

**AN ANNOTATED
BIBLIOGRAPHY
OF SURVEY AND ANALYSIS
METHODS
FOR STUDY OF INDIGENOUS
AGROFORESTRY SYSTEMS**

Tracy J. Suchocki and James H. Fownes



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**An Annotated Bibliography of Survey and Analysis
Methods for Study of Indigenous Agroforestry Systems**

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INTRODUCTION

The issues surrounding land use in tropical countries have led to many studies of indigenous or traditional land uses. In recent years, those agricultural systems incorporating trees (termed agroforestry) have been subjected to particular scrutiny. Students of agroforestry systems are faced with choosing among methods from a variety of disciplines, including agriculture, anthropology, range management, forestry, sociology, and economics. One of the most difficult decisions in planning and conducting such studies is which methods to use and why. The purpose of this annotated bibliography is to highlight the survey and analysis methods used in a select group of publications spanning a variety of scale, purpose, and detail.

This bibliography is by no means comprehensive. We selected papers that we felt were widely available and illustrative of various approaches. In the annotations, we have not attempted to summarize articles or to recapitulate the conclusions of the authors. Rather, we have attempted to comment on the authors' choices of methods, descriptions, and questions in a way that would be helpful in guiding future students and researchers. We would be grateful for any corrections, updates, or important new publications to include in future editions.

DESCRIPTION OF INDEXING CATEGORIES

To guide the reader more quickly to pertinent studies, and to prepare for computer-assisted searches of the database, we categorized the publications by type of article, survey method, geographic region, and land-use system. The latter two categories follow common usage in the agroforestry literature, exemplified by the International Council for Research in Agro-Forestry (ICRAF) agroforestry systems inventory project (collected in P. K. R. Nair (ed.) *Agroforestry Systems in the Tropics*, Kluwer Academic Publishers, 1989). The categories also permitted the creation of cross-reference tables giving an overview of what kind of studies are common or rare.

TYPE OF ARTICLE

- Book:** A listed book may include both primary and review type studies.
- Primary:** "Primary" indicates an article based upon original field research.
- Review:** The term "review" implies that the article is a review of primary articles.

SURVEY METHOD

Architectural Analysis:	Mapping of plant location and distribution in both horizontal and vertical dimensions.
Census:	Information gathered through government census.
Economic Analysis:	Collection and analysis of operating costs, the market value of products such as food, fodder and timber, or non-monetary benefits such as soil conservation.
Field Survey:	The systematic collection in the field of quantitative data such as farm composition, biomass, productivity and soil properties.
Interview:	Data collected through interviews with farmers and households. Such data might include the amount of time spent on fuelwood and fodder collection, types collected and distances traveled for their collection.
Literature Review:	Conclusions or generalizations based on published information.
Mathematical programming:	Computer programs or other techniques used to simulate the output of different cropping alternatives.
Observation:	Qualitative descriptions of agroforestry systems based upon the authors' observations. Tree and crop species are often listed with management practices.
Questionnaire:	Includes data collected through questionnaires distributed to farmers or other people in the survey sample.

GEOGRAPHIC REGION

American Tropics	Central and South America, including (for convenience) Chile
East & Central Africa	Zaire and East
Pacific Islands:	Micronesia, Polynesia, and Melanesia, not including Papua New Guinea
South Asia	India and Himalaya
Southeast Asia	Including Philippines, Indonesia and Papua New Guinea
West Africa	West of Zaire

LAND USE SYSTEM

- Alley cropping:** Agricultural crops are planted between parallel hedgerows of fast-growing woody species.
- Fuelwood plantations/
Multipurpose tree woodlot:
and** Firewood and timber species are planted on degraded or abandoned lands. These plots are usually found in distant outlying fields.
- Homegardens:** Small scale, complex systems where many types of trees and crops are grown around home compounds. Fruit trees are often the predominant tree species present.
- Improved fallow:** Fruits, fodder, fuel or timber continue to be harvested from woody species that are left to grow on a plot during the fallow stage.
- Multilayer tree gardens:** A complex system where trees, shrubs and crops are grown together, producing many canopy layers or strata. Such gardens are not limited to the vicinity of the home site.
- Multipurpose trees on
crop land:** A system where fodder, fuel, timber and fruit trees are grown on field bunds, terraces or plot/field boundaries.
- Plantation crop combinations:** The integration of trees and plantation crops such as coffee, cacao or coconut grown together. Fruit, fuelwood or fodder trees can be intercropped, and planted in some regular arrangement or scattered as shade trees.
- Protein banks:** Protein-rich fodder trees are grown on farms or rangelands for the production of cut and carry fodder.
- Shifting cultivation (swidden):** Agricultural land is opened, often by "slashing" and "burning" a mature or secondary forest. Crops are then cultivated on the newly cleared land. Selected trees are either kept in the system or planted. The system is abandoned to fallow after several years.
- Taungya:** Farmers are permitted to cultivate crops during the early establishment phase of a stand of trees. The use of the land for crop cultivation is usually in exchange for the planting, management and care of the trees by the farmer.
- Trees on rangeland/pasture:** Trees are grown in some arrangement or randomly scattered throughout the rangeland or pasture.

Structure and Function of Traditional Agroforestry Systems in the Western Himalaya. I. Biomass and Productivity

Authors:	Toky, OP; Pradeep K; Khosla, PK
Source:	Agroforestry Systems. 1989, 9:47-70.
Type of Article:	Primary
Geographic Region:	South Asia (Western Himalaya, Himachal-Pradesh, India)
Survey Methods:	Field Survey Interviews
Land-use System:	Multipurpose trees on crop lands

An in-depth study of three types of agroforestry systems was made. The first system was dominated by agricultural crops cultivated on terraced hill sides. On the bunds of the terraces, fodder, fuel and/or timber trees were grown. In the second class of systems, agricultural crops were grown in between trees in orchards of *Prunus domestica* (plum) and other fruits. Fruit trees were uniformly spaced in combination with fodder tree species. In the third agricultural system, fruit trees were grown in regular spacing while fodder or timber were left on the field bunds and annuals were grown in the interspace. Farm composition, estimate of biomass, productivity, pattern of biomass distribution and, nutrient cycling were examined in the three types of agroforestry systems. Three replicates of each type of system were found on farms with similar topography. Ten 10 X 10 m quadrats were placed along a transect on each farm and frequency, density and basal area were recorded for each tree species. Ten 50 X 50 cm quadrats were used for annual crops. Species composition, biomass and productivity patterns were estimated for each system. An "importance value index" was calculated for each species, and this value was then used to compare the systems. Species diversity was based on the Shannon Index. Quadrats were harvested in March and August, and analysis was run on the separate plant components. Results were discussed in terms of the increasing shortage of fuel, fodder and packaging material in the western Himalaya.

Homestead Agroforestry in Bangladesh

Authors:	Leuschner, WA; Khaleque, K
Sources:	Agroforestry Systems. 1987, 5: 139-151.
Type of Article:	Primary
Geographic Region:	South Asia (Bangladesh)
Survey Method:	Interviews
Land-use System:	Homegardens

A study based on interviews with farmers was conducted to determine the prospects for strengthening existing homestead agroforestry systems. A purposive (non-random) sample was surveyed in seven districts that represented a cross section of Bangladesh's three main agro-ecological zones. These districts and agro-ecological zones included, (1) Barisal (delta), (2) Chittangong and Sylhet (hills), and (3) Dhaka, Mymeningh, Pabna and Rangpur (plains and drylands). These villages were chosen because they were near or associated with other agricultural demonstration sites. In each village, thirty households were interviewed, including village leaders and other influential people having an impact on the local "receptive attitude" toward the program. Typical farm structure, species grown, and function were described. Survey focused on the amount of time spent by each household member collecting wood and/or fodder, type collected, alternative uses for collected material, and distances traveled for collection. Farmers' experience and knowledge of tree cultivation were also determined. Conditions for the success of the project concluded the report.

Compound Farms of Southeastern Nigeria: A Predominant Agroforestry Homegarden System with Crops and Small Livestock

Authors:	Okafor, JC; Fernandes, ECM
Source:	Agroforestry Systems. 1987, 5: 153-168.
Type of Article:	Primary
Geographic Region:	West Africa (Southeastern Nigeria)
Survey Method:	Observations
Land-use System:	Homegardens

The authors described multi-species gardens in farm home-compounds of Nigeria based upon their observations. Land is dominated by plains under 200 m elevation. Rainfall ranged from 4000 mm yr⁻¹ near the coast to 1,250-2,500 mm yr⁻¹ inland. Major soil groups include Ultisols and Oxisols, Alfisols, Inceptisols and Entisols. Dominant crops of the system included yam, cassava, cocoyam, banana, plantain, maize, pumpkin, melon and leafy vegetables. One hundred and sixty-one species of trees and shrubs found on the farms were listed along with their uses and functions. The authors briefly discussed the arrangement of garden components in relation to the distance of the residence of the farmer, but methods were not described. Trees and shrubs that were frequently used for food were found within and around compound farms while other species not regularly used were more commonly found in distant fields. Vertical strata and spatial distribution of crops on mounds were shown schematically.

Surveying Farmers' Agroforestry Plots: Experiences in Evaluating Alley-Cropping and Tree Border Technologies in Western Kenya

Authors:	Scherr, SJ; Roger, JH; Oduol, PA
Sources:	Agroforestry Systems. 1990, 11: 141-173.
Type of Article:	Review
Geographic Region:	East and Central Africa (Western Kenya)
Survey Methods:	Interviews Questionnaires
Land-use Systems:	Alley cropping Multipurpose trees on crop lands

How to design and implement questionnaires to conduct surveys of agroforestry systems was described. The methods were demonstrated and tested by the survey and evaluation of alley cropping systems and tree borders around crop fields established by farmers working with the CARE Agroforestry Extension Project in Western Kenya. Since these two types of agroforestry systems both employ a large number of different types of multipurpose trees, and are practiced in various agroecological zones, the case study was considered to be widely applicable. The authors focused on the collection of the following information; type of user, type of site where used, priority functions, tree and crop components, expected yields and services, and inputs. These standard descriptors could then be used to systematically document existing and proposed agroforestry systems. The definition of survey objectives was seen to be the most important part of the survey. Some examples of objectives included: 1) To survey the range of farmers agroforestry practices. 2) To survey the range of designs used in a selected type of agroforestry practice. 3) To survey the characteristics of selected agroforestry designs. and 4) To survey the differences in one of the above variables, by type of plot, farm or user. The type of information each survey would yield was described. Criteria for the selection of survey questions, how to define the technology being studied and how to incorporate observations and quantitative measurements were discussed. The selection of the survey sample was based on issues such as sampling unit and structure, sample frame, and sample size. The case study illustrated who carried out the surveys used in the case study, how they did it, and the handling of the data afterward. The authors concluded with lessons learned from the case study.

The Influence of Trees in Selected Agroecosystems in Mexico

Author:	Farrell, J
Source:	Agroecology: Researching The Ecological Basis For Sustainable Agriculture (Gliessman, SR ed.). 1990, 169-183. Ecological Studies Vol. 78. New York, USA; Springer-Verlag.
Type of Article:	Primary
Geographic Region:	American Tropics (Tlaxcala, Mexico)
Survey Method:	Field survey
Land-use System:	Multipurpose trees on crop lands

The effects of two tree species, *Prunus capuli* and *Juniperus deppeans*, in traditional cropping systems in Tlaxcala Mexico was studied. At low elevations, these and several other trees have been traditionally planted as field borders or interdispersed within maize fields. At higher elevations, trees and crops have been found mixed in orchards. The selection of the study site was not discussed. Authors primarily focused on the alterations of soil properties, air temperature, relative humidity, and crop yields due to the trees. Five trees were selected for sampling, and of these, two were randomly chosen for sampling surface-soil chemical properties along transects extending from the base of each tree. The soil properties measured included; nitrogen, water soluble phosphorus, total carbon, pH, and cation exchange capacity. Effects on maize were assessed by comparing yields near to versus far from trees.

Agroforestry Practices of Gajarat State

Author:	Verma, DPS
Source:	The International Tree Crops Journal. 1990, 6:17-30.
Type of Article:	Primary
Geographic Region:	South Asia (Gajarat State, India)
Survey Method:	Interviews
Land-use System:	Multipurpose trees on crop lands

How farmers have integrated tree seedlings (supplied by the forestry department) onto their farms was studied. The two main agroforestry systems found were intercropping and the peripheral planting of trees along the borders of fields. A questionnaire that randomly sampled farms was stratified among the state's eight different agroclimatic zones. Sample size of each zone was maintained at 0.4% of the total number of farmers practicing either of the above two types of agroforestry. Results were separated by water regime of the areas. Tree species used were mainly eucalyptus, due to the farmers' lack of knowledge and experience with other trees. Tree and crop combinations, farmers' estimates of the effects of trees on crop production, and spacing adapted for agroforestry were presented.

Colonos, Agriculture and Adaptation in the Colombian Amazon

Authors:	Eden, MJ; Andrade, A
Source:	Journal of Biogeography. 1988, 15:79-85.
Type of Article:	Primary
Geographic Region:	American Tropics (southeast Colombia)
Survey Method:	Field survey
Land-use System:	Shifting cultivation (swidden)

A comparison of similar shifting cultivation systems dominated by manioc was made to determine if they both exploited forest resources in the same way. The name Colonos described a group of older-established settlers in the middle Caqueta basin of southeast Colombia. The colonos co-exist with the indigenous Andoke and Witoto tribes. Both systems were studied to determine how much the colonos replicated the indigenous tribes' agricultural practices. A survey based on a point-centered quarter method (from Dix, 1961, see annotation #50) was used to obtain crop compositional data from seventeen fields. Relative and absolute crop densities were then calculated. Qualitative observations were made of other fields and yard gardens. The discussion focused on the types of land cultivated (floodplain vs. free draining), prominent crop species (sweet manioc, maize, banana), planting patterns and nutrient status of the soils in each system. Significant contrasts between the systems were found in terms of selection of forest to clear, selection of soil drainage conditions, and crop diversity.

Traditional farming Systems of South-Central Chile, with Special Emphasis on Agroforestry

Authors:	Altieri, MA; Farrell, J
Source:	Agroforestry Systems. 1984, 2:3-18.
Type of Article:	Primary
Geographic Region:	American Tropics (Chile)
Survey Methods:	Observations Interviews
Land-use System:	Homegardens

Cropping patterns, use of local resources, and farming practices employed in south-central Chile were studied. Information was gathered through a month-long survey based on interviews and general observations. The geographic region studied lies between the Andes and the slopes of the Coastal Range where a regular flow of water is available throughout the year. Most soils in the central valley are deep, alluvial, and high in organic matter. Farming systems of the area were grouped into small-scale intensive systems and commercial enterprises. Small-scale farms ranged up to 1 ha, maintaining 5-10 tree species (mostly fruit and nut), 10-15 annuals, 3-4 animal species and grape arbors. *Eucalyptus globulus* are planted as living fences and harvested for fuelwood and poles. Local methods of pest, plant disease, weed, and soil management were described. Schematic diagrams of the structural layout of a small scale intensive farming system and of a 12 ha commercial farming systems were shown. The combination of trees and crops and the planting patterns varied depending on the dietary needs of the family, size of the land and/or available markets.

An Evaluation of Structure and Function of Tropical Homegardens

Authors:	Fernandes, ECM; Nair, PKR
Source:	Agricultural Systems. 1986, 21:279-310.
Type of Article:	Review
Geographic Region:	General (tropical and subtropical regions)
Survey Method:	Literature review
Land-use System:	Homegardens

Ten homegarden systems from different geographical and ecological regions were described based on their functional and structural aspects. These examples of homegardens were selected from a computerized database of an agroforestry systems inventory put together by the International Council for Research in Agroforestry. A summary of biophysical and socio-economic aspects of selected homegardens was tabulated along with the major components of each system. The analysis showed the average size of a homegarden plot was <0.5 ha, and they were structured to form 3-5 vertical canopy strata. Schematic diagrams illustrated structural composition of typical homegardens found in Java, Northern Tanzania, the Pacific Islands and southeast Nigeria. For each system, the authors discussed prominent crops and their products found within each layer of the vertical strata, and their percent of total volume occupying the canopy. Lists of woody perennials and herbaceous species found in selected homegardens from Burkina, Grenada, Java, Mexico, Pacific, Philippines, Nigeria, Sri Lanka, Tanzania and India were appended to this study.

Multiple Objective Programming: An Approach to Planning and Evaluation of Agroforestry Systems - Part 1: Model Description and Development

Authors:	Mendoza, GA; Campbell, GE; Rolfe, GL
Sources:	Agricultural Systems. 1986, 22:243-253.
Type of Article:	Primary
Geographic Region:	General
Survey Method:	Mathematical programming
Land-use System:	Agroforestry

Multiple Objective Programming is an approach to handling problems where several functions are optimized simultaneously. This method was used to determine the optimal cropping patterns for a specific land area over a specified time. The authors argued that this framework for planning and evaluating agroforestry systems allows one to take into account the following features of agroforestry system: (1) multiple dimensions (including space and time), (2) multiple uses (forestry and agricultural), (3) multiple products (forest, agricultural, forage and, livestock), and (4) multiple disciplines (economic, social and environmental). Due to lack of data or input functions, this approach cannot currently take into account ecological and economic interactions of tree species with other crop and livestock components within the system.

Multiple Objective Programming: An Approach to Planning and Evaluation of Agroforestry Systems: Part 2 - An Illustrative Example and Analysis

Authors:	Mendoza, GA; Campbell, GE; Rolfe, GL
Sources:	Agricultural Systems. 1986, 23:1-18.
Type of Article:	Primary
Geographic Region:	General
Survey Method:	Mathematical programming
Land-use Systems:	Plantation crop combination Trees on rangelands or pastures

The application of Multiple Objective Programming models was illustrated by using a sample problem based on a hypothetical forest of 3200 ha along with field data on cropping systems and product outputs. The crop data and geographic information was based on previously published research on four cropping systems in combination with black walnut timber and nut production. The model used these studies to investigate the silvicultural and economic relationship of these multiple cropping strategies, and analyzed the economic value of each.

Agroforestry and the Small Farmer: A Case Study of Kilema and Kirua Vunjo in Kilimajaro

Authors:	O'king'ati, A; Mongi, HO
Source:	International Tree Crops Journal. 1986, 3:257-265.
Type of Article:	Primary
Geographic Region:	East and Central Africa (Tanzania)
Survey Methods:	Field survey Interviews
Land-use System:	Homegardens

Sites for this study were chosen based on similar farming systems that developed on the steep slopes (14% to 27%) of highland East Africa. Farmers from four randomly selected villages were interviewed and their farms were surveyed for the types of crops grown. Farm sizes ranged from 0.2 to 1.2 ha, supporting an average of 10 people per household. An average of 39 local tree species were grown on the farms, (21 timber, 10 fodder, and 8 fruit or other). Fodder, timber and fuelwood tree species names were not listed in this report. The survey found that farmers were purchasers of lumber and poles due to the nature of the market system or a general unwillingness to cut down their own trees. Major staple crops included banana, coffee, mangos, papaya, oranges, lemon, avocado, passion fruit, and tomato. Grass was grown on steeper terrain along contours to prevent soil erosion and as a supplement to fodder for cattle.

The Role of On-Farm Trials in the Evolution of Composite Technologies: The Case of Alley Farming in Southern Nigeria

Authors:	Atta-krah, AN; Francis, PA
Sources:	Agricultural Systems. 1987, 23:133-152.
Type of Article:	Primary
Geographic Region:	West Africa (southern Nigeria)
Survey Methods:	Field survey Interviews
Land-use System:	Alley cropping

A three part experiment that focused on the performance of technology developed under farm conditions was conducted by the International Livestock Center for Africa (ILCA). The authors sought to use the data gathered and evaluated by the farmer "to ensure the relevance of on-station research". To obtain the necessary information, the farmer was required to control, manage and utilize the technology himself/herself. Part one included five alley farm trials planted with *Gliricidia* and *Leucaena*. In part two of the study, ILCA's involvement of planting and management was reduced and farmers were encouraged to adapt the system to meet their own needs and circumstances. Twelve alley farms were planted on farmers fields, utilizing joint researcher/farmer participation. *Leucaena* and *Gliricidia* were both established from seed. This stage determined the acceptable and manageable size of initial alley farms, as well as being demonstration sites for other farmers. In part three, ILCA set out to determine the "relevance, workability and acceptability of the system to farmers". A new site was selected to avoid farmer dependence on researchers involvement. Once farmers were taught the necessary planting techniques, trees were distributed and 76 alley farms were planted in the first year. The project was monitored through farm visits to collect information on the condition of the trees, food crops planted, management activities, general farm condition and farmers' perspective of the system. Farm evaluation was based on a score system ranging between 1 (poor) and 4 (excellent). Tree utilization, farmer perceptions, adaptation and diffusion of technology were discussed.

ICRAF's Agroforestry Systems Inventory Project

Author:	Nair, PKR
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 22-38. Dordrecht, Netherlands; Kluwer Academic Publishers.
Type of Article:	Primary and Review
Geographic Region:	General
Survey Methods:	Field survey Interviews Literature review
Land-use System:	Agroforestry

The International Council for Research in Agroforestry (ICRAF) set out to gather information that could be organized in a uniform framework and format in order to compare, collate, synthesize and evaluate agroforestry systems. Their objectives included "to identify the weaknesses and constraints of the systems, as well as their potential for improvement and wider applicability." Inventory methods consisted of data collected through ICRAF, field visits, mail survey, and literature searches. General considerations and format for data collection are included in the appendix. This paper provides a list of features that can be used to characterize different agroforestry systems.

Classification of Agroforestry Systems

Author:	Nair, PKR
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 39-52. Dordrecht, Netherlands; Kluwer Academic Publishers.
Type of Article:	Review
Geographic Region:	General
Survey Methods:	Field survey Questionnaire
Land-use System:	Agroforestry

Some criteria for classification of agroforestry systems include; spatial and temporal arrangements of components, relative importance and role of components, production aims/outputs, and, social and economic features. The author arranged these components into four groups by which agroforestry systems can be analyzed. These include; structural basis, functional bases, socioeconomic bases, and ecological bases. Constituents and use of each group/class are discussed.

Agroforestry Systems, Practices and Technologies

Author:	Nair, PKR
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 53-62. Dordrecht, Netherlands; Kluwer Academic Publishers.
Type of Article:	Review
Geographic Region:	General
Survey Method:	Literature review
Land-use System:	Agroforestry

A brief description of different agroforestry practices was given along with examples from various geographical regions (South Pacific, South-east Asia, South Asia, Middle East and Mediterranean, East and Central Africa, West Africa, and American Tropics). Prominent agroforestry systems and practices in the tropics and subtropics were elaborated. A table of major agroforestry systems summarized information on: agroforestry practice, brief description, major group of components, main types of component interactions in space/time, primary role of woody component and agro-ecological adaptability. These categories were used as a basis for the land-use system categories in this annotated bibliography.

Kandyan Gardens of Sri Lanka

Authors:	Jacob, VJ; Alles, WS
Source:	Agroforestry Systems. 1987, 5:123-137.
Type of Article:	Primary
Geographic Region:	South Asia (Sri Lanka)
Survey Methods:	Field survey Interviews
Land-use System:	Homegardens

The Kandyan forest gardens and homegardens were studied through farm surveys and interviews. Methodology for site selection and surveys were not discussed. The thirty farm holdings studied ranged from 0.4 to 2.0 ha, each farmer maintaining an average of 1 ha. An average of 8 to 15 crops were grown on most of the farms. Important woody species included; *Areca catechu*, *Artocarpus heterophyllus* (jack fruit), and *Cocos nucifera* (coconut), bushes of plantain and coffee and vines of *Piper nigrum* (black pepper). Cacao was grown on approximately 25% of the farms as a minor export cash crop. Crop diversity was not found to be correlated with farm size, but planting density was higher on smaller holdings. Production was calculated by converting yields per unit area into monetary returns/values. A summary of 25 crops divided the yields into the percent consumed and the percent sold. A "Time Concentration Index" was used to calculate monthly income of individual farms in order to evaluate its yearly distribution.

Use of Multipurpose Trees in Hill Farming Systems in Western Nepal

Authors:	Fonzen, PF; Oberholzer, E
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 187-197. Dordrecht, Netherlands; Kluwer Academic Publishers. Also in Agroforestry Systems. 1984, 2:187-197.
Type of Article:	Primary
Geographic Region:	South Asia (Palpa district, Nepal)
Survey Methods:	Field survey Interviews
Land-use System:	Multipurpose trees on crop lands

Agroforestry practices on fields with 40-70% slope were studied in the hills of the Western Development region of Nepal. Two villages were chosen in the Palpa District, however, site selection and field survey methods were not described. Multipurpose trees, which were naturally generating and deliberately retained, were grown in contour strips along terraces. The ten most prominent species (of the 52 listed) constituted two-thirds of the tree species planted on most farms. These included; *Litsea polyantha*, *Garuga pinnata*, and *Musa spp.* Cultivated crops included; *Zea mays*, various pulses (*Phaseolus spp.*) and vegetables. The arrangement of the components differed between irrigated and non-irrigated lands.

Multipurpose Trees and Shrubs on Farmlands in Tamil Nadu State (India)

- Authors:** Jambulingam, R; Fernandes, ECM
- Source:** Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 121-137. Dordrecht, Netherlands; Kluwer Academic Publishers. Also in Agroforestry Systems. 1986, 4:17-23.
- Type of Article:** Review
- Geographic Region:** South Asia (Tamil Nadu State, India)
- Survey Method:** Literature review
- Land-use Systems:** Multipurpose trees on crop lands
Trees on rangeland or pasture

The authors discussed agroforestry systems commonly practiced in southern India, which include growing multipurpose trees intercropped with cereals or pulses and in pastures. Five trees that were grown on croplands and three trees grown on rangelands were described in detail, including; seed/stem source, germination, planting density, cultivation and uses. Other multipurpose trees and shrubs found on Tamil farmlands were listed. Conclusion discussed possible scientific interventions that may improve productivity such as the introduction of new tree species and improved germplasm materials.

Agroforestry Farming Systems in the Homesteads of Kerala, Southern India

Authors:	Nair, MA; Sreedharan, C.
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 139-164. Dordrecht, Netherlands; Kluwer Academic Publishers. Also in Agroforestry Systems. 1986, 4:339-363.
Type of Article:	Review
Geographic Region:	South Asia (southern India)
Survey Method:	Literature review
Land-use System:	Homegarden

The author described homegarden systems found throughout southern India based on a literature review. Major crop and tree species were listed along with their common name, scientific name, growth form, economic produce, growing season, average production per plant or unit area, and average market price per kg. Data showed an intensification of cultivation as individual holdings got smaller. Coconut was the most dominant tree species of the homegardens. Arecnut, black pepper, cacao and cashew were also prominent crops grown within these systems. Based on their literature search, the components of the system were analyzed in terms of species dominance (importance), dietary values and/or economic values. Based on the literature, an analysis of labor, capital, and input requirements along with marketing compared these high input systems to rice and coconut monocropping systems. The authors concluded that the advantages of the high input systems included the production of a variety of outputs such as food, fodder, fuelwood, and timber, as well as benefits such as soil conservation, soil fertility, and higher labor utilization in densely populated areas.

Intercropping Under Coconut in Sri Lanka

- Authors:** Liyanage, MDS; Tejwani, KG; NAIR, PKR
- Sources:** Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 165-179. Dordrecht, Netherlands; Kluwer Academic Publishers. Also in Agroforestry Systems. 1984, 2:215-228.
- Type of Article:** Review
- Geographic Region:** South Asia (Sri Lanka)
- Survey Methods:** Observations
Literature review
- Land-use System:** Plantation crop combinations

Intercropping under coconut, which dominated land-use systems in the southwest regions of Sri Lanka, was investigated. Common crops grown under coconut included tubers, cereals, legumes, fruit trees and spices. A schematic diagram illustrates black pepper, cacao and coffee grown as intercrops within a coconut plantation. Yields of coconut intercropped with various common crop species were presented. Resource input (water and labor), productivity, environmental benefits, and socioeconomic aspects of the system were discussed. Constraints, potentials and research needs of intercropping systems in Sri Lanka were presented.

Multistoreyed Agroforestry Garden System in West Sumatra, Indonesia

Authors:	Michon, G; Mary, F; Bompard, J
Source:	Agroforestry Systems In The Tropics. (PKR Nair, ed.). 1989, 243-268. Dordrecht, Netherlands; Kluwer Academic Publishers. Also in Agroforestry Systems. 1986, 4:315-338.
Type of Article:	Primary
Geographic Region:	Southeast Asia (Western Sumatra)
Survey Method:	Observations
Land-use System:	Homegardens

Agricultural systems were grouped as predominantly rice cultivation on irrigated fields, or mixed tree gardens for both subsistence and commercial purposes. Most families had at least one plot of each type of system. Factors that influenced each gardens composition and architecture included; the garden size in relation to the rice field managed by the family, cash and consumption needs of the family, and the location of the garden (i.e., altitude and position in the crater). Schematic diagrams illustrated two types of gardens dominated by *Durio* and *Pterospermum*. In one system, these species occupied the upper canopy at 40 meters and covered approximately 90% of the plot surface. A mid-story of *Toona* and *Alagium* grew above a lower tree layer of nutmeg, cinnamon, and various fruit trees. The total tree canopy coverage was approximately 200% of the plot surface. The second system illustrated the growth of coffee and under *Durio* and *Pterospermum*. The role of agroforestry gardens and rice fields in meeting the family needs in terms of food, fuelwood, timber and cash expenses was presented. Values were obtained for commercial products and were estimated for consumed products.

The Chagga Homegardens: A Multistoried Agroforestry Cropping System on Mt. Kilimanjaro (Northern Tanzania)

Authors: Fernandes, ECM; O'king'ati, A; Maghembe, J.

Source: Agroforestry Systems. 1984, 2:73-86.

Type of Article: Primary

Geographic Region: East and Central Africa (northern Tanzania)

Survey Method: Observations

Land-use Systems:
 Homegardens
 Multipurpose trees on crop lands
 Protein banks
 Fuelwood plantation/multipurpose tree woodlot

General observations of the Chagga homegarden on Mt. Kilimanjaro were presented. Predominant crops of these systems included, *Musa spp* (banana), *Phaseolus vulgaris* (beans), *Zea mays* (maize), and *Ipomoea batatas* (sweet potato). Bananas and coffee were main cash crops. Approximately thirty tree species were listed along with their uses and functions. In this system, these species occupied 30 to 50% of the plot surface, with 1500 bushes/ha of coffee grown underneath. This list included *Rauwolfia inebrians*, *Tectona grandis*, *Albizia schimperiana*, *Trema guineensis*, *Ficus spp.*, and *Olea welwitschii*. In a schematic presentation of the canopy structure, several zones were described. In the lowest zone, 0 - 1 m, food crops such as taro, beans herbs and fodder grasses were found. From 1 to 2.5 meters, the banana formed a canopy along with some fruit and fodder trees. Preferred fuel and fodder species were found from 15 to 30+ meters. Within the lower zones, there was continuous overlap of the canopies with the recruitment of young trees. Trees were grown to a size of 0.6 to 1 m³, allowing a rotation between 60 and 80 years. Run-off water from neighboring homegardens and from above slopes was directed through homegardens by a network of irrigation/drainage furrows.

Tropical Forest Architectural Analysis as Applied to Agroforests in the Humid Tropics: The Example of Traditional Village-Agroforests in West Java

Authors:	Michon, G; Bompard, J; Hecketsweiler P; Ducatillion, C
Source:	Agroforestry Systems. 1983, 1:117-129.
Type of Article:	Primary
Geographic Region:	Southeast Asia (West Java)
Survey Method:	Architectural analysis
Land-use System:	Homegardens

Authors used architectural analysis to describe the physical arrangement of traditional Javanese village-agroforests. Trees were classified according to their development stage, which included; potential future development, fully expanded trees (present), or decaying trees. In agricultural systems, these were also described as; plants with potential production, plants with actual production, and plants with decaying production. The arrangement of the producing species defined the architectural layout of the producing system, which was then analyzed for space use efficiency. Long term management was viewed by looking at total species composition. The paper also provided an example of a forest profile, which was drawn from a survey of a 40m x 20m plot. The vertical strata of the Javanese systems included spontaneous herbs and shrubs (*Acanthaceae spp.*, *Amaranthaceae spp.*, and *Melastomaceae spp.*) between 0 and 3 meters. *Myrtaceae spp.*, citrus, guava and cocoa were found between 3 and 12 meters. *Aglaia duku*, leguminous species and a few other semi-wild trees were found between 6 and 25 meters. Finally, trees such as *Durio zebethinus* dominated the canopy between 12 and 33 meters. Horizontal and temporal components of the system were also discussed.

Indigenous Agroforestry of Pohnpei 1. Plant Species and Cultivars

Authors:	Raynor, WC; Fownes, JH
Source:	Agroforestry Systems. 1991, 16:139-157.
Type of Article:	Primary
Geographic Region:	Pacific Islands (Pohnpei Island)
Survey Methods:	Field survey Interviews
Land-use System:	Multilayer tree gardens

The indigenous Pohnpeian agroforestry system is an extensive multilayer tree garden, extending beyond the immediate area of the home compound. Previous surveys estimated that agroforestry covered 33.4% of the land area. Fifty-four study sites were selected by randomly choosing points on a grid superimposed on a map of the island (probability proportional to size). Farms were systematically surveyed through plots laid out along a compass line passing through the center of each land holding. In each farm, ten 201 m² plots were inventoried for plant local name, cultivar name and plant height. Visual estimates of percent ground cover were made for herbaceous plants too numerous to count. Species were grouped into vertical strata of the canopy. Within the plots surveyed, 102 species of trees, shrubs and crops were identified and listed with scientific and local names, period of introduction, frequency, life history, products, vegetative type, density and additional remarks. In addition to species diversity, important crops such as yam, breadfruit, plantain and banana had many cultivars. The lack of consistent differences among farms suggested that farmers' preferences were more important than ecophysiological constraints in determining species composition.

Indigenous Agroforestry of Pohnpei 2. Spatial and Successional Vegetation Patterns

Authors:	Raynor, WC; Fownes, JH
Source:	Agroforestry Systems. 1991, 16:159-165.
Type of Article:	Primary
Geographic Region:	Pacific Islands (Pohnpei Island)
Survey Method:	Field survey
Land-use System:	Multilayer tree gardens

This paper focused on the spatial and temporal distribution of the plant species in the Pohnpeian agroforestry system (see annotation #25). Plots within land holdings were classified into four zones, depending on their distance from the home compound. This method of analysis reflected the fundamental importance of farm management on spatial distribution of plants as determined by factors such as labor requirement, sex roles, and crop security. Temporal patterns were based on farms' reported age, plant species composition and plant size. Farms were grouped into four successional stage classes, ranging from Stage 1 (farms initiated on new lands) to Stage 4 (fallow). The spatial distribution of crops interacted with successional stage, depending on the balance between labor availability versus regrowth of gap-colonizing plant species.

An Approach to Developing Methodologies for Evaluating Agroforestry Systems in India

Authors:	Nair, PKR; Dagar, JC
Source:	Agroforestry Systems. 1991, 16:55-81.
Type of Article:	Review
Geographic Region:	South Asia (India)
Survey Method:	Literature review
Land-use Systems:	Alley cropping Multipurpose trees on crop lands

Five agro-ecological zones were identified for India based on climate, geographical spread, soils and vegetation, main land-use system, ecological problems, and agroforestry practices. Major types of agroforestry systems and their benefits were tabulated for each region. A list of approximately 90 multipurpose trees along with their uses, was presented to show the many species that are understudied by scientists yet have a high potential for improving systems. The authors briefly discussed three sets of approaches to evaluating agroforestry systems. These approaches included study of (1) productivity, which can be evaluated by calculating economic yields, calculating the economic value of a product, or by using the land equivalent ratio, (2) sustainability, based on soil related (ecological) parameters such as the addition of organic matter, erosion control, improvement of physical properties, improved nutrient cycling, etc. and (3) adoptability, which pertains to future projects.

Experimental Agroforestry - Progress through Perception and Collaboration?

Author:	Huxley, PA
Source:	Agroforestry Systems. 1985, 3:129-138.
Type of Article:	Review
Geographic Region:	General
Survey Method:	Literature review
Land-use System:	Agroforestry

This paper discussed the need for compiling research methodologies to study multipurpose trees in order to evaluate multiple outputs and mixed cropping potentials. At the time of publication, the author had compiled 24 papers which represent guidelines for researchers. Papers were grouped into various categories. Specific research methodologies were not discussed, but this paper provides access to a body of literature focused on research methodologies.

Dynamics of Fallow Successions and Introduction of Robusta Coffee in Shifting Cultivation Areas in the Lowlands of Papua New Guinea

Author:	Allen, BJ
Sources:	Agroforestry Systems. 1985, 3:227-238.
Type of Article:	Primary
Geographic Region:	Southeast Asia (Papua New Guinea)
Survey Method:	Field survey
Land-use Systems:	Multilayer tree gardens Plantation crop combinations Improved fallow

In Papua New Guinea lowlands, two distinct and separate land-use systems were derived from a forest fallow system of shifting cultivation. After land clearing, one system involved mixed-crop food gardens for about 18 months followed by fallow, whereas the other involved the establishment of permanent robusta coffee plantations. Predominant trees in the multilayer tree gardens included *Artocarpus altilis* (breadfruit), *Pometia pinnata*, *Cocos nucifera* (coconut), and sago palms. Crops included *Dioscorea spp.* (yam), *Musa spp.* (banana), *Colocasia esculenta* (taro), *Saccharum officianale* (sugarcane), as well as more than 27 other species that were listed. The coffee-based system originated from a government program to introduce robusta coffee as a cash crop. Families were urged to plant 500 coffee bushes, and to plant leucaena as a shade tree. Methodology for the field surveys was not described. The sequence of garden site clearing, planting and harvesting followed by fallow was shown diagrammatically. The patterns of invading grass and tree species was plotted over time (35 year fallow) and schematic representation showed the cross-sectional transects through fallows at different stages (1, 5, 10, and 25 year old fallows). Finally, the author discussed the structure of farm management on a village level, noting land tenure, labor distribution between men and women, and areas where villagers collected fuelwood and building materials.

Women and Agroforestry: Four Myths and Three Case Studies

Authors:	Fortmann, L; Rocheleau, D
Source:	Agroforestry Systems. 1985, 2:253-272.
Type of Article:	Review
Geographic Region:	American Tropics, South Asia and East and Central Africa (Dominican Republic, India (Uttarakhand) and Kenya)
Survey Method:	Literature review
Land-use Systems:	Homegardens Agroforestry

Common assumptions made about women and their roles in agricultural production, environmental protection, and economic matters of the family were presented. An extensive literature review of agroforestry studies showed how these assumptions could lead to the neglect of very valuable information held by women concerning land-use systems. A description of three specific case studies revealed the consequences of neglecting to include women in decision making and planning of agroforestry systems. The first case study was based on the Plan Sierra Development Project in the Dominican Republic. In this study, it was shown that women were responsible for and depend on products on a subsistence level (fuel, water, fodder for large animals, small livestock, milk, vegetable gardens, dyes, basket weaving etc..) while men mostly concerned themselves with producing cash crops. The second case study was based on the Chipko movement in the Uttarakhand region of India. The active role of women in mobilizing forest protection and reforestation was illustrated. Women's involvement in tree planting and agroforestry workshops sponsored by the Kenya Energy Non-Government Organizations Association was highlighted in the third study. From these studies, it was shown that women and men often have different roles in society and require different resources from the same forested area. Therefore, the authors concluded that projects should include a way to determine what women use and what they need from a system, separate from that of men. This paper referred to many other case studies.

The Role of Agroforestry in the Farming Systems in Rwanda with Special Reference to the Bugesera-Gisaka-Migongo (BGM) Region

Authors:	Balasubramanian, V; Egli, A
Source:	Agroforestry Systems. 1986, 4:271-289.
Type of Article:	Primary
Geographic Region:	East and Central Africa (Rwanda)
Survey Methods:	Field survey Interviews
Land-use Systems:	Homegardens Multipurpose tree woodlot

Rapid population growth (3.6% yr⁻¹) and limited amounts of arable land in Rwanda have been decreasing the average size of farm holdings over the years. Thirty-six important tree species that were integrated onto farms were listed along with their family name, form, origin, propagation, and uses. Crops grown around the homestead included coffee, banana, beans, groundnut, maize and sorghum. Cassava, sweet potato, sorghum and fodder grass were grown in distant fields. Rainwater was conserved through the use of overlapping mounds that trap water and hold in moisture. The methodology for the study was not described. Eighty six percent of households in the area cultivated trees on their farms (i.e., *Ficus spp.*, *Sesbania spp.*, *Cedrela serrulata* and *Cassia spectabilis*). *Eucalyptus spp.* and *Grevillea robusta* were planted on relatively degraded, infertile lands. During the first two years of growth, these woodlots were intercropped with food crops such as beans, sorghum, and maize. Beer, cooking and dessert types of bananas were cultivated in mixed stands. Farmers cash income was based on banana beer and surplus crops that were sold at nearby markets. The authors found that soil degradation was leading to a decreasing trend in yields, and concluded that this system was not sustainable.

The Tree/Crop Interface - or Simplifying the Biological/Environmental Study of Mixed Cropping Agroforestry Systems

Author:	Huxley, PA
Source:	Agroforestry Systems. 1985, 3:251-266.
Type of Article:	Review
Geographic Region:	General
Survey Method:	Field survey
Land-use System:	Agroforestry

The author proposed studying tree/crop interfaces to investigate the influence of each species on surrounding components within a system. For this presentation, a simplified approach was taken, with the acknowledgment that more plant components, species, animals and/or intra-specific interactions need to be accounted for in order to get a more complete understanding of how the system is functioning. Tree/crop interactions that affect environmental resources such as radiation, water, nutrients and microclimate were illustrated in a schematic diagram. Successive steps were recommended by the author which break down the difficulties of analyzing the biological and environmental interactions. These steps included; (1) detailed descriptions of the agroforestry system through a detailed field survey, (2) in-situ analysis of field dynamics through biophysical and environmental measurements, (3) modifications, perturbations and re-analysis of (2), and (4) experimental layouts. The author then presented schematic diagrams of 3 experimental designs with hypothetical results.

Approaches to the Economic Evaluation of Agroforestry Farming Systems

Authors: Etherington, DM; Matthews, PJ
Source: Agroforestry Systems. 1983, 1:347-360.
Type of Article: Primary
Geographic Region: General
Survey Method: Economic analysis
Land-use System: Agroforestry

The authors described the computer program MULBUD for economic analysis of agroforestry systems. Specifications for a computer package to conduct economic analysis were grouped into two categories; (1) general program requirements such as language, size and data format and (2) analytical requirements. The latter category included constraints of land, labor, capital and seasonal variability, which were considered essential to valid economic analysis. The program includes labor requirements, cost assumptions, and seasonal distribution of inputs and outputs to integrate multiple crops at the farm level. A printout from an analysis of a 1 acre plot of a coconut-banana-cocoa system from Sri Lanka illustrated uses of the program. MULBUD has also been applied to smallholder agroforestry systems in other regions such as Tonga, Kenya, Papua New Guinea, Thailand and Western Samoa.

***Acacia albida* and Other Multipurpose Trees on the Fur Farmlands in the Jebel Marra Highlands, Western Darfur, Sudan**

Author:	Miehe, S
Source:	Agroforestry Systems. 1986, 4:89-119.
Type of Article:	Primary
Geographic Region:	East and Central Africa (Sudan)
Survey Method:	Field survey
Land-use System:	Multipurpose trees on crop lands

The Fur agroforestry system cultivates subsistence crops on terraces under stands of multipurpose trees such as *Acacia albida*, *Cordia abyssinica*, and *Ziziphus spina-christi*. The trees are used for food, wood, fodder, and fencing. A description of the agroforestry system developed by the Fur people was based on field visits to selected villages in 1982 and 1983. Methods for selecting farm sites and conducting surveys were not described. Seventeen tree species were listed along with their characteristics and uses. The arrangement and interactions between components was described in a schematic diagram based on an agricultural calendar and temporal interactions of the system. The authors also analyzed production and market prices during those years of the study.

An Evaluation of the *Acacia albida*-based Agroforestry Practices in the Hararghe Highlands of Eastern Ethiopia

Author:	Poschen, P
Source:	Agroforestry Systems. 1986, 4:129-143.
Type of Article:	Primary
Geographic Region:	East and Central Africa (eastern Ethiopia)
Survey Method:	Field survey
Land-use System:	Multipurpose trees on crop lands

An evaluation of agroforestry practices in eastern Ethiopia was made. A series of 27 sites were selected which represented a range of factors such as, the soil type, size, density and shape of trees. At each site, one plot located under the canopy of the trees was paired with another plot placed in the open field. Plot sizes varied between 30 and 80 m², and were considered "equal in all respects except for the presence of the tree". Sites were then grouped according to soil type and tree planting densities. Data presented included: (1) grain yield of maize and sorghum in plots, (2) comparison of maize and sorghum stalk and root weight, and (3) estimates of annual gross returns per ha of maize and sorghum crops with and without *Acacia albida*.

Characterization and Evaluation of Agroforestry Systems: The Case of Acosta-Puriscal, Costa Rica

Authors:	Lagemann, J; Heuvelop, J
Source:	Agroforestry Systems. 1983, 1:101-115.
Type of Article:	Primary
Geographic Region:	American Tropics (southwest Costa Rica)
Survey Methods:	Field survey Questionnaires
Land-use Systems:	Plantation crop combinations Trees on rangeland/pasture Multipurpose trees on crop lands

Prominent agroforestry systems in Acosta-Puriscal were analyzed by looking at the interactions between the components of each system and their productivity. Farmers with small land-holdings and low standards of living were chosen for this study. Sites were selected based on both topography and agro-climatic conditions. A description of the area included data such as rainfall, temperature, topography, socioeconomic conditions (i.e., market structure, farm resources and product sales), and land allocation. The area was stratified by topography and climate, as they both were felt to have a strong influence on the type of system employed. Randomly selected farms were then surveyed by questionnaire to determine land-use allocation and field sizes. Interactions between tree and crop components were studied using the complexity index formula by Holdridge. Assessments of performance and sustainability of the system were made through farm visits during the growing season.

Plant Species in the Kilimanjaro Agroforestry System

Authors:	O'king'ati, A; Maghembe, JA; Fernandes, ECM
Sources:	Agroforestry Systems. 1984, 2:177-186.
Type of Article:	Primary
Geographic Region:	East and Central Africa (Mt. Kilimanjaro, Tanzania)
Survey Methods:	Field survey Interviews
Land-use Systems:	Homegardens Multipurpose trees on crop lands Protein banks Fuelwood plantations/multipurpose tree woodlot

This study presented an inventory of plant species found within the Kilimanjaro agroforestry system. Thirty subjectively selected farms were chosen from 6 villages for the survey. Plant species and local names were identified with the help of the farmers. One hundred and eleven plant species were recorded, including 53 tree species, 29 food crop species, 21 economically useful non-woody species, and 8 weed species. These were listed along with comments on their growth forms.

Traditional Agroforestry, Parcel Management, and Social Forestry Development in a Pioneer Agricultural Community: The Case of Jala-Jala, Rizal, Philippines

Author:	Olofson, H
Source:	Agroforestry Systems. 1985, 3:317-337.
Type of Article:	Primary
Geographic Region:	Southeast Asia (Philippines)
Survey Method:	Interviews Questionnaires
Land-use System:	Multipurpose trees on crop lands Multipurpose tree woodlot

Land use by Filipino farmers migrating to the Rizal area was studied. Questionnaires were distributed to 39 farmers, selected based upon their availability. Information was gathered from 138 parcels. From this information, parcels were grouped into different types of land-use systems such as; (1) support trees planted on contours through a parcel or as field borders (fast growing legumes grown for fodder and charcoal and/or fruit trees), (2) multipurpose trees on crop lands (trees pruned to decrease shading effect, and the pruning was used for mulch), (3) multipurpose tree woodlot (some proportion of the field is used for wood production), and (4) incipient aquaculture (produce trees useful in catching shrimp). Seven case studies, based on interviews with the farmers, were presented.

Nutrient Cycling in Two Traditional Central American Agroforestry Systems

Authors:	Glover, N; Beer, J
Sources:	Agroforestry Systems. 1986, 4:77-87.
Type of Article:	Primary
Geographic Region:	American Tropics (Costa Rica)
Survey Method:	Field survey
Land-use System:	Plantation crop combinations

This study contrasted litterfall nutrients in coffee - Erythrina and coffee - Erythrina - *Cordia alliodora* plantations. Within each system, litterfall traps were placed at 0.5 m intervals from the base of three randomly selected *E. poeppigiana* trees. The litter was collected every two weeks and samples were analyzed for N, P, K, Ca and Mg. Soil samples around trees were analyzed for organic matter content, acidity, N, K, Ca and Mg. The analysis compared the magnitude of litterfall nutrient fluxes to the magnitude of low-input fertilizer use, but litterfall is a within-system cycle and should not be confused with an input into the ecosystem.

Comparative Analysis of the Village Ecosystem Function of Different Tribes Living in the Same area in Arunachal Pradesh in North-eastern India

Authors:	Maikhuri, RK; Ramakrishnan, PS
Sources:	Agricultural Systems. 1991, 35:377-399.
Type of Article:	Primary
Geographic Region:	South Asia (north-eastern India)
Survey Methods:	Field survey Interviews
Land-use System:	Improved fallow

This study looked at how traditional societies function within a village ecosystem. Economic activities, connections with the forest environment, and the coexistence of tribal communities were investigated. General observations were made over two years of 15 randomly selected families from each of four tribes. Fields were surveyed using twenty quadrats per plot for five frequencies of cultivation (60, 30, 20, 10 and 5 years). An importance value index was calculated for each species based on relative frequency, density and abundance. Tree species were not listed, but were shown to have a relatively high importance value. The efficiency of each system was calculated by using an input/output ratio based on energy flow in megajoules. Detailed energy flow charts were diagrammed for the Nishi, Kachari and animal husbandry systems.

Structure and Function of the Agroforestry System in the Pithoragarh District of central Himalaya: An Ecological Point of View

Authors:	Ralhan, PK; Negi, GCS; Sing, SP
Source:	Agriculture, Ecosystems and Environment. 1991, 35:283-296.
Type of Article:	Primary
Geographic Region:	South Asia (north-eastern district of central Himalaya)
Survey Method:	Field survey
Land-use System:	Multipurpose trees on crop lands

Three villages having contrasting irrigation techniques were chosen for this study. Cultivation systems of the Nanpapo were primarily rainfed, while those of the Majirkanda and Deot were irrigated 60% and 90% respectively. Complete inventories (published previously) were made for more than 60% of each village. Data from the inventories were presented and included; cropping patterns, allocation of crops under different irrigation, labor, fertilizer, seed and pesticide input, and yield of the system. Based on the information gathered, energy output/input flows were calculated and used to analyze the efficiency of the system, allowing a comparison between irrigation practices to be made.

Crop Diversity in Tropical Swidden Cultivation: Comparative Data from Colombia and Papua New Guinea

Author:	Eden, MJ
Source:	Agriculture, Ecosystems and Environment. 1988, 20:127-136.
Type of Article:	Primary
Geographic Region:	American Tropics and Southeast Asia (Colombia and Papua New Guinea)
Survey Method:	Field survey
Land-use System:	Shifting cultivation (swidden)

Eleven farms were surveyed in south-eastern Colombia (Araracuara), and seven farms from south-west Papua New Guinea. Data for the analysis was collected by the point-centered quarter method as described by Dix (1961) (see annotation #50). Methods of choosing sites or sampling were not described. The Simpson and Shannon diversity indices were used to analyze the species complexity of the systems. Results were then compared with data from other swidden communities found in the literature. Since each swidden was dominated by one crop species, low diversity was found for all the swidden plots. The author concluded that high plant diversity is not the main requirement for the sustainability of these swidden plots. Rather, the adaptation of individual crop species and the relation of cultivation to fallow conditions may be equally important as plant diversity to the performance and sustainability of swidden systems.

Household Food Security, Nutrition, and Crop Diversification Among Smallholder Farmers in the Highlands of Guatemala

Authors:	Immink, MDC; Alarcon, JA
Source:	Ecology of Food and Nutrition. 1991, 25:287-305.
Type of Article:	Primary
Geographic Region:	American Tropics (Guatemala)
Survey Method:	Interviews
Land-use System:	General agriculture

Although trees were not included in this system, this article presented a study which compared cash versus subsistence cropping. Economic status, food security, and nutrition balance were evaluated for smallholder households managing different cropping patterns. Data of farm production, household expenditure, and food requirements were gathered through a large survey of randomly selected farms.

Ecological Aspects of Swidden Cultivation Among the Andoke and Witoto Indians of the Colombian Amazon

Authors: Eden, MJ; Andrade, A

Source: Human Ecology. 1989, 15:339-359.

Type of Article: Primary

Geographic Region: American Tropics (Colombia)

Survey Method: Field survey

Land-use System: Shifting cultivation (swidden)

Agricultural practices developed by the Andoke and Witoto tribes were studied to gain detailed information of the swidden crop conditions and soil-plant relations. Eleven swidden plots were surveyed by the point-centered quarter method (see annotation #50). Plot selection was not described. Thirty eight cultivated plants were listed along with their uses and location (i.e., in swidden or yard garden). A comparison of soil conditions under swidden agriculture and natural forest growth was also made. Three pairs of topsoil samples were collected within 20-30 m of field/forest boundaries. Soil profiles were analyzed for chemical composition, (i.e., bulk density, clay %, moisture, organic carbon, pH and exchangeable cations). Based on the survey, the authors concluded that these swidden systems do not simulate the mature forest, but is better thought of as being equivalent to the phase of gap formation and early stages of forest succession.

Swidden-fallow Agroforestry in the Peruvian Amazon

Authors:	Denevan, WM; Padoch, C
Source:	Advances In Economic Botany. Volume 5. New York Botanical Garden. Bronx, New York. Jan. 1988.
Type of Article:	Book
Geographic Region:	American Tropics (Peruvian Amazon)
Survey Methods:	Field survey Interviews Architectural Analysis Economic Analysis
Land-use Systems:	Shifting cultivation (swidden) Improved fallow

This book includes eight papers which discuss the Bora agroforestry system in the Peruvian Amazon. The second study examined the vegetation structure of six different aged fallows (3-19 years old). Each site was described in terms of size and vegetation. A line intercept method was used to determine the vertical strata within each field. Fallows were mapped, and data was combined with information obtained from farmers through interviews. In the fourth paper, fallows between 10 and 35 years were studied. Plant distribution by diameter class was determined for each fallow. Architectural analysis and trends in height/diameter relationships were made. Inventories of the fallows were made in the fifth paper. Plant components were identified and their relative abundance was determined by sampling randomly placed quadrats within the sites. The species were recorded along with their uses and relative abundance. An economic evaluation along with marketing analysis was made in the 6th paper. Interviews were made in 5-10 households within 13 villages to collect information which was used in combination with data from other literature. Household income derived from forest products and crop cultivation along with trade patterns and markets were discussed.

Data Collection In Developing Countries, 2nd ed.

Authors:	Casley, DJ; Lury, DA
Source:	Oxford University Press. Oxford, England. 1987.
Type of Article:	Book
Geographic Region:	General
Survey Methods:	Field survey Questionnaire Census
Land-use System:	General Agriculture

This book covered aspects of data collection through various methods of surveys, questionnaires, and censuses. Topics such as data prioritization, collection, analysis, interpretation and presentation were discussed. The authors attempted to point out problems of different techniques along with useful tools to collect sufficient data which adequately represent the population being studied. The authors mainly concentrated on data collection rather than statistical methods. However, the authors briefly discussed how to interpret estimates and their errors to determine when a sample size could be extrapolated to the whole population or just a general region. Examples of how to tabulate data were also given.

Agroforestry in Sub-Saharan Africa

Authors:	Cook, CC; Grut, M
Source:	World Bank Technical Paper Number 112. The World Bank. Washington, D.C. 1990.
Type of Article:	Book
Geographic Region:	West Africa (sub-Saharan)
Survey Methods:	Field survey Interviews Observations Literature Review Economic Analysis

Land-use Systems:	Multipurpose trees in crop lands Improved fallow Homegardens Fuelwood plantation/multipurpose tree woodlot Alley cropping
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This book studied farmers' motivation to invest land, labor and capital in agroforestry systems. The study included both a literature review of agroforestry practices in Africa and seven case studies of field surveys. The papers from the literature search were reviewed by a panel as a basis for the subsequent field studies. Field visits were made to five sites identified from the review, plus two additional sites. Interviews and field surveys were conducted, but methods were not described. Data from the seven case studies were analyzed to identify common technical, economic, social and institutional issues. The technical considerations revealed that improving the use of indigenous species was more advantageous than introducing exotic species, that multipurpose fast growing trees were preferred by the farmers and that low-labor farming systems were favored in low population density areas. The common economic issue was the amount of time required for any return on agroforestry investments. On the social level, it was found that agroforestry adaptations vary based on gender, age and socioeconomic levels. Recommendations were made for the future design of agroforestry research projects.

Ecological Succession in New and Old Swiddens of Montane Papua New Guinea

Author:	Manner, HI
Source:	Human Ecology. 1981, 9:359-377.
Type of Article:	Primary
Geographic Region:	Southeast Asia (Papua New Guinea)
Survey Method:	Field survey
Land-use System:	Shifting cultivation (swidden)

The Kauwaty practice subsistence farming through shifting cultivation on the steep forested slopes of the Bismark Mountains of Papua New Guinea. The structural and functional changes of new and old swiddens were analyzed through field surveys. Through sampling 25 m² quadrats, the author quantified the species composition, biomass and net productivity changes that occur over time within these "gardens". Methods for selecting the 5 gardens in various stages of production were not described. Four 25 m² quadrats were randomly located in gardens aged 3 months, 1 year and 3 years after initial planting. Due to site restrictions, only 1 and 2 quadrats of the same size were placed in gardens aged 9 months and 3 years, respectively. Species composition was determined by counting all cultivars and their varieties within the quadrats. Biomass was estimated in the 3 month old plot by comparisons with sample plants of the same cultivars. In the older gardens, plants were harvested and weighed. The biomass of bananas was estimated by allometric regression described elsewhere. Biomass data were on a dry weight basis. Net primary productivity (NPP) was determined by the sum of biomass change and the plant losses by death and shedding estimated during the period 1972-1973. A rapid increase in crop biomass during the first year was followed by a rapid decrease in both biomass and productivity in subsequent years.

Nature-intensive Agriculture: The Food Production System of Yap Islands

- Author:** Falanruw, MC
- Source:** Traditional Ecological Knowledge: A Collection Of Essays. RE Johannes (ed.). IUCN, Gland, Switzerland and Cambridge, UK. 1989. pp. 35-40.
- Type of Article:** Primary
- Geographic Region:** Pacific Islands (Yap Islands)
- Survey Method:** Observations
- Land-use System:** Shifting cultivation (swidden)

People of Yap have developed farming systems that protect the soil from severe erosion and nutrient losses. The Yapese agricultural system was described through observations made by the author who had lived on the island for 17 years. Taro patches, tree gardens and intermittent gardens comprised the food production system. Tree gardens included coconut, breadfruit, betel nut, *Citrus* spp. and four cultivars of bananas planted around homes and in drained areas. Yams, which are valued as a food crop and are also prized on traditional occasions, were cultivated in intermittent gardens. These gardens are developed in areas of secondary growth after the canopy has been opened up to permit sunlight to enter.

An Application of the Point-centered Quarter Method to the Sampling of Grassland Vegetation

Author:	Dix, RL
Source:	Journal of Range Management. 1961, 14:63-69.
Type of Article:	Primary
Geographic Region:	General
Survey Method:	Field survey
Land-use System:	General Agriculture

The point-centered quarter method of conducting field surveys yields data for both species composition and species density. This system is based on the premise that the measurements of the distance between the plants is more efficient in the field than measuring total plants per unit area. Within the area of interest, a pin is placed vertically into the soil. The surrounding area is then divided into quarters by two lines drawn through the pin; one being parallel with the line of traverse, and the second being perpendicular to the first. Within each quarter, the plant (or shoot) closest to the pin is identified and its distance from the pin is measured. The positions of the pin within the field are determined objectively along a compass line. Absolute density, relative density, and relative frequency may all be determined from the data. An importance value may also be calculated based on the sum of the two relative values. In this study, this method was tested on three grasslands in western North Dakota. Although agroforestry was not discussed, this paper has been frequently cited.

Financial and Economic Analyses of Agroforestry Systems

Authors:	Sullivan, GM; Huke, SM; Fox, JM (eds.)
Source:	Proceedings of a Workshop Held in Honolulu, Hawaii, USA, July 1991. Paia, HI: Nitrogen Fixing Tree Association. 1992.
Type of Article:	Book
Geographic Region:	General
Survey Methods:	Field survey Questionnaire Interview Observation Literature review Mathematical programming Economic analysis
Land-use System:	Agroforestry

The theory and methods for economic analysis of existing and potential agroforestry systems were presented. Five central themes of discussion included: what should be analyzed and why; criteria and methods for data collection; applicability of experiment station and on-farm trials for economic analysis; the need for agroforestry market analysis; and methods and models for economic analysis. Thirteen contributed papers presented case studies of economic analysis of indigenous, introduced, and experimental agroforestry systems.

Seasonality and Yield of Breadfruit Cultivars in the Indigenous Agroforestry System of Pohnpei, Federated States of Micronesia

Authors:	Raynor, WC; Fownes, JH
Source:	Tropical Agriculture. 1993, 70:103-109.
Type of Article:	Primary
Geographic Region:	Pacific Islands (Pohnpei Island)
Survey Method:	Field survey
Land-use System:	Multilayer tree garden

This study combined relatively intensive on-farm monitoring of individual breadfruit trees with an extensive survey of agroforest vegetation. In the intensive component, number of flowers, fruits set, and fruits ripening were monitored at two week intervals on 87 trees of five major cultivars. Cultivars differed in seasonality, with some fruits ripening for most of the year, which implies that quantitative yield surveys cannot be performed on a short-term basis. Statistical analysis using tree canopy volume as a covariate showed significant effects of cultivar, site elevation, and soil pH. Summary allometric equations of yield versus trunk diameter at breast height were developed for the five cultivars and for the combined data from all trees. Farms for the extensive survey were selected randomly (probability proportional to size) and transects of circular plots laid out across farms (see papers 25 and 26). From the vegetation survey data and the summary allometric equations, annual breadfruit yield of the agroforest landscape, with confidence intervals, was calculated.

Land Use System by Geographic Region

Land Use System	Pacific Islands	Southeast Asia	South Asia	East and Central Africa	West Africa	American Tropics	General
Shifting Cultivation (Swidden)	49	42,48				7,42,44,45	
Improved Fallow		29	40		47	45	
Multilayer Tree Garden	25,26,52	29					
Homegardens		22,24	2,17,20,30	12,23,30,31,37	3,37,47	8,30	9
Alley Cropping			27	4	13,47		
Protein Banks				23,37			
Multipurpose trees on crop land			1,6,18,19,27,41	4,23,31,34,35,36,37	47	5,36	
Plantation crop combinations		29	21			36,39	
Trees on rangeland /pasture			19			36	
Fuelwood Plantations /multipurpose tree woodlot				23,31,37,47	47		
Agroforestry		38	30	30		30	10,11,14,15 16,28,32,33 51
General Agriculture						43	46,50

Geographic Region by Survey Method

Survey Method	Pacific Islands	Southeast Asia	South Asia	East and Central Africa	West Africa	American Tropics	General
Field Survey	25,26,52	29,42,48	1,17,18,40,41	12,31,34,35,37	13,47	5,7,36,39,42,44,45	14,15,32,46,50,51
Interviews	25	38	1,2,6,17,18,40	4,12,31,37	13,47	8,43,45	14,51
Observations	49	22	21	23	3,47	8	51
Questionnaire		38		4		36	15,46,51
Literature Review			19,20,21,27,30	30	47	30	9,14,16,28,51
Mathematical Programming							10,11,51
Architectural Analysis		24		23		45	
Economic Analysis					47	45	33,51
Census							46

Land Use System by Survey Method

Land Use System	Field Survey	Interviews	Observations	Questionnaire	Literature Review	Mathematical Programming	Architectural Analysis	Economic Analysis	Census
Shifting Cultivation (Swidden)	7,42,44,45,48	45	47, 49				45	45	
Improved Fallow	29,40,45,47	40,45,47	47		47		45	45,47	
Multilayer Tree Garden	25,26,27,29,52	25							
Homegardens	12,17,31,37,47	2,8,12,17,31, 37,47	3,8,22,23, 47		9,20,30,47		24	47	
Alley Cropping	13,47	4,13,47	47	4	27,47			47	
Protein Banks	37	37	23						
Multipurpose trees on crop land	1,5,18,31,34, 35,36,37,41, 47	1,4,6,18,31, 37,38,47	23,47	4,36,38	19,27,47			47	
Plantation crop combinations	29,36,39		21	36	21				
Trees on rangeland /pasture	36			36	19				
Fuelwood Plantations /multipurpose tree woodlot	31,36,37,47	31,36,37,38,47	23,27	38	47			47	
Agroforestry	14,15,32,51	14,51	51	15,51	14,16,28,30,51	10,11,51		33,53,51	
General Agriculture	46,50	43		46					46