends with the cultivation of domestic trees. Three types of forest environment influenced by man can be distinguished in this process: conserved forests, modified forests, and transformed forests. During the domestication process, there is a growing human energy per unit of worked forest, so that three phases in the progressive domestication of forests can be distinguished: (i) a phase in which social measures are progressively introduced with a view to controlling the use of high-value tree species; (ii) a phase of manipulation of wild tree species in which socially oriented management practices are boosted with measures intended to increase the productive and reproductive potential of valued species; and (iii) a phase of cultivation of genetically modified trees. Following the co-domestication of forests and trees, the various types of forest and/or tree cultivation system can be distinguished. More attention has so far been paid to understanding the features of the first and last phases than those of the various intermediate phases represented by the management of indigenous forests and agroforestry systems. The latter are marked by a modification of natural forest ecosystems that is very different from a state in which biological diversity has been somewhat reduced but in which a greater proportion of useful resources are present. Such systems provide interesting examples of the wide range of choices for forest resource management with varying degrees of biodiversity and productive values.

433 **Williams, P.A., Gordon, A.M.** ***et al.*** 1997. Agroforestry in North America and its role in farming systems. In *Temperate Agroforestry Systems,* p. 9-84. Wallingford, UK, CAB International.
The first part of this chapter provides an introduction to agroforestry in North America under the following headings: history and

background; farms, forests, woodlots and land-use changes; driving forces in agroforestry; and agroforestry, wildlife and biodiversity. The second part describes the agroforestry systems and related practices found: windbreak systems for fields, livestock, farmsteads and other areas; silvopastoral systems - range management and silvopasture, silvopasture in the SE, Pacific NW and British Columbia, the mid-west and NE, and mesquite [Prosopis glandulosa] in the SW (problems and opportunities). The third part discusses various aspects of intercropping/alley cropping systems: with black walnut [Juglans nigra] and other nut production systems; weed control in tree rows and other cultural considerations; and ecological interactions. The remainder of the chapter discusses integrated riparian management systems, forest farming systems, biomass production and other plantation systems, and agroforestry policy - institutional requirements and learning processes.

434 **Buck, L.E.** 1997. The social organization of agroforestry innovation: modeling the emergence of agroforestry knowledge and information in northeastern North America. In *Agroforestry for sustainable land-use: fundamental research and modelling temperate and Mediterranean application,* p. 191-196. International workshop held in Montpellier, France, 23-29 June 1997. Montpellier, France, CIRAD.
The transformation of agroforestry potential in temperate zones into a broader reality runs up against a major problem: the lack of knowledge of procedures that could lead to innovations in agroforestry technology and practices. A project is under way at Cornell University to draw up models of the management of agroforestry knowledge and information systems.

435 **Combe, J. & Budowski, G.** 1978. *Classification des techniques agroforestières.* Turrialba, Costa Rica, CATIE, 61 pp.
A classification of agroforestry techniques is proposed, using the three following elements: the different crops combined with a forestry component, the main function of this forestry component, and the distribution of this forestry component in time and in space. The use of these three elements is discussed and clarified with a view to proposing a terminology that takes account of terms already in use. The work also contains a list of the main agroforestry techniques, with a large number of examples.

3.2 SOCIAL, ECONOMIC AND CULTURAL ASPECTS

450 **Adesina, A.A. & Coulibaly, O.N.** 1998. Policy and competitiveness of agroforestry-based technologies for maize production in Cameroon: an application of policy analysis matrix. *Agricultural economics,* 19: 1-13.
This article assesses the cost-effectiveness from the viewpoint of society, together with the impact of political changes on the competitiveness of maize produced thanks to agroforestry-based technologies in Cameroon.

451 **Akhter, S., Nath, T.K. *et al.*** 1997. People's perception and preference towards growing multipurpose tree species. *Chittagong University Studies, Part II: Science,* 21: 87-94.
A survey was carried out in a forest-poor region of Bangladesh in order to gain an idea of the distribution and uses of multipurpose tree species and the income generated by such species. A questionnaire was used to collect data. Landless people and those with marginal, small, medium or large farms cultivated multipurpose trees in and around farms, not only for fruit, fodder, fuelwood and construction materials, but also for shade and shelter, and to create living fences. Fruit trees were dominant in most cases because of their multiple uses. However, *Dalbergia sissoo* was the species preferred by multipurpose tree growers, for it provides construction timber, fuelwood, fodder and various other benefits. The income from multipurpose trees increases progressively from the category of landless farms to that of large farms.

452 **Akuba, R.H. & Mahmud, Z.** 1991. Coconut based farming systems at Perkarangan. *Industrial Crops Research Journal,* 4: 33-42.
The Indonesian *perkarangan* cultivation system is defined as a home garden planted mainly with foodcrops. In 1987, the area covered by this potential agricultural resource was a little over 5 million ha. Surveys throughout Java in 1985 showed that 53.5% of farmers grew coconuts in *perkarangan* systems, 34.4% on farms, 8% in *perkarangan* systems and on farms, and 3.8% on ridges or bunds. The coconut growing model in other parts of Indonesia is also described. The article then considers the following aspects of coconut-based farming systems: the choice of hybrids and types for different zones; spacing; and the choice of crops suitable for intercropping in specific agroecosystems. Guidelines based on the results of research in Indonesia and other countries are also provided.

453 **Akyeampong, E., Hitimana, L. *et al.*** 1995. The agronomic and economic performance of banana, bean and tree intercropping in the highlands of Burundi: an interim assessment. *Agroforestry Systems,* 31: 199-210.
Two unconventional methods are explained: farmers and experts assess the value of trees in trials, and an economic analysis incorporates the effect of yield variations on the variability of net values.

454 **Anderson, J., Bertrand, A. *et al.*** 1994. Le fourrage arboré à Bamako: production et gestion des arbres fourragers, consommation et filières d'approvisionnement, *Sécheresse,* 5: 99-105.
In peri-urban Sahelian areas, the contribution of the woody layer to livestock feeding is become less and less confined to above-ground grazing, and tree fodder is increasingly being collected for sale in the towns. More livestock are being reared in urban areas today, and there is a simultaneous growth in the human and sheep population of African megalopoles. Sheep are reared in urban households basically for religious and cultural reasons. The case of Bamako is discussed, and tree fodder supply lines are described and analysed. These lines rely on urban collectors-sellers who handle collection, harvesting, transport by bicycle and sale to consumers. One particular woody species, *Pterocarpus erinaceus*, is increasingly frequently and regularly involved because it lends itself to the mode of transport, with the result that this species is now under a serious threat of

degradation. Trials with a view to viable management of fodder trees have been made within the framework of the Forestry Development and Production Operation, which manages the reserved forests on the edges of Bamako.

455 **Arnold, J.E.M.** 1990. Tree components in farming systems. *Unasylva,* 41(1): 35-42.
Why do farmers decide to plant trees? The impact of arboriculture on household food security.

456 **Arnold, J.E.M.** 1991. *Tree products in agroecosystems: economic and policy issues.* London, IIED, 21 pp.
Trees in agroecosystems are located in two distinct areas, either being planted and managed within farming systems, or being managed as common property resources (CPRs) in order to provide the income needed to supplement out already available farm income. These non-forest production sources are expanding as the degradation of neighbouring forests increases and the demand for fuel, fodder and other products rises. As State expropriation, privatization and encroachment reduce CPRs and depredations degrade those that remain, there is a general trend towards a greater dependence on on-farm resources. This paper does not deal with production systems that are completely in the forest, but with systems based on shifting cultivation, or locally owned forest land, considering forestry rather than agricultural production. Such systems are more affected by policies and practices linked to the use of forest land and resources than by agricultural policies and practices. In its first section, the document reviews trends in the uses of forest products and dependency on them, discussing them in terms of household inputs (as firewood and food products), agricultural inputs (as fodder and mulch) and their roles (sources of income and employment). The second part of the paper examines the role of CPRs as a source of forest products, discussing models of CPR use and two types of management: community forestry on public land; and local community management, under an agreement with the Forestry Department, under which the local people receive a larger proportion of forest food products in exchange for management of forest regeneration. The third part of the paper describes trends in the growing and management of trees within farming systems, tree management discussion models and factors influencing management changes. The effects of national policies, programmes and project interventions on CPRs are examined and summarized in the final section.

457 **Arnold, M.** 1998. Cultures arboricoles de producteurs extérieurs pour les industries forestières: l'expérience des Philippines et de l'Afrique du Sud. *Social Forestry Network Papers,* Winter 97/98: 5.
Arrangements under which small farmers grow trees under contract for the large-scale timber industry can work to the advantage of both parties. This paper examines two successful plans in the Philippines and South Africa. Farmers quickly adapted the recommended silvicultural practices to their own circumstances and realized that growing trees for others brought in enough income for them to give up cash crops on arable land. However, the poorest farmers were generally not in a position to run the associated risks and make the necessary initial outlay. The author stresses the importance of boosting the capacity of institutions, for example farmers' cooperatives, in order to promote a balance of power between outside growers and timber companies.

458 **Auclair, D., Prinsley, R. *et al.*** 2000. Trees on farms in industrialised countries: silvicultural and economic issues. *In* B. Krishnapillay, E. Soepadmo, N.L. Arshad *et al.,* eds. *Forest and Society: the role of research,* 1: 761-776. 21st IUFRO World Congress, Kuala Lumpur, 7-12 August 2000. Kuala Lumpur, IUFRO World Congress Organising Committee.
There is a trend today towards a reduction in the area devoted to intensive farming in industrialized countries. Many farmers are growing trees, while others are making innovations in agroforestry techniques. One of the main differences between farm forestry silvicultural management and large-scale

silvicultural management is the presence of a farmer and a farm within the system. Many roles and values are attributed to trees, but many farmers adopt agroforestry less for financial or environmental reasons than for social and cultural reasons.

459 **Bantilan, C.C., Fujisaka, J.S. *et al.*** 1989. Farmer-participatory methods for hedgerow farming systems development and extension in sloping upland environments. *Laguna, IRRI,* 1-22.
This paper analyses the understanding of farmers' perceptions and practices, together with their technical knowledge of soil erosion. It also describes adaptive research and farmer-to-farmer teaching methods in order to spread the relatively complex technology of hedgerow-based farming systems.

460 **Bara Guye, M.** 1995. Conflits et alliances entre agriculteurs et éleveurs: le cas du Goll de Fandène. *Arbres, Forêts et Communautés Rurales,* 7: 5-12.
The coexistence of farmers and herders on the same land is often seen as the potential source of friction over access to and use of available resources. This does not, however, mean that these two groups are natural antagonists, for in most traditional rural Senegalese societies, the association of agriculture and animal husbandry has always been more the rule than the exception. Unfortunately, the destructuring of this traditional production system and the implementation of new—and often exclusive and inappropriate—regulations have been determining factors in upsetting this balance. Regulations on natural resource management are in fact often designed to meet the needs of the dominant production system.

461 **Barbeau, G.** 1994. Tropical fruit trees in the non-French Caribbean. Crops, exports, trends. *Fruits,* 49: 335-339.
The commercial development prospects for some of the many fruit trees cultivated in the non-French Caribbean are promising. These countries are working to set up agricultural diversification programmes in which tropical fruit production has a special place. This article focuses on fruit tree development projects, outlets on to the fresh and processed fruit markets, and medium-term production prospects. The following fruits are discussed: akee, avocado, Barbados cherry, breadfruit, cashew, Chinese gooseberry, citrus, custard apple, golden apple (ambarella), guava, mango, sapodilla plum and sapota. A table of the areas in non-French Caribbean countries planted with fruit trees is also given.

462 **Baroni, C., Pret, P. *et al.*** 1997. Le palmier du Borkou, végétal social total. In *L'homme et le milieu végétal dans le bassin du Lac Tchad,* p. 349-365. Seminar of the Réseau Méga-Tchad held in Sèvres, France, 18-20 September 1991. Paris, ORSTOM.
There is a close interdependence in Borku in northern Chad between the extensive palm grove and its inhabitants. On the one hand, the existence and form of the palm grove and the varieties planted are the result of human intervention, while, on the other, human life is possible in these desert places only thanks to the presence of the date palms. They protect the inhabitants and their gardens from the intense heat of the sun and from the violence of the winds (with palm fencing). Dates are the chief wealth and the essential commodity of trade, while all the components of the palm are used in various ways, particularly in connection with housing. The system of rights over date palms and their harvests are typical of the *daza* world of which Borku is part.

463 **Bekele, T.A.** 1997. *A participatory agroforestry approach for soil and water conservation in Ethiopia.* Wageningen, Netherlands, Wageningen Agricultural University, 229 pp.
Soil erosion is severely threatening Ethiopia's agricultural resource base. Past rehabilitation efforts have been immense, but the result has been discouraging. Exclusion of farmers and their indigenous knowledge in planning, the use of uniform and "foreign" soil conservation and reforestation technologies, misuse of food-for-work programmes and lack of conducive land tenure and tree usufruct have all contributed. Farmers preferred the local knowledge-focused and production-based land

management technology, and rejected the conservation-based development initiatives and introducedinnovations. The farmers and the experts remained divorced and the land degradation problem continued unabated. Research was carried out in Tikurso, located in the North Shoa zone of Amhara Regional State, to devise a methodology by which such problems could be overcome. A soft-system approach to on-farm, farmer participatory research resulted in the construction of an agroforestry approach by which: (1) trust and friendship between farmers and facilitators can be established; (2) indigenous skills of farmers can be studied and adapted for better performance; (3) socio-economic diagnosis and environmental assessment is made with farmers; (4) production-based conservation interventions are planned and implemented by farmers' will; and (5) farmer-discerned evaluation can be conducted and corrective feedback obtained

464 **Besse, F., Dutrève, B. *et al.*** 1999. La place de l'arbre dans deux capitales de l'Afrique de l'Ouest: Nouakchott et Ouagadougou. *In* P. Moustier, A. Mbaye, H. De Bon, H. Guérin & J. Pages, eds. *Agriculture périurbaine en Afrique subsaharienne,* p. 207-219. Acts of an international workshop held in Montpellier, France, 20-24 April 1998. Montpellier, France, CIRAD, CORAF.
The world population is inexorably becoming urban, and it is forecast that by the year 2000, 50% of the planet's inhabitants will be living in towns. This trend is stronger and faster in developing countries, but little is known about the environmental, economic and sociological impact of this concentration, so that it is hard to assess. Trees already bring many advantages to urban or peri-urban zones, and they could offer others too, so long as their introduction into the urban fabric is integrated with town planning and involves the inhabitants. This form of planning is still very recent in developing countries, and there is a lack of information on relations between new urban inhabitants, especially the poor, and tree systems. Two studies were carried out, one in Nouakchott and the other in Ouagadougou, in order to develop approaches to forestry in urban environments and identify the roles of the various stakeholders. These studies allowed two approaches to the biological and social environment to be tested, and these trials highlighted the need for a better knowledge of the urban environment, the inhabitants and the available plant material. They showed that urban forestry is not a priority for a population faced particularly with problems of hygiene and water supplies.

465 **Boutrais, J.** 1980. L'arbre et le boeuf en zone soudano-guinéenne. *Cahiers de l'ORSTOM,* 17: 235-246.
The combination of savannah and trees distinguishes the Sudanian zone very clearly from the Sahel and from rain forests. However, it is the result of an unstable balance between two elements of vegetation which are in fact in competition. Without the intervention of fires, trees would often gain the upper hand. Fires and deforestation by farmers encourage the establishment of savannah in terms of both height and density of ground cover. When herders light fires in the dry season, they also help bring about conditions favourable to savannah vegetation as they move into these new grazing lands. For them, as for farmers, trees are firstly an obstacle to their activity, although their relations to trees are not in fact confined to this antagonism. Just as farmers deforest or plant or protect trees at the same time, herders fear their proximity or draw benefit from them, depending on the case. However, in the long term they do unconsciously favour their establishment.

466 **Busby, R.J.N.** 1985. *A guide to financial growing of tree analysis.* Rome, FAO, 103 pp.
This document offers a framework for analysing the monetary costs involved in planting trees, as well as the expected gains or losses.

467 **Cable, T.T., Rodiek, J.E. *et al.*** 1991. Windbreaks, wildlife, and hunters. *In* T.T. Cable and J.E. Rodiek, eds. *Wildlife and habitats in managed landscapes*, p. 35-55. Washington, DC, Island Press.

A brief history is given of shelterbelt planting in the USA and literature is reviewed on wildlife populations in shelterbelts and the design of windbreaks for wildlife. Results are given of a survey of licensed hunters in Kansas to determine the amount and economic value of hunting in shelterbelts and the species of game involved. Results showed the importance of shelterbelts as a recreational resource in Kansas. Shelterbelts provide high-quality opportunities for quail, pheasant and deer hunters; the hunting opportunities have economic value. Shelterbelts are declining in the Great Plains and, if the trend continues, this may lead to decreases in wildlife populations and an adverse effect on the quality and quantity of hunting.

468 **Carter, J.** 1995. Alley farming: have resource-poor farmers benefited? *Natural Resource Perspectives,* June: 6.
In the past 20 years, much scientific interest has been focused on alley farming, which has been presented as a sustainable, intensive system capable of radically improving the long-term prospects of resource-poor farmers in tropical zones. Although it is impossible to give a precise figure, the total expenditure world-wide on alley farming research, development and promotion can be estimated at roughly $US 10 million. It has now been widely recognized that the system has less potential than was thought at the outset, with the main limitations appearing in the technical and socio-economic spheres. It is now technically possible to define the biophysical and socio-economic circumstances in which the technique has the best chances of success: a predominance of maize, poor or falling soil fertility, annual rainfall of over 1 000 mm, soil pH of over 5.5, a scarcity of trees, heavy population pressure, a majority of farmers with guaranteed tenure, enclosures for livestock, and a dependence on agriculture for the household's income. The experience of ICRAF in East Africa has confirmed these features and added two new ones: land with a moderate slope, and fertile subsoil. It is suggested that future work should focus on sectors with these features. The article also provides definitions of different alley farming systems.

469 **Chazée, L.** 1990. L'agriculture d'oasis et les palmeraies en Somalie. *In* V. Dollé & G. Toutain, eds. *Les systèmes agricoles oasiens,* 11: 67-75. Meeting held in Tozeur, Tunisia, 19-21 November 1988. Montpellier, France, CIHEAM-IAM.
Somalia is still a modest producer of dates, and most of its consumption is covered by imports from Iraq. Oasis date cultivation is almost always practised in conjunction with other activities. Farmers with a variety of activities raise some livestock (sheep, goats, camels) using extensive systems, trade with towns in the north or other regions of the country, and also gather incense or carry on coastal fishing. Oasis farming at present provides only a small part of these farmer-herder-traders' income. However, close to urban centres, some recent examples show that it is possible to make a reasonable living from oasis farming.

470 **Clarke, W.C., Makuku, S.J. *et al.*** 1996. *Supporting local initiatives in woodland regeneration. A case study from Ntabazinduna communal land, Zimbabwe.* London, IIED, 12 pp.
This document describes initiatives to manage woodland on common land in Zimbabwe. Government programmes had not met with success and had misunderstood the true needs of the communities. The latter therefore worked out their own woodland management strategy. The authors discuss study methods, using participatory research techniques. The results provide greater understanding of how these local practices can be promoted.

471 **Clark, J.R., Matheny, N.P. *et al.*** 1997. A model of urban forest sustainability. *Journal of Arboriculture,* 23: 17-30.
A model is presented for the development of sustainable urban forests, which applies general principles of sustainability to urban trees and forests. The central tenet of the model is that sustainable urban forests require a healthy tree and forest resource, community-wide support and a comprehensive

management approach. For each of these components, criteria and indicators are presented which can be used to assess their status at a given point in time. The most significant outcome of a sustainable urban forest is to maintain a maximum level of net environmental, ecological, social, and economic benefits over time.

472 **Clouet, Y.** 1995. Les oasis. *Mappemonde,* 4: 44-48.
This article takes the form of a teaching aid, offering first a typology of oases, and then an analysis of the development problems encountered. The emergence of a dominant model closely integrated with the market economy (United States, Argentina, Australia and central Asia) leads to disruptions, often a source of problems for the inhabitants, and a forced adaptation to the global economy.

473 **Conford, P. & Shiva, V.** 1992. Recovering diversity: a future for India. In *A future for the land: organic practice from a global perspective,* p. 127-138.
Sustainability and diversity are ecologically linked, because diversity offers the multiplicity of interactions which can heal ecological disturbance to any part of the agro-ecological system. Non-sustainability and uniformity mean that a disturbance in one part will affect all other parts of the system. The issues surrounding the disappearance of diversity in India through the adoption of monocultures of uniform, high-yielding varieties of crops or uniform stands of forest trees are examined and examples given. The ecological and economic aspects of this loss of diversity, particularly over the past 20 years, are considered. Solutions being offered include biotechnology, which is dismissed as perpetuating the problems caused by the Green Revolution, and organic farming, which is seen as more appropriate to local communities being based as it is on diversity. A project initiated by local women in Kangad, a village in the Balganga Valley, to protect an area of forest from felling is cited as an example of how diversity can be recovered to the betterment of local communities.

474 **Courade, G.** 1980. La gestion du patrimoine forestier dans un secteur fragile: les grassfields du Bamenda (Cameroun Anglophone). *Cahiers de l'ORSTOM,* 17: 265-266.
The Bamenda highlands have grass savannah landscapes—or grassfields—which are the outcome of human degradation of upland forests. The domestication of the landscape can be seen in stripped hillsides, valley bottoms taken over by raffias, shade trees above coffee bushes, eucalyptus planted in clumps or along roads, kola nut and other fruit trees around homes. This total transformation of the original forest landscape was brought about by a numerous, dynamic, sedentary population, who share the area—an area that seems increasingly limited, in view of the techniques used—with the Fulani, whose herds are growing constantly. The region is thus marked by a relative sparseness of trees, their domestication, a reforestation effort through the introduction of new species (conifers), and a bitter competition between farmers and herders for any usable space, thus pushing trees back into inaccessible sectors and giving rise to erosion.

475 **David, S.** 1995. What do farmers think? Farmer evaluations of hedgerow intercropping under semi-arid conditions. *Agroforestry Systems,* 32: 15-28.
The author, a sociologist, examines farmers' perceptions of the impact and the potential of adopting intercropping systems in an area in the Machakos district of Kenya.

476 **De Leener, P.** 1988. The efficiency of trees in African agrarian production and rural landscapes. In *Agroforestry: the efficiency of trees in African agrarian production and rural landscapes,* p. 59-89. Meeting held in Kigali, 11-16 June 1991. Wageningen, Netherlands, CTA.
This publications gives an overview of the wide range of answers to various questions concerning the efficiency of trees in African agrarian production: What is the true importance of trees in the agrarian economy? How do they adjust in farming systems, particularly in fields and on grasslands? What types of organization do they give rise to? And

what types of social, technical or economic practices do they give rise to?

477 **Dewees, P.** 1993. *Economic dimensions to the use and management of trees and woodlands in smallholder agriculture in Malawi*. Background paper prepared for the Malawi National Policy Review. 99 pp.
The central focuses of this paper are the relation between use strategies for economically productive land among smallholders in Malawi, the use of farmland for growing and managing trees, and the advantages of local management and use of woodland. The paper consists of five main parts: an introduction; the cultivation and management of trees on customary land—trees on farmland and agroforestry systems; the management and harvesting of woodland; household firewood use and energy policies—evaluating responses, market interventions and the impact of policies; the economics of trees, the management of woodland and the implications for policies and planning. There are three annexes giving detailed data.

478 **Dewees, P.A.** 1992. *Social and economic aspects of Miombo woodland management in southern Africa: options and opportunities for research.* Centre for International Forestry Research, 47 pp.
This work identifies and explores the various sectors linked to research on the social and economic aspects of *miombo* management in South Africa. It also describes the various problems connected with local management of these formations and discusses different research subjects.

480 **Dewees, P.A.** 1993. *Social and economic incentives for smallholder tree growing: a case study from Murang'a District, Kenya.* FAO Community Forestry Case Studies No. 74.
This report seeks to provide a better understanding of the economic context of smallholder agriculture in Kenya, particularly as concerns tree management and associated practices. Although the report focuses on tree-linked activities in the Murang'a district, a high-potential farming area in Kenya's Central province, many of the observations and conclusions are applicable to other parts of the country. Taken together, periodic observations and land-use inventories offer proof that trees have an important role to play as one of many land-use possibilities for smallholders in the agricultural highlands of Kenya. In some cases, farmers grow trees to meet the demand for building posts, wood charcoal and fuelwood and in response to other market forces. Trees are also grown to mark boundaries or provide shade for other crops such as tea or coffee. However, there is still the question of why farmers keep trees on land that could be used for other crops with the potential to produce a considerably higher income. The main point in this discussion of tree planting in Kenya is the connection between questions of land tenure, capital accumulation and the use of labour. A number of tree crops and the commonest management practices are the long-term result of these closely connected issues. Others have been adopted either following relatively recent interventions or as a result of changes in traditional management practices. Chapter 1 explores present knowledge of the spread of trees in the Kenyan highlands. Chapter 2 discusses how rural capital and labour constraints can contribute to a widescale adoption of different practices. Chapters 3 and 4 explore the development of the traditional land tenure system in the Murang'a region and changes resulting from the relationship between tree tenure and land tenure. Chapter 5 describes the importance of *Acacia mearnsii* production in the first half of the 20th century. And the final chapter examines some of the challenges facing planners and developers in their efforts to encourage farmers to plant more trees.

479 **Dewees, P.A.** 1993. *Trees, land and labor.* Washington, DC, World Bank, 52 pp.
This document presents the results of research on the establishment and management of woodland by farmers in a densely populated area of Kenya, based on land-use studies and a survey of households. The study examines the hypothesis that tree growing complements formal employment as a strategy to overcome

the input problems of poor markets and alleviate the land-use constraints imposed by the migration of labour. Planning policy and objectives are discussed in the context of the interaction between rural reforestation, the generation of rural employment and land use.

481 **Diallo, A.N.** 1994. L'arbre et la haie dans les systèmes agraires de la prefecture de Faranah. *Flamboyant,* 31: 24-29.
This study was carried out in the framework of a pilot lowland development scheme, while giving support to operations of the French Association of Volunteers for Progress in Guinea. Its aim was to gain a clearer picture of the place of trees in traditional approaches to land occupation and use, as well as in the new systems springing up with lowland development. Trees are seen as elements in the landscape, economic and social elements, and elements forming enclosures.

482 **Dubost, D.** 1989. L'oasis: mythe agricole et réalités sociales. *Cahiers de la Recherche Développement,* 22: 28-43.
The whole agricultural concept of oases is questioned in this article. Without seeking to be polemical, it considers whether oases—land that has been cultivated for centuries in order to support sedentary human groups, as a complement to the nomadic life of pastoralists and traders—are still suited to the new economic order based on urbanization and industrialization. The rise of a market economy makes the traditional agricultural techniques of drawing and distributing water obsolete—like the mixed cropping system, a classic feature of oases, and one opposed to rationalization and mechanization. However, the main drawback of oasis agriculture is that it requires farmers to have a whole range of skills for the different types of production involved. Lastly, the system calls for a multiplicity of upstream supply services and downstream marketing circuits. A new division of farms is proposed: peri-urban horticultural farms, date farms, and pioneer cereal growing attempts. In this context, the canalization of farmers' initiatives must be based on a development strategy that takes account of the economic and social concerns of farmers or would-be farmers. The oasis of the future will remain an inhabited space—a special place for the exercise of the bonds of solidarity and antagonism.

483 **Dwyer, J.F., Childs, G.M. *et al.*** 2000. Forestry in urban and urbanizing areas of the United States: connecting people with forests in the 21st century. *In* B. Krishnapillay, E. Soepadmo, N.L. Arshad *et al.*, eds. *Forest and Society: the role of research,* 1: 629-637. 21st IUFRO World Congress, Kuala Lumpur, 7-12 August 2000. Kuala Lumpur, IUFRO World Congress Organising Committee.
Those in charge of managing resources are faced with challenges throughout the world because of growing urbanization and its effects on forest resources. These challenges can be met if the managers work towards: (i) a management of forest resources in urban zones, and (ii) a connection of urban inhabitants with forests and their management. There are possibilities of meeting these two objectives through the involvement of a broad range of urban residents and organizations in the joint management of forest resources in urban areas. Adaptive approaches to forest management in these zones are described, and the efforts to involve individuals and groups in this management are discussed, with examples drawn from Chicago. Involving urban residents in resource management can have implications for the management of forest resources ranging from the urban landscape to the natural landscape.

484 **Enilorac, M.P. & Peltier, R.** 1994. Durabilité des systèmes agro-sylvo-pastoraux *akambas* du Kenya. Concept de la ferme minimale durable et possibilités d'adoption des innovations. *In* M. Sébillotte, ed. *Recherches-Système en Agriculture et Développement Rural,* p. 501-502. International symposium held in Montpellier, France, 21-25 November 1994. Montpellier, France CIRAD-SAR.
In the semi-arid zones of the Yatta highlands in central Kenya, which have been inhabited for only 50 years, the authors studied the development of the Akamba people's agrosilvopastoral farms. A theoretical farm model can be defined, satisfying the minimal

needs of a family, corresponding to the traditions of these people, and seeming to be *a priori* environmentally and economically sustainable.

485 **FAO** 1985. *Understanding tree use in farming systems.* Based on the workshop on planning fuelwood projects with the participation of rural people, Lilongwe, Malawi, 12-20 November 1984. Rome, FAO, 82 pp.
This document, based on a workshop on planning fuelwood projects with the participation of rural people, describes the features of farming and land-use systems and their classification, especially in southern and eastern Africa. It also contains a section dedicated to the role of women in such systems. Another section is devoted to agroforestry, its roles, its institutional aspects, and related research. The second half of the work is devoted to data gathering: what should be gathered, how this should be done (different methods are described), who should do it, when and where. The last part analyses the planning of fuelwood projects.

486 **FAO** 1987. *Boisements en milieu rural.* Rome, 130 pp.
Certain forest products, such as fuelwood, are indispensable to human beings. Almost all the rural inhabitants of non-industrialized countries are dependent on forests and trees for at least some products essential to their daily lives. This study focuses on one of the main production strategies for meeting these needs—rural afforestation by and for the inhabitants, which has a growing importance in view of the ever faster exhaustion of resources. In recent years, programmes aimed at encouraging and supporting rural people in their efforts have been the main concern of forestry services, and considerable experience has already been gained on this type of programme. The aim of this study is to collect this information together in order to gain a better understanding of the different circumstances in which the planting, management and use of trees and forest products directly benefit rural people, and to indicate how the latter can be most effectively supported.

487 **FAO** 1987. *Boisements ruraux. Approches à l'auto-assistance villageoise.* Rome, FAO, 84 pp.
This document is a report on the work of the study session on planning self-help fuelwood projects, which was held at Ouagadougou under the auspices of FAO from 3 to 14 February 1986. The aim of the meeting was to examine the role of trees in traditional farming systems and local agrarian production systems in greater depth, and to consider the approaches best suited to encouraging rural people to participate.

489 **FAO** 1995. *Integrating woodfuel production into agroforestry extension programmes in Southeast Asia.* East Java, Indonesia, 23-30 April 1995. Bangkok, 142 pp.
This document is a collection of papers from the sub-regional workshop on the integration of woodfuel production into agroforestry extension programmes in Southeast Asia. The workshop was intended to develop awareness of the potential of woodfuel production in agricultural systems to meet consumer demand.

488 **FAO** 1996. *Domestication and commercialization of non-timber forest products in agroforestry systems.* Proceedings of an international conference held in Nairobi, 19-23 February 1996. Rome, FAO.
This conference was coordinated by ICRAF with the participation of a number of other national and international bodies, and was the first world-level meeting on the domestication and commercialization of non-timber forest products produced by agroforestry systems. Five subjects were debated by different groups during the two days of the conference. The 26 keynote papers have been divided into five sections, apart from the first two, which act as an introduction. The two introductory papers (i) discuss links between the domestication and commercialization of non-timber forest products and the implications for agroforestry, and (ii) describe ICRAF strategy concerning the domestication of non-timber forest products. The remaining papers are arranged according to subject: identification of

products, evaluation and monitoring (2 papers); indigenous and ethnobotanical knowledge (3 papers); product development, management and marketing (6 papers); product development and adoption by farmers (11 papers); and policies and institutional aspects (2 papers). The acts also include the five reports of the working groups and a recommendation from the conference to FAO for the World Food Summit.

490 **Fortmann, L., Antinori, C. *et al.*** 1997. Fruits of their labors: gender, property rights, and tree planting in two Zimbabwe villages. *Rural Sociology,* 62: 295-314.
An analysis of tree planting by women and men in two Zimbabwe villages shows that the women plant significantly fewer trees than the men on farmland where length of tenure is uncertain because of the probability of a change in their marital situation. However, men and women plant in the same way on common land, where continued possession is sure so long as they remain resident in the village. These results show the importance of gender-linked security of land tenure on the household level.

491 **Fortmann, L. & Nhira, C.** 1993. *Local management of trees and woodland resources in Zimbabwe: a tenurial niche approach.* Oxford, UK, Oxford Forestry Institute.
This study starts from relatively new starting points in terms of concepts: the social forest (encompassing all the trees used by local inhabitants independently of their location, density, species or size) and land tenure (which considers ownership and tenure relations in detail, including the complexities of tree tenure). On the basis of interviews with key people, writings on the subject and rapid rural appraisal, the frequency of four management mechanisms (sacred control, pragmatic control, civil contract, and new institutions and rules) are examined through different types of land tenure, and strategies for an improved management are proposed in order to reduce conflicts in each type of land tenure.

492 **Franzel, S.** 1999. Socioeconomic factors affecting the adoption potential of improved tree fallows in Africa. *Agroforestry Systems,* 47: 305-321.
This article offers a review of the development of improved fallows in three countries—Kenya, Cameroon and Zambia.

493 **Genin, D., Hervé, D. *et al.*** 1995. Relations between society and the environment: the sustainability of cropping systems with long grazed fallows in the Andes. *Cahiers de la Recherche Développement,* 41: 20-30.
Cropping systems with long grazed fallows in the Andes combine individual decisions on the two or three years of cropping with collective decisions on the length of fallow (three to fifteen years) and on the start and end of the period when what is otherwise common pastureland is put under crops. These fallows are normally seen as intended to restore fertility, and while they do help to limit potato nematode infestation, chemical, physical and microbiological changes in the soil are sometimes contradictory. However, fallows provide food for flocks, allow fertility transfer and are a source of fuel. On the other hand, in the Andean view of things, both technical and symbolic effectiveness are needed if the soil is to be productive. Traditional management of the land and of climatic risks requires collective rituals intended to guarantee fertility and ward off natural calamity. Today, however, a crisis in the symbolic systems underlying such rituals are having an effect on the dynamics of how these cropping systems are run. A systematic and interdisciplinary approach is attempted, focusing on these technical and sociocultural factors.

494 **Gilmour, D., Jodha, N. *et al.*** 1995. *Tree management in farmer strategies: responses to agricultural intensification.* Oxford, UK, Oxford University Press, 292 pp.
This work is the result of research carried out by the Oxford Forestry Institute in order to gain a better understanding of how tree management contributes to farmers' strategies, inasmuch as they respond to pressure by intensifying the use of land and other resources. The project was supported by

grants from the Rockefeller Foundation, the Ford Foundation and the Economic and Social Committee of the Overseas Development Administration of the United Kingdom. The book is divided into four parts and combines the results of studies carried out in East Africa and East Asia. Part I gives an overview, consisting of one chapter, "Issues" (J.E.M. Arnold, p. 3-17). Part II, "Trends in farm trees", has four chapters: trees in the landscape of the central hills of Nepal (D.A. Gilmour, p. 21-42); trends in tree management in the use of arid land in western Rajasthan (N.S. Jodha, p. 43-64); changes in tree cover from forests to farms in Pakistan (M.R. Pigeon, p. 65-89); and farmer models of trees in West Africa (K. Warner, p. 90-137). Part III, "Factors affecting farmers' decisions", has four chapters; household needs: tree strategies in western Kenya (S.J. Scherr, p. 141-173); farmers' responses to the shortage of trees: the case of fuelwood (P.A. Dewees, p. 174-197); a tree products market as motivation (P.A. Dewees & N.C. Saxena, p. 198-241); and tree planting, the household and work allocation: the cases of Kenya and India (P.A. Dewees & N.C. Saxena, p. 242-267). Part IV, "Conclusion", has one chapter, on retrospection and prospects (J.E.M. Arnold, p. 271-287). An analytical index is included.

495 **Gregersen, H., Draper, S. *et al.*** 1989. *People and trees. The role of social forestry in sustainable development.* Washington, DC, World Bank, 273 p.
There will be huge investments in forestry and cultivated trees in the medium-term future in order to bring about a balance between environmental stability and local demand for forest products. The authors of this work describe their experiences and give relevant information, discussing the issues and problems encountered. They also give examples of how such problems can be solved. The detailed overview of programmes and projects listed in this work shows that two of the most important conditions for success are (i) a high local participation, and (ii) a strong political commitment to long-term solution of the problems. The work is divided into two main parts, the first presenting a rational approach to helping social forestry, and the second discussing problems connected with the planning and implementation of projects in this sector.

496 **Gumbo, D., Mukamuri, B. *et al.*** 1990. Indigenous and exotic fruit trees: why do people want to grow them? *In* R.T.L. Prinsley, ed. *Agroforestry for sustainable production. Economic implications.* London, Commonwealth Science Council.
ENDA-Zimbabwe's Community Management of Woodland Project is operative in four areas in the Chivi and Zvishavane districts of southern Zimbabwe. It is a dry agricultural zone, with an average annual rainfall of between 500 and 650 mm. The project approach is based on a village-level planning process on the part of communities. Research is carried out with farmers, and a village-level plan drawn up for management of woodland and plantations. Village-level research showed three key issues, which then formed the basis of the project: trees are essential for maintenance of the local ecosystem; they are a multipurpose resource; and management of indigenous woodland was seen by farmers as a necessary strategy. During the first years of the project (19878-1989), between a quarter and a third of all the trees planted were fruit trees (both indigenous and exotic). The reasons for this local enthusiasm for fruit trees are discussed, and they include historical factors, marketing and transport considerations, local preferences, seasonal roles and economic values. Each of these factors is examined, with comparisons between the different project zones. It is concluded that a whole range of factors, including local conditions, has to be taken into account in order to understand why fruit trees are planted.

497 **Haddad, Y.** 1996. *Approche de la gestion et du fonctionnement des plantations d'arbres d'alignement en milieu urbain au travers d'une démarche pluridisciplinaire physiologique, économique, paysagère et socio-politique.* Université Denis Diderot, 232 pp.

The planting of trees in lines helps shape the structure and layout of towns, and these trees can create social bonds. If this social and urbanistic role is ignored and stress is laid only on the environmental role, the major responsibility for the malfunctioning of plantations can be attributed to the degradation of our environment, rather than to the lack of coordination between the activities of a range of separate actors who do not take account of the wealth and complexity of line trees. In order to assure good management and create plantations that will sustainably fulfil their functions, it would be advisable to: (i) learn more about urban trees through field studies on the part of researchers and professionals who are aware of the dynamic, complex nature of line trees and their urban environment; and (ii) establish a permanent chain of command so that a structure can be proposed that corresponds to the objectives, and a type of planting chosen that is suited to the current technical and economic context, taking account of the constraints of the site; after this, the means needed for its establishment and maintenance of its quality throughout its existence can be defined. The best guarantee of the success of such a long-term project as the planting of trees is for local management—which allows a response to site-specific social needs and constraints—to be set in the broader management context of the community in which the future of urban development will be played out. One approach would be to work out a solution for each situation thanks to the development of truly interdisciplinary approaches; such solutions would be realistic rather than idealistic, and would be the result of a consensus between the various stakeholders, bearing in mind a common good that they want to share.

498 **Hasund, Dabbert S., Dubgaard, A. *et al.*** 1998. Valuable landscapes and reliable estimates. *In* D.A. Dabbert & L. Slangen, eds. *The economics of landscape and wildlife conservation,* p. 65-83. Wallingford, UK, CAB International.
An empirical study is presented concerning evaluation of a permanent policy change for preserving ponds, ditches, stone walls, solitary trees, field islets and similar landscape elements of arable land in Sweden (1989, 1991 and 1994; n=337, 195 and 297, respectively). The landscape elements may be considered as non-rival and non-excludable goods that are continuously providing a flow of services. The environmental problem is described in terms of the depletion of landscape elements and the values that are attributed to them. Contingent valuation method surveys are presented, followed by the estimates of willingness to pay. An attempt to disaggregate the values into various types of elements, reasons for valuing the elements and use or non-use values is also presented. The temporal stability of the estimates and the temporal reliability of the CVM are analysed and discussed. The temporal reliability is tested systematically by a predictive model and by assaying explanatory variables and coefficients with respect to WTP over time.

499 **Hviding, E. & Bayliss-Smith, T.** 2000. *Islands of rainforest.* Burlington, Ashgate, 371 pp.
An ethnographic study examines land-use practices and conflicts from the viewpoint of indigenous peoples. Agroforestry, harvesting, conservation and ecotourism are considered in an historical context, moving from precolonial production systems, through colonial-period developments, to the encounter with Asian forestry companies.

500 **Ichaou, A., Bellefontaine, R. *et al.*** 1999. Ecosystèmes forestiers contractés des plateaux du sahel nigérien: vers une meilleure connaissance du fonctionnement interactif entre les systèmes écologiques et les systèmes humains. In *Gestion locale des ressources forestières,* p. 14. Meeting held in Bamako, 13-16 September 1999. Montpellier, France, CIRAD.
Parallel with implementation of Niger's Domestic Energy Strategy, research and development are being carried on to refine new and more appropriate scientific tools for the management of contracted forest ecosystems in the western highlands of Niger. Reflection on the strengths and weaknesses of early technical and socio-economic experience

with rural markets revealed a real need for study and analysis, first of the physical systems involved and secondly of the social systems, as well as the interactive links between the two. Initial development approaches showed their limitations in the management of Sahelian forests. Although the scant knowledge of the functioning and production capacities of the forest systems was partially to blame, the main reason was that the human systems had not been sufficiently studied and taken into account. Under the conceptual approach of this research, the first step is to determine the vital features common to the systems. The second step is to examine their hierarchy, so as to gain a better grasp of the dynamics of the mutual relations indispensable in order to manage and develop forests. These steps seem vital in order to establish a comprehensive approach that takes account of their interactive functioning. The few applications already deduced from study of contracted ecosystems provide openings to define clear objectives and lay down management rules that will work to the benefit of the local people. This paper describes only the broad outlines of this approach.

501 **Jahiel, M.** 1998. Rôle du palmier dattier dans la sécurisation foncière et alimentaire au Sud-Est du Niger. *Sécheresse,* 9: 167-174.
Southeastern Niger has a classic Sahelian climate, with an annual rainfall of between 200 and 500 mm. Its agricultural potential is based on a network of lowlands, where rainfed crops are concentrated, and a series of enclosed depressions, in the centre of which the water table is at the surface and where the soil can be rehabilitated and put to profitable use. Like the whole Sahelian zone, this area has undergone major climate changes; thus, after a very rainy period from 1950 to 1967, it entered a much drier phase, which is still continuing. These climatic vagaries have had major repercussions for local production systems, with farmers steadily shifting from an agricultural system based exclusively on animal husbandry and rainfed crops to a more diversified type that allows the risks to be more evenly distributed. These new farming choices have in particular led to more intensified use of the soil in depressions, and have, for example, allowed a progressive demarginalization of certain fruit crops, mainly dates, which were introduced only recently. Increased cultivation of exotic fruit species such as dates in *manga* farming systems has been helped particularly by the search for security of tenure (brought about by a decrease in the amount of arable land following a fall in the level of the water table) and by the need to increase farm income following a fall in yields of rainfed crops.

502 **Joo, R., Seong, Y. *et al.*** 1997. An assessment of domestic timber production potential in the Republic of Korea. *FRI Journal of Forest Science Seoul,* 56: 100-107.
The aim of this paper is to show that despite an increase in the harvestable growing stock of domestic forest resources, domestic timber production should continue at the present level in the years to come. The paper thus examines statistics from other writings on the subject and from the government regarding the status of forest resources, various projections of the potential yield of the country's forests, recent trends in the timber market, and economic and political factors affecting timber production. It concludes that the forecast of a rise in domestic production is unlikely to be fulfilled. Salaries in the forestry sector have risen sharply in comparison with timber prices over the past thirty years, seriously compromising the economic viability of forestry. At the same time, recent demographic trends show an increasingly serious shortage of silviculture workers in the future. Unless there is a marked increase in labour productivity, labour will thus be a major factor constraining any rise in domestic timber production. Silviculture in Korea has been and still is a heavily subsidized industry, and local and central government funding also has a major effect on domestic timber production. However, interest in multipurpose management approaches has recently been growing fast, so that government funding should be allocated to the production of non-forestry services and products. There is an urgent need to develop forestry policies to deal with the constraints on

increasing domestic timber production, as well as the production of other forest products.

503 **Kennedy, L.** 1995. L'industrie du coïr au Kerala: économie traditionnelle et mutations sociales. *Etudes rurales,* 137: 39-53.
Coir (a fibre extracted from the stringy covering that makes up the mesocarp of coconuts) has been manufactured in Kerala for centuries, and the sector is still a major source of employment, especially for women. However, this industry, which is still run traditionally, is suffering a serious crisis because of the fall in international demand and the appearance of competitors. The government's current recovery and rehabilitation plan proposes the introduction of a certain degree of mechanization, reflecting recent changes in Kerala society. Mass emigration to the Persian Gulf has speeded up the changes, and the resulting rise in people's standard of living makes the laborious work involved in coir-manufacturing even less attractive.

504 **Lifran, R.** 1999. Economie: conditions technico-économiques d'adoption des innovations agroforestières. In *Bois et forêts des agriculteurs,* p. 13-22. Acts of meeting held in Clermont-Ferrand, France, 20-21 October 1999. Clermont-Ferrand, France, INRA/Cemagref/Ministère de l'Agriculture et de la Pêche.
This paper describes research to define the economic conditions under which certain forestry innovations that are still little used, such as the planting of precious species on grasslands, could be accepted by farmers or forest owners. In view of the low adoption rate of these innovations, the author looked for comparisons in similar but more widely adopted systems, while basing himself theoretically on a model that incorporated the short- and long-term impact of the innovation on the balance of the production system and also on the value of the household's property.

505 **Lundstrom, S. & Jiven, A.** 1998. *Water, trees and people: a gender approach to the water and agroforestry system in Haubi, Kondoa, Tanzania.* Uppsala, Sweden, 50 pp.
This study examines erosion problems in Haubi village, in the Kondoa eroded area, Tanzania, and discusses the possibilities of using agroforestry as a solution. In addition to literature studies and a review of available information, primary data were collected in 1997 through group meetings and interviews with 11 men and 11 women. The questions covered structure of the family, ownership rights, division of labour, opinions and knowledge about agroforestry and estimated problems and benefits from it. It is found that the gender patterns of production and reproduction mean that women have different priorities in agricultural production. Men and women have different access to and control over resources related to agroforestry. They often have different opinions of the importance of various forest resources. They rank benefits, problems and species differently. This implies that participation incentives for men are different to those of women, and that agroforestry programmes must be aware of these in order to succeed. The main conclusion of the study is that agroforestry could be an important weapon in the battle against erosion. However, this implies a continued well organized water system and a new perspective on the women's situation.

506 **Mahapatra, A.K. & Paul, C.** 1997. Socio-economics of agroforestry participation: a user perspective model. In *Agroforestry for sustainable land-use: fundamental research and modelling temperate and Mediterranean application,* p. 211-216. International workshop held in Montpellier, France, 23-29 June 1997. Montpellier, France, CIRAD.
The socio-economic situation of the target population of agroforestry programmes can act as a constraint on these people's participation. A review of the biophysical aspects, parallel with a study of the socio-economic environment in which the agroforestry system develops, is useful with a view to establishing and assessing its adoption and spread. A regional analysis of groups of farmers in India showed the complex interaction of socio-economic factors in the agreement or refusal of farmers to take part in

tree planting programmes. The decision of landowners concerning the planting of trees on their land depended on their varying capacities to obtain resources—land, income, etc.—and their varying interest in modernizing their farming system. A useful application of a discriminatory analysis is the establishment of a forecast model in order to distinguish owners with differing degrees of potential for the planting of trees.

507 **Mary, F. & Dury, S.** 1993. Fonctions économiques des fruitiers dans les jardins de villages péri-urbains en Indonésie: le cas de Cibitung, Java Ouest. In *Journées FLHOR vergers tropicaux,* p. 38-40. Annual CIRAD-FLHOR meeting, Montpellier, France, 30 August-5 September 1993. Montpellier, France, CIRAD.
Over past decades, village gardens close to the capital of Java have been turned into diversified fruit orchards, focusing particularly on various cash crops. The proximity of urban markets and the control of the marketing of fruit by the villagers themselves mean that these lines of production are really worthwhile. The trees in village gardens also have an important function in savings strategies and are often used as collateral in order to obtain a loan for the village, their production then devolving to the lender as interest. Since current consumption expenses are covered by other activities, the trees in these gardens have the special feature of providing an income, often seasonal, without much investment in terms of labour, and one that is easy to invest or reinvest. The sale and purchase of trees play a part in the capital accumulation strategies of landless families.

508 **Mary, F. & Dury, S.** 1994. The ignored economic importance of village gardens in western Java. *Fruits,* 49: 141-150.
The village gardens of western Java have undergone major changes in their floristic composition, reflecting a marked change in their economic and social functions. Whereas at the start of the century they were expected to diversify and complement the villagers' diet, which was mainly rice-based, today these gardens—and more especially certain fruit orchards—cover several functions, with the generalized marketing of products bringing in a monetary income, and the redistribution of this income helping to maintain the social balance. A unique mechanism by which the tree or garden is used to guarantee a loan works as an insurance system should there be an unforeseen need for cash. The tree thus obtained in guarantee constitutes a profitable investment for the lender. Although the commercial function of village gardens is the object of considerable study, little is yet known about the inheritance, insurance and investment functions.

509 **McCollin, D., Baudry, J. *et al.*** 2000. Hedgerows: perspectives on biodiversity and environmental management. Selected papers from the "Hedgerow conservation: policy, protection and evaluation" meeting. *Journal of Environmental Management,* 60: 3-118.
This special issue intends to bring issues relating to the ecology, management and conservation of hedgerows to a wider audience. Eight papers, plus an introductory paper by the special editor (McCollin, D.) address three main topics: hedges as an important landscape and environmental resource, including analysis of UK hedge survey data; hedges and species diversity (woodland plants, butterflies, invertebrates, birds); and a paper on the socio-cultural meaning of hedges, with implications for future management policies.

510 **McConnell, D.J.** 1992. *The forest-garden farms of Kandy, Sri Lanka.* Rome, FAO, 117 pp.
The forest garden farms of S. and SE Asia represent one of the world's classical agricultural systems. This report, which presents the results of an analysis of the systems around Kandy, Sri Lanka, was commissioned by the Farm Management and Production Economics Service (AGSP) of FAO, in recognition of the importance of the system for the preservation of biodiversity and the need for sustainable agriculture. A farming systems approach is used to describe, quantify and evaluate the farm. This approach suggests that the success of a farm should be evaluated

on the basis of a wide range of performance criteria, of which commercial return (in general the only criterion applied in western agriculture) may be only one of several factors, or hardly relevant at all (although in some cases it may be the dominant factor). The study is presented in 6 chapters: (1) An introduction to forest-garden farms - which are defined as systems supplying all or most of a family's basic material requirements from a small area of highly diverse tree, palm and vine crops, and from short-term ground level crops grown beneath the tree canopies; (2) Evaluating the structure of Kandy forest-gardens; (3) Farm income; (4) Farm costs and net returns; (5) Farm family populations, work force and labour use; and (6) Implications for agricultural development planning. An annex discusses performance evaluation criteria for farm systems: productivity; profitability; stability; diversity; flexibility in product use and disposal; time-dispersion of production and income; sustainability; and compatibility and complementarity.

511 **Mungai, D.N.** 1990. Economic considerations of alley cropping for food production in semi-arid areas. *In* R.T. Prinsley, ed. *Agroforestry for sustainable production. Economic implications,* p. 311-320. London, Commonwealth Science Council, p. 311-320.
This work seeks to offer a preliminary technical assessment of the biological potential of alley cropping in semi-arid areas, on the basis of ecological and physiological research carried out by the National Dryland Farming Research Station at Machakos in Kenya between 1987 and 1988. It also suggests variables applicable for a cost-benefit analysis of the system.

512 **Muniz Miret, N., Vamos, R. *et al.*** 1996. The economic value of managing the acai palm (*Euterpe oleracea* Mart.) in the floodplains of the Amazon estuary, Para, Brazil. *Forest Ecology and Management,* 87: 163-173.
The extraction of non-wood forest products (NWFP) can bring in considerable income for the inhabitants of developing countries in tropical zones. The research described in this article focused on the extraction of NWFPs in the Amazon estuary area (Para, Brazil), assessing the economic aspects of acai palm (*Euterpe oleracea*—a type of palm predominant in the Amazon floodplains) management. This palm is used for its hearts and its fruit, the latter being a staple food of the inhabitants of these regions, while the former is exported to other regions of Brazil. The productivity, income and expenditure connected with traditional acai palm management by households were examined in secondary forests and home gardens. The net present value of income from land managed for palm fruit and hearts was calculated at different distances from the central market in Belem (0-60 km, 60-85 km and 85-115 km). The intensity of acai management ranges from simple collection in natural forest areas to intensive cultivation, with the degree of intensity depending on two main factors: distance from the market, and household resources. All the calculations of income showed fluctuations in prices because of the seasonal nature of production. Acai proved to be a high-value production system even at the highest rates of interest. At an interest rate of 15%, the present net values were $US 1 337-2 693 per hectare in managed secondary forest, and $US 4 266-6 930 per hectare in home gardens. The results of the survey are discussed in terms of the possible future management of acai palms and the seasonal fluctuations in yields, a feature common to many NWFPs.

513 **Ndoricimpa, L. & Guillet, C.** 1984. *L'arbre-mémoire: traditions orales du Burundi.* Paris, Editions Karthala, 249 pp.
The mythical and historical traditions of Burundi have never received the close attention that has been given to the Griot of West Africa or the Abiru of neighbouring Rwanda. Each Burundian was in a way the guardian of an ancestral heritage handed down from generation to generation during evenings when each person's talent was allowed full freedom of expression. However, this collective popular memory was crystallized around certain high places marked by trees—sacred groves, natural forests preserved for ritual purposes, circles of huge ficus trees, the

now untouchable remains of ancient royal residences. This network of sacred trees meant that the hills of Burundi were, in the strict sense of the term, a memorable landscape where myths and legends, rites and powers were played out in all their detail. More broadly speaking, the whole culture drew its material from the natural environment. A research team centred on the Burundian Civilization Centre started listening to this fund of oral tradition that had been ignored or dismissed for too long. This entails patient research, which consists both of recording and transcribing the words of old people, and making an inventory of trees protected by popular veneration despite economic pressures that can be imagined.

514 **Pandey, S., Lapar, M. *et al.*** 1998. A microeconomic analysis of adoption of contour hedgerows in the Philippine uplands. *In* A.-F. & F.W.T. Penning de Vries, eds. *Soil erosion at multiple scales: principles and methods for assessing causes and impacts,* p. 83-98. Wallingford, UK, CAB International.
Soil degradation in the sloping uplands of Asia is a serious problem that threatens the sustainability of agriculture. Although several soil conservation technologies have been developed and promoted, their adoption has not been widespread. A microeconomic analysis of adoption of contour hedgerows by upland farmers in the Philippines was conducted to identify factors that determine adoption. A number of farmer characteristics were found to condition adoption. The relative importance of these factors, however, differed across sites. Farmers did not perceive yield increase to be the major benefit from adoption. The high cost of establishment and maintenance of hedgerows and the loss of land to hedgerows were considered to be the major disadvantages by non-adopters. The economics of the contour hedgerow system was found to improve substantially if crop intensification or cash cropping is possible. In addition to the need to develop a range of more cost-effective technologies, the study points out the need to develop a better understanding of the effects of production system characteristics on incentives to adoption. The results also highlight the need for a targeted approach to technology development and dissemination.

515 **Peltier, R.** 1994. Du reboisement imposé à la prise en compte des savoirs traditionnels. Chroniques des sols Hardé du Nord-Cameroun. *Natures Sciences Sociétés,* 2: 67-79.
In the Sudano-Sahelian region of northern Cameroon, there are huge areas of soils with very scant plant cover, known as *hardé* in the Peul language. Urged on by development services, which used an authoritarian approach, insisting that such land must be reforested, forestry researchers first tried methods using large-scale mechanical equipment and fast-growing exotic species, but these attempts met with failure. They then reconsidered the problem, studying farmers' practices and the natural dynamics of the vegetation. The agropastoral societies of this region have in fact refined a development method based on a set of anti-runoff systems and on a rotation between rainy-season grazing and dry-season sorghum cultivation. The possibility of replanting certain areas was examined, combining reforestation based on multipurpose local species with management of the spontaneous grassy layer.

516 **Pillot, D. & Sibelet, N.** 1995. Chronique d'amour illicites entre l'exogène et l'endogène, ou le poids de l'histoire face au choc des logiques individualles. Innovations bocagères aux Comores. *In* P. Byé & J. Muchnik, eds. *Innovation et sociétés. Quelles agricultures? Quelles innovations? Dynamismes temporels de l'innovation,* p. 69-78. Acts of the 14th seminar on rural economics, Montpellier, France, 13-16 September 1993. Montpellier, France, CIRAD.
In the Comoros Islands, the Niumakéké peninsula saw an apparently spontaneous movement toward bocaging of the landscape in the 1970s. This innovation could in fact only be made by rehabilitating certain technical elements introduced ten years earlier, adapting and completely reorganizing them. In another region—Koni—extension

focused specifically on bocaging in the 1980s. Analysis of the situation in 1992 showed that this approach too was largely adapted by farmers to address economic concerns (intensification) different from those of the project (soil protection and rehabilitation). Comparison of the two situations shows the capacity of farming societies to take new methods and lessons on board by incorporating them into their own systems.

517 **Pleines, G., Schmithüsen, F. *et al.*** 1995. Logiques paysannes et reboisement: le cas d'Andohavary sur les hautes terres de Madagascar. *Cahiers de la Recherche Développement,* 42: 62-76.
An understanding of social and material constraints, as well as reflection on the aims pursued by the local population, are two important elements in drawing up an integrated rural development programme. The data on which the present article is based were collected through interviews in a village. They show that participation in reforestation was mainly motivated by a wish to gain access to land and to produce wood. The farmers see planting trees in a long-term perspective (thinking that their children will benefit from the timber) of self-sufficiency (allowing them to avoid expenditure). They say that planting trees, seen as a complement to agriculture—to which the best soils are devoted—could be of major benefit to them. They see reforestation from a viewpoint determined by their fundamental cultural, socio-economic and environmental situation.

518 **Prinsley, R.T.,** ed. 1990. *Agroforestry for sustainable production. Economic implications.* London, Commonwealth Science Council, 417 pp.
This volume contains the papers given at the Commonwealth Science Council meeting in Swaziland in 1989. There are discussions of how economic and financial analyses can be used to assess the net benefits of agroforestry enterprises for farmers, institutions and companies. Economic, financial, social and technical issues are examined.

519 **Raintree, J.B.** 1991. *Socioeconomic attributes of trees and tree planting practices.* Rome, FAO, 115 pp.

520 **Riad, M.** 1996. The palm sector in Egypt. *In* M. Ferry, D. Greiner, S. Bedrani & J.P. Tonneau, eds. *Options Méditerranéenes. Journées Internationales sur le Palmier Dattier dans l'Agriculture d'Oasis des Pays Méditerranéens,* p. 45-54. Elche, Spain, 25-27 April 1995. Series A, Séminaires Méditerranéens No. 28. Paris, CIHEAM.
Egypt is the world's second largest date producer, and the date palm is found in all the cultivated regions in the country. However, demographic growth means that a new development policy for the date sector must be established in order to meet future needs.

521 **Saxena, N. & Ballabh, V.** 1995. *Farm forestry in South Asia.* New Delhi, Sage Publications, 393 pp.
This work is the outcome of a workshop on the socio-economic aspects of the planting of trees by farmers in South Asia, which was organized by the Anand Rural Management Institute from 11 to 15 March 1991. It focuses particularly on the question of why farmers plant and protect trees. It contains 14 case studies from different ecological regions of South Asia.

522 **Scoones, I. & Pretty, J.** 1990. Rapid rural appraisal for economics: exploring incentives to tree management in Sudan. *In* R.T. Prinsley, ed. *Agroforestry for sustainable production. Economic implications,* p. 147-181. London, Commonwealth Science Council.
Rapid rural appraisal techniques offer an approach to understanding the complexity of agricultural systems in general, as well as possible local variations. This document analyses examples taken from two villages near Khartoum, which illustrate the different determining factors behind the rural population's motivations to plant, care for and use trees, be these motivations local, national, institutional, economic or cultural.

523 **Sharland, R.W.** 1991. Trees in the garden: interaction between the wild and agricultural domains in practice among the Moru of the southern Sudan. *Unasylva,* 42(1): 55-61.
An account of the traditional subsistence farming system of the Moru people, which depends on rainfed agriculture, supplemented by hunting and gathering in the surrounding wild bush. Settlements consist of extended family groups, with the garden immediately around the house compound being used for the cultivation of crops requiring high fertility soil, and the staple crop, sorghum, grown in specific field types (in association with sesame, cowpeas, and millets) on land cleared from the wild bush every 2-3 yr. The importance of trees to the farmers, and their understanding of the characteristics of trees are discussed, giving examples of the species involved. The treatment of trees when clearing land depends on the species, size and condition: some mature trees are left because they may not be worth killing (especially if they have a high crown), they may provide edible fruit and shade (for workers in the field) or be of ritual significance; most trees are cut at 60-90 cm height, saving time in clearing (when there is a labour shortage as planting is done at the same time) and allowing rapid regeneration in the following fallow; and a few very large or vigorous trees are killed, usually by fire. Fuelwood is generated during land clearance, and is collected, dry, when required; there is no shortage, so trees are not cut for this purpose (although they are cut for charcoal). Particular species are recognized as good for fuelwood because they burn for a long time, and produce little smoke, although some species are valued for smoke production in indoor fires, in order to control insects. Particular tree species are also recognized as indicators of good soil fertility, which is judged by the ability of the soil to grow crops (either in general or specifically). Other tree species are recognized as valuable browse, particularly for goats (sheep are also kept, and some cattle in restricted areas). The potential for use in formalized agroforestry systems of many of the indigenous tree species recognized as useful by the Moru is noted, as is the value of the Moru understanding of the interactions between trees and crops as a resource to researchers and extensionists.

525 **Sibelet, N.** 1995. *L'innovation en milieu paysan ou la capacité des acteurs locaux à innover en présence d'intervenants extérieurs. Nouvelles pratiques de fertilisation et mise en bocage dans le Niumakélé (Anjouan Comores).* Paris, Paris-Grignon, Institut National Agronomique, 400 pp.
This work offers a reflection on farmer innovation or the capacity of local stakeholders in the farming world to innovate when outside agents are present. The research has three main thrusts: (i) the origins, conditions and effects of innovation; (ii) the stakeholders in innovation (farmers), the agents (outside intervening parties), and their relations; and (iii) attitudes and strategies of stakeholders' social groups with regard to innovation. A comprehensive approach led in a first phase to concentration on farmer innovation by going back into history to find its origins, then, in a second phase, to following its development through farmers' strategies and outside contributions. In the present case, the farmers developed a coordinated system of innovations combining fertilizing by cattle, bocaging, and a change in the cropping system. Lastly, this research suggests re-examination of situations seen as cases of farmers' resistance to change, rather than automatically denying their capacity to innovate. It also contributes to reflection on new research and development practices, particularly action research.

526 **Singh, P., Pathak, P.S.** ***et al.*** 1995. *Agroforestry systems for sustainable land use.* Lebanon, Science Publishers, 283 pp.
This volume contains a collection of studies on land degradation and associated risks, indigenous and improved agroforestry practices, and the potential of these plant formations for carbon sequestration. Socio-economic aspects of the adoption of techniques by farmers are also described, as well as recent agroforestry advances in eight countries (Australia, China, Hungary, India, Indonesia, Nepal, Sri Lanka and United Kingdom).

527 **Styger, E., Rakotoarimanana, J.E.M. *et al.*** 1999. Indigenous fruit trees of Madagascar: potential components of agroforestry systems to improve human nutrition and restore biological diversity. *Agroforestry Systems,* 46: 289-310.
Biodiversity in eastern Madagascar is threatened by slash and burn agriculture, which is resulting in species extinction, land and soil degradation and rural impoverishment. An ethnobotanical study was undertaken to determine the domestication potential of indigenous fruit tree species as components of agroforestry systems. Four major selection criteria were used: nutritional and income needs of the population, diversification of the agroecosystem, and protection of plant and animal diversity. At 3 sites, Andasibe, Masoala and Ranomafana, in the humid primary forest region of eastern Madagascar, a total of 150 wild fruit species from 82 genera and 42 families were identified, of which 85% were indigenous and 92% of woody habit. In contrast to most of the deforested areas in Madagascar, the rural population in these areas possess an intimate knowledge of indigenous plant resources. Most of the indigenous fruits are collected from the forest but for a few species, domestication is initiated by managing naturally established species or by planting individual trees in agricultural fields. Wild fruits supplement the daily diet, substitute for exotic fruits, gain importance during periods of food shortage and are most appreciated by children. Commercialization of wild fruits is mainly undertaken by the poorer section of the population. Gender related differences in knowledge and preferences for species were identified and related to the respective household responsibilities. A list of the 26 priority species was established based on the preferences of children, women and men at the 3 sites. Local, fruit-eating lemur species are also highly dependent on indigenous fruit trees and are crucial for successful regeneration of forest vegetation.

528 **Supuka, J.** 1998. *Codes of practice for landscape and the appraisal of trees in settled areas.* 180 pp.
A monograph based on a review of experience in Czechoslovakia and selected works from the USSR, Western Europe, N. America and Bulgaria, illustrated with 41 photographs and plans. The 5 main chapters deal with: the evolution of settlement and current problems of landscape management in towns; classification and evaluation of the functions of urban landscapes (green spaces); proposed standards for the spatial and formal structure of landscape elements in residential and industrial areas; problems of social and economic appraisal of landscape and trees, both abroad and in forest, agricultural and urban areas of Czechoslovakia; and a proposed system of urban tree valuation in Slovakia. Trees are valued (in Kcs) according to the discounted costs of establishment and maintenance, multiplied by indices expressing ecological, aesthetic and other values; these are tabulated together with the local standard (normal) ht. and d.b.h. growth of 34 indigenous and exotic tree species, and the b.a., crown diam. and ht. growth of 53 shrub species, at 5-yr intervals.

529 **Terreaux, J.P.** 1996. Le boisement dans l'exploitation agricole: modèles micro-économiques de prise en compte des externalités. *In* G. Balent, ed. *La forêt paysanne dans l'espace rural: biodiversité, paysages, produits,* p. 183-194. Etudes et Recherches sur les Systèmes Agraires et la Développement No. 29. Paris, INRA.
Public or private forests, the latter including farm forests, play a social and ecological role, as well as an economic one, on both local and national levels. It is now accepted that although timber production is at present the main objective of management methods, forest resource management must also encompass the assessment of the economic and non-economic values of forest goods and services, as well as the environmental costs and advantages bound up with their presence or changes in them. This paper describes the main management methods.

530 **Thampan, P.K.** 1994. *Trees and tree farming.* Cochin, India, Peekay Tree Crops Development Foundation, 447 pp.
This book, which is published by a non-profit organization which has as its primary objective the dissemination of information on tree based farming systems and their influence on soil fertility, environment and human welfare, contains 18 chapters by various authors covering (among others) socioeconomic and ecological aspects of tree based farming systems (agroforestry), mostly with reference to India. The chapters are: 1. Tree farming for food and nutrition; 2. Principles and practices of agroforestry; 3. Agroforestry options for the reclamation of problem soils; 4. Coconut based agroforestry in Sri Lanka; 5. Soil fertility aspects of tree farming; 6. Potential of Rhizobium and other biological inputs in tree farming; 7. Trees and mycorrhiza; 8. Trees and tree based farming systems in the arid zones of India; 9. Unexploited tropical fruit trees with promising economic value; 10. Tree spices; 11. Conservation of medicinal and aromatic tree species through agroforestry; 12. Dasamoolam - a group of drugs containing 2 subgroups which constitute the panchamoolas, or 10 drugs, which are preparations from 10 species (many trees); 13. Allelopathic effects of Eucalyptus in agroforestry; 14. Trees with promising value in the biocontrol of crop pests; 15. Biological control of forest tree diseases; 16. Tree breeding perspectives in tropical forestry; 17. Biotechnological options for tree farming; and 18. Trees and climate.

531 **Tulachan, P. & Batsa, A.** 1994. Gender differences in livestock production management in the Chitwan District of Nepal. *Journal for Farming Systems Research Extension,* 4: 121-135.
This article describes gender-linked differences in indigenous knowledge and division of labour in livestock production and management. It uses a combination of techniques, such as fixed-interval surveys, rapid rural appraisal and random observation, to obtain information on two sites in the Chitwan district of Nepal. The results suggest that women play a key role in the household in livestock production management, performing over 80% of the total labour. Sociocultural systems such as those found in Daejo and Pewa (where it is customary to give livestock to the young bride) seem to emphasize women's greater responsibility in caring for and managing livestock. Women know much more than men about local fodder plants and trees, as well as local ways of treating sick animals. On the other hand, men know more about improved fodder and fodder crops than women. While women bear the main responsibility for caring for and managing a household's livestock, men actually sell the animal products and receive the money, so that women are at a disadvantage in decisions over livestock improvements. The article concludes that women should be the main focus of any livestock programme, not just because they are the ones who take care of the animals, but also because of sociocultural values. Women farmers must be trained and encouraged to become entrepreneurs, so that they receive money from the sale of livestock products.

532 **Underwood, M.** 2000. Fruit trees, gender and community forestry in Zululand, South Africa. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources of Africa,* p. 253-260. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
This paper describes an off-forest community forestry programme carried out by the University of Zululand in the 1990s. The women's demands concerning fruit trees seem to be one of the key factors in the success of community forestry programmes in the region. A multidisciplinary approach was adopted in order to analyse problems linked with community forestry in this sector, with special attention to the contribution of women. Problems connected with this type of approach are also discussed, and methods suggested to promote and assess the products of off-forest trees.

533 **Warner, K.** 1993. *Patterns of farmer tree growing in Eastern Africa: a socio-economic*

analysis. Oxford, UK, Oxford Forestry Institute, 270 pp.
This report is the result of a joint project carried out by the Oxford Forestry Institute and the French International Centre for Research in Agroforestry, with the aim of collecting, organizing and processing primary and secondary data from eastern Africa on key socio-economic factors affecting farmers' decisions to grow trees. The project was part of a broader OFI research programme funded by grants from the Rockefeller Foundation and the Overseas Development Administration of the United Kingdom. The first two chapters of the report consist of an introduction and an analysis of the data on regional patterns of tree growing, as identified in the course of a study covering eight countries. The analysis identified variables affecting farmers' decisions on the planting of trees: land tenure and rights; agricultural and livestock management practices; dependency on forest products and the supplies possible to obtain from existing trees; the size and accessibility of markets; the cost—constraints connected with labour, security of tenure and capital; cultural factors and attitudes; and government and NGO interventions. The eight chapters that follow are national reports (Kenya, Uganda, Rwanda, Burundi, Tanzania, Malawi, Zambia and Zimbabwe). Some general information is given (on context, agroecological zones, land tenure systems, the economy, the rural sector and government land-use policies, crops and trees) as well as an agroecological analysis. The final chapter consists of a bibliography, giving information on the sources consulted for each of the preceding chapters.

534 **Webster, S., Davis, C. *et al.*** 1997. *Arboricultural practice: present and future.* Proceedings of a conference organised by the Arboricultural Advisory and Information Service (Tree Advice Trust) and the Arboricultural Association. UK, Department of the Environment, Transport and Regions, 152 pp.
Eighteen papers are presented on arboriculture in the UK, arranged in 6 sections. Section 1, Setting the scene, has 3 papers: Arboriculture revisited (Webster, S.; Davis, C.; Angell, J.); Opening statement: why a research conference (Patch, D.); and Ministerial statement (Beresford, Sir P.; Angell, J.). Section 2, Threats to trees, has 6 papers: Stress and tree performance (Jones, H. G.); Trenching: a cause of root damage (Crane, B.); Tree disease: the question of cause (Gibbs, J. N.); Monitoring amenity tree health (Strouts, R. G.); Gypsy moth [Lymantria dispar]: the threat to Britain's trees (Finch, R. R.); and Integrated pest management: gypsy moth (Booth, D. C.). Section 3, Threats from trees, has 2 papers: Long-term monitoring of soil moisture deficits on clay soils near trees (Biddle, G.); and Direct damage by urban tree roots (Nicoll, B. C.; Coutts, M. P.). Section 4, Wildlife and trees, has 2 papers: Mammals and birds associated with trees: the damage they cause (Pepper, H. W.); and Wildlife and trees in urban areas: the good they do (Game, M,). Section 5, Supply and establishment, has 4 papers: Assessment of nursery stock in amenity trees (McKay, H. M.; McEvoy, C.); Preconditioning trees to improve outplanting performance (Hipps, N. A.; Nicoll, F.); Potential for tree growth on sites contaminated with heavy metals (Wilkins, D. A.); and Practical experience growing trees in derelict and contaminated sites (Goodman, A. C.). The last section, The future, has 1 paper: Research requirements in arboriculture (Last, F.).

3.3 POLITICAL AND LEGISLATIVE ASPECTS

550 **Alloke, P. & Issoufou, M.** 1991. *Le rapport entre la tenure foncière et la tenure de l'arbre.* Niger, Ministère de l'Agriculture et de l'Elevage, 96 pp.
The main objectives of this study are on the one hand to define the different traditions concerning the normative relationship between man and tree, through rights of control, access and transmission over trees and their products, so as to understand the incentives and constraints regarding protection of the environment, and on the other hand to draw conclusions in order to make recommendations within the framework of the rural code and the forestry code.

551 **Arnold, M. & Dewees, P.** 1998. Rethinking approaches to tree management by farmers. *Natural Resource Perspectives,* 26: 8.
This article examines strategies for managing trees on farmland and suggests a framework for political intervention. Farmers in most places plant or maintain some trees on their land. Historically speaking, very little attention has been focused on this component of the agricultural landscape, although specific political measures can be identified and distinguished from those concerning forestry.

552 **Barrow, E.G.C.** 1990. Usufruct rights to trees: the role of Ekwar in dryland central Turkana, Kenya. *Human Ecology,* 18: 163-176.
The law controlling usufruct rights over trees (*ekwar*) is a primordial aspect of the silvopastoral system of the Turkana, allowing a balanced management of natural resources in the drylands of central Kenya. This article describes how the system works.

553 **Baumer, M.** 1988. *Agroforesterie et aménagement du territoire.* Nairobi, 48 pp.

554 **Bernus, E.** 1980. L'arbre dans le nomad's land. *Cahiers de l'ORSTOM,* 17: 171-176.
Nomads have often been accused of being destroyers of forests and propagators of deserts, through use of the axe, fire and goats. However, trees are indispensable to nomads' lives, providing raw materials (poles, beds, bowls, etc.), fuel, food (fruit) and grazing (leaves and fruit). After briefly showing the range of uses of trees in pastoral zones, the author tries to determine whether nomads are in fact the unscrupulous marauders so often depicted as the antithesis of farmers, who are attached to their land and are the creators of selected parkland that bears witness to long establishment and a deliberate improvement strategy. But should the situation be seen as that of a conquering, destructive society, which endangers precarious balances, as opposed to farming societies, which are concerned with an overall development leading to a growth in the productivity of the land?

555 **Bertrand, A.** 1985. Les nouvelles politiques de foresterie en milieu rural au Sahel. Réglementations foncières et forestières et gestion des ressources ligneuses naturelles dans les pays de la zone soudano-sahélienne. *Bois et Forêts des Tropiques,* 207: 23-39.
The first part of this article is devoted to land management and the regulations governing land use in rural Sahelian zones. The author reviews land laws from ancient times, those inherited from the colonial era and their development since independence, and how this varies from one country to another. The present uncertainties brought about by this development affect solutions to forestry problems. The author also analyses forestry policies and regulations, giving an historical summary for this aspect too. The effects of forestry regulations on rural people are discussed in greater detail. Lastly, a major section of the article is devoted to the development of new forestry policies in rural zones. These must provide a balance between man-made forest and the development of natural forests, and farmers must be involved in the measures adopted.

556 **Bertrand, A.** 1991. Les problèmes fonciers des forêts tropicales africaines. Le foncier de l'arbre et les fonciers forestiers. *Bois et Forêts des Tropiques,* 227: 11-16.
Forests and trees are at the centre of economic and social relations within the rural world and between the latter and urban agglomerations and the State. A number of these relations are connected with land tenure, and the present article describes various elements of their analysis. In particular, it shows that although rights over trees are generally in line with the rules governing tenure of farmland, the written or oral rules and customs constituting forest tenure law are by their nature variable, varying in fact depending on time and place. There are thus a number of forest tenure systems, varying according to whether they are prior to, during or after any agricultural use. The role of the State seems determining and needs to be rethought.

557 **Boffa, J.M.** 2000. West African agroforestry parklands: keys to conservation and sustainable management. *Unasylva,* 51(1): 11-17.
This article reviews the main factors involved in the management of agroforestry parkland in semi-arid regions of West Africa, where trees are an integral part of the farming system. The positive effects of trees on the whole farming system are recognized, and the author gives a brief description of the research and development strategies to be pursued in order to ensure good conservation and improved management of these traditional land-use systems. This article thus provides different examples of technical improvements and economic incentives aimed at boosting the protection and reproduction of agroforestry parkland. The author also describes the direct impact of agricultural and forestry policies on the development of agroforestry parklands in West Africa.

558 **Brotons, G.B.** 1999. Nécessité et difficultés d'une protection juridique de la palmeraie d'Elche. *In* S. Bedrani & D. Greiner, eds. *Agroéconomie des oasis,* p. 41-47. Montpellier, France, CIRAD.
The Elche palm grove, the largest in Europe, has a cultural, landscape and productive value. The first law protecting it was passed on 8 March 1933, when its defence was declared to be of public interest. Later, the grove was declared a national artistic garden. On 9 May 1986, a new law to protect the grove was drawn up by the Valencia regional government. Negotiations between farmers' organizations and the Elche local government on modifications to the law have so far been unsuccessful, leading to the present state of the Elche palm grove.

559 **Bruce, J.W. & Fortmann, L.** 1989. *Agroforestry: tenure and incentives.* Madison, Wis., USA, University of Wisconsin Land Tenure Center, 46 pp.
This document focuses on interactions between land tenure and the planting of trees in developing countries. The first three parts (tenure, green spaces, and the State and forest reserves) is a revised version of a report on the proprietary dimensions of agroforestry prepared for an AAA technical session ("Agroforestry; a global perspective on potentials and constraints", San Francisco, 15 January 1989). The fourth part is devoted to the evaluation of tenure issues when setting up projects.

560 **Bruce, J.W. & Fortmann, L.** 1999. Contemporary uses of tree tenure. *In* L.E. Buck, J.P. Lassoie & E.C.M. Fernandes, eds. *Agroforestry in sustainable agricultural systems,* p. 237-243. Boca Raton, Fla., USA, Lewis Publishers.
This study examines different cases in which rights over trees are of practical importance, with special attention to their equity and political implications. There are three major types of case: cases where tree tenure replaces land tenure, cases where tree tenure is used to obtain resources under the direct control of the owner, and cases where the State exercises these rights to protect the public interest.

561 **Bruce, J.W., Fortmann, L. *et al.*** 1993. Tenures in transition, tenures in conflict: examples from the Zimbabwe social forest.

Rural Sociology (University of Wisconsin Land Tenure Center), 58: 626-642.
Land tenure relations in Zimbabwe are complex. The landscapes of rural communities are divided into areas in which different uses of resources are practised and for which there are specific types of tenure. However, several resources can occupy the same space, and competition between systems can place the same resource in niches falling under different and incompatible types of tenure. A conflict can lead to the superposition of several niches. Co-management is the only way of solving the problems.

562 **Burgess, P.J., Brierley, E.D.R. *et al.*** 1999. Farm woodlands for the future. In *Farm woodlands for the future.* Conference held at Cranfield University, Silsoe, UK, 8-10 September 1999. Silsoe & Oxford, UK, BIOS Scientific Publishers.
The European Union seeks to increase tree planting on farms, and the UK Government's Forestry Strategy for England aims for a continued expansion of woodland to provide social, environmental and economic benefits to society. This book on Farm woodlands for the future arose from a conference held at Cranfield University during 1999, which examined the benefits of new farm woodlands, and questioned if current policies really promote farm woodland planting. It contains 18 papers from the conference by various authors, which combine the perspectives of policy makers, researchers, land agents, farm woodland managers and promoters. The papers are arranged in 5 sections: 1, The socio-economic role of farm woodlands (3 papers); 2, The value of farm woodlands for shelter, biodiversity and landscape enhancement (4 papers); 3, The economic value of farm woodlands (5 papers); 4, The value of agroforestry, poplar and short rotation coppice (3 papers); and 5, Promotion of farm woodlands (3 papers).

563 **Carter, E.J. & Gronow, C.J.V.** 1992. Strategies for supporting tree cultivation on private land in the Middle Hills of Nepal. *Banko Janakari,* 3: 13-18.
Private forestry is receiving growing attention in silviculture projects in Nepal. Despite this, strategies to support tree cultivation on private land are seldom clearly defined. In describing field experience in the Dolakha and Dhankuta districts, this paper discusses how and why approaches to support the private planting of trees have been poorly conceived. It holds that an investigation focusing on farmers and using a participatory approach (similar to that used in community forestry), and thus making full use of indigenous knowledge, would be more appropriate. It then describes briefly how this could be done.

564 **Current, D. & Scherr, S.J.** 1995. Farmer costs and benefits from agroforestry and farm forestry projects in Central America and the Caribbean: implications for policy. *Agroforestry systems,* 30: 87-103.
This article lays out the results of an assessment of the benefits of agroforestry and farm forestry projects in Central America and the Caribbean, together with implications for policy. Tree planting provides farmers with financial, as well as social, economic and environmental benefits. These benefits are great enough to justify political interventions that would give explicit recognition to the potential for planting trees on farmland, and thus provide a political environment favourable to such efforts. New or revised policies are needed, particularly in a period of reduced public spending, in order to (i) limit outside subsidies for this type of operation (rather than financial grants), (ii) promote development of the market in tree products, (iii) adopt inexpensive extension strategies, in consultation with local communities, (iv) support research, and (v) reduce red tape.

565 **Dewees, P.A.** 1995. Trees and farm boundaries: farm forestry, land tenure and reform in Kenya. *Africa,* 65: 219-235.
Tree cultivation and exploitation are often found on high-potential land in Kenya. While some of the related practices are linked to economic considerations such as markets and prices of specific tree products, others are derived from or have developed parallel with traditional practices. This article traces

contemporary demarcation practices in Kikuyu areas of Kenya, entailing the planting of trees in hedges, back to their traditional antecedents. Customary law prescribed clear mechanisms to demarcate land for which rights of use had been acquired. These mechanisms, marked mainly by the planting of certain trees on farm boundaries, were recognized with certain limitations by the colonial administration and were later incorporated (without any really clear awareness of their traditional role) into the body of contemporary agrarian laws that emerged following agrarian reforms at the start of the 1960s. The agrarian reforms tended to blur customary distinctions between rights of control over trees and rights of use and access, seeing rights of control as equivalent to rights of ownership. As a result, rights of use and access, which had been guaranteed to landless people under customary law, were for the most part eliminated.

566 **D'Herbès, J.M., Ambouta, J.M.K. *et al.*** 1997. *Fonctionnement et gestion des écosystèmes forestiers contractés sahéliens.* Paris, J. Libbey Eurotext, 274 pp.
The increasing scarcity of water means that vegetation in Sahelian zones is shrinking and forming some unique structures, which now require study and understanding so that they can be turned to the best account. Not all contracted ecosystems—i.e. systems formed by a juxtaposition of zones with vegetation and bare soil—have been degraded, and they do not therefore justify the costly reforestation projects that can sometimes go part-way to fulfilling the intended aim. "Understanding for a better management of Sahelian forests" was the subject of an international workshop held in Niamey from 20 to 25 November 1995, organized by the Directorate for the Environment of the Niger Ministry of Water and the Environment, CIRAD-Forêt and ORSTOM, and attended by development researchers and field experts. This meeting allowed policies being implemented in Niger to be examined in the light of present scientific knowledge on these contracted forest ecosystems.

567 **Eboh, E.C.** 2000. Tenure differentials between land and trees and implications for sustainable management of off-forest tree resources in Eastern Nigeria. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources in Africa,* p. 261-286. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
The prospects of sustainable management of off-forest tree resources depends to a large extent on the helpful effects and/or constraints of existing tenure systems for trees and land. Traditional views equate traditional ownership with common ownership. Modern paradigms, which use a contextual/holistic model, require fuller tenure studies. This model was used to study the interrelations between traditional tree and land tenure in Eastern Nigeria, focusing on the strengths, weaknesses, potential and constraints for sustainable management of off-forest tree resources.

568 **FAO** 1985. *Tree growing by rural people.* Rome, FAO, 130 pp.
This document has three main objectives: to describe the context into which innovations regarding rural forestry have been introduced, to record the various strategies that have been used to encourage tree growing by local people, and to discuss planning and institutional issues. The first part of the work describes traditional ways of managing the rural environment. The second part discusses the various approaches that have been adopted in participatory management and development activities with regard to tree planting. The third part covers the broad area of government support services, as well as institutional aspects. The role of forestry services and NGOs is also considered.

569 **Follis, M.B. & Nair, P.K.R.** 1994. Policy and institutional support for agroforestry: an analysis of two Ecuadorian case studies. *Agroforestry Systems,* 27: 223-240.
Although institutional and policy issues are now recognized as major priorities in agroforestry research, few studies based on real field experience seem to have been undertaken. With a view to filling this gap, a

study was carried out in Ecuador to assess the institutional and political impact on the spread of agroforestry by using two field projects as case studies. The projects were in environmentally very diverse locations: the Amazonian lowlands (the Coca Agroforestry Project, 1985-1990) and the mountainous Andean region (the PROMUSTA Project, started in 1986). The Coca Project (launched by the Ministry of Agriculture and the National Forestry Directorate, with considerable support from USAID) sought to boost the wood, coffee and livestock production of smallholder families by (i) combining high-value indigenous tree species (mainly *Cordia alliodora* and *Jacaranda copaia*) with coffee (*Coffea canephora*) and grazing, (ii) introducing new management and harvesting practices for coffee, and (iii) introducing *Desmodium ovalifolium* to improve pasture and as ground cover for coffee bushes. The PROMUSTA Project (launched by the Cooperative for Assistance and Relief Everywhere [CARE] and the Ministry of Agriculture) sought to promote soil conservation techniques and sustainable agricultural practices on sloping land through the use of various agroforestry techniques. The impact of political and institutional constraints (such as land tenure, research, marketing and credit) on implementation of these projects was assessed on the basis of interviews with farmers and project officers and of analysis of secondary data. The Coca Project was judged as unsatisfactory because of the lack of marketing of products and the non-availability of credit. The main institutional constraints for the Andean project included legal obstacles to obtaining arable land, the scarcity of financial support from the State, and a shortage of accessible credit. While access to land was not a serious constraint in the lowlands, it was vital in the mountainous areas. The study supports the view that political and institutional assessments must become an essential component of the design and implementation of agroforestry projects. Although the components of a sound political framework may be similar in most developing countries, it is impossible to develop universally applicable procedures for formulating agroforestry policy, because of geographical differences between the systems and institutional issues connected with their adoption.

570 **Fortmann, L.** 1987. Tree tenure: an analytical framework for agroforestry projects. *In* J.B. Raintree, ed. *Land, trees and tenure,* p. 17-34. International Workshop on Tenure Issues in Agroforestry, Nairobi, 1985. Nairobi, ICRAF.
This paper analyses the components of tree tenure, interrelations between trees and land tenure, and their respective importance in the agroforestry sphere.

571 **Fortmann, L.** 1990. Locality and custom: non-aboriginal claims to customary usufructuary rights as a source of rural protest. *Journal of Rural Studies,* 6: 195-208.

572 **Fortmann, L. & Bruce, J.W.** 1988. *Whose trees? Proprietary dimensions of forestry.* Westview Press, 341 pp.

573 **Freudenberger, K.S.** 1995. *Tree and land tenure: using rapid appraisal to study natural resource management: a case study from Anivorano, Madagascar.* Rome, FAO, 85 pp.
This case study follows various FAO Trees and People Programme publications on the use of rapid rural appraisal (RRA) methods to study trees and land tenure. It applies the procedures described by the author in 1994 (FAO Community Forestry Field Manual 4) and shows not only what has been learned through use of RRA, but also discusses the practical aspects of using the procedure. The case study is based on the village of Anivorano in Madagascar, which has a wide range of endemic animal and plant species. Degradation of these natural resources caused international and local concern, and RRA was part of a one-year research programme to find out about land use and tenure in Madagascar. The six chapters of the report are as follows: an introduction; preliminaries to the field survey; research activities in the field; the community and its resources; implications for sustainable resource management; and the strengths and limitations of RRA.

574 **Freudenberger, M.S.** 1997. Tree tenure and farmed parklands agroforestry systems in the Sahel: constraints and opportunities. *In* G. Bonkoungou, E. Ayuk and I. Zoungrana, eds. *Les parcs agroforestiers des zones semi-arides d'Afrique de l'Ouest,* p. 7-34. Meeting held in Ouagadougou, 1993. Nairobi, ICRAF.
Traditional agroforestry systems combining trees and crops (agroforestry parklands) are known throughout the Sahel in West Africa. Trees maintained on cropland serve various purposes for farmers, ranging from the great variety of products consumed by households to a whole range of marketable tree products. Rural people certainly recognize the important role of these trees in maintaining and improving soil fertility. Throughout the Sahel, particularly close concentrations of high-value tree species are found in combination with annual and perennial crops in the immediate vicinity of villages. Tenure over these marketable species is on the whole clearly defined. Although research on tree tenure in the Sahel has increased very recently, very few field data are available based on analysis of case studies. This article is a broad review of the debate on tree tenure in the Sahel. It is based on the research experience of the Land Tenure Center of the University of Wisconsin–Madison. The first part reviews the debate on land and tree tenure in the Sahel, also providing examples, most of them from the centre's recent research programmes in Senegal, Mali, Gambia and Niger. The second part gives a series of recommendations for future applied research, as well as reforms to regulations.

575 **Ganry, F. & Campbell, B.** 1993. Sustainable land management in African semi-arid and subhumid regions. In *SCOPE workshop.* Dakar, 15-19 November 1993. Dakar & Montpellier, CIRAD-ca.
Maintaining the natural resource base over time in dryland areas of the tropics (which cover the arid, semi-arid, and subhumid regions) requires that desertification and land degradation be controlled. Because of their areal importance, on a global scale, their potential for food and wood production, and their vulnerability, the semi-arid regions, in particular of Africa, are of special importance. The book contains the proceedings of a SCOPE (Scientific Committee on Problems of the Environment) workshop held between 15-19 November 1993, in Dakar, Senegal. It presents 30 papers which bring together experiences of physical and social scientists from Francophone, Anglophone and Lusophone countries who have been working on land issues in Africa. The first section of the book is made up of 11 papers which discuss sustainable management of the biological, physical and chemical fertility. In the second section five papers examine the measures being taken against erosion in rural Africa and what new approaches are currently being introduced. Section three contains three papers which analyse the sustainable management of irrigated lands. The fourth section (11 papers) focuses on the sustainable management of cultivation, agropastoral and agroforestry systems. Finally four discussion groups make policy recommendations and determine the research priorities for sustainable land management systems.

576 **Gautier, D.** 1994. L'appropriation des ressources ligneuses en pays Bamiléké. *Bois et Forêts des Tropiques,* 240: 15-28.
The appropriation of woody resources in Bamiléké land leads the author to consider trees in their various forms of spatial distribution. A reflection on tree systems allows a correspondence to be established between the status of the land and these forms of appropriation, which are divided into three spheres: within the household compound, where trees are subject to intensive management; the edges of family land, where there are semi-extensive stands (hedges and raffias), and spaces within the cultivated area, with sacred groves and savannah. The combination of stands corresponding to the three forms of tree appropriation allows an analysis of the Bamiléké landscape from a new perspective, with a view to sustainable rural development.

577 **Geilfus, F.** 1997. Des "arboriphobes" aux arboriculteurs: promouvoir la foresterie

paysanne en République dominicaine. *Réseau foresterie pour le développement rural,* 22: 23.
This paper describes how farmers' attitudes to farm forestry have changed considerably in the Dominican Republic over the past 20 years, to a large extent because of the success of the innovative Zambrana Project supported by the ENDA-Caribe NGO. It shows that under certain conditions (for example the absence of an economically attractive alternative use for arable land and a growing shortage of farm labour), even without significant subsidies, there may be sufficient motivation to bring about widespread tree management among smallholders. The project adopted a flexible participatory approach to technological development in order to allow farmers maximum flexibility in the choice of species and in technological choices. The project also took into account the criteria involved in farmers' decision-making processes, taking particular note of the relative shortage of labour and land. A major aspect of the strategy was the use of "social rewards", which meant encouraging the oldest and most respected farmers to develop their interest in trees and thus to improve their position of respect within the community. The result was a widespread adoption of tree management practices. At present prices, it seems that forestry on agricultural land offers an economically attractive alternative to annual crops. In the longer term, one of the main concerns was that the success of the project might saturate the market, especially since one species, *Acacia mangium*, is predominant.

578 **Gregersen, H., Oram, P. *et al.*** 1992. *Priorities for forestry and agroforestry policy research: report of an international workshop.* Washington, DC, IFPRI, 95 pp.
This workshop focused on economic and political issues connected with the development of alternatives to shifting cultivation, since the latter is one of the main factors in deforestation. It also worked on a wide range of research subjects. The first part of the report is a summary giving the results that emerged from the workshop, summing up some of the priorities and approaches identified in the context of future research initiatives concerning policy. The views of five thematic working groups are then presented. Lastly, recommendations are given on the establishment of policy research programmes. The second part of the work includes five papers prepared for the workshop, exploring research priorities and describing the state of knowledge in different key areas.

579 **Guitton, J.L., Dupraz, C. *et al.*** 1994. Quel projet agroforestier pour l'Europe tempérée? *Revue Forestière Française,* 46: 179-188.
An overview of the different forms of agroforestry practised or experimented with in temperate zones shows three distinctive features in the context of the late 20th-century European countryside: many traditional forms of agroforestry are being revived, and new practices are also growing up; agroforestry is carried on with a close eye to the present needs of Western society; and there are still strong technical and socio-economic constraints. Obstacles to the spread of agroforestry are the difficulty of producing high-quality timber with isolated trees (deciduous species) or very sparsely planted trees (conifers). Plantations set up in the Auvergne and Languedoc-Roussillon regions of France will throw light on this aspect. An agroforestry law needs to be established, inasmuch as today an agroforestry plot cannot be classified in terms of land registry, taxes or CAP regulations. CAP has set up a management and land freeze policy; agroforestry could be a supplementary tool, serving these new mechanisms to reduce fallow areas and their impact on the environment.

580 **Hislop, M. & Claridge, J.** 2000. *Agroforestry in the UK.* Edinburgh, UK, Forestry Commission, 127 pp.
This bulletin provides advice about the establishment and management of a range of agroforestry systems in the UK. It is based on a decade of research undertaken by scientists from a number of British and European institutes. The agricultural industry in the UK is going through a major period of change. Health and welfare concerns such as the BSE

crisis and the transportation of live animals are affecting the livestock farmer. Environmental concerns over the use of fertilizers and pesticides are affecting arable enterprises. These concerns are just part of the current debate about the future of the countryside in the UK and are encouraging farmers, foresters and policymakers to explore alternative approaches to land use. Agroforestry is one such alternative. The possibility of combining agriculture and forestry on the same unit of land appears attractive. In theory, agroforestry could improve productivity, livestock welfare, wildlife habitats and provide diversification opportunities, as well as reducing fertilizer and feed inputs. The fact that there is little experience of agroforestry systems in the UK may be due to uncertainty about the practicalities of establishment and management and the associated costs and benefits in the short and long term. The objective of this bulletin is to reduce that uncertainty; it is divided into 4 sections (and 11 chapters). Section 1, Background, introduces agroforestry, describes the historical and current context for the bulletin and explains the complexity (in terms if interactions) of agroforestry systems compared to conventional agricultural or forestry systems. It includes are 3 chapters: Introduction; Origins of agroforestry and recent history in the UK; Understanding and management of interactions. Section 2 provides advice on the establishment and management of various agroforestry options (silvopastoral and silvoarable systems) and makes recommendations for best practice, based on current research experience; it has 4 chapters: Trees in agroforestry systems; Grazing livestock management; Alternatives to grazing livestock; and Arable crops in agroforestry systems. Section 3 considers the impact of agroforestry systems on the environment and gives advice on how to fit agroforestry sympathetically into the landscape; it has 2 chapters: Environmental impacts; and Agroforestry in the landscape. Section 4 considers the social implications of the increased adoption of agroforestry systems in the UK and provides an economic assessment of a range of agroforestry scenarios using the best information currently available; it has 2 chapters: The social implications of agroforestry; and The economics of agroforestry in the UK. The bulletin is recommended for use by farmers, farm and forestry advisers, landowners, students and all others with an interest in developing alternative land-use systems in the countryside.

581 **ICRAF** 1987. *Land, trees and tenure.* International Workshop on Tenure Issues in Agroforestry, Nairobi, 1985. Nairobi, ICRAF, 412 pp.
This document contains the papers presented at the international workshop on tenure issues in agroforestry held in Nairobi in 1985. Most of the 28 papers are regional examples focusing on this issue in Africa, Asia and Latin America.

582 **ICRAF** 1988. *Agroforestry potentials for the land use systems in the bimodal highlands of Eastern Africa, Kenya.* Nairobi, ICRAF, 153 pp.
Through research institutions in the region, ICRAF promoted a collaborative approach in order to develop agroforestry techniques suited to the present circumstances, while boosting the capacity of national organizations to generate them. Three phases are identified in this method: planning, formulation and implementation. The first phase consists of the preparation of a blueprint by each participating country, identifying the problems and opportunities, together with the land-use systems selected in an ecozone for development of these techniques. In the research phase, the specific objectives and investigative methods to be used for this development are defined. The implementation phase entails the setting up of on-station and on-farm experiments.

583 **Krott, M. & Nilsson, K., eds.** 1998. *Urban forestry: multiple-use of town forests in international comparison.* First European Forum on Urban Forestry, IUFRO Working Group S.6.14.00, Wuppertal, Germany, May 1998. Freising, Germany.

After 2 introductory addresses (1 in German), the report from this conference is presented in 3 sections: I. Introduction - 1 paper by Krott on urban forest management within the focus of people and trees; II. Urban forestry in the scientific view: highlights and background analysis - 9 papers (8 in English, 1 in German) by various authors on various aspects of urban forestry, including the impact of values, interests and political dynamics, conflict management, perception and meaning, planning and management, forest landscape research and practice, the COST (European Cooperation in the field of Scientific and Technical Research) Action E 12 'Urban Forests and Trees', and the Tree Route Network (a network of European researchers and professionals); III. Urban forestry in practice: experiences from European towns - 13 papers, from Bratislava (Slovakia), Brussels (Belgium), Budapest (Hungary), Cleveland and Dunstan (UK), Essen (Germany), Helsinki (Finland), Merano (Italy), Paris (France), Prague (Czech Republic), Rostock (Germany), Vantaa (Finland), Verona (Italy) and Wuppertal (Germany).

584 **Louppe, D.** 1991. Réflexions sur les haies-vives et brise-vent en Nord Côte d'Ivoire (region de Korhogo). *Revue Forestière Française,* 3: 129-135.
This article describes a living fence development project in a densely populated zone, intended to mark the boundaries of landholdings, with the participation of local people.

585 **Mailliet, L. & Bourgery, C.** 1993. *L'arboriculture urbaine.* Paris, 318 pp.
Management of the green heritage of towns falls under a long-term town planning project based on five indissolubly linked aspects—landscape, economy, technology, regulations, and communications. Analysis of experience in certain communities over the past ten years shows that all the following aspects must be developed simultaneously: reflection on the image of the town in the future; organization of technical skills, while improving knowledge and seeking new and more effective tools (mapping systems, databanks, etc.); planning and formulation of long-term objectives by decision-makers, so that the necessary human and financial means are available; adoption of coordinated regulations, laying down a proper tree code; and provision of information, building of awareness, and use of the media to involve citizens—the main recipients and users of the green heritage—in any action. The approach and principles discussed in this work cannot lead to one single town planning model, for whatever the size of town and the extent of the heritage involved, the success of any town plan depends on respect for an integrated approach. Urban arboriculture will find its place only if proper woodland policies are drawn up and pursued over time.

586 **Mayers, J.** 2000. Company-community forestry partnerships: a growing phenomenon. *Unasylva,* 51(1): 33-41.
This article examines relations between enterprises and communities, discussing satellite crop maps, joint enterprises, other contracts and informal mechanisms. It reviews their advantages and disadvantages, and draws some lessons on the potential of partnerships to assure security of forest goods and services, and the conditions under which good partnerships can be developed with regard to trees outside forests.

587 **Ministry of Finance and Planning** 1981. *Report of the sample survey of the intercropping in coconut lands,* vol. 1. Colombo, Ministry of Finance and Planning, 95 pp.
This report contains the results of a survey undertaken in 13 selected areas in Sri Lanka in order to study present constraints on the development of intercropping on privately owned coconut lands. The information collected during this survey came from farmers who practise intercropping, and considered tenure and management status and the area of cultivated land, as well as irrigation, types of crop involved in intercropping systems, and the main constraints felt by farmers on any future development.

588 **Moore, R.** 1992. Integrating wood production into Australian farming systems. *Agroforestry Systems,* 20: 167-186.
About 21% of farmland in Australia is seriously degraded by erosion. Trees can help to solve the problem, while also producing wood and thus diversifying agricultural income, as well as reducing the country's wood imports and increasing forest product exports. New industries based on wood from farmland thus need official guidelines, planning on national, regional and local scales, and innovative ways of financing planting.

589 **Neef, A. & Heidhues, F.** 1994. The role of land tenure in agroforestry: lessons from Benin. *Agroforestry Systems,* 27: 145-161.
This article analyses relations between land tenure law and agroforestry in Benin. It highlights the fact that tenants, landless farmers and most women are at a disadvantage as against landowners because they are not in a position to adopt agroforestry systems. This is because of the lack of forestry resources, the uncertainty of land use and restrictions on the planting of permanent crops. Government intervention and tenure conflicts between sedentary farmers and herders reduce rural people's security of tenure, as well as the willingness of smallholders to make long-term investments or to protect natural resources. At the end of the article, conclusions are drawn with regard to political interventions and the planning of projects concerning land tenure.

590 **Peltier, R.** 1992. L'arbre et le Burundi. *Bois et Forêts des Tropiques,* 233: 5-6.
Between 1980 and 1990, 50 million trees were planted. Although this of course does not solve all the forestry, agricultural, pastoral and social problems of a country like Burundi, it should act as an encouragement and example for everybody—government officials, research experts and developers.

591 **Raintree, J.B.** 1986. Agroforestry pathways: land tenure, shifting cultivation and sustainable agriculture. *Unasylva,* 38(4): 2-15.
This article provides some ideas on the extent, implications and potential role of agroforestry to help in examining land tenure issues. It seeks to draw attention to some major changes in the land tenure system as a result of wide-scale trends in land use in tropical countries. These changes are considered within an environmental and development perspective.

592 **Rodgers, A., Salehe, J. *et al.*** 2000. Woodland and tree resources on public land in Tanzania: national policies and sustainable use. *In* A.B. Temu, G. Lund, R.E. Malimbwi *et al.*, eds. *Off-forest tree resources in Africa,* p. 312-329. Proceedings of a workshop held in Arusha, Tanzania, 12-16 July 1999. Nairobi, African Academy of Sciences & ICRAF.
Public land is defined as that outside exclusively government-owned land (national parks and protected areas) and private land. It is controlled by villages and districts. This paper introduces a model showing the conversion of public woodland, either in terms of the legal status of the land or in terms of plant cover.

593 **Schmutz, T.** 1994. L'avenir des haies passe par un engagement des acteurs institutionnels. *Revue Forestière Française,* Special issue 1994: 125-129.
This article contains a study of costs, showing that hedges must be considered as a linear forest, despite their special form. Thus, when one moves away from self-regenerating models, like linear coppices, it is found that owners can undertake the start-up investment only if the institutions involved provide them with financial, technical and juridical support.

594 **Schmutz, T.** 1997. Haies et paysages. *Forêt Entreprise,* 113: 51-55.
Hedgerow management used to be decided between landowners and their tenant farmers. Today, new stakeholders hope to take their place here: local communities, watershed agencies, and hunting, fishing or nature preservation associations. In many types of landscape, hedges are now recovering a very definite place and roles, and these will have a growing influence on the shape of tomorrow's rural environment.

595 **Schmutz, T., Bazin, P. *et al.*** 1996. *L'arbre dans le paysage rural.* Paris, IDF, 48 pp.
After being abandoned, neglected or uprooted, trees in the French countryside have been the fresh focus of interest for some years now. There have been many local initiatives to resume their maintenance and planting and to preserve those that have survived. This brochure is intended to accompany the campaign launched in 1994 by the Ministry of the Environment and the Ministry of Agriculture and Fisheries to promote trees in the rural landscape. It seeks to assess these initiatives and draw lessons from them. It describes the various possible ways of supporting a tree promotion policy in the countryside, and the juridical and technical tools that can be used by the stakeholders. The French Forestry Development Institute (IDF) has been working on line-planted hedges in partnership with associations, the government and local communities for 20 years. It was responsible for launching the concept of farmland hedges made up particularly of local species, and the refinement of new planting techniques. This document gives some of the knowledge acquired by the IDF and will be followed by a series of technical brochures developing the various related topics.

596 **Simons, A.J., Dieters, M.J., Matheson, A.C. *et al.*** 1996. Delivery of improvement of agroforestry trees. *In* A.C. Matheson, ed. *Tree improvement for sustainable tropical forestry.* QFRI-IUFRO Conference, Caloundra, Queensland, Australia, 27 October-1 November 1996.
The improvement of agroforestry trees is as much a social and political challenge as a biological one. To engender a tree-planting culture amongst a diverse client group of resource-poor farmers, greater understanding is required of germplasm demand and supply issues and farmers decision-making processes. Domestication efforts will have to focus first on priority species which have been determined following rigorous characterisation methodologies. These methods will include determination of farmers and biological thresholds for improvement. Case studies are presented for a range of species which demonstrate the diversity of approaches needed for agroforestry tree species. Common to these strategies are a need to accelerate the research process to deliver appropriate improvement at an early date. Steps such as propagation-active multiplication of germplasm are required to reduce the lag phase between identification and adoption of improved material. Genetic impact will be most felt when the germplasm delivery pathways are in place to capitalise on useful variants identified. Examples are given of strategies for Prunus africana, Calycophyllum spruceanum, Irvingia spp. and Uapaca kirkiana.

597 **Sinclair, F.L., ed.** 1995. *Agroforestry: science, policy and practice.* Selected papers from the agroforestry sessions of the IUFRO 20th World Congress, Tampere, Finland, 6-12 August 1995. Dordrecht, Netherlands, Kluwer Academic Publishers, 287 pp.
Consolidation of scientific advances is now incorporated into a process focusing on research coupled with the development of a political framework encouraging the adoption of sustainable land-use practices. This volume contains a collection of papers for the agroforestry session of the 20th IUFRO World Congress, held at Tampere, Finland, describing agroforestry as a multidisciplinary science.

598 **Soignon, J.** 1997. Statut juridique de l'arbre en ville. *In* L.M. Rivière, ed. *La plante dans la ville,* p. 85-90. Meeting held in Angers, France, 1996. Paris, INRA.
The author describes the various types of juridical status and the regulations concerning trees in towns in France.

599 **Williams, T.O.** 1998. Multiple uses of common pool resources in semi-arid West Africa: a survey of existing practices and options for sustainable resource management. *Natural Resource Perspectives,* 38.
Common resources, such as rangelands, forests, fallows and ponds, provide social and economic benefits to a wide range of users in semi-arid West Africa. However, the definition and application of institutional

measures governing the use of these resources sometimes leads to social conflict and degradation of the resource. This article analyses the weakness of institutional mechanisms and suggests possible lines of action.

600 **Zéba, S.** 1997. Quelques aspects juridiques de la gestion des parcs agroforestiers au Burkina Faso. *In* G. Bonkoungou, E. Ayuk and I. Zoungrana, eds. *Les parcs agroforestiers des zones semi-arides d'Afrique de l'Ouest,* p. 51-63. Meeting held in Ouagadougou, 1993. Nairobi, ICRAF.
This paper is a reflection on the juridical aspects of agroforestry parkland management in Burkina Faso. It is based on an initiative of the Friends of Nature Foundation, Naturama, for rehabilitation of the socio-ecological balance of 17 villages on the edges of the Kaboré Tambi National Park in southern Burkina Faso. The agrarian, land tenure and forestry laws in force in Burkina Faso do not encompass the concept of agroforestry parkland, and this can lead to controversy, inasmuch as this man-made form of vegetation is the dominant type throughout the country. Historically speaking, customary law has guided parkland management, leading to the present forms of these areas, which have also been shaped by pastoral transhumance and agricultural migration, particularly in the country's Sudanian regions. This article describes some cropping practices underlying variations in agroforestry parkland. A decree of 4 July 1935 established a new forestry juridical system in French West Africa, superseding customary systems, and more recently a decree of 4 June 1991 instituted agrarian and land tenure reform in Burkina Faso. These customary and modern juridical systems are described and analysed in relation to management and development strategies for agroforestry parkland. Recommendations on priorities for action are proposed in the light of this analysis.

CHAPTER 4: EDUCATION AND RESEARCH

610 **Auclair, D.** 1995. Un programme européen de recherches coopératives en agroforesterie: utilisation alternative des terres agricoles avec des arbres à croissance rapide. *Parcours Demain,* 93-100.
The research is carried out along two parallel lines: on the one hand, the collection and analysis of technical data on the choice of trees (species, genotypes), installation and management techniques for trees, the effects of agroforestry systems on agricultural production or pastoral management systems, and on the growth, form and quality of trees; on the other hand, the incorporation of these data into an agroforestry modelling system, allowing the forecasting of medium- and long-term consequences on the micro- and macro-economic levels.

611 **Auclair, D.** 1996. Scientific and technical basis for silvopastoral systems in Europe. *In* M. Etienne, ed. *Western European silvopastoral systems,* p. 195-206. Paris, INRA.
A research project aimed at developing new, more extensive land-use systems that would be better adapted to market demands was launched in 1993 with 18 research and development bodies from six European countries, and the financial participation of the European Commission. The idea is to diversify intensive uses of farmland by planting fast-growing trees intended to produce high-quality timber, which would be widely spaced in order to allow agricultural activity to be continued. The research is carried out along two parallel lines: on the one hand, the collection and analysis of technical data on the choice of trees (species, genotypes), installation and management techniques for trees, the effects of agroforestry systems on agricultural production or pastoral management systems, and on the growth, form and quality of trees; on the other hand, the incorporation of these data into an agroforestry modelling system, allowing the forecasting of medium- and long-term consequences on the micro- and macro-economic levels.

612 **Auclair, D. & Cailliez, F.** 1994. Les besoins de recherche en agroforesterie. *Revue Forestière Française,* 46: 141-151.
Study of various agroforestry systems in France and other parts of the world reveals many gaps in knowledge, flowing mainly from the separation between the scientific disciplines concerned. Development of agricultural sciences is fostered by the progress of intensive monocropping and of fundamental and applied research. In many situations, a better integration of agricultural and forestry activities is highly desirable. The development of techniques for synthesizing knowledge is becoming essential with regard to land use, which closely combines biological, technical, human and environmental issues. The questions raised by agroforestry call for a multidisciplinary approach. Agroforestry research has been carried on for about 20 years now, but mainly in countries of the South, where many traditional practices require combined management of agricultural production and trees. In the European Union, research programmes are being carried on regarding the alternative use of farmland for fast-growing trees, farm forestry, timber intercropping and silvopastoralism. The problems encountered are of an economic and juridical order.

613 **Auclair, D. & Dupraz, C., eds.** 1999. *Agroforestry for sustainable land-use. Fundamental research and modelling with emphasis on temperate and Mediterranean applications.* Selected papers from a workshop held in Montpellier, France, 23-29 June 1997. Kluwer Academic, 272 pp.
Sixteen of the ninety-four papers presented at the congress have been selected and revised especially for publication. The main authors are G. Schroth, C. Dupraz, L. Lehmann, E.C. Rowe, J. Benzarti, R.L. Knowles, S. Meloni, F.X. De Montard, P. Balandier, A. Cabanettes,

M. Mayus, M. Van Noordwijk, F. Mary and M. Etienne.

614 **Brewbaker, J.L.** 1990. Genetic improvement of multipurpose trees for agroforestry systems. In *Proceedings of the 19th IUFRO World Congress,* p. 304-315. Montreal, Canada, 5-11 August 1990. Montreal, Canada, IURFRO World Congress Organizing Committee.
The genetic improvement of multipurpose trees (MPTs) is discussed with emphasis on fast-growing, N-fixing tropical species, where the need for breeding appears greatest. It is suggested that the breeder must have a major role in prioritizing species for improvement, with emphasis on species that are easily bred and that offer large, protected germplasm bases. Interspecific cross-fertility appears to characterize many MPTs, calling for broadly based studies of all species that might be part of the useful germplasm base for improvement. It is stressed that knowledge of the chromosome numbers and breeding systems of MPTs is very limited, but is essential to breeding progress. It is also noted that breeding methods for such trees (with the aim of using them in agroforestry systems) differ little from those used for crops where the primary focus is on yield. The current status of breeding progress is reviewed briefly for some high-priority species (Leucaena, the Acacia mangium/A. auriculiformis complex, Cajanus cajan, Calliandra calothyrsus, the Casuarina cunninghamiana/C. equisetifolia/C. glauca/C. junghuhniana complex, Dalbergia sissoo, Erythrina, Faidherbia [Acacia] albida, Gliricidia sepium, Inga vera, Albizia falcataria, Prosopis juliflora/P. pallida, and the Sesbania grandiflora/S. macrantha/S. sesban) complex.

615 **Buck, L.E.** 1995. Agroforestry policy issues and research directions in the US and less developed countries: insights and challenges from recent experience. *Agroforestry Systems,* 30: 57-73.
Efforts to improve the performance of agroforestry systems and expand the area used for such systems, as well as the number of people able to benefit financially from this integrated approach to agricultural and natural resource management, are hindered throughout the world by negative land-use policies. There is an urgent need for a change in policy, if agroforestry is to develop. In the past two years this has led to fresh evaluation of agroforestry policies and to more specific planning. In the United States, agroforestry came from the academic world in the mid-1980s. A multi-organizational agroforestry assessment process has put the national policy and the design of programmes on the agenda of the agroforestry community, while an effort has been made to influence the 1995 draft law on farms. The Advisory Group on International Agricultural Research and various collaborators have focused on the identification of policy issues as a basis for establishing silviculture and agroforestry research priorities. After a short review of the forces behind agroforestry development in industrialized and less developed countries, the article highlights initiatives to evaluate recent policies in each sphere. The issues and priorities arising from these processes are discussed. An explanation is sought for the constraints and inconsistencies hampering the effectiveness of policies, and this is then used as a basis for a promising approach for intervention on research. It is suggested that specialists from the human sciences could have a favourable influence on agroforestry policy, inasmuch as the various custodians of political systems are becoming more aware of the interdependence of different sectors. Interventionism, stakeholder-focused perspectives and participatory methods would then be used to help bring about political innovation and carry out evaluations. This approach is compatible with the participatory processes used in developing the new techniques that have helped to establish agroforestry as a prototype for sustainable development.

616 **Budowski, G.** 1994. Agroforestry training and education in Central America: learning from past experiences. *Agroforestry Systems,* 28: 21-26.
It is important to examine past experience if we are to discuss present and future agroforestry education and training

programmes, and the present article discusses Central American experience in this field over the past 40 years. During this period, the author has trained over 150 postgraduate students and run 19 intensive courses in different countries in the region. These activities have shown that an adequate library, documentation, field research and teaching staff are essential elements for the success of programmes. Moreover, for short sessions, intensive field practice concerning data collection and analysis must have a high priority in study programmes. Although short sessions must as a rule be more general, future teaching can focus on specific agroforestry techniques that are common to the different countries in the region.

617 **CIRAD** 1997. *Agroforestry for sustainable land-use. Fundamental research and modelling, temperate and Mediterranean applications.* International Agroforestry Workshop, Montpellier, France, 23-29 June 1997. Montpellier, France, CIRAD, 452 pp.
Agroforestry has been practised for thousands of years and entails many different forms of land use. The system is very widespread in many parts of the world, particularly in the tropics, and is now experiencing a revival in temperate regions, as a result of an economic and environmental context that fosters a greater integration of agriculture and forestry. An understanding of the complex, multipurpose systems involved is becoming a priority research subject, and this international workshop provided a forum for exchanges of scientific and technical information on the issue. Special attention was given to temperate and Mediterranean applications.

618 **Cruz, C.** 1998. Potential impact of biotechnology research for multipurpose tree species. In *Multipurpose Tree Species Network Research Series Paper.* Arlington, Virginia, USA, F/FRED Project Management Office, 3: 58.
The basic objective of this study was to assess the potential socio-economic effects of biotechnology research on multipurpose **trees** (MPTS), with particular reference to resource management problems in the forestry sectors of the Philippines, Thailand and Nepal. Three research areas were identified for investigation: (1) tissue culture for the production and enhancement of planting material; (2) tissue culture for genetic improvement; and (3) the use of micro-organisms to enhance performance. Research into areas (1) and (3) is classified as applied, and has short-term returns, while (2) is classified as strategic, with long-term returns. The problem of deforestation in the countries concerned is discussed, and an analysis made of the potential sectorial beneficiaries of biotechnology research on MPTS. The forest resource management problem is examined and emerging strategies for sustainable development and equity discussed. An assessment is made of MPTS biotechnology research in the context of prevailing forest management strategies, analysing each of research areas (1)-(3) in turn. Costs and benefits are considered and the implications for government strategies in reforestation and participatory agroforestry discussed.

619 **Dollé, V.** 1995. *Quel avenir pour les systèmes oasiens au Sud du Sahara? Situation actuelle, perspectives d'évolution, enjeux pour la recherche.* Contribution to the CIRAD-ORSTOM-SPAAR working document *Quelques réflexions à propos de l'intensification en Afrique de l'Ouest et du Centre*. Montpellier, France, CIRAD, 13 pp.
Oasis systems, which have been perfected in Africa north of the Sahara for centuries now, can act as a development model for rural societies south of the Sahara. Recent droughts are leading north Sahelian pastoral societies to assure part of their subsistence through the practice of an oasis-type agriculture. What is the situation of oasis agriculture south of the Sahara? What are its prospects of development? What challenges does its development offer for research? This document advances some possible approaches to the development of this type of agriculture south of the Sahara.

620 **Etienne, M.** 1996. *Western European silvopastoral systems.* Paris, INRA, 276 pp.

The research described in this book is the result of a long collaboration between INRA and FAO-CIHEAM (Centre International de Hautes Etudes Agronomiques Mediterraneennes) through the Inter-Regional Cooperative Research and Development Networks on Pastures and Fodder Crops, and on Sheep and Goats, and also between INRA and the EEC through the Alternative Agricultural Land-Use with Fast Growing Trees Project (ALWAYS). The book is the first to compare how the same agroforestry techniques have been adopted to contrasting situations (temperate lowlands, temperate mountains, Mediterranean forests and rangelands), and shows that several approaches can provide ideas for developing new policy decisions in European or Mediterranean contexts. Viewpoints from different types of environments and different branches of science are compared. Interactions between components are described and modelled in order to build, through a system approach, a multistoreyed system for multiple production and use. The review provides some keys for the development of sustainable silvopastoral systems and stresses the importance of focusing research on multidisciplinary approaches - it is expected to be a useful tool for researchers, forest managers and livestock farmers in European and Mediterranean countries. After an introduction by the editor (Research on temperate and tropical silvopastoral systems: a review), the book is divided into 2 main parts (chapters), each containing papers by various authors. Chapter one, Functioning of silvopastoral systems, has 2 sections: Viewpoints from three types of environments (3 papers on silvopastoral systems in a temperate climate (sown pastures), mountain climate (wooded Jura Mountain pastures) and Mediterranean climate (dehesas)); and Last results in three fundamental aspects (5 papers on tree-herb interactions, fodder-animal interactions, and tree-animal interactions). Chapter two, Silvopastoral systems management, has 3 sections: Viewpoints from three scientific branches (3 papers on the viewpoints of the forester, the range scientist, and the animal scientist); Latest results on two points (4 papers on fodder systems, and models); and Examples (3 papers on silvopastoral management in larch (Larix decidua), downy oak (Quercus pubescens) and cork oak (Quercus suber) forests). A conclusion discusses the future for research on silvopastoralism in Europe and the Mediterranean Basin. At the end of the book abstracts are given in English and French, and there are keyword indexes in English and French, an author index and a list of the 37 contributors.

621 **Ferry, M.** 1996. La crise du secteur phoenicicole dans les pays méditerranéens. Quelles recherches pour y répondre? *In* M. Ferry, D. Greiner, S. Bedrani & J.P. Tonneau, eds. *Options Méditerranéennes. Journées Internationales sur le Palmier Dattier dans l'Agriculture d'Oasis des Pays Méditerranéens,* p. 129-158. Elche, Spain, 25-27 April 1995. Series A, Séminaires Méditerranéens No. 28. Paris, CIHEAM.
The sheer area of hot desert land in southern Mediterranean countries, the adaptation of date palms to the agroecological conditions of oases, and their economic and cultural attractions mean that date cultivation holds an important place throughout the countries of North Africa and the Middle East. Although about a third of the date palms in the world are found in the Mediterranean region, Mediterranean date farming is in crisis: irrigation water is growing scarcer and/or more expensive; degradation of the soil, the water table and the steppe environment is increasing; traditional oases are producing less and less; and modern plantations are often based on fragile and economically and environmentally high-risk production systems. The governments of a number of countries have made large-scale investments, but although these have helped to increase date production, this growth is still considerably lower than the population growth. Examples of successful development or effective resistance to the crisis do exist: Israeli date growing; peri-urban production systems, compensating for the shortage of farmland through mixed activities; farms of a good size with adequate labour and water resources and

an accessible market. In countries to both the south and north of the Mediterranean, teams of scientists are following various lines of research on the date palm, but will this research provide solutions to the main problems raised by the crisis in Mediterranean date growing?

622 **Ferry, M., Greiner, D. *et al.*** 1999. Analyse de données agroéconomiques des oasis de différents pays africains: évaluation de l'état des connaissances et propositions de recherches à engager pour promouvoir des systèmes de production durables. *In* M. Ferry, S. Bedrani & D. Greiner. *Agroéconomie des oasis,* p. 9-20. Montpellier, France, CIRAD.
The authors draw up research proposals based on a rapid analysis of the available agroeconomic data on oases in the Mediterranean region and in some countries outside this zone.

623 **Forrest, M., Konijnendijk *et al.*** 1999. *Research and development in urban forestry in Europe.* Report of COST action "Urban forests and trees" on the state of the art of urban forestry research and development in Europe. Luxembourg, Office for Official Publications of the European Communities, 363 pp.
This document, compiled by 60 authors from 20 European countries, gives a good overview of European research on urban forestry.

624 **Franzel, S., Jaenicke, H. *et al.*** 1996. *Choosing the right tree. Setting priorities for multipurpose tree development.* The Hague, ISNAR, 87 pp.
Setting priorities among different tree species in the context of research aimed at improving genetic material means that the research perspective must be combined with the farmers' perspective, so that species giving the best results will be chosen. It is a process calling for both socio-economic and biophysical know-how, and is based on evaluation of the needs of users, i.e. poor farmers. Researchers carry out surveys on the regional level to determine the species preferred by farmers, then they meet in a workshop to assess these species in terms of their suitability for research and their probability of adoption, taking political objectives into account as well. After drawing up a shortlist of four to six species, researchers carry out fresh field surveys to assess the value of the products of these species. On the basis of the results, they then grade the species. This procedure allows a certain flexibility of action and can be adapted to the researchers' specific needs. Although setting priorities is not in itself a new activity, the procedures described in the present document are innovative, in that they have a structure, are objective, and involve the participation of both researchers and farmers. They have been tested in the damp valleys of West Africa, and work is at present going on in other regions to refine them still further.

625 **Hodge, S.J., ed.** 1991. *Research for practical arboriculture.* UK, 222 pp.
Proceedings of a seminar held at the University of York, April 1990, organized by the Arboricultural Association and the Forestry Commission. Twenty-six papers are presented in eight sections: Setting the scene (3 papers); Amenity tree establishment (4); Trees in towns (3); Tree stability (4); Tree health (3); Disorders of amenity trees (6); Arboricultural safety (1); and Concluding remarks (2).

626 **Hosmani, M.M., Chittapur, B.M. *et al.*** 1999. *Farm productivity: new century, new challenges.* Dharwad, India, Mrs Sarasijakshi Hosmani, 256 pp.
32 chapters present recent trends and research priorities for a variety of crops, agricultural developments and techniques in India as a means of reviewing the forthcoming challenges for the new century. Titles of papers are: India marches into 21st century; rice; wheat; sorghum; maize; millets; grain legumes; groundnut; soyabean; cotton; sugarcane and sugar production; choice fruit trees; dryland horticulture needs emphasis; spices - India the global leader; potato; vegetables; floriculture; protected cultivation; forage production and development; challenges in irrigation water management; dryland agriculture: challenges are increasing;

integrated farming systems; cropping systems; towards organic agriculture; agroforestry; biofertilizers; trends in weed management; integrated pest management; integrated plant disease management; farm mechanization; agro-biotechnology; higher education and training in agriculture.

627 **ICRAF** 1992. *Agroforestry research in the Miombo ecological zone of Southern Africa.* IARY proceedings of an international workshop, We, Malawi, 16-22 June 1991. Nairobi, ICRAF, 88 pp.
This report contains papers written for the Conference on Agroforestry Research in the Miombo Ecological Zone of Southern Africa. The conference was divided into seven sessions: (i) issues linked to the germplasm of multipurpose trees; (ii) the design and evaluation of agroforestry experiments; (iii) the selection of multipurpose tree species for agroforestry; (iv) the management of multipurpose tree species for agroforestry; (v) soil improvement in agroforestry; (vi) food and fodder production in agroforestry; and (vii) the socio-economic aspects of agroforestry.

628 **Jager, A. de, Werf, E. van der, *et al.*** 1992. Ecological agriculture in South India: an agro-economic comparison and study of transition. In *Mededeling Landbouw Economisch Instituut.* The Hague, 459: 80.
This report describes two research programmes carried out on organic agriculture on various sites in South India. Experiences of 12 farmers in transition towards organic agriculture are described and analysed. A gradual approach is crucial for success. The duration of the transition period is directly related to the previous farming system, specifically the amounts of mineral fertilizers used. An average transition takes 3-5 years. The comparative performance of seven farm pairs, consisting of one organic and one conventional reference farm, is analysed in relation to agronomic and economic performance. Organic farms achieve similar economic results to conventional farms, with gross margin/ha (Rs 10 620 and Rs 11 515, respectively) as well as net farm income/labour/day (Rs 32). Labour input per ha also shows no significant difference. Trees and livestock are far more numerous on organic than conventional farms (respectively, 7:1 and 4:1).

629 **Klopfenstein, N.B. & Kerl, J.G.** 1995. The potential of biotechnology in temperate agroforestry practices. *Agroforestry Systems,* 32: 29-44.
Technologies in forest molecular biology and tissue culture could play an increasing role in the choice of genotypes for successful establishment of agroforestry practices. Research areas such as micropropagation, somatic embryogenesis, genetic engineering, marker-aided selection, and molecular diagnostics are merging with traditional forest biological studies to help identify and produce better-suited trees for agroforestry plantings. A combination of classical and molecular biological research could be used to improve pest and stress resistance of selected genotypes, modify structure and function, and monitor pests of trees. This merger of approaches, as well as continued technological development, could accelerate the production and selection of suitable tree genotypes for agroforestry plantings.

630 **Konijnendijk, C.C., Randrup, T.B. *et al.*** 2000. Urban forestry research in Europe: an overview. *Journal of Arboriculture,* 26.
An overview of current research in Europe was carried out within the framework of COST Action E12 “Urban Forests and Trees”, a pan-European research network. This article gives some of the main results of a comparative analysis of 20 national reports. The analysis shows that research on urban forests and trees in Europe tends to be fragmented and poorly coordinated. Universities and public research institutes, most of them with a past in the field of silviculture and horticulture, dominate research. Appropriate research is mainly financed by the State and local authorities, but there are significant differences from country to country regarding the level of activity, the subjects chosen and the institutions involved.

631 **Leakey, R.R.B., Simons, A.J. *et al.*** 1997. The domestication and commercialisation of indigenous trees in agroforestry for the alleviation of poverty. In *Agroforestry Systems: directions in agroforestry research,* p. 165-176. Adapted from selected papers presented to a symposium on tropical agroforestry organized in connection with the annual meetings of the American Society of Agronomy, 5 November 1996, Indianapolis, USA.
New initiatives in agroforestry are seeking to integrate into tropical farming systems indigenous trees whose products have traditionally been gathered from natural forests. This is being done in order to provide marketable products from farms that will generate cash for resource-poor rural and peri-urban households. This poverty-alleviating agroforestry strategy is at the same time linked to one in which perennial, biologically diverse and complex mature-stage agroecosystems are developed as sustainable alternatives to slash-and-burn agriculture. One important component of this approach is the domestication of the local tree species that have commercial potential in local, regional or even international markets. Because of the number of potential candidate species for domestication, one crucial first step is the identification of priority species and the formulation of a domestication strategy that is appropriate to the use, marketability and genetic potential of each species. For most of these hitherto wild species little or no formal research has been carried out to assess their food value, potential for genetic improvement, or reproductive biology. To date their marketability can only be assessed by their position in the local rural and urban market-places, since few have attracted international commercial interest. To meet the objective of poverty alleviation, however, it is crucial that market expansion and creation are possible, hence for example, it is important to determine which marketable traits are amenable to genetic improvement. While some traits that are relatively easy to identify do benefit the farmer, there are undoubtedly others that are important to the food, pharmaceutical or other industries that require more sophisticated evaluation. This paper presents the current thinking and strategies of ICRAF in this new area of work and draws on examples from the ICRAF programme.

632 **McPherson, E.G. & Simpson, J.R.** 1999. *Carbon dioxide reduction through urban forestry: guidelines for professional and volunteer tree planters.* Albany, Pacific Southwest Research Station, 237 pp.
This handbook was produced by the Pacific Southwest Research Station as a tool for foresters, local authorities, NGOs and others in determining the effects of urban forests on the reduction of carbon dioxide in the atmosphere.

633 **Mir-Azizuddin & Azizuddin, M.** 1993. Organic farming for coffee. *Indian Coffee,* 57: 18-20.
Research on the use of organic manures as fertilizers for coffee, and whether such fertilizers are sufficient in themselves, is briefly reviewed. The potential for nutrient recycling in a coffee-agroforestry-based cropping system using leguminous trees is also discussed.

634 **Nair, P.K.R.** 1993. State-of-art of agroforestry research and education. *Agroforestry Systems,* 23: 95-119.
Organized agroforestry research started only 15 years ago. The main research categories since then have been methodological, descriptive (systems and components), experimental, quantitative and economic. The diagnosis and design method and the procedures for designing and analysing field trials have been the main research spheres. Advances have also been made in socio-economic and on-farm research. In the sphere of education and training, the main advances have been in non-diploma and short-term teaching. Future agroforestry research will develop quickly from descriptive to quantitative and experimental, with an increasing level of multidisciplinary involvement.

635 **Newman, S.M.** 1997. Poplar agroforestry in India. *Forest Ecology and Management,* 90: 13-17.
A short bibliographical review, based on TREECD and CAB Abstracts until October 1994 and filled out with field trips in India, is described in this article on the development of poplar (*Populus* spp.) agroforestry and associated research in India. Development of an agroforestry model, involving an association between farmers, the private sector (the example cited, Wimco, is a match company) and the government, would be useful with a view to fresh surveys for its application in other parts of India and in other countries. A certain number of suggestions are given for future research with a view to system optimization for resource-poor farmers. These suggestions include changes in varieties of trees and crops, the spacing of trees, and the use of small-diameter logs and other poplar products.

636 **Oduol, P.A. & Sunil, P.** 1998. Genetic improvement of *Sesbania sesban* for agroforestry systems. In *Tree improvement: applied research and technology transfer,* p. 169-187. Enfield, USA, Science Publishers.
The problems associated with the improvement of multipurpose trees in agroforestry are discussed. The case of Sesbania sesban, an important agroforestry species, is used as an example, citing the results of studies done at 3 sites with different bioclimates in Kenya. Aspects described and discussed are genetic variation in provenances (e.g. variation of 197% and 1544% was observed in height and biomass, respectively, in 75 provenances from various parts of the world), the selection process for elite ortets with specific traits (potential gains of 40%), their mass production through vegetative propagation as clones, and their evaluations in diverse environments using both morphological and physiological criteria.

637 **Persley, G.J.** 1992. *Replanting the tree of life. Towards an international agenda for coconut palm research.* Wallingford, UK, CAB International, 156 pp.
The coconut palm is a multipurpose tree grown in all the tropical regions of the world. However, its potential is threatened by the development of other oil-producing crops whose production is increasing on the world oil market. The Technical Advisory Committee of the Consultative Group on International Agricultural Research therefore asked the Australian Centre for International Agricultural Research to examine the possibility of an international research initiative concerning the coconut palm. This book describes the results of this study, using a style accessible to a broad audience.

638 **Raintree, J.B.** 1983. *Une méthodologie pour le diagnostic et la conception de systèmes agroforestier d'aménagement des terres.* Nairobi, ICRAF, 26 pp.
ICRAF seeks to promote research and development of improved agroforestry systems of soil use in order to improve the social, economic and nutritional well-being of people in developing countries. Its research strategy therefore puts the main accent on refining a diagnosis and design method intended to guide agroforestry research and development toward solutions to soil management problems that can be adapted to specific situations. This document shows the main features of the methodology being developed, explaining its basis and internal logic.

639 **Raintree, J.B. & Hoskins, M.W.** 1990. *Appropriate R&D support for forestry extension*. Nairobi, ICRAF, 20 pp.
This document examines the nature of the information required for participatory development efforts in the context of community forestry and agroforestry (seen here as promotion of the use of multipurpose trees and crop systems to satisfy a variety of local needs) projects for rural development. The authors suggest that a broad-based approach to research and development (R&D) is needed in order to obtain such information, and this in turn will require new kinds of links between extension activities and R&D. Approaches leading to a maximal participation are discussed, and light is thrown on some

research considerations concerning the decision on "what to extend" in any given situation. This includes: the choice of trees; the choice of the right tree technology (or cropping systems needing reflection on problems/potential/purposes and combinations/positioning/functional components [species]/practical set-up/management); combining participation and organizational innovations. The last part of the paper discusses "how to extend" and suggests the need for a new model incorporating extension research needs. It is envisaged as the extension of farming systems research (FSR), providing the missing link between research carried out by a research centre and development work within the community. In some cases, such links have already started to develop informally, as the following examples show: on-farm research or "adaptive" research carried out by research institutions; development trials undertaken by development bodies and authorities; and monitoring and evaluation activities within community forestry projects. The document proposes a new, more formal link called "extension R&D" (or ER&D). The need for such a link when implementing agroforestry projects is also described, and is illustrated with ICRAF's diagnosis and design (D&D) approach (an FSR approach sensitive to the tree components of farming systems and more explicit on questions of system design). In both cases, the missing link is identified as the stage of design or engineering. The idea of ER&D is based on the equivalence of FSR adaptive research and developmentalists' development trials. It is envisaged as operating thanks to an ER&D agent based within a community (who would combine the traditionally separate roles of researcher and development agent) and work in an ER&D team with local collaborators. The role of the ER&D agent is described and compared with that of the classic development agent. The institutional and training aspects of the proposed model are also discussed.

640 **Raintree, J.B. & Warner, K.** 1986. Agroforestry pathways for the intensification of shifting cultivation. *Agroforestry Systems,* 4: 39-54.

Shifting cultivation is a system that deliberately combines trees and leafy crops and is one of the oldest forms of agroforestry. However, scientific agroforestry is not strictly speaking an alternative form of shifting cultivation, but an approach that reorganizes the same basic elements in more intensive, sustainable and politically viable forms of land use. A review of types of shifting cultivation leads to a working framework to identify agroforestry interventions and development approaches appropriate to specific systems.

641 **Rao, M., Kamara, C. *et al.*** 1990. Methodological issues for research on improved fallows. *Agroforestry Today,* 2: 8-12.

One choice for a land management system that will allow more intensive cropping while maintaining soil fertility, is a rotation system with planted fallows, which improve the soil faster than natural vegetation. Field trials to develop such improved fallow systems are carried out at the ICRAF Machakos Station in Kenya, at Chipata and Chalimbana in Zambia and at Yaoundé in Cameroon, with the AFRENA research network. This research is only a first stage, but it has highlighted a certain number of important technical questions for such systems. These include the choice of tree species, the length of cropping and fallow periods, the size and arrangement of trial plots, and management practices. These issues are discussed in relation to two agroforestry techniques, both of which use multipurpose trees in fallow periods: systems in which trees planted in fallows alternate with crops, and alley cropping between lines of hedges.

642 **Sanchez, P.A.** 1995. Science in agroforestry. *Agroforestry Systems,* 30: 5-55.

Agroforestry research is at present changing from a collection of predominantly descriptive studies into more scientific approaches based on process-led research. This paper describes the principles and properties required for a scientific approach to agroforestry. Two key principles distinguish agroforestry systems from farming and forestry systems: competition and complexity. And these two

principles in turn point to two desirable properties: cost effectiveness and sustainability. All four of these elements involve biophysical and socio-economic questions (two appendices list the biophysical and socio-economic/ecological guiding principles and hypotheses in agroforestry research). The paper discusses the four elements, using references and examples accessible to the author and not intended as an exhaustive review. The biophysical determinant of agroforestry systems is management of the competition between trees and crops for light, water and nutrients, to the benefit of farmers. Simultaneous agroforestry systems are more sensitive than sequential ones to competition. An equation of crop/tree interactions helps in measuring the competitive factor as against the positive effects on fertility. Alley cropping, a simultaneous agroforestry system, has limited applicability, because the competitive factor usually exceeds the advantageous effects on fertility. *Faidherbia albida* parkland (a silvopastoral system), another simultaneous system, is almost always advantageous, because the inverse phenology of *F. albida* reduces competition to a minimum while increasing the effect on fertility. Sequential systems such as improved fallows also reduce competition to a minimum, but the processes responsible for increasing crop yields have not for the most part been measured in terms of quality. New methods are being developed for measuring below-ground interactions. Socio-economic and environmental complexity is typical of agroforestry systems. A participatory, analytical and multidisciplinary typology for areas of different sizes is the first step in any effective agroforestry research. The variety of products and services must be manipulated in a way that puts money into farmers' pockets. Domestication of indigenous trees with high-value products increases cost effectiveness, especially in the case of materials that can be marketed as various finished products. Policy research intervention is often needed in order to help farmers during the first years before the trees become productive and demonstrate their positive environmental functions. Profitable agroforestry systems are potentially sustainable, controlling erosion, increasing biodiversity and conserving carbon, so long as nutrient use is balanced by nutrient returns through detritus and the strategic use of fertilizer, particularly phosphorus. A list of gaps in research shows where data are needed if we are to grasp the competition, complexity, cost effectiveness and sustainability aspects of agroforestry.

643 **Singh, G., Arora, Y.K. *et al.*** 1990. *Agroforestry research (in India and other countries).* Dehra Dun, India, Surya Publications, 189 pp.

This work gives a full overview of agroforestry research, especially in India. The authors have assembled and consolidated quantitative data from less accessible sources (reports, reviews, seminars, symposia, bulletins, etc.) produced by various research institutes and universities in India. Trends in other parts of the world are also reviewed. The first chapter is an introduction: the history and definition of agroforestry; the different types of system used; agroforestry practices in watershed management; land capacity classification; food, fuel and fodder demands; soil and water conservation; soil improvement; small-scale agroindustries; and modification of the microclimate and ecological balance. The next five chapters review research work on agrosilviculture and silvopastoralism, and on agrohorticultural systems in five Indian agro-climatic regions: the hills region, the flat alluvial region, the arid and semi-arid region, the tropical region, and the humid and sub-humid region. In each region, research in different geographical sectors and/or states is examined separately, with many examples and great quantities of data. The seventh chapter reviews the types of agroforestry system found in Africa, Asia (Pakistan, Sri Lanka, Nepal, Bangladesh, China, Thailand, Indonesia, Java, Malaysia, Philippines and Vietnam), the Americas (United States, Brazil, Costa Rica, Colombia, Peru, Venezuela and Mexico), Europe, and Oceania (Australia and Fiji). The last part of the book consists of a list of tree species used in agroforestry, indicating also the climatic

zones where they are found, together with their uses.

644 **Steiner, K.G.** 1985. *Cultures associées dans les petites exploitations agricoles tropicales en particulier en Afrique de l'Ouest.* Eschborn, Germany, GTZ, 347 pp.
Intensification of traditional cropping systems, and more especially of intercropping, constitutes a challenge for researchers and those in charge of extension work. These very complex cropping systems require a totally new approach and methods. Although research on intercropping systems is recent, a considerable amount of information has already been assembled. This document gives an overview of present knowledge, to make it available to development programmes.

645 **Steppler, H.A.** 1990. Agroforestry training: global trends and needs. *Agroforestry Systems,* 12: 49-56.
This article describes the main lines of a conference that discussed the general principles and practices used in agroforestry training, including the design, development and evaluation of appropriate training programmes. It also considers the questions of who needs training and why, in the context of the paralysis in training (with trained people acting as trainers rather than working in the field, or with the most capable people constantly receiving further training).

646 **Tomboc, C.C. & Luna, A.M.** 1994. *Proceedings of the regional expert consultation on farmer to farmer adaptative agroforestry research.* Cebu, Philippines, 4-10 October 1992. Bogor, Indonesia, APAN, 302 pp.
This volume consists of a compilation of reports on agroforestry system research in Asia, presented at the regional expert consultation held in Cebu, Philippines, in October 1992.

647 **Wood, P.J. & Burley, J.** 1991. *A tree for all reasons: the introduction and evaluation of multipurpose trees for agroforestry.* Nairobi, ICRAF, 158 pp.
This work constitutes a handbook for the planting and evaluation of perennial woody plants (trees, shrubs, bushes, palms, bamboos, canes, etc.) within agroforestry systems. It is made up of four parts: basic concepts for the selection of species in agroforestry, the design and planning of research activities, monitoring and evaluation, and major research fields. The annexes contain a list of the main multipurpose trees and their products.

CHAPTER 5 : GENERAL WORKS

655 **ACTA** 1994. *Jachères 94. Journées Nationales d'Informations Techniques ACTA-ANPP-MAP.* Versailles, France, 27-28 September 1994. Paris, ACTA, 217 pp.
This study meeting on fallows in France was divided into eight sessions: regulations; types of fallow and cover; upkeep and destruction of fallow covers; effects of fallows on successive and neighbouring crops; non-food fallows; fallows and the environment; the choice of fallows on the basis of farm objectives and constraints; and synthesis and future prospects.

656 **American Forests** 1994. *Growing greener communities.* Proceedings of the Sixth National Urban Forest Conference, Minneapolis, USA, 14-18 September 1993. Washington, DC, American Forests, 280 pp.
This volume contains selected papers from the sixth conference on urban forests held in Minneapolis in September 1993.

657 **Arnold, J.E.M.** 1991. *Foresterie communautaire: un examen de dix ans d'activité.* Rome, FAO, 39 pp.
This document seeks to assemble and summarize knowledge on community forestry acquired in the ten years prior to its appearance. Inasmuch as it is a summary, it focuses on the major theories and conclusions expressed and does not discuss the projects, cases, data and observations that are found in abundance in the material on which it is based.

658 **Baumer, M.** 1995. *Arbres, arbustes et arbrisseaux nourriciers en Afrique occidentale.* Dakar, ENDA, 260 pp.
This work presents a collection of species used in food in West Africa. The descriptions allow identification of the species and the uses made of it, and in many cases details on the processes allowing its consumption. It is interesting that species that contribute indirectly to food by the role they play in processing have also been included. While most of the descriptions concern local species, some introduced species are also covered—for local people who have adopted them have shown a certain inventiveness in putting them to previously unknown food and para-food uses.

659 **Bazin, P.** 1992. *Boiser une terre agricole.* 2nd ed. Paris, IDF.
The ownership of farmland has traditionally been considered a source of wealth and security. However, in the space of only a few years, under the combined effect of demographic crises and economic constraints, unbuilt-on land has lost its value, while related costs are constant or growing, so that today there are no buyers for land that used to be highly sought-after. With farm rents barely covering costs and the absence of people willing to farm the land, and faced with a net capital loss, owners are increasingly seeing afforestation as an alternative that will allow them to earn a living. In the face of the need to ensure cost effectiveness, owner farmers are turning to planting trees on less easily mechanized land in order to concentrate their efforts on the rest. However, problematic farmland is not automatically good forestry land. Successful afforestation requires the assembly of sufficient finance, regular monitoring of plantations, know-how, and the availability of qualified advice. Timber must in fact be seen as a crop, with its attendant constraints and risks, which are all the greater inasmuch as the crop is exposed to natural hazards for several decades. However, the rewards are great when the farmer can establish and bequeath a high-quality timber inheritance to his heirs. This booklet is addressed to farmers and other rural inhabitants who want to plant trees on farmland, offering an approach and describing simple, adapted technical and economic solutions. Financial assistance facilities for the improvement of agricultural land have been set up parallel with traditional assistance for forestry investment. Details are given in a supplement to the publication.

660 **Bazin, P., Jégat, R. *et al.*** 1995. *Les talus du bocage.* Paris, 53 pp.
Renewed attention to risks of flooding, and indeed pollution, of land has led to a reappraisal of the attractions of ridges in bocage landscapes. Ridges can be of more help than hedges in controlling water and erosion. However, their installation requires know-how that has been dying out. What contributions can ridges make to rural development? What are the traditional and more modern practices involved in the establishment and restoration of ridges? This work seeks to provide answers to these and other questions.

661 **Bonkoungou, G., Alexandre, D.Y. *et al.*** 1994. *Les parcs agroforestiers des zones semi-arides d'Afrique de l'Ouest.* Conclusions and recommendations of an international symposium, 25-27 October 1993, Ouagadougou. Nairobi, ICRAF, 22 pp.
The commonest agricultural production system in the semi-arid zones of West Africa is that of agroforestry parkland, under which farmers preserve trees scattered in their cultivated fields. These trees contribute to environmental protection and provide many useful products for the household and national economy. An international symposium was organized in Burkina Faso to review the state of biophysical and socio-economic knowledge, identify management techniques that could be extended, and draw up recommendations on research priorities.

662 **Bougery, C. & Castaner, D.** 1988. *Les plantations d'alignement, le long des routes, chemins, canaux, allées.* Paris, 416 pp.
The tenacious will to plant over the centuries means that line trees occupy a special place along roads, paths, canals and streets. Today this specific landscape form constitutes an important heritage that should be managed with skill and adapted to the present context, in view of changes in the road network, in the purpose of canals, in rural sites, etc. This work thus seeks to ensure a positive future and the continued existence of this precious heritage, by providing details of necessary methods and techniques for the many overseers and managers responsible for it in the government departments in charge of infrastructure and capital works, consulting firms, waterway authorities and local communities.

663 **Budowski, G., Christanty, L. *et al.*** 1990. *Tropical home gardens*. Selected papers from an international workshop held at the Institute of Ecology, Padjadjaran University, Bandung, Indonesia, 2-9 December 1985. Tokyo, United Nations University Press.
The objectives of this conference were to review currently available information and research results on home gardens from different tropical regions (South and South East Asia, Latin America, Africa, and the tropical Pacific Islands), to identify gaps in this knowledge, and to discuss future research needed for the implementation of home garden programmes. After an introduction, and list of recommendations made at the conference, 17 papers are presented in 2 parts. Part 1, Regional overviews, has 4 chapters with reviews of home gardens in tropical America (Budowski, G.), tropical Asia, with special reference to Indonesia (Christanty, L.), tropical Africa (Okigbo, B.N.) and the Pacific Islands (Thaman, R.R.). Part 2, Topical papers, has 13 chapters. Four are on general aspects of home gardens in Java (Abdoellah, O.S.; Karyona, 2 papers); the humid tropics of Ghana (Asare, E.O.; Oppong, S.K.; Twum-Ampofo, K.); and tropical America (Ninex, V.). Six other chapters concentrate on food production and nutritional aspects of home gardens: The food production system of the Yap Islands [part of the western Caroline Islands and one of the 4 Federated States of Micronesia] (Falanruw, M.V.C.); Promoting native edible plants for home gardens in northern Thailand (Hoyyeepoo, K.); Diet, nutritional status, and potential need for home gardens in the tea plantation [in West Java] (Husaini, M.A.; Suhardjo; Megawangi, R.; Nurhadi, E.; Supardi, D.; Djojosoebagio, S.; Karyadi, D.); Measuring food production and consumption, and the nutritional effects of tropical home gardens (Immink, M.D.C.); A nutritional calculus for home garden design: a case-study from West Java (Marten, G.G.);

and Advancing Pacific Island food gardening systems: some observations and suggestions (Sommers, P.). The remaining 3 chapters are: An evaluation of the structure and function of tropical home gardens (Fernandes, E.C.M.; Nair, P.K.R.); Transforming traditional home gardens and related systems in West Java (Bogor) and West Sumatra (Maninjau) (Michon, G.; Mary, F.); and On estimating the net social and economic value of urban home gardens (Vasey, D.E.). There are 2 appendices (A list of herbaceous and woody plants grown in home gardens worldwide (Brazil, M.A.); and a Sample data sheet for agro-forestry system description), references, and a list of participants and contributors.

664 **CIRAD** 1996. *Les parcs à faidherbia.* Montpellier, France, CIRAD, 311 pp.
This work reviews the knowledge accumulated over the past ten years on *Faidherbia* parkland. It shows that it can be a precious tool to serve agrarian societies in the Sahel so long as it is judiciously used. The first part of the work contains data on the functioning and production of the *Faidherbia* tree. The second part contains data on the influence of these trees on crop production (including a description of the methods used and the results obtained, particularly with cotton). The third part moves on from the study of isolated trees, trees and livestock or trees and crops, and examines the parkland system as a whole, within a village area, a farming system or a region. The fourth part asks the major question of whether *Faidherbia* trees should be planted, and, if so, where, with what plant material, and what associated symbionts.

665 **Conforti, J., Peyron, G. *et al.*** 1993. *Bibliographie. L'agriculture d'oasis.* Montpellier, France, CIRAD-SAR/GRIDAO, 159 pp.
A global approach is needed in order to understand oasis agriculture as a particular way of using arid zones. This bibliography contains 312 entries concerning: deserts and arid zones in which oases can be rehabilitated; issues such as micro-climate, salinity, erosion, water, pastoralism and the date market; non-agricultural aspects such as history, wildlife and crafts; and oasis crops and the date palm, as well as its environment and companion crops.

666 **Dupriez, H. & De, L.P.** 1987. *Jardins et vergers d'Afrique.* Paris, L'Harmattan, 354 pp.
Gardens and orchards are places with a complementarity between food, medicine and livestock production, and between associated plants that exploit the soil together to the benefit of human beings, while preserving and improving it. They are places where economic activities essential to the household's livelihood and the food self-sufficiency of rural and urban people are carried on. They are places where the work of men and women are constantly rooted in the natural environment. This volume is a practical handbook intended for market gardeners, agronomists, rural technicians and students.

667 **Dupriez, H. & De, L.P.** 1993. *Arbres et agricultures multiétagées d'Afrique.* Nivelles, 280 pp.
After a first section devoted to relations between human beings and trees, this work discusses farming systems in Africa that combine trees and other cultivated species. It includes a description of multistorey agriculture and a discussion of productivity, environmental aspects, and soil fertility.

668 **FAO** 1989. *Urban and peri-urban multipurpose forestry. An annotated bibliography.* Rome, FAO, 29 pp.
This document is an annotated bibliography with 80 entries on multipurpose forestry in urban and peri-urban areas.

669 **FAO** 1995. *An annotated bibliography on urban forestry in developing countries.* Rome, FAO, 100 pp.
This document is a compilation of the most relevant works (almost 600 entries) on urban and peri-urban forestry drawn from the TREE and AGRIS databases.

670 **FAO** 2000. *Les parcs agroforestiers en Afrique subsaharienne.* Cahier FAO Conservation No. 34. Rome, FAO, 258 pp.

This document reviews present knowledge on agroforestry parkland systems, mainly located in the semi-arid and sub-humid zones of West Africa. It describes their distribution, their diversity, how they are to be classified, present trends and determining factors, tree/soil/crop biophysical interactions, and improved parkland management techniques. The institutional set-up is considered, as well as constraints linked to forestry policy in the Sahel. The production, use and sale of products from these parklands are also discussed.

671 **Floret, C., Pontanier, R. *et al.*** 1993. *La jachère en Afrique tropicale.* Dossier MAB No. 16. Paris, Unesco, 86 pp.
This document takes stock of knowledge about fallows in tropical Africa. It indicates the major lines and the main working hypotheses for a cooperative research and development programme on the practice of fallows and the environmental and agricultural implications.

672 **Floret, C. & Serpantié, G.** 1993. *La jachère en Afrique de l'Ouest.* International workshop held in Montpellier, France, 2-5 December 1991. Paris, ORSTOM, 494 pp.
This workshop allowed participants to examine the various aspects of fallows in West Africa, define study methods for this system, and make comparisons with situations elsewhere (Europe, North Africa, Latin America and Indonesia). Five issues were considered: the general question of fallows (points of view, concepts and methods); the functions and purposes of fallows in agrarian systems; fallows in cropping systems and the impact of their suppression on agriculture and the environment; the dynamics of fallow vegetation and the reconstitution of natural environments; and the role played by fallows in livestock and forestry systems. Current research programmes and projects were also considered.

673 **Fortmann, L. & Riddell, J.** 1985. *Trees and tenure: an annotated bibliography for agroforesters and others.* Wis., USA, Land Tenure Center, 135 pp.
This bibliography contains 131 entries and also gives brief explanations of major dimensions of relations between land tenure and trees, and the implications for planning projects.

674 **Gholz, H.L., ed.** 1987. *Agroforestry: realities, possibilities and potentials.* Dordrecht, Netherlands, Martinus Nijhoff, 227 pp.
This compilation of the acts of a series of agroforestry seminars held at Florida University between October 1985 and June 1986 contains 13 papers, including six case studies based in India, Nigeria, Central America and Peru.

675 **Huxley, P.A.** 1999. *Tropical agroforestry.* London, Blackwell Science Ltd., 371 pp.
This work makes an analytical examination of the principles and practical implications of agroforestry. It focuses on how agroforestry systems work, taking into account the conflicts and compromises arising from farmers' needs, as well as the biological potential and constraints of crops. Section I introduces the nature of agroforestry and discusses various aspects of the practice of carrying on livestock production within such systems, as well as their roles in soil and water conservation. Section II analyses plant management within these systems, while Section III considers the nature of interfaces between trees and crops. Section IV describes useful features of the tree component of agroforestry systems; Section V describes changes caused by trees in their immediate environment and also discusses the sustainability of such systems. The last section discusses agroforestry research, its philosophy and its practice.

676 **ICRAF** 1987. *Agroforestry, a decade of development.* Nairobi, ICRAF, 323 pp.
This work is divided into five sections: introduction; environmental, institutional and development aspects of agroforestry; particularly striking agroforestry systems in different geographical zones; impact measurement and technology transfer; and research results and proposals for research activities. The questions raised in the course of

this work show the need for inter-institutional cooperation in regional, national and international terms.

677 **IDF** 1981. *La réalisation pratique des haies brise-vent et bandes boisées.* Paris, IDF, 129 pp.
This work contains practical advice on establishing windbreak hedges, mainly in the agricultural sector, although all the methods and techniques described can very well be applied to planting in other sectors (along roads and motorways, and in public gardens, parks, green spaces, etc.). Since 1973 the Institute for Forestry Development has set up many trial plots and field demonstrations in collaboration with provincial departments of the Ministry of Agriculture, Chambers of Agriculture and the National Institute for Agronomic Research. Each of the chapters of the work corresponds to a practical aspect: the role of hedges and windbreaks; structure, orientation and regulation; different types of windbreak; how to choose and combine species; purchase of seedlings; planting; cutting for shaping and maintenance; rehabilitation of old hedges; costs.

678 **IDF** 1988. Dossier special. Haies brise-vent: pour protéger, produire et aménager. *Forêt Entreprise,* 52: 68.
The main focuses here are: the rationale and effects of bocaging; bocage landscapes throughout the world; hedges and the environmental wealth of farmland; windbreaks and agricultural and forestry crops; the production of hedges; taking hedges into account in rural development; methods and techniques developed by the French Institute for Forestry Development; farm forests and their initial development; organizing a windbreak initiative.

679 **IDRC** 1985. *International Seminar on Shelterbelts.* Manuscript report on the proceedings of a seminar held in Tunis, 31 October-3 November 1983. Tunis, IDRC, 251 pp.
Six main issues were discussed at this meeting: the aerodynamic and microclimatic effects of windbreaks; instruments and methods to measure the physical effects of windbreaks; the biological effects of windbreaks; statistical methods to measure the biological effects of windbreaks; the establishment, upkeep and exploitation of windbreaks; and research and training needs and priorities, and international cooperation. Nineteen papers examined these issues, each being followed by a discussion: G. Guyot, "Les effets aérodynamiques et microclimatiques des brise-vent et des aménagements régionaux"; M. Charfi, "Recherche sur les effets aérodynamiques et microclimatiques des brise-vent"; G. Guyot, "Matériel et méthodes utilisables pour caractériser les effets physiques des brise-vent"; O. De Villele, "Les effets biologiques des brise-vent"; M.H. El Lakany, "Biological effects of shelterbelts and windbreaks in arid regions"; F. Olesen, "Investigations into shelter effect experience with wind protection in Danish agriculture"; Zhu Zhao Hua, "On multiple effects of intercropping with paulownia"; A. Khalique, "Windbreak studies in Pakistan"; L.O.Z. Onyewotu, "Shelterbelt effects on the yield of agricultural crops: a case study of a semi arid environment in northern Nigeria"; A.M. Jensen, "Les effets des brise-vent en zone tempérée et tropicale"; R. Delecolle, "Méthodes statistiques d'étude de l'influence biologique des brise-vent"; G.M. Khalil, "Influence of windbreaks on microclimate and crop yields in West Nubaria region"; A.I. Niang, "Délimitation des parcelles paysannes et brise-vent dans le basin arachidier sénégalais"; G. Pattichis, "Establishment, maintenance and utilization of shelterbelts"; M. Charfi, "Les espèces et les techniques utilisées dans l'établissement des brise-vent dans le périmètre de Hadjet VII (Centre Tunisie)"; F.Y. Adekyia, "Establishment, techniques and management of shelterbelts under harsh desert conditions of N. Sudan"; Zhu Zhao Hua, "A general situation of protecting forests in China"; H. Karasahin, "Brise vent et lutte contre l'érosion éolienne en Turquie".

680 **INRA** 1996. *La forêt paysanne dans l'espace rural: biodiversité, paysages, produits.* Paris, INRA, 267 pp.

Hedges, copses, woods and gallery forests play a twofold role in the countryside, affecting both the landscape and the environment. For their owners, they also represent a resource whose production, exploited to varying degrees, contributes to farm income. In this context, farm forests—in other words, the various pieces of woodland managed by farmers—have for some years been seen as new elements with economic, environmental and scientific implications. The present work is a collection of papers on a wide range of subjects: forest fragmentation and biodiversity; the purifying function of woodland; the landscape role; the dynamics of woodland in terms of time and space; economic importance; forms of improvement and development.

681 **INRA/CEMAGREF** 1999. *Bois et forêts des agriculteurs.* Acts of a study meeting held in Clermont-Ferrand, France, 20-21 October 1999. Clermont-Ferrand, France, INRA/Cemagref, Ministère de l'Agriculture et de la Pêche, 346 pp.
This volume is a collection of papers presented at the October 1999 AGRIFOR seminar organized jointed by Cemagref and INRA. Three major issues were considered: the production of technical frames of reference and bases for economic calculations regarding mixed cropping; agroforestry systems, water and biogeochemical cycles within agrarian systems; and the development of existing farm forests. These different issues are illustrated by 17 papers, reflecting the wide range of research fields involved in this whole question.

682 **Kaabia, A., Benzarti, A. *et al.*** 1990. *Séminaire maghrébin d'agroforesterie.* Acts of a seminar held in Jebel Oust, Tunisia, 23-27 October 1989. Tunis, Ministère de l'Agriculture/GTZ, 226 pp.
This collection of the acts of the Maghreb seminar on agroforestry contains 20 texts on five subjects: agroforestry systems; multipurpose trees and shrubs; economic, social and juridical considerations in agroforestry; the role of agroforestry in environmental management and development; and research, training and extension. Under the first heading, an effort is made to define agroforestry systems, describing them and indicating whether they are traditional or new practices. Multipurpose trees and shrubs, whether spontaneous or introduced and acclimatized, are described under the second heading, particularly in terms of their physiological and phyto-ecological features, their products and by-products, and the quantity and quality of these. The third section considers the economic, social and juridical aspects of agroforestry system management, while the fourth discusses the role of agroforestry in environmental management and development. The fifth then considers methodological approaches to agroforestry research, training and extension, as well as communications between these three research poles.

683 **Kerkhof, P.** 1991. *L'agroforesterie en Afrique.* Paris, 254 pp.
Agroforestry is being seen as a new hope for Third World farmers today. By combining the planting of trees with crops and animal husbandry, it helps move towards a solution of the threefold problem of low agricultural production, increasing wood shortages and environmental degradation. Hundreds of agroforestry projects are now being implemented. However, they have a hard task, for there are few models to follow and no simple, reliable technique. This study reviews first-hand experience of what actually happens in practice, describing 21 projects in different parts of Africa and showing what has worked, as well as what has failed. It focuses on the problems and dilemmas met with by experts in the field, and the lessons that they draw, often at their own expense. The projects cover a wide range of environmental situations and agroforestry approaches, from intercropping in the humid mountains of Rwanda to natural regeneration of vegetation in the Sahel desert. The accumulated experience of these projects opens up important prospects for the development of agroforestry and provides some essential keys for the more efficient design of projects.

684 **Larue, D.** 1996. *L'arbre dans la ville.* Foncier conseil, 166 pp.
Although France's heritage of urban and forest trees is one of the most splendid in the world, know-how on planting, maintenance and preservation is tending to be lost. This practical guidebook is intended to revitalize this know-how, helping people to understand and know trees—their value within the urban landscape, planting techniques, development, rehabilitation, conservation, and diagnosis of the planted landscape.

685 **Leach, G. & Mearns, R.** 1988. *Beyond the woodfuel crisis: people, land and trees in Africa.* Earthscan Publications Ltd., 309 pp.
This volume reviews the main issues, positive choices, constraints and successes of the woodfuel sector in the context of sustainable land use and natural resource management. The introductory chapter examines conventional views of the woodfuel "crisis". Part I considers rural zones in five chapters: trees for the rural population; silviculture for soil management; constraints on change; coping with constraints; and case studies (24 in all). Part II considers urban centres in four chapters: paying the price; trees for towns; fuel and economics; and urban cases (6 case studies).

686 **Leloup, S.** 1994. *Multiple use of rangelands with agropastoral systems in southern Mali.* Wageningen, Netherlands, Wageningen Agricultural University, 101 pp.
This work describes thesis research focusing on different aspects of rangelands in agropastoral systems in southern Mali. The main findings are that: (i) the conditions of rangelands have deteriorated over past decades as a result of their multiple uses; (ii) animal productivity is increasingly dependent on the farming system; and (iii) the influence of cropping systems on animal productivity leads to a deterioration in rangelands.

687 **Lizet, B. & De Ravignan, F.** 1987. *Comprendre un paysage. Guide pratique de recherche. Ecologie et aménagement rural.* Paris, INRA, 147 pp.
The first step in trying to understand a landscape is to contemplate it and let all the questions it raises come to the surface. What is the reason, in the middle of open countryside, for that mosaic of colours with those bright green enclosed meadows on that hill across the way? What is the reason for those russet-coloured patches of bracken with their geometric forms, standing out against the dull, dark mass of those gorse thickets? What is the reason for those regular lines of pines, which were clearly planted, a little further off? What is the reason for that network of newly opened paths on that high ground? And, in the valley, what about that big maize field beside small plots of grass, with hedges punctuated by pollarded trees? What is the reason for that huge, cement-covered building, close to that old tile-roofed farmhouse? And those two unusual palm trees at the entrance to the village, outside that wealthy-looking house? Behind each of these questions, there are men and women who farm, eat, cut wood, transport things, tend flocks, trade and move around. It is a long story, and we can discover the details by walking through the countryside and talking with the inhabitants. Then the landscape—the face of the countryside—starts to come to life, telling us what is left of relations between the people and the natural environment they have shaped, and what is being transformed, what is vanishing, and what the future might be.

688 **Maldague, M., Hdalik, A. *et al.*** 1986. *Agroforesterie en zones forestières humides d'Afrique.* Report on a sub-regional seminar held in Makokou, Gabon, 1-8 July 1985. Paris, Unesco, 313 pp.
This volume contains the acts of a seminar on agroforestry in rainforest zones of Africa, held in Gabon in July 1985. After an introduction, the different parts of the work are as follows: the present state of agroforestry in countries in the tropical rainforest zone of Africa (case studies from the Republic of the Congo, Gabon, the Central African Republic, Zaire, Benin, Côte d'Ivoire and Togo); agroforestry and how it can be used in the context of development; and the prospects for agroforestry in Africa.

689 **Marcar, N., Ismail, S. *et al.*** 1999. *Trees, shrubs and grasses for saltlands. An annotated bibliography.* Canberra, ACIAR, 316 pp.
This annotated bibliography contains several hundred entries concerning trees, shrubs and grasses that will grow on saltlands.

690 **Mendez, M.R., Murgueitio, E. *et al.*** 1999. *Agroforestería para la producción animal en América Latina.* Rome, FAO, 515 pp.
This volume contains the acts of the first electronic conference on agroforestry for livestock production in Latin America, held between April and September 1998. The conference was organized by the Foundation of the Centre for Investigation of Sustainable Agropastoral Production Systems, Cali, Colombia, and FAO's Animal Production and Health Division. The publication contains articles and observations on experience with agroforestry systems, including silvopastoral systems and the use of multipurpose tree and shrub fodder species.

691 **Ministère de l'Aménagement, du Tourisme et de l'Environnement, Burundi,** 1990. *Fichier technique de vulgarisation agroforestière.* Bujumbura, Ministère de l'Aménagement, du Tourisme et de l'Environnement, Burundi, 99 pp.
This technical handbook reviews simple, efficient techniques for agroforestry development and erosion control. It was drafted and refined under the "rural nursery" component of the World Bank/Fonds d'Aide et de Coopération reforestation project, and is intended particularly for field staff, agricultural experts, instructors and trainers.

692 **Nair, P.K.R.** 1985. *Fruit trees in tropical agroforestry systems.* Nairobi, ICRAF, 89 pp.
Agroforestry systems include a range of fruit- and nut-producing trees and shrubs. Most of these species are underexploited and used only on a limited scale. This document examines the environmental and socio-economic advantages of such trees in comparison with other perennial tree and shrub species as components of tropical agroforestry systems, and discusses the problems and prospects for extension of such systems.

693 **Nair, P.K.R.** 1993. *An introduction to agroforestry.* Dordrecht, Netherlands, Kluwer Academic Publishers, 499 pp.
This university manual, based mainly on a course given at the University of Florida, is divided into six sections, containing 25 chapters in all. It reviews events in agroforestry over the past 15 years, including advances in the fields of the biophysical and socio-economic sciences. Although the main focus of the work is the tropics, where agroforestry is particularly promising, experiments and experiences in temperate zones are also discussed. It is intended for students, teachers and researchers in the fields of agroforestry, agriculture and tropical land use. Section I, the Introduction, contains two chapters: (1) The History of Agroforestry; and (2) Definition and Concepts of Agroforestry, including communities, farms and social forestry. Section II, Agroforestry Systems and Practices, contains eight chapters: (3) Classification of Agroforestry Systems; (4) Distribution of Agroforestry Systems in the Tropics; (5) Shifting Cultivation and Improved Fallows; (6) *Taungya*; (7) Homegardens; (8) Plantation Crop Combinations; (9) Alley Cropping; and (10) Other Agroforestry Systems and Practices. Section III, Agroforestry Species, contains three chapters: (11) General Principles of Plant Productivity; (12) Agroforestry Species: the Multipurpose Trees; and (13) Component Interactions. Section IV, Soil Productivity and Protection, contains five chapters, giving more detailed information than the other sections, because this aspect has been the object of more research than the others and is often seen as one of the most important aspects of the issue. The five chapters are concerned with: (14) Tropical Soils; (15) Effects of Trees on Soil; (16) Nutrient Cycling and Soil Organic Matter; (17) Nitrogen Fixation; and (18) Soil Conservation. Section V, "Design and Evaluation of Agroforestry Systems, contains seven chapters: (19) The Diagnosis and Design (D&D) Methodology; (20) Field Experiments in Agroforestry; (21) On-Farm

Research; (22) Economic Considerations; (23) Sociocultural Considerations; and (24) Evaluation of Agroforestry Systems. (25) Agroforestry in the Temperate Zone.

694 **ORSTOM** 1994. *A la croisée des parcours: pasteurs, éleveurs, cultivateurs.* Paris, ORSTOM, 337 pp.
This volume is a collection of texts concerned with livestock farmers, their practices, and their relations with the rural world and society as a whole. It also shows that today there are approaches that allow the paths of change taken by pastoral societies to be plotted so that a more comprehensive reflection on livestock farming can be carried out. The work is divided into the following parts: livestock systems and pastoral systems; the disciplines in question; resource use and management of natural environments; animal husbandry-agriculture, herders-cultivators; animal husbandry models and practices.

695 **Padilla, S.** 1995. *Manejo agroforestal andino.* Quito, FAO-Netherlands, 262 pp.
This volume is intended for field experts, planners, students, etc., and contains information on a range of agrosilvopastoral development field experience in the Andes region.

696 **Penaloza, W.R.** 1990. *Simposio agroforestal en Mexico: sistemas y métodos de uso múltiple del suelo.* Linares, Mexico, 14-16 November 1989. 2 vols. 800 pp.
Sixty-one papers from this symposium are presented in four parts, with Parts I and II in Volume 1, and Parts III and IV in Volume 2. Part I, on traditional agroforestry systems, contains 19 papers on agrosilvicultural systems (including forest trees and plantation species) and living fences. Part II, on silvopastoral systems and the use of wildlife, contains 12 papers. Part III, on integrated systems for the use of arid and semi-arid zones, contains 18 papers, covering techniques, evaluation, species and provenance trials, etc. And Part IV, on the economics and planning of agroforestry systems, contains 12 papers.

697 **Pointereau, P. & Bazile, D.** 1995. *Arbres des champs, haies, alignements, prés vergers ou l'art du bocage. Pour protéger, retaurer et gérer les arbres "hors forêt".* Toulouse, France, Solagro, 137 pp.
1945-1995: fifty years in which the expansion of forests has disguised the reduction in the number of cultivated trees and their abandonment. The modernization of agriculture has disrupted bocage landscapes in which trees, meadows and cattle coexisted so well. Trees had their place in the rural economy: hedges to enclose fields and protect livestock, trees to provide fodder, trees to provide fuelwood, ordinary and line orchards, mulberries, lines of trees to provide shade on roads. However, everything has changed. Silk is produced in China. Vehicles are air-conditioned. Intensive orchards are already overproducing, and the decreasing numbers of farmers no longer have time to go out and trim the hedges. What will be the use of trees in fields in the 21st century when there are already so many trees in the forests? To shape a landscape, to prevent water from overflowing and eroding the soil, to generate biodiversity, to build up a sustainable agriculture. This book tells the history of these trees that human beings decided to cultivate outside forests. It describes planting and maintenance techniques, gives details of laws, regulations and financial measures, and discusses the variety of initiatives in France and elsewhere in Europe. It clears the way for trees outside forests to play a full role in the creation of contemporary landscapes.

698 **Reynolds, L.** 1995. *Pasture-cattle-coconut systems.* Rome, FAO, 668 pp.
Large areas of tree crops are found in the tropics, some of which can be combined with animal husbandry and grazing. With 11 million ha, coconut palms are the tree crop best suited to such a combination, with its broad spacing, its particular morphological features, and the high amount of sunlight that reaches the surface of the ground. Over 90% of the area covered by coconuts lies in Asia and the Pacific, where millions of households depend on them. The work also describes the

advantages and disadvantages of such combinations.

699 **Richards, P.** 1982. *Agroforestry.* Oxford, UK, CAB, 44 pp.
This bibliography contains 171 annotated entries on the vast subject of agroforestry. It is one of the series of synthetic works published by the Commonwealth Agricultural Bureaux on a specific subject. In the case of agrosilviculture and silvopastoral systems, the entries are classified by geographical location (Europe, Asia, Africa, Central and North America, South America, and Oceania). The other chapters concern agrosilvopastoral systems, economic and social aspects, tree species used in agroforestry systems, and the effects of agroforestry on the soil.

700 **Riddell, J. & Fortmann, L.** 1983. *Land tenure issues in agroforestry.* Madison, Wis., USA, University of Wisconsin, 150 pp.
This annotated bibliography contains about 3000 entries on agroforestry land tenure issues.

701 **Riou, G.** 1995. *Savanes: l'herbe, l'arbre et l'homme en terres tropicales.* Paris, Masson/Armand Colin, 270 pp.
This work contains four sections. First, the aims, method, terminology and geographical areas are defined. The accent is laid on the "geographer's landscape" and on a systemic approach, considering the complex problems involved in a particularly rich terminology, as well as difficulties in tracing the precise shape of the savannah sphere. The following section offers an analysis of simple geographical units that combine grass and trees and that are affected by human activity to a greater or lesser extent. The following chapters outline various complex organizations of landscapes, from the dampest to the most arid. The last part discusses various issues concerned with the savannah geosystem and how it works. Relations between people and nature and between environments and societies are referred to throughout this reflection.

702 **Rivière, L.M., ed.** 1997. *La plante dans la ville.* Acts of a meeting held in Angers, France, 5-7 November 1996. Paris, INRA, 351 pp.
This volume, the fruit of a meeting of sociologists, town planners and agricultural experts, offers a review of relations between plants and urban communities, supported by European examples. After a study of the position and functions of plants in towns, significant current examples of the use of plants as a development tool are reviewed. The specific features of urban sites are also studied in agronomic terms (very artificial soils, modified climates, the importance of stress resistance).

703 **Rocheleau, D., Weber, F. *et al.*** 1988. *Agroforestry in dryland Africa.* Nairobi, ICRAF, 311 pp.
This practical handbook is intended for use by field staff in sub-humid and semi-arid regions of Africa, including researchers working with local people's organizations, community developers, development workers, development specialists in government bodies and national research bodies, development teachers, indeed all those working in the development and research sphere. The work is made up of three parts. Part I consists of three chapters. Chapter 1 provides an introduction to agroforestry and describes the roles of different agroforestry practices within a community. Chapter 2 describes the process and methods of participatory planning with the community in order to identify and adapt agroforestry to local needs. The procedures are described for drawing up information summaries, making rapid surveys of the landscape and local community, and carrying out various types of interview, as well as the use of their results. Chapter 3 discusses the evaluation of agroforestry projects. Part II (Chapters 4 to 7), on agroforestry practices, describes 15 practices in different types of zone: agroforestry in croplands—scattered trees, vegetation strips, alley cropping, home gardens and improved fallows; agroforestry and structural conservation measures—trees, shrubs and grass on small and large terraces, protection and stabilization of waterways, gulleys and microcatchments, and water management; agroforestry in linear

structures—living fences, windbreaks, trees and shrubs demarcating boundaries and borders, along waterways, around flood plains, along roads and tracks, and around houses and public places; and agroforestry on grazing land. Part III, on tools for agroforestry research and development, contains eight appendices giving information on appropriate trees and shrubs for the region, guidelines for evaluating community needs and designing appropriate agroforestry activities, a glossary, and lists of acronyms, regional contacts and references.

704 **Saldias, M., Johnson, J. *et al.*** 1994. *Guía para uso de árboles en sistemas agroforestales para Santa Cruz, Bolivia.* Santa Cruz, Bolivia, Centro de Investigacion Agricola Tropical, 188 pp.
This handbook seeks to identify the most useful and promising species, providing information on the features of each species and on its uses and potential in agroforestry systems.

705 **Soltner, D.** 1995. *L'arbre et la haie pour la production agricole, pour l'équilibre écologique et le cadre de vie rural.* 10th edition. Angers, France, 208 pp.
Whenever farmers have surrounded their fields, meadows, farms and villages with hedges, shelterbelts, ridges and ditches, they have created a bocage landscape. But why did they plant these hedges and trees and set up these ridges? What is their use today? How are they to be maintained today, and why and how are they to be replanted? This book provides clear, practical answers to all these questions.

706 **Stefulesco, C.** 1993. *L'urbanisme végétal.* Paris, IDF, 323 pp.
Squares, public gardens, parks and green spaces conjure up an environmental quality to which city-dwellers increasingly aspire. How are these spaces to be designed today in order to meet the wide range of needs, while benefiting from past experience? Green town planning offers answers to these questions on the basis of many examples from the history of towns in France and other countries. The origin, development and uses are discussed, while measurements, drawings and photographs offer keys to understanding such urban spaces as avenues, promenades, squares, footpaths and esplanades. The importance of plant composition in the structure of towns becomes clear. This book is intended for developers, elected representatives, professionals and technical services, in order to help in drawing up town planning programmes and implementing landscape projects.

707 **Swinkels, R.A. & Scherr, S.** 1991. *Economic analysis of agroforestry technologies: an annotated bibliography.* Kenya, ICRAF, 215 pp.
This publication provides an overview of writings concerned with economic analysis of agroforestry technologies. Over half the 230 documents listed have been published since 1985. Almost all are in English (three in French and six in Spanish) and their geographical distribution is as follows: Asia (72, or 31%), Africa (63, or 27%), Latin America (28, or 12%), Australia/New Zealand (19, or 8%), USA/Canada (11, or 5%), Europe (3, or 1%), and worldwide (37, or 16%). The entries are arranged in alphabetical order by author, and there are three indices by author, language and geographical location, and ten by descriptors. The descriptors are (i) ecozones (humid, sub-humid, semi-arid, arid, montane, lowland, and temperate), (ii) type of analysis, (iii) level of analysis (plot, farm, plantation, project, community, region, country), (iv) source of data—empirical (case studies, farm surveys and plot research), non-empirical (evaluations and biological models) and unspecified, (v) agroforestry technology—mixed plantation (trees in home gardens, annual or perennial crops and grazing land), block planting (afforestation and fodder banks), strip and line planting (alley cropping, demarcation planting, living fences and windbreaks) and sequential/rotational planting (*taungya* and improved fallows), (vi) tree/shrub species, (vii) tree/shrub products, (viii) tree/shrub services, (ix) cultivated species/grass, and (x) livestock species. The types of economic analysis described and

indexed under (ii) are described in detail in a separate section.

708 **Thampan, P.K.** 1994. *Trees and tree farming.* Kerala, India, Peekay Tree Crops Development Foundation, 447 pp.
This volume offers wide-ranging information on the socio-economic and environmental aspects of farm forestry. Its 18 chapters cover a wide variety of terrains, and subjects such as trees and human nutrition, medicine, and the influence of trees on the local and global climate.

709 **Thies, E.** 1995. *Principaux ligneux (agro-) forestiers de la Guinée. Zone de transition Guinée-Bissau, Guinée, Côte d'Ivoire, Ghana, Togo, Bénin, Nigeria, Cameroun.* GTZ, 540 pp.
This catalogue describes 105 tree species, including timber species, the main agroforestry species and species with major socio-religious importance. It includes over 400 illustrations of trees and over 200 references.

710 **Weigel, J.** 1994. *Agroforesterie pratique.* Paris, Ministère de la Coopération, 211 pp.
In tropical farming systems, trees play a role both in providing various goods and services, and also in protecting soil and improving its fertility. Present and future rural development is thus dependent among other factors on the continuation of these functions. The more intensive agricultural and pastoral production systems become, the more space there will be available for agroforestry systems. In order to recover a wooded landscape, knowledge is needed of how to protect the trees that nature regenerates, and also how to reforest artificially. This handbook answers practical questions regarding such agroforestry reconstitution in the forms most usually encountered or most viable within the context of village extension work in the dry tropical zones of Africa.

711 **Weigel, J.** 1994. *Agroforestry handbook for development officers in dry tropical Africa.* Paris, Ministère de la Coopération, 211 pp.
In tropical farming systems, trees play a role both in providing various goods and services, and also in protecting soil and improving its fertility. Present and future rural development is thus dependent among other factors on the continuation of these functions. The more intensive agricultural and pastoral production systems become, the more space there will be available for agroforestry systems. In order to recover a wooded landscape, knowledge is needed of how to protect the trees that nature regenerates, and also how to reforest artificially. This handbook answers practical questions regarding such agroforestry reconstitution in the forms most usually encountered or most viable within the context of village extension work in the dry tropical zones of Africa.

712 **Young, A.** 1997. *Agroforestry for soil management.* Wallingford, UK, CAB International, 328 pp.
This work is based on over 700 published bibliographical references, and summarizes the present state of knowledge on agroforestry and soil management. It includes the results of field trials on farming systems and research on the soil/plant process. It also lists research needs in this sector.

713 **FAO** 2001. *Les arbres hors forêts—Vers une meilleure prise en compte.* FAO Conservation Guide. Rome, FAO, 280 pp. (in press).
The first part of this document defines trees outside forests, highlighting the importance of this resource, describing its dynamics, noting factors affecting it, and giving an overall, up-to-date evaluation. The second part presents a series of case studies illustrating the present situation of trees outside forests, with examples of evaluation of this resource in eight countries (Costa Rica, France, India, Kenya, Mali, Morocco, Namibia and Sudan). These case studies were selected with a view to showing the main factors involved in certain regions (desertification, timber supplies), the dangers for certain species of trees outside forests (the destruction of line trees, the degradation of agroforestry parkland), and the economic potential of certain products (carob, jelly plum or marula,

locust bean and karité), as well as illustrating a variety of evaluation methods (national reconnaissance inventories, regional satellite evaluation and participatory surveys).

714 **FAO** 2001. *Trees outside the forest: toward rural and urban integrated resource management.* Working document. Rome, FAO, 40 pp.
This discussion paper on trees outside forests defines this resource, highlighting its importance, describing its dynamics, noting factors affecting it, and giving an overall, up-to-date evaluation.

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