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PLANNING NATIONAL AGROFORESTRY RESEARCH
Guidelines for Land Use System Description

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1. INTRODUCTION

In 1986, the International Council for Research in Agroforestry (ICRAF) began large-scale collaborative agroforestry research activities with national institutions in Africa. This Agroforestry Research Network for Africa (AFRENA) initiated programs in four major ecological zones: the upland plateau of southern Africa, the humid lowlands of west Africa, the humid and sub-humid highlands of East Africa, and the semi-arid region of the Sahel.

The ecozone approach was developed to help resolve some of the special problems of agroforestry research in Africa. The variety of farming systems and production constraints found in Africa demands development of a rather large number of different agroforestry technologies. Yet the institutional and material resources available to individual countries for the needed multi-disciplinary research are insufficient to cope with this task. The ecozone focus was proposed as a way to expand institutional complementarity beyond national boundaries, and provide a practical basis for networking among agroforestry researchers from different countries (Torres 1985, Torres 1986, Torres and Raintree 1985, SACCAR/ICRAF 1986).

Each of the AFRENA ecozonal programs is composed of country- specific projects (targeted to farming systems and/or technologies of high national priority, and managed by national researchers), as well as zonal projects considered to be of interest throughout the ecozone (managed by ICRAF researchers).

The responsibility for decision-making on the research agenda for AFRENA lies firmly with national policy-makers. A National Agroforestry Committee (NAC) composed of high-level representatives of national ministries and research organizations, is set up where one does not already exist. Decisions regarding zonal research are made at zonal planning workshops, by country participants.

The NAC in each country appoints a multi-institutional multi-disciplinary technical Agroforestry Task Force to work with ICRAF on setting up the research program. One of the principal responsibilities of the Task Force in the research planning phase is description of land use systems in the target ecological zone of the country, to identify priority systems, problems, and producers for subsequent research.

This paper summarizes the objectives and methodology for carrying out this research planning process, and presents detailed guidelines for carrying out the land use system description stage. Future ICRAF papers will discuss subsequent stages of research planning. While developed for use in the AFRENA context, it will hopefully also be of use to researchers outside the AFRENA network in setting up agroforestry research programs.

Section 2 discusses AFRENA objectives and approaches to agroforestry research planning, and provides an overview of the AFRENA research planning process. Section 3 explains the conceptual basis of land use system evaluation for agroforestry purposes, and the process of "matching" systems with agroforestry technologies. Section 4 provides guidelines for land use system description, using the AFRENA Worksheets for Land Use System Description which may be found in Appendix A. Appendix B provides sample sketches used for completing the worksheets. Appendix C provides a brief note on use of the worksheets for agroforestry development (rather than research) activities. Appendix D provides a glossary of technical terms used in the worksheet.

2. AFRENA OBJECTIVES AND APPROACHES IN RESEARCH PLANNING

Agroforestry can be defined as the intentional growing of multipurpose trees in combination with crops, animals, or other land uses. Despite their historical importance in farming systems throughout the world, agroforestry practices have only recently become the object of formal scientific research. The sheer number of potential agroforestry components, lay-out, spacing, and management options has made it very difficult to carry out research planning in a systematic fashion. One of the early concerns of ICRAF was to find a methodology for identifying the most promising and highest priority agroforestry research lines within this wide range of possibilities.

The outcome of this work was ICRAF's "Diagnosis and Design" (D&D) methodology, which is now in wide use. The diagnostic methodology, and its application at different levels of analysis (farm, community, watershed) is described in ICRAF (1983), Raintree (1984), Rocheleau (1984), Hoekstra (1985), and Raintree (in press). The design methodology is elaborated in Huxley and Wood (1984). The D&D approach bases research decisions on the "user perspective". It assumes that the choice and design of agroforestry interventions must respond directly to the particular needs and constraints facing farmers and other land users in a particular environment.

The approach is based on "farming systems research" (Shaner et al 1982), which is farmer-oriented, systems-oriented, focused on problem- solving, interdisciplinary, complementary to

disciplinary agricultural research, focused on-farm research, and a channel for feedback from farmers to station-based scientists (Merrill Sands 1986, p.10). The traditional definition of farming systems is expanded to include other forms of land management, including forestry and rangeland. This more broadly defined system is referred to at ICRAF as a "land use system." A given physical region may have several land use systems (for example, commercial plantations plus smallholder subsistence farms).

A particular "land use system" represents a "research domain" from an agroforestry perspective. Evaluation of a land use system is expected to provide detailed specifications for technologies to be generated through research, in terms of desired objectives, required characteristics of multipurpose trees, and required management characteristics of the technology. These specifications are then translated into a detailed research program. Subsequent re-diagnosis and re-design during the research process continues through interaction between researchers and the target farmer population.

For the AFRENA research planning process, which attempts to evaluate all major land use systems in the target ecological zone, the "D&D" process had necessarily to be modified. Whereas standard "D&D" applied to a single land use system depends heavily on detailed visual interpretation of the landscape and direct farmer and community interviews, the "macro D&D" process used in AFRENA has to depend heavily on "windshield surveys", secondary data, and key informant interviews. Because this process is less detailed, the conclusions taken from it regarding agroforestry potentials must be viewed as hypotheses. These hypotheses are presented in a document prepared jointly by the Task Forces and ICRAF, as a "blueprint for agroforestry research" in each country and in the eco-zone. Priority systems for immediate research are subsequently analyzed in a more detailed manner (through a "micro D&D"), both to verify "macro D&D" analyses, and to collect detailed information required for subsequent research design.

Table 1 presents the basic steps of the AFRENA research planning exercise, for a given ecological zone (e.g., unimodal upland plateau or the humid lowlands). This list has been modified from that originally developed by F. Torres (see SACCAR/ICRAF 1986), with considerable input from D. Hoekstra and J. Raintree. There are six major stages: institutional arrangements, zonal description, land use system description, evaluation of agroforestry potentials, research prioritization, and research design.

Institutional Arrangements for Research Planning

1) Set up a multi-institutional National Agroforestry Committee. The requirements of multi-disciplinarity and multi-institutional input required for effective agroforestry research are met in AFRENA through the setting up of the NAC's, which then appoint

TABLE 1. STAGES OF THE AFRENA RESEARCH PLANNING PROCESS

INSTITUTIONAL ARRANGEMENTS FOR RESEARCH PLANNING

1. Set up a multi-institutional National Agroforestry Committee which appoints a National Agroforestry Task Force to carry out planning activities.

ZONAL DESCRIPTION

2. Delineate land area within target ecological zone

3. Describe general biophysical and socioeconomic characteristics of target ecological zone

4. Review policy factors affecting agroforestry priorities and programs in the target zone

5. Identify and evaluate research institutions which could participate in agroforestry resarch, and development institutions which could collaborate in on-farm research

LAND USE SYSTEM DESCRIPTION

6. Identify major land use systems within the target zone

7. Characterize land use systems and identify key system constraints (complete "Worksheets for Land Use System Evaluation" and prepare "Land Use System Summaries")

EVALUATION OF AGROFORESTRY POTENTIALS

8. Identify candidate agroforestry technologies for each system, by "matching" technologies with system characteristics described in Worksheets)

9. Carry out "Macro D&D" mission with experienced ICRAF agroforesters to propose specific technologies and research approaches (completes "Blueprint for Agroforestry Research")

PRIORITIZATION OF SYSTEMS AND TECHNOLOGIES FOR RESEARCH

10. Identify priority land use systems and priority agroforestry interventions for national agroforestry research (responsibility of National Agroforestry Committee)

11. Organize zonal planning workshop to identify priority land
use systems and agroforestry interventions for zonal research, and possible research complementarity (for zonal programs)

(Table 1, continued)

DESIGN OF RESEARCH PROGRAMS

12. Prepare for "micro D&D" mission: choose research sites, collect background data for the sites, and identify missing information needed for research design.

13. Carry out "micro D&D" mission to representative sites of priority system, to verify "macro D&D," and finalize specifications for proposed interventions (complete "Micro D&D Report")

14. Organize research design workshop to develop research guide-lines, experimental sequence, tentative research designs, and division of labour among research institutions (complete "Proposal for Agroforestry Research")

15. Complete detailed research planning of research designs, assessments, administrative planning, selection of MPT's (complete "Agroforestry Research Protocols")

the multi-institutional, multi-disciplinary National Agroforestry Task Force to carry out planning activities in each country.

Zonal Description

2) Delineate land area. The target ecological zone is delineated rather broadly, because it is expected that a division of labour between participating countries will make it possible to address the problems of several sub-zones and systems. Also, one of the objectives of AFRENA is to help set up a broad "blueprint" for agroforestry research, so that as more resources become available for agroforestry research, a set of priorities will already be available. For national research programs working outside such a network, it might be preferable to carry out a complete inventory of land use system in nationally-targeted ecozones--and carry out the rest of the prioritization procedure discussed below on that basis.

Delineation of the target zone is done on the basis of mapping key biophysical characteristics, such as altitude, rainfall, potential growing period days, evapo-transpiration, etc. Two or more major sub-zones may be identified, e.g. the "dry" and "wet" zones of the unimodal upland plateau or the "mid- altitude" and "high-altitude" zones of the sub-humid east African highlands.

3) Describe general biophysical and socioeconomic characteristics. Once the zone is delineated, a summary description is made of the major characteristics of the zone, based on secondary data sources. Socioeconomic characteristics should include all major factors which are common across land use systems, for example agricultural credit availability, land tenure patterns, availability of fertilizers, and agricultural marketing infrastructure.

4) Review policy factors. Research planning also requires a review of national and regional policy variables which affect agroforestry priorities and programs in the target zone. This step encourages the interaction of technical research planners and development planners, and hopefully a greater congruence between research and development programs. Scherr (1987) discusses the major policy issues for agroforestry research and development: agroforestry's role in development policy, institutional arrangements for agroforestry activities, provision of agroforestry inputs, land use and tenure rules affecting agroforestry, and pricing and marketing policies for agroforestry products.

At this early stage of research planning, emphasis is on evaluation of national land use problems and development policies, to help choose agroforestry research priorities. This involves review of basic policy documents (Development Plans, land resource inventories, special studies of land use problems) and interviews with key policymakers in different development and academic institutions. Past, current, and proposed agroforestry policies and programs in the country and ecozone should also be summarized.

Basic information on local development priorities, institutions doing agroforestry, availability of agroforestry inputs, tenure rules, and marketing of agroforestry products, is later collected for each land use system through the Land Use System Worksheets. Particular policy issues thought to have major impact on agroforestry research and development, may be selected for subsequent in-depth study within the AFRENA research programme.

5) Identify and evaluate research institutions. The last step of the zonal description is identification and evaluation of institutions which could participate in agroforestry research. These include existing research stations, facilities, and programs in the target regions for core research; specialized research resources (such as fruit tree research units, medicinal plant research units or on-going University case studies of farming systems in the target regions); and existing development institutions which could collaborate for on-farm research. The latter may include government extension services, commodity cooperatives, integrated rural development projects, or long-term extension/development projects run by non-governmental organizations.

Land Use System Description

6) Identify major land use systems. The description stage begins with a preliminary identification of all broad land use systems within the zone, according to criteria significant for agroforestry research. This is done jointly by ICRAF and Task Force scientists, based principally on secondary data and the personal knowledge of task force members. The methodology for carrying out land use system identification is described in Section 3.

7) Characterize land use systems. Following the land use system identification, the Agroforestry Task Force, accompanied by an ICRAF scientist to assist with the methodology, visit and characterize all major land use systems, using the "Worksheets for Land Use System Evaluation," found in Appendix A. The methodology for land use system description is described in Section 4.

Evaluation of Agroforestry Potentials

8) Identify candidate agroforestry technologies for each system The next step in the AFRENA process is for a multi-disciplinary group of agroforestry experts at ICRAF to identify agroforestry potentials in the land use systems. Using the land use system worksheets, they evaluate the organization, problems and constraints of each system. They then develop hypotheses regarding the probable future evoution of the system, a set of strategies for intensification of the system, and specific agroforestry technologies/interventions which seem appropriate to each system. This process of "matching" technologies with systems is explained further in Section 3.

Table 2 presents a summary of this analytical approach for the smallholder maize/livestock system of the unimodal plateau of Zambia. This was one of seven broad land use systems which had been identified in the ecozone, of which five were considered of interest for research planning. Within the broad land use system, there were three major sub-systems--farmers with specific tenure rights, farmers operating under communal tenure rights in zones of land scarcity (and pressure on fallow length), and farmers operating under communal tenure rights in zones of abundant land (where longer fallows were sustainable). While the basic strategy for development is the same for all the sub-systems, the specific agroforestry technologies proposed for development of integrated crop/livestock management systems differ.

After completing this preliminary matching exercise, the team then identifies any information missing from the worksheets which would be needed in order to confidently propose specific technologies.

9) Carry out macro D&D mission. A joint ICRAF/national task force reconnaissance ("Macro D&D") mission is then sent to briefly visit the target land use systems, and collect or verify needed information. The team goes to all the major systems (although this may be modified in the case of particular countries), spending two or three days in each system. The field activities involve visual evaluation of the landscape, interviews with key regional officials (provincial and district agricultural officers and development planning officers), and visits to a small number of farms to elicit farmer comments and interpretations.

The outcome of this mission is a provisional "Blueprint for Agroforestry Research," This document summarizes the results of zonal and land use system description and evaluation, tentatively describes the specifications for proposed technologies, and suggests specific lines of agroforestry research.

Prioritization of Systems and Technologies for Research

10) Identify priority land use systems. After reviewing the "blueprint" document, the National Agroforestry Committee in each country decides which land use systems and which specific agroforestry technologies should be given priority in national research efforts.

11) Organize zonal planning workshop. The NAC members for each country bring their list of tentative priorities to a zonal planning workshop. This workshop offers an opportunity to identify land use systems, agroforestry technologies, and or specific MPT needs which are important at a zonal level. Potential complementarity between the research needs of different countries are evaluated. The workshop should come to

TABLE 2: AGROFORESTRY PLANNING FOR THE SMALLHOLDER MAIZE-CATTLE LAND USE SYSTEM OF THE UPLAND PLATEAU OF ZAMBIA *

LAND USE CHARACTERISTICS	LAND USE PROBLEMS	DEVELOPMENT STRATEGY	PROPOSED AGROFORESTRY TECHNOLOGIES
Growing period: 120-180 days Soils: Moderately leached acidic sands in uplands; sandy loams and clays in dambos Pop'n. density: 30/km 2 Pop'n pressure: Below carrying capacity Locations: Parts of Southern, Central, Eastern, Lusaka Provinces Average farm size: 2-20 hectares Subsistence products: Maize, sorghum, millet, cassava, beans Cash products: Livestock, maize sunflower, groundnut tobacco, cotton Input use: Ox-plough, some fertilizer and manure	Declining and uncertain crop yields Fodder shortage Erodable soils Declining wood supply Dambo degradation	INTEGRATE CROP AND CATTLE ENTERPRISES IN UPLANDS: - Through regulated leys for farmers with specific tenure rights - Through hedgerow intercropping for farmers with communal tenure practicing continuous cultivation - Through enriched fallows for farmers with communal tenure practicing short fallow rotations INCREASE DRY SEASON FODDER SUPPLY (for all farmers) INTENSIFY AND STABILIZE CROP PRODUCTION ON DAMBOS	Shrub legume-grass leys with living fences Hedgerow intercropping with MPT's for soil fertility fodder, fuel Enriched fallows of MPT's for soil fertility, fodder, fuel Fodder trees on pastures around corrals with living fences Strips of fodder trees and other MPT's on perimeters of dambos

* Zambian Agroforestry Task Force and ICRAF, 'A blueprint for agroforestry research in the unimodal upland plateau of Zambia', ICRAF, Nairobi, Kenya, August 1986 (Draft).

tentative conclusions about zonal, country, and institutional responsibility for generation of specific technologies for specific systems.

Design of Research Projects

12) Prepare for micro-D&D mission. The next step of the research planing process is the "micro D&D," carried out jointly by the ICRAF and national task forces in representative sites of the target land use system or systems for which research is being planned. In the "micro D&D", the hypotheses from the "D&D" need to be tested on the ground with farmers, to verify and quantify the analysis at the community and farm levels, to find out farmer reaction to the proposals, to identify divergences between farmer and policy priorities, to modify initial technology designs, and to collect detailed information required for research design.

Because so much prior information on the system has been collected, it is not necessary to carry out a classical "D&D" exercise such as that described in Raintree (1984) and ICRAF (1983). Rather, the field exercise should focus on what is not already well understood about the system. A list of specific questions which need to be answered should be developed for use in farmer and key informant interviews.

Special attention should be paid to choosing two or three communities (or sub-districts) for study, which are representative of important identified variations in the system. Basic background information on these should be collected before the mission, including production, land distribution and tenure, population, key markets, etc. The necessary official contacts should be made before the mission begins, emphasizing the importance of visiting different "types" of farm households (e.g., poor, modestly well off, and "model" farmers; female-headed as well as male-headed households; households with and without cattle, households with and without off-farm income).

13) Carry out micro D&D mission. The field mission should be carried out in two or at most three sub-districts or communities, rather than in many different different ones, so that important community-level interactions and problems can be identified. The emphasis will be on direct interviews with farmers. Care must be taken to interview both men and women in the households. If information is required on a specific topic, key informants will also be interviewed for their knowledge about specific aspects of the land use system.

By the end of the mission, it should be possible to confirm, reject, or modify the hypotheses made earlier about the system, and to develop a list of technology specifications based on D&D findings. These would include:

- functions (what problems/potential should be addressed by the technology, with priorities)

- outputs (specific technical outputs needed to achieve objectives);

- locations (for which landscape niche technology is intended, and biophysical site characteristics)

- multipurpose tree/shrub specifications (for climatic and edaphic suitability, desired outputs, desired growth/phenology, and response to plant management);

- spatial arrangements (which plants in association, in what geometry, with what spacing)

- technology management (establishment, training and pruning, harvest, removal, associated management of non-woody components)

Spatial arrangements are not listed here, but would include any specifications indicated by the D&D for hedgerow orientation, density, number of rows in hedge, or in-row and between-row spacing. Table 3 presents an example of such a list for hedgerow intercropping in the humid lowlands of Cameroun. A tentative list of MPT's which might meet the specifications should also be developed.

14) Organize research design workshop. The Micro D&D mission is followed by a Research Design Workshop. The objective of this Workshop is to finalize the above lists of specifications, and to establish the research sequence and component experiments required to develop the technology according to these specifications. Tentative experimental designs and assessment methodologies may be proposed.

Table 4 outlines the basic experimental research steps for development of agroforestry technologies, although a particular research plan will usually involve only selected steps, modified to meet particular research objectives. Each step may, of course, consist of several experimental trials, because the objective of the AFRENA programs is rapid development of technologies for on-farm use, "basic" research studies are usually undertaken only to support that technology development.

The Workshop should also be used to propose a more detailed "division of labour" between different research groups and institutions. For example, the Forestry Research Department may be put in charge of MPT germplasm collection and elimination trials, the Agronomy Department in charge of tree/crop interface studies, and the Farming Systems Research Department in charge of on-farm management trials. Alternatively, scientists in

TABLE 3.

SPECIFICATIONS FOR HEDGEROW INTERCROPPING TECHNOLOGY
FOR SOUTHERN CAMEROUN PLATEAU

FUNCTIONS	OUTPUTS	TARGET LOCATIONS	MPTS	MANAGEMENT
Increase soil fertility Reduce fallow period with sustainable yields Increase production of major crops: groundnut,cassava plantain,bananas, cocoyam,yams,maize, Reduce labour required for weeding Reduce labour required for clearing/land preparation preparation	Double yields/units land/unit time of groundnuts,cassava, plantain (other crops also, if possible Build up soil organic matter Buffer soil acidity	Crop plots with mixed intercropping of groundnuts, cassava, plantain bananas,cocoyams, yams, maize - ½ hectare average size Avg.altitude-600-900 masl Rainfall-bimodal, Avg.1500-2000 mm/year Isolation- 1841 hours (Yaounde) Avg.temperature 25° Mean annual variation 2°4 Avg. humidity 70+ Soils-well drained, orthic ferralsols, pH 4.0-5.0 Nutrient status varying with length of fallow and cropping history; principal target is soil subject to fallow of only 1-3 yrs Undulating terrain, crop plots on slope or tops of hills,average slope percent percent	Acid-tolerant Leaves slow-decomposing (or mixture) Faster-growing than Eupatorium High production of leafy biomass Long-lasting Deep-rooting habit Doesn't harbour pests or diseases Thorn-less Fire-resistant No negative impact on crops Coppicing	Limit shading of groundnuts Zero tillage where possible Ease of MPTS establishment Minimum labour requirements for hedge management Managed as improved fallow and/or semi-continuous alley-cropping Time and frequency of cutting of hedge dependent on crop components, sequence (especially groundnut) Hedge establishment possibly after first groundnut crop Biomass to be cut and burned(controlled burn) when managed as fallow Incorporation of mulch limited by labour constraints

TABLE 4. EXPERIMENTAL RESEARCH STEPS FOR DEVELOPMENT OF AGROFORESTRY TECHNOLOGIES *

Preliminary

- MPT Germplasm identification
  (literature review, ethnobotanical surveys)
- MPT Germplasm acquisition
  (local collection, international seed supplies)
- MPT Nursery propagation
  (selection of germplasm, germination trials, pre-treatment trials, seedling propagation, establishment of arboretum)

MPT screening

- MPT Elimination trials
  (screening of larger numbers of MPT's in small plots for survival in target environment)
- MPT Vigour/phenology trials
  (for selected accessions, to study MPT behavior and basic management potentials)
- MPT Performance/management trials
  (for selected accessions, to study MPT response to management under conditions of proposed prototype technology)

Prototype development

- Tree/crop interface trials
  (for most promising accessions, to study interactions of trees with crops)
- Survey of selected farmer practices/conditions
  (study of farmer practices which would affect management of proposed agroforestry technologies)
- Technology (trees + crops) management trials
  (for most promising accessions, to identify best management practices for the design of prototype agroforestry technologies; on-station and on-farm trials)
- Prototype technology design
  (design prototype technology, using best MPT's and best management techniques)

Dissemination

- Prototype technology trials
  (researcher and farmer evaluation of prototype technology performance and management characteristics; on-station and on-farm trials)
- Extension research
  (evaluation of constraints to adoption of technology, e.g., nursery infrastructure, access to MPT germplasm, farmer training requirements, land tenure/land use policies)

different research stations or departments may prefer to carry out all the necessary research for one particular technology. In the case of zonal research, the responsibilities of specific country institutions in zonal research should be specified.

The outcome of this meeting and its immediate follow-up will be preparation of a "Proposal for Agroforestry Research," presenting the basic set of experiments, their objectives, experimental factors, research methods (including treatments, possible experimental designs, and assessments to be taken), timing, and notes explaining the experimental sequence in terms of technology specifications based on the land use system evaluations.

15) Complete detailed research planning. Following the Research Design Workshop, national scientists with principal responsibility for carrying out the research, with the assistance of ICRAF scientists, will develop a more detailed set of research protocols, including experimental designs, survey questionnaires, and a detailed research plan identifying needed labour and material resources and a time schedule for taking assessments. The final selection of MPT's for initial research will be made, and germplasm acquisition begun. Arrangements for land preparation for experimentation and purchase of needed supplies will be made. Research implementation then begins. It is expected that the process of re-diagnosis and design will be refined throughout the research process, through continuous interaction between researchers and the target farmer population.

3. EVALUATING LAND USE SYSTEMS FROM AN AGROFORESTRY PERSPECTIVE

This paper is intended principally to provide guidelines for the Land Use System Description stage discussed above. However, in order to understand why certain descriptive information is collected at this stage, it is important to understand how it will be used in agroforestry research planning.

The process of differentiating land use is rather complicated for agroforestry, because of the need for more information about the system as a whole than is usually required for single-commodity investigation. It is important to recognize that what differentiates one system from another for purposes of nother type of research may not be relevant for agroforestry research. Even where very good farming systems research-based typologies are available, they may need to be re-evaluated for use in agroforestry planning. Except in rare circumstances, they usually neglect to evaluate the existing or potential role of trees in the system (with the exception of traditional commercial tree crops). Many are far too disaggregated for research planning purposes, or are based on theoretical, rather than actual, land use practices.

In order to decide the criteria for differentiating systems for purposes of agroforestry research, one must begin by evaluating research goals. AFRENA programs anticipate four broad types of research:

- multipurpose tree germplasm screening and selection;
- analysis of soil/tree/crop interactions;
- design of spatial layouts and management systems for prototype agroforestry technologies; and
- extension research, including adaptive technical research and evaluation of infrastructural and other factors affecting adoption of agroforestry technologies.

In deciding whether or not to differentiate two land use systems in the planning stage, the operative question is: would you have to design different agroforestry-technologies with substantially different components, interactions, landscape niches arrangements and designs, for these two systems? Because it is difficult to answer this question with authority before actually evaluating the system, the process of land use system identification must be an iterative one. One must hypothesize a set of systems, evaluate them in terms of constraints, probable future evolution, and agroforestry potentials, and then revise the hypothesis as necessary.

ICRAF is currently in the process of reviewing known prototype agroforestry technologies, and identifying the environmental and socioeconomic circumstances under which they would appropriately be proposed for intervention in a particular land use system (Scherr, forthcoming). Researchers have identified five major factors which significantly affect the choice and design of agroforestry technologies for particular systems: biophysical conditions, the organization of the production system (resource use and intensity, components, and management practices), landscape organization, specific system constraints, and the socioeconomic environment.

ICRAF hopes eventually to develop quantifiable criteria for each of these factors, but currently the process of evaluation is still an "art" as much as a "science." Table 5, prepared by John Raintree of ICRAF, illustrates the appropriate conditions for specific technologies for selected variables by landscape niche, land use intensity, and base production systems.

TABLE 5

MATCHING AGROFORESTRY TECHNOLOGIES TO LAND USE SYSTEMS *

LANDSCAPE NICHE	BASIC PRACTICE	SPECIFIC INTERVENTION	LAND USE[a/] INTENSITY I	II	III	IV	V	COMMENTS & EXAMPLES	RE NO
					FORESTRY				
FOREST	FOREST ENRICHMENT	w/MPTs	•	•				To diversify production	1
		w/herb.crops	•	•				Food vs. high value cash crops	2
		w/livestock	•	•				Cattle,sheep,pigs	3
	TAUNGYA	"Departmental"	•	•				Advantage for forest dept.	4
		"Integral"	o	•				Thai Forest Villages	5
					SHIFTING CULTIVATION				
FALLOWED CROPLAND	FALLOW ENRICHMENT	Economic enrichment	•	•	•			Cash crops(trees,rattans,etc)	6
		Biological enrichment		•	•			Fast growing nitrogen-fixing trees for accelerated or more complete fertility. restoration	7
	TRANSITION TO PERMANENT INTERCROPPING	To mixed intercropping			•	•		Dispersed trees as intercrop for production and/or service roles	8
		To hedgerow intercropping		•	•	•	•	Coppicing fallow trees in hedgerows; gradual intensification/transition from conventional 'bush'fallow	9
				*				to alley cropping w/partial fallow	10
					*			to permanent alley/cropping(#18)	
						*		to dense,multistorey intercropping	
		To multistorey intercropping					*	(see also #·20-24,41)	
	PLANTED ROTATIONS	Agrosilvicultural		•	•			Cropping under compatible forest trees	11
		Silvopastoral		•	•			Fodder trees and shrubs browsed in fallow vegetation	12
		Agrosilvicultural		•	•			Fruit trees, root crops,planted in fallow for food and pig feed	13
	TRANSITION TO TREE CROP SYSTEMS	Commercial trees	•	•	•			High value,labour-saving, marketable tree crops (established by taungya method)	14
		Subsistence food trees		•	•			Yield/nutritive value greater than field crops (taungya,field crops to tree crops)	15
					PERMANENT FIELD AGRICULTURE				
PERMANENT ARABLE FIELDS	MPTs HERBACEOUS CROPS	Mixed intercropping							
		- dispersed trees			•			Shade for crops,economic trees	16
		- dense mixtures			•	•		Multistorey intercropping	17
		Line/strip planting							
		-contour lines				•	•	Hedgerow intercropping	18
		-on terraces & bunds				•	•	(alley cropping)	19
		-dense,complex multistorey					•	May begin to resemble intensity of homegarden system	20

* Prepared by John B. Raintree in April, 1986 for computerized data base "Land use systems and matching agroforestr practices." ICRAF. Nairobi.

TREE CROP PLANTATIONS ON FARMS

			I	II	III	IV	V		
BLOCKS OF LANDS	HORTICULTURAL TREE CROPS	Multipurpose plantations			•	•	•	Multipurpose. groves,orchards etc.(econ.value greater than arable crops)	
								- horticultural	21
								- agrihorticultural	22
								- hortipastoral	23
								- agrihortipastoral	24
	"	Specialized commercial plantations w/ local processing				•	•	Multiplier effects of value added processing for absorption of 'excess'rural labour	25
WOODLOTS	ENRICHMENT OF EXISTING WOODLOTS	w/MPTs				•	•	Increased productivity, stability & diversity	26
"		w/herb.crops				•	•		27
		w/fodder/animals				•	•		28
"	PLANTED WOODLOTS	w/MPTs				•	•	Multipurpose	29
PASTORAL SYSTEMS									
RANGE LAND	EXTENSIVE SILVOPASTORAL SYSTEMS	MPT'S on rangeland (shade,windbreaks, fodder,other products)	•					Rehabilitation of existing trees	30
			•	•				Animal dispersed trees	31
				•				Planted trees (zonal,mixed)	32
PASTURE	INTENSIVE SILVOPASTORAL SYSTEMS	Productive MPT's natural or improved pastures			•	•		Dispersed trees on pasture	33
					•	•		Linear plantings	
								- Live fencing	34
								- Windbreaks	35
								- Other hedgerows	36
					•	•		Block plantings (fodder banks,etc.)	37
"	SPECIAL PURPOSE	Apiculture	•	•	•	•	•	Selected trees	38
		Sericulture				•	•	Mulberry	39
SPECIAL LOCATIONS IN THE LANDSCAPE									
HOME COMPOUNDS	HOMEGARDENS	Low-intensity	•	•	•			Incipient	40
		High -intensity				•	•	Complex, multistorey	41
		"					•	Specialized commercial	42
BOUNDARIES	BOUNDARY PLANTINGS	MPTs on boundaries, field borders,etc			•	•	•	Living fences	43
					•	•	•	Windbreaks	44
					•	•	•	Other hedgerows(multipurpose)	45
PUBLIC OR SHARED SPACES	COMMUNITY AGROFORESTRY	Community woodlots			•	•		(see # 29)	46
		Roadside plantings		•	•	•	•	(see # 43-45)	47
		Amenity plantings	•	•	•	•	•	Shelter & Esthetics	48
"	EROSION CONTROL FOR PUBLICOR SHARED SPACES	Gully plugging		•	•	•	•	Trees & grasses	49
		Gully banks		•	•	•	•	Trees & grasses	50
		Upper watersheds		•	•	•	•	Improved infiltration	51
		Shelterbelts		•	•	•	•	Site-specific designs	52
SPECIAL ENVIRONMENTS									
COASTAL AQUAFORESTRY OR RIVERINE ENVIRONMENTS		Salt water	Mangrove						53
		Fresh water	Fish feed						54
		Riverbanks	Bank stabilization & flood control						55
DESERT ENVIRONMENTS		Dune fixation							56
		Oases							57

a/ NOTE ON 'LAND USE INTENSITY' INDEX

Where possible, provisional indications are given of the overall land use intensity at which the different practices are most likely to be applicable. (This is Based on the occurance of appropriate landscape niches, compatibility with existing land use traditions vis-a-vis labour intensity, and other factors associated with the "adoptability" of the agroforestry intervention. The average intensity index of a given area may be the product of a mosaic of different land use or field types of different intensities.)

Stage I: Lowest intensity, associated with extensive "forestry", "forest fallow" shifting cultivation, or extensive pastoral systems

Stage II: Typically associated with more intensive "forestry", "bush fallow" systems, or more intensive pastoral systems

Stage III: Typically associated with "short fallow" or "ley" systems

Stage IV Typically associated with permanent "annual cropping" systems

Stage V Highest intensity,associated with "multiple cropping" systems & very high rural population densities

1) Biophysical conditions (Worksheets Part 1, II-III). Biophysical conditions affect both the choice of MPT species for use in agroforestry interventions, and their expected performance in terms of biomass production, tree/soil interactions, etc. The most essential variables are climate and soils, then land forms and differential land use along soil/landform catenas. Supplementary information is needed on hydrology, vegetation, geology and fauna/diseases.

2) Organization of the production system (Worksheets Part 1 and 3, II-IV) . Characteristics of the production system (for crops, livestock and trees) determine the choice and design of agroforestry prototype technologies. Important aspects are the land use intensity of the system, specific components in the system, and specific management practices.

Land use intensity. Identical environmental conditions often call for quite different agroforestry interventions under different conditions of land use intensity. It is, for example, usually inappropriate to propose high-input continuous cropping agroforestry systems in land-extensive forest or bush fallow systems. Farmers operating under these conditions can intensify production by alternative methods, and most wood products are still cheap and easily available. Where purchased input use is high, farmers may have promising alternatives to agroforestry approaches through, e.g., purchased fertilizers. In highly labour-intensive systems, labour required for agroforestry production may reduce labour available for other key activities, and this must be minimized by technology design.

When developing strategies for land use intensification through agroforestry, it is useful to identify the most likely pathways for intensification of the system. The three general approaches to intensification are through expansion of the area under cultivation (e.g., through new establishment of permanent tree crop plantations in what is currently forest land), reduction in fallow periods (through, e.g., biologically enriched fallows), or increasing yields per unit area (through, e.g., intercropping with soil-improving trees) (Raintree and Warner 1986). It is possible that different sub-systems may intensify in different ways, for example, with livestock production continuing to expand extensively through incorporation of new grazing lands, while cropping on limited fertile soils intensifies through increasing yields under continuous cultivation.

System components. The actual components of the farming system may affect the choice of agroforestry technologies. While alley-cropping can be utilised with most grains, rotation fallows may be preferred for tobacco or cotton, to help break the nematode cycle. Mixed farming systems can use hedgerow intercropping designed to include fodder MPT's, while pastoral systems in which livestock are maintained away from crops may require alternatives such as feed banks or fodder trees planted on grazing lands).

Management practices. The nature of current farmer management practices may offer the opportunity for introduction of certain agroforestry technologies, while precluding others. Of special importance are existing agroforestry practices, land preparation, rotation sequence, use of fallows, techniques for fertility improvement, techniques for soil erosion control, and feeding and penning of animals.

3) Landscape organization (Worksheets Part 3 Section I-II,V). The choice and design of agroforestry prototype technologies is strongly influenced by where in the system trees can be established, whether due to the local geography of production, or land tenure rules. Farmers often manage fields in different locations at different levels of intensity. Intensive alley-cropping may be feasible in one system only in near fields (because those are the only ones cultivated intensively), but in another system only in far fields (because near fields already receive intensive fertility management through manuring or fertilizer application). Farming systems with homesteads located on farmland have different agroforestry potentials than those where homesteads are concentrated in villages or along roads.

Tenure rules may limit rights to plant, protect, or harvest trees. It may be difficult to introduce tree-planting in crop fields where community tenure rules allow communal grazing of crop residues in private fields after harvest. Boundary plantings of multipurpose trees may be welcomed in areas where land adjudication is complete, but completely rejected in areas where farmers are still debating farm boundaries.

4) Specific system constraints (Worksheets Part 4). Table 6 shows how different constraints call for the planting of different types of trees (for fuel, soil fertility, building poles, food, etc). Choice of MPT components for use in agroforestry technologies demands a quite specific diagnosis of such constraints. For example, the MPT species (and varieties) to be included in a fodder bank would probably be different if the objective were year-round fodder production for dairy cows, rather than supplemental nutrition for oxen at ploughing time.

5) The socioeconomic environment (Worksheets Part 3, Section VIII, Sections III- VI marketing questions). To assess the potential and constraints of a particular agroforestry technology in a particular region, it is important to understand the socioeconomic environment within which producers operate. The key variables are availability of labour, land, capital, markets, and infrastructure.

For example, it is probably inappropriate to propose highly labour-demanding alley-cropping systems in zones of chronic agricultural labour shortage. The strategy for improving cash income through sale of MPT products will be markedly different for systems operating outside the capital city, than for frontier zones. The level of management complexity for a proposed agroforestry system should bear some relation to the existing infrastructure for extension and farmer education.

TABLE 6. POTENTIAL LAND USE SYSTEM CONSTRAINTS AND AGROFORESTRY SOLUTIONS

Land Use System Constraints	Possible Agroforestry Solutions
PRODUCTS NEEDED	
Cash	Sale of tree products
Savings/investment	High-value trees for harvest when income is needed
Food (calories)	Trees producing high-carbohydrate fruits or nuts when food is short
Food (protein, oils, vitamins)	Trees producing fruits or nuts high in protein, oil, or vitamins
Food (for processing)	Trees with products which can be processed for storage or sale
Sawnwood	Trees for sawnwood
Polewood	Manage trees for polewood
Fiber for building or crafts	Trees or palms high in fiber
Wood for tools/woodcrafts	Trees with good wood for tools/crafts
Livestock feed (calories)	Fodder trees which produce feed in periods of shortage
Livestock feed (protein)	"Protein banks"
Fuel for households with land	Trees producing high-quality fuelwood
Fuel for landless households	"Improve" communal woodlands with fast-growing fuelwood species
Fuel for urban households or rural processing	Woodlots or other on-farm trees for sale by rural producers
Medicines, preparations	Trees with medicinal products
Chemicals, industrial oils, resins	Trees with chemical products
LAND SERVICES NEEDED	
Soil fertility	Intercropping with trees, mulching
Soil erosion	Trees on terraces and bunds, intercrop trees with crops on slopes
Weed control	Trees to provide shade or mulch at appropriate times
Pest control	Trees (or tree products) with insecticidal properties
Water absorption/retention	Trees planted during fallow to improve compacted soils
On-farm drainage	Trees with high moisture-holding capacity and deep root structure
Watershed/floodplain mgmt.	Trees along waterways; on barren lands; on slopes
Fencing	Living fences or fenceposts
Boundaries	Productive hedges
Wind shelter	Shelterbelts of productive trees
Shade/shelter	Shade trees where livestock herded, at waterholes; home compounds
Staking for climbing plants	Trees managed as live stakes

Nonetheless, because of the fairly long time horizon required for agroforestry research, it is necessary to evaluate conditions affecting agroforestry design and components in terms of probable constraints and evolution of the system at some period in the future. As a rule of thumb in the AFRENA exercises, we try to consider a period 15-20 years in the future. If there are no cattle in the system now, is it likely there will be in 20 years? If there is insufficient land use intensity to justify alley-cropping now, will this persist in the coming decades? If market opportunities are poor now, are development programs underway which will improve them over the next two decades? This may involve making some heroic assumptions--which should be made explicit--but is more realistic than simply assuming that the current situation is permanent.

Note on variations in the system (Worksheets Part 3, Section VII). It may not always be possible to identify discrete, homogenous land use systems which differ sharply from one another. In some cases, for one or more of the above variables, differences between producers in different areas reflect a continuum. It may be more convenient to consider them as a single system, but to clearly identify patterns of variation.

In the humid lowlands of Cameroun, for example, we initially identified three systems on the southern Cameroun plateau, based on major differences in land use intensity (long-fallow shifting cultivation to semi-continuous cropping). But since the system was essentially the same--fallow-based food crops production plus permanent cocoa plantations--and since even farmers in the long- fallow systems had some plots which were managed very intensively, we chose to consider them as a single system. The variations in the system were reflected in choice of sites for on-farm testing of specific technological approaches, and in research on management of agroforestry interventions to improve soil fertility as both fallows and semi-continuous cropping systems.

4. COMPLETING THE WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION

The Land Use system Description stage should enable researchers and policy-makers to identify high priority systems and problems on which to focus limited agroforestry research/development resources, through:

a) describing the socioeconomic, environmental, and institutional context within which systems operate;
b) descibing system characteristics which affect the choice of agroforestry components, management, and spatial arrangements;
c) indicating relevant variation in the system, in order to choose "micro D&D" and research sites which will reflect

problems and potentials throughout a given land use system; and d) identifying on-going research and institutional resources which could be used in agroforestry research and development, in order to plan research programs effectively.

The "AFRENA Worksheets for Land Use System Description" found in Appendix A, were designed to meet these objectives. At first glance, the worksheets may appear to be rather complicated. We believe, however, that they are not more complicated than they need to be. ICRAF scientists attempted to devise a shorter, simpler set of worksheets (ICRAF 1985), but these simply did not provide enough information to confidently recommend agroforestry interventions. Hopefully, continued experience with the worksheets will suggest ways in which to shorten or simplify it. But, as explained above, realistic matching of systems to agroforestry technologies requires accurate understanding of the basic system.

When filled out with informants who have long experience working in the system, particularly those with a farming systems background, the process of completing the worksheets is in fact fairly rapid (less than a day per system). The following procedure is recommended for use of the Worksheets as a "rapid appraisal" tool within the AFRENA context, which requires simultaneous evaluation of several land use systems. Other users, who have already identified target land use systems for agroforestry research, may want to complete the worksheets in a more leisurely, comprehensive fashion. Indeed, once the target system is chosen for AFRENA activities, the worksheets should be reviewed carefully, and any remaining gaps, questions, and uncertainties answered by the resident research team. For suggestions on use of the worksheets in agroforestry development projects, see Appendix C.

a) Preliminary identification of land use systems in the target ecological zone. The basis for identifying land use systems was discussed in the previous section. It is best to keep the systems broadly defined. Ultimately the number of land use systems defined in the Unimodal Upland Plateau and Humid Sub-Humid Highlands, e.g. ranged from 3 to 7 per country. It makes sense to go through an initial exercise of differentiating systems liberally, based on differences in the variables discussed in section 3, and then recombine for purposes of research planning those systems whose agroforestry potentials seem to be similar. The art in this exercise is that of identifying differences which result in fundamentally different agroforestry options, from those which only require different approaches at the adaptive research stage.

b) Identification of priority systems for land use evaluation. From the initial list of systems, cross off those which are insignificant in terms of the total production or population; those which are so inaccessible that efficient research will be impossible; and those which are clearly not policy priorities

(for example, large commercial estates are often given lower priority in AFRENA activities).

The NAC should help to rank the remaining systems by:

- percent of the rural population estimated to be in the system;
- the seriousness of known environmental and land use problems which might be addressed by agroforestry; and
- political priorities, or importance (current or future) in the national economy.

Researchers may consider dropping from the list for field visits any systems which appear at the bottom of all three lists. For purposes of the zonal evaluation, however, all major systems should be included. Put any land use systems which show up near the top of all three lists at the beginning of your field activities. Adjust the order of field visits for ease of logistical access to different regions.

c) Preliminary filling in of worksheets. Before beginning the field exercise, review the worksheets, and tailor the questions to your zone. You may want to add or delete questions, or modify the terminology. See how much of the worksheets informed members of the task force can fill out themselves or through available secondary data. Flag those items in Part 3 for which little or no information is available, as top priority for attention in the field. Also flag items about which there is uncertainty, for cross-checking in the field.

Table 7 suggests key secondary sources and key informants. Time in the field is expensive; it should be reserved for answering questions which cannot be answered in any other way. The emphasis is on visual observation, clarification and interpretation of confusing secondary data, consultation with knowledgeable experts, and collection of key secondary documentation not centrally available.

d) Efficient use of field time Make a detailed map of proposed stops in each hypothesized land use system. Particularly try to visit areas that none of the task force is familiar with, and those for which there is obvious confusion regarding its relation with one or another systems.

Try to spend at least three days in each land use system: one day for interviewing key informants as a group, one day for splitting the task force to interview farmers and specially-identified key informants, and one day for reviewing the worksheets and resolving key contraditions or gaps in information. Visit several locations within the land use system for a "windshield survey", at least.

Meet initially with one or more individuals who should be knowledgeable about the region. The key informants are likely to be public officials, such as long-term Provincial or District Agricultural Officers. At least three farms should be visited to get farmer opinions, although without any pretense that their views are necessarily representative. The purpose is more to explore non-official points of view.

TABLE 7
SOURCES OF INFORMATION FOR COMPLETING THE WORKSHEETS

Topics	Secondary Data Sources	Informants	Other
I.ENVIRONMENTAL PROFILE	Climatic information Regional soil maps Atlases	Verify with DAO's and PAO's *	Visual survey of soil catenas
II. LAND USE PRACTICES	Ag'l Census data for province/district Prov/district ag'l statistics office Prov/district coops Nat'l agricultural boards/studies Farming system studies	DAO's,PAO's Leaders of farmer organiz.	Visual survey of: practices agroforestry erosion trees
III.TENURE AND LAND USE INTENSIFICATION	District-level pop'n data, rural/urban Provincial records (if easily available)	DAO's,PAO's Provincial planning officers **	
IV. LANDSCAPE ORGANIZATION	Regional geographies	DAO's,PAO's Land use planners	Visual survey Aerial photos
V. LABOUR RESOURCES AND EMPLOYMENT	Pop'n Census labour data for province/district Prov/district ag'l statistics office	DAO's,PAO's Provincial planning officers	
VI. MARKETING OF PRODUCTS	District/Provincial trade/production statistics	DAO's,PAO's Provincial economics officers Reg'l market cooperatives Wholesalers	
VII.CONSTRAINTS TO INTENSIFICATION		DAO's,PAO's Farmer representatives	
VIII. VARIATIONS IN THE SYSTEM		DAO's,PAO's Farmer representatives	
IX. DEVELOPMENT ACTIVITIES AND INFRASTRUCTURE	Research station documents	Prov.planning officers Major tree-planting projects of extension Directors of extension research station's	

NOTES FOR TABLE 7:

* ('PAO') and ('DAO') refer, respectively to the Provincial Agricultural Officer and District Agricultural Officer, usually representing the Ministry of Agriculture. Where forestry and animal husbandry activities are not included within the Ministry of Agriculture, one should also visit the Provincial and/or District Officers for these ministries.

** Provincial planning officers may be associated with either the national Ministry of Planning, or with the Provincial Government.

Efficient collection of the worksheet material in a short field period requires good organization and efficiency. Each member of the team should take responsibility for seeing that certain pieces of information are collected, although others will also be asking those questions to informants. The worksheets are not intended to be used as questionnaires. You will probably wish to prepare checklists of key information needed for use in interviewing different types of informants. Each evening, review the worksheets and see what information is missing; make plans to complete those sections the next day.

Do not be concerned if you cannot answer all the questions in the worksheets satisfactorily. Do identify remaining questions and contradictions, so that they can be investigated during the Macro D&D reconnaissance mission and subsequent research phases.

One of the logistical problems with this process is that you will sometimes be interviewing and surveying in different parts of a single system, or using a single informant to obtain information on more than one system. It makes sense to use more than one set of worksheets while working, and before moving on to the next system--or after returning home--to prepare a master set, including landscape sketches (see Appendix B) and/or photographs. The master set would be based on your final hypotheses defining the different land use systems.

Don't be hesistant at any stage to re-define a land use system while or after you are in the field. The subsequent "macro D&D" mission may re-group them once again. The important thing is to collect the relevant information in a systematic way.

e) Presenting your report. In earlier AFRENA exercises, the Task Force was requested to prepare a land use system evaluation report. If the worksheets have been properly and legibly filled in, this time-consuming phase of report-writing is probably not necessary. However, it would be very helpful to prepare a simple chart (not so simple to prepare!) which clearly identifies major characteristics of the land use systems; and another which clearly summarizes your judgement on major land use problems and constraints to intensification of each system. It would also be helpful to prepare a tentative ranking of systems in terms of their importance, or their interest for agroforestry research, and to explain the basis for this ranking. These charts will form the basis of an oral presentation to ICRAF staff and Task Forces from other countries in the zonal project, and for subsequent land use system analysis and selection of priority agroforestry technologies for research. Table 8 presents two examples of summary descriptive charts, which were prepared for systems in Cameroun and Malawi. The summary charts on principal system constraints may be drawn directly from Part 4 of the Worksheets.

Table 8. Land Use System Description Summaries

a) Smallholder land use systems in the forest zone of Cameroun

Characteristics	Coffee/Food/Crop/Cocoa System	Plantation Workers System	Cocoa/Food Crop System
Principal	Lowlands of Southwest Province and Moungo Dept. (Littoral Province)	Near Douala, Buea, Moungo	Southern Cameroun Plateau
Rainfall (mm)	Over 3000	Over 3000	1500-2000 (+transitional zone 2000-3000)
Altitude (masl)	0-200	0-90	200-850
Principal Soils Orders	Nitosols	Xanthic Ferralsols/ Orthic Ferralsols/ Andosols/Nitosols	Orthic Ferralsols
Principal Food Crops	Cocoyam Plantain, Cassava	Cassava	Cocoyam, Plantain Cassava, groundnut
Principal Source of Cash	Coffee(+food crops, pineapple, oil palm, cocoa)	Plantation employment	Cocoa (+food crops, oil palm, coffee)
Market Integration of Farm Households	Moderate to High	High	Low to High
Use of Inorganic Fertilizer	Common on coffee, pineapple, some food crops	Minimal	Minimal
Population Density (/Km²)	25-50 (50% of area) 12-25 (25% of area) 3-12 (25% of area)	6-25 (but high land pressure due to plantations)	25-100 Near Yaounde 6-12 Bush fallow 3-6 Forest fallow
Approximate Number of Farm Household (1984)	75,000	50,000	300,000
Ethnic Influences on Agriculture	Anglophone, Strong influence from West Pronvince and Nigeria, Principal ethnic groups-Ejagham, Bakossi, Issanguele	Mixed immigration especially from West and Southwest Provences	Francophone Principle ethnic groups-Bassa, Ewondo

Table 8. b) Smallholder Land Use Systems in Malawi, unimodal plateau

	KASUNGU PLAIN	LILONG	MAYANI	CHILADZULU	BARAKA-MWAKSABO	CHILUMGU
Natural Region	KASUNGU PLAIN	LILONGWE PLAIN	DOWA/DEDZA & NTCHEU	SHIRE HIGHLANDS	BALAKAS REGION/SALIMA LAKE SHARE PLAIN	RUKURU VALLEY & MZIMBA
Silv.cultural zone	D	D	G (Plus EXM)	C (Plus M)	C	D & Bb
Growing Period (Days)	<180 (150-180)	>180 (180-210)	>180 (210-270)	>180 (210-270)	<180? (150-210)	180 (150-180)
RAINFALL	800-1000mm ?	800-1200	800-1200mm	800-1200mm	800-1200m ??	800-1500mm
Soil Type/Texture	Ferralitic-Sandy	Ferrugnous-Loamy	Ferruginous/Lithosol Loamy sandy	Ferruginous -Loamy	Alluvial/Lithosols Loamy/sandy	Ferrallitic/Sandy
Altitude/Slope	1000-1400m/Flat	1000-1200 m /flat	1200-1600 m / steep	800-1500 medium	600-1000 m Gentle	1100-1250m/moderate
Population Density	Medium (25-100/km2) (Av 85p km2)	High (100-200 p/km2 (Av 150 p/km2)	High (50-150/km2) (Av 95 p/km2)	V.High (100-250p/km2 (Av 150p/km2)	Medium (26-100p/km2) (Av 65 p/km2)	low to Medium(0-50) (Av 25)
Cropping Area	Small Av 2 Ha	Small Av 2 Ha	Small Av 1 Ha	V Small Av. 4 ha	Small Av 2 ha	Medium Av 3 Ha
Herd Size	Small	Small	Very Small	V V. Small	Small	Medium
HOUSEHOLD ORGANIZATION						
Clustered	Yes	Yes	Yes		Yes	Yes
Scattered	-	-	Tending towards	Tending towards	-	-
COMPONENTS						
Subsistence Crops	Maize, G.nuts, beans	Maize,G.nuts, beans	Maize, S.potatoes,	Maize, pulses,	Maize,Cassava,G.nuts Irish potatoes	Maize,G.nuts,beans, millet
Cash Crops	Tobacco, Groundnuts	Tobacco,.Groundnts	Veg., wheat, fruits	Pulses (peas) fruits	Tomatoes, cotton	Groundnuts, Maize
Livestock	Cattle/goats/pigs	Cattle, goats, Pigs	Cattle,,goats	goats?	Cattle/goats	Cattle/goats
CROPPING LAND						
Upland/Slopes	maize,G.nuts,Tobacco beans, etc.	Maize,G.nuts,Tobacco beans etc	Food crops,vegetables In the dry season	Maize, Pulses (reley cropping)	all crops	Maize,G.nuts, beans Millet, Tobacco
Depressions	Some vegetables, sugarcane	Some vegetables/ sugarcane	Vegetables/fruits	Pulses,vegetables, sugarcane	Vegetables	-
GRAZING						
Upland/Hills	dry season Grazing	dry season grazing	-		Wet season Grazing	Grazing (fallow)
Dambo	Grazing	Grazing	Grazing	-uncultivatable dambos/outside system (L. chilwa marshes)	Grazing	Grazing
SOIL FERTILITY MAINT						
Fallow	Limited	None	None	No	Some	Yes (bush fallow)
Crop Rotation	Some	Some	Some	No	No	Yes
Intercropping	Maize & Beans only	Maize & Beans	Yes	Yes	No	Maize & beans only
Manuring	Limited	Limited	Limited	Some, green manuring	limited	Yes?
fertilizer	Some - 50%	Some - 50%	Limited-25% (low pH?)	Limited & burrying Crop residue	Some 60%	Yes - 60%
SOIL CONSERVATION						
Contour Planting/Ridging	Yes	Yes	Yes	Yes	Yes	Yes
LAND PREPARATION						
Hand	Yes	Yes	Yes	Yes	Yes	Yes
Ox-plough	Some - 30%	No	No	No	Some 20%	Yes - 60%?
Tractor	No	No	No	No	No	No
LIVESTOCK MANAGEMENT						
Stall, feeding	No	No	No	V.limited	None	No
Herding	Yes	Yes	Yes	Limited	Yes	Yes
Fencing	No	No	No	In Dambos	No	No
LABOUR						
Family	Yes	Yes	Yes	Yes	Yes	Yes
Hired	Some	Yes	Some	Yes		Limited
Off-farm income	Limited	Yes	Some	Yes	Some	No
MARKETING						
Good	-	-	-	-	-	No
Fair	-	Yes	Yes	-	-	No
Poor	Yes	-	-	-	Yes	Yes

5. CONCLUSION

The methodology for agroforestry research planning outlined in this paper has evolved with every new country study for AFRENA. It is not intended as a rigid set of rules for information collection, but rather as a framework which country researchers can modify to suit their own needs and priorities. The quality of the Land Use Description phase will be reflected in the ease and correctness with which priority agroforestry technologies are subsequently selected. Comments and suggestions for improvement of the methodology and the Worksheets from those who carry out the planning exercise are welcome.

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APPENDIX A

AFRENA* WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION

International Council for Research in Agroforestry
P.O. Box 30677
Nairobi, Kenya

MARCH 1987

COUNTRY: _____

LAND USE SYSTEM: _____

DATE COMPLETED: _____

* AFRENA is the Agroforestry Regional Network for Africa, a research program of the Collaborative Division of ICRAF. AFRENA operates through national research programs in selected countries in four of the major ecological zones of Africa: the unimodal upland savannah of southern Africa, the bimodal highlands of eastern Africa, the humid lowlands of central west Africa, and the semi-arid lowlands of the Sahel.

AFRENA WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION
Part 1. Description from Secondary Data

I. POPULATION

Title of System _____

Area covered by System (estimate from map) _____ km 2

Approximate total population _____

Population density (circle below the average rural population per km 2, excluding gazetted forests = total area divided by pop'n)

1 Very low (< 10)
2 Low (10-20)
3 Medium (20-60)
4 High (60-200)
5 Very high (200-500)
6 Dense (> 500)

Is this figure misleading? i.e., are there significant areas which are not available for expansion of farming activities, or other reasons for not using potentially available land?

Special characteristics of population, settlement, or ethnicity which define the system:

Is there permanent net immigration to communities in this land use system? from where

Is there permanent net outmigration to communities in this land use system? to where?

Is there seasonal migration to communities in this land use system for agricultural or other activities? from where? for what activities?

What proportion of households in the system have:
Male head of household
Female head of household (male absent) _____
Female head of household (single) _____

Comments:

II. CLIMATE

Latitude_____ Longitude_____
Altitude range _____ to _____ meters

Metereological Stations Used:
Name_____ Latitude_____ Longitude_____ Altitude _____
Name _____ Latitude_____ Longitude_____ Altitude _____

Mean annual rainfall _____ mm (for Station 1; if more than one Station, attach data for following variables)

Mean monthly rainfall: (in millimeters)			
	Jan _____	May _____	Sept _____
	Feb _____	Jun _____	Oct _____
	Mar _____	Jul _____	Nov _____
	Apr _____	Aug _____	Dec _____

Indicator of rainfall reliability:

Mean monthly maximum temperature (in o C):			
	Jan _____	May _____	Sept _____
	Feb _____	Jun _____	Oct _____
	Mar _____	Jul _____	Nov _____
	Apr _____	Aug _____	Dec _____

Mean monthly minimum temperature (in o C):			
	Jan _____	May _____	Sept _____
	Feb _____	Jun _____	Oct _____
	Mar _____	Jul _____	Nov _____
	Apr _____	Aug _____	Dec _____

Absolute minimum daily temperature _____ o C
(if not available, indicate occurence of frost _____)

Mean monthly air humidity: Units _____			
	Jan _____	May _____	Sept _____
	Feb _____	Jun _____	Oct _____
	Mar _____	Jul _____	Nov _____
	Apr _____	Aug _____	Dec _____

Mean monthly wind velocity:			
	Jan _____	May _____	Sept _____
	Feb _____	Jun _____	Oct _____
	Mar _____	Jul _____	Nov _____
	Apr _____	Aug _____	Dec _____

Note type and height above ground of anenometer used to measure wind velocity

If no data, in what months are there strong winds?:

III. SOILS AND LANDFORMS

List major types of soils, according to place in the landscape. Characterize using codes below.

Indicate soil classification system(s) used: _____

	UPLANDS	SLOPES	DEPRESSIONS	OTHER _____
Soil Class				
Soil Group				
Texture				
Drainage				
pH				

CODES

Texture	Drainage	pH
1 Sandy	1 Well-drained	1 Acid
2 Loamy	2 Moderately drained	2 Neutral
3 Clayey	3 Poorly drained	3 Base
	4 Seasonally waterlogged	
	5 Permanently waterlogged	

Notes on geology and parent rock material:

Hydrology (briefly describe key characteristics):

Typical depth of groundwater table: _____

Typical Slopes: (circle one) flat (0-4 %) gentle (5 -7 %) moderate (8 -30 %) severe (31 + %)

IV. LAND USE AND FARM PRODUCTION

Estimate the area (or proportion of land) under each major type of land use in the land use system (or area in which land use system found). Convert to hectares.

	YEAR _____	COMMENTS
Annual crops		
Perennial crops		
Fallow land		
Planted pastures		
Natural pastures		
Rangeland		
Accessible woodlands		
Swamps		
Unused lands		
Other _____		
Other _____		

AFRENA WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION
Part 2. Documentation Needed

Please attach the following information, properly referenced. If district-level data unavailable, use provincial/regional data. Check the blank if sources need to be collected locally during the field exercise.

__ District-level data on historical crop areas, yields, production

__ District-level data on cropping patterns

__ District-level data on farm and off-farm labour use, by sex

__ District-level data on fertilizer use (by crop, if possible)

__ District-level data on use of credit (by crop, if possible)

__ Farming System studies of target land use system

__ District-level data on historical livestock numbers, numbers per km 2, and production

__ Existing inventories of local tree species and uses

__ District/regional data on woodfuel consumption levels and use patterns

Development Activities

__ Tables/Maps showings location of development, tree-planting, and research institutions/projects

__ Documents on major regional development projects

__ Program documents from regional research institutions

__ Program documents from regional extension services

AFRENA WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION
Part 3. Field Description

I. LANDSCAPE AND LAND USE

Sketches and Photos

Prepare topographical sketch (or map) of the landscape, showing major hydrological features, topography, major landforms

Prepare land use sketch of the landscape, showing major land use in specific parts (including location of homesteads, cropland-- and the cropping catena, grazing land, woodlots, forests, etc.)

Take photographs of the landscape, from various vantage points

Settlement Patterns

Indicate the dominant settlement patterns:

___ Linear, on ridges
___ Linear, along rivers
___ Linear, along roads
___ Scattered
___ Clustered (small)
___ Clustered (villages)
___ Other _____

Comments:

Associated Land Use Systems

What major land use systems interact with this one through sharing/disputing resources (e.g., protected forest encroachment; nomadic herding vs. agriculturalists)?

What major land use systems interact with this one through important flows of production inputs/outputs (e.g., commercial plantations using labour from nearby smallholdings)?

What major land use systems interact with this one through environmental effects (e.g., watershed erosion on the upper slopes affecting rice production downstream)?

II. FARM DESCRIPTION

Type of Farm System: (mark predominant types)

___ Cropping System
___ Livestock System
___ Crop/Livestock (separate systems)
___ Mixed Crop/ Livestock
___ Forest System
___ Other _____

Land Tenure:

For the types of land listed below (accessible to users of the system), describe major types of tenure status, typical size of unit (in hectares), and principal uses.

The major types of tenure rights are:

1 Communally controlled, permanent specific rights of use
2 Communally controlled, temporary specific rights of use
3 Communally controlled and operated
4 State owned, under leasehold to specific users
5 State owned and operated
6 Freehold
7 Illegal or irregular use of land (e.g., squatters)

TYPE OF LAND	TYPES OF TENURE STATUS	AVG. SIZE	USED FOR:
Home compound			
Off-compound gardens			
Cropland			
Grazing land			
Woodlands			
Other_____			

Comments:

Is there significant sharecropping? Describe prevalence and terms.

Is there significant renting in or out of cropland? Describe prevalence and conditions/terms of rent.

Is there significant gathering by the poor or landless from farmer plots? Indicate for what products and at what times of the year.

Processes of Intensification

How do people acquire new/more land in this system? (check whether each process is used by most, some, or few farmers)

M S F By using or inheriting parent's property
M S F By claiming unused land nearby
M S F By seeking rights to unused communal land
M S F By seeking rights to communal land already in use
M S F By purchasing unused agricultural land
M S F By purchasing used agricultural land
M S F By migrating to less populated zone
M S F Land is unavailable; must find non-farm employment
M S F Other _____

How are producers responding to increased land pressure in this system? Circle frequency of each response, and describe the changes taking place, specifying niches and products.

	PRODUCERS RESPOND BY:	DESCRIBE
M S F	Moving to newly cleared land of similar quality	
M S F	Converting land of one use type to another	
M S F	Decreasing the average length of fallow	
M S F	Increasing yields per unit land through higher inputs	
M S F	Tolerating reduced yields	

Off-farm Employment

What percentage of the work force works off-farm for more than one month of the year? Male _____ Female _____

What are the major types and location of off-farm agricultural employment for men in this land use system?

What are the major types and location of off-farm agricultural employment for women in this land use system?

What are the major types and location of off-farm non-agricultural employment for men in this system?

What are the major types and location of off-farm non-agricultural employment for women in this system?

III. CROP PRODUCTION (including well-known woody perennials)

Management Systems (mark all applicable)

COMMENTS

___ Shifting cultivation
___ Permanent rainfed cultiv. - annuals
___ Permanent rainfed cultiv. - perennials
___ Permanent irrigated cultiv. - annuals
___ Permanent irrigated cultiv. - perennials
___ Intensive homegarden/compound production
___ Incipient homegarden/compound production
___ Other _____

Major crops (check all relevant categories):

CROP	HOME CONS.	CASH SALE	GROWN ON: UPLNDS	SLOPES	DEPR.	AREA PER FARM	TOTAL AREA

Marketing of crops

For each crop listed above, indicate major marketing channels (e.g., local barter/sale, direct sale in village or regional markets, local or outside traders, cooperatives, marketing boards, processing enterprises, etc.), form of marketed product, and marketing problems/constraints. (see next page)

CROP	MARKETING CHANNELS	FORM	PROBLEMS

Management Practices

Crop sequence. Briefly summarize the sequence in which crops are planted on a particular plot of land. Indicate intercropping. ATTACH chart.

Fallow management. Calculate the |R' factor for fallow systems. |R = £ yrs land cultivated X 100/ £ yrs land cultivated + £ yrs in fallow.|

Fertility. Mark what proportion of producers use each of the following practices (F = few, | 25%; S = some, 25-75%; M = most, | 75%). If available, indicate actual percentage. For each practice, specify for which crops.

PRACTICE	FREQUENCY	CROPS
Forest fallow	F S M	
Bush fallow	F S M	
Grass/short fallow	F S M	
Crop rotation	F S M	
Intercrop with leguminous crops	F S M	
Bury grass/weeded material (in mounds)	F S M	

PRACTICE	FREQUENCY	CROPS
Burn vegetation before using land	F S M	
Burn crop residues	F S M	
Use (vegetative) compost	F S M	
Use mulch	F S M	
Use livestock manure	F S M	
Use industrial fertilizer	F S M	
Other _____	F S M	

Conservation practices. Mark what proportion of producers use each of the following practices (F = few, S = some, M = most):

PRACTICE	FREQUENCY	COMMENTS
Cut off drains	F S M	
Check dams	F S M	
Microcatchments	F S M	
Tied ridges	F S M	
Terraces	F S M	
Contour ploughing	F S M	
Contour ridges	F S M	
Contour hedgerows	F S M	
Windbreaks	F S M	
Other tree-planting	F S M	
Grass strips	F S M	
Pasture reseeding	F S M	
Other _____	F S M	

Comments:

Source of power. Mark what proportion of producers use each of the following sources of power for agriculture:

PRACTICE	FREQUENCY	COMMENTS
Hand cultivation	F S M	
Ox-plough, own animals	F S M	
Ox-plough, hired animals	F S M	
Tractor, own	F S M	
Tractor, hired	F S M	
Other _____	F S M	

Comments:

Agricultural Labour

Cropping calendar. Attach a sketch of the cropping calendar.

Which crop activities are done predominently by men?

Which crop activities are done predominantly by women?

Is paid hired labour used for any tasks during the year? if so, for what types of work and at what times of the year?

What percent of farm households in this land use system use permanent hired labour? what percent use casual hired labour?

Is group or communal labour used for any tasks during the year? If so, which tasks and when?

IV. ANIMAL PRODUCTION

Animals in the System

Indicate proportion of households having each type of animal (F = few, S = some, M = most), or statistics, if available.

ANIMAL TYPE	% HOUSEHOLDS	TYPICAL HERD SIZE
Cattle	F S M	
Pigs	F S M	
Sheep	F S M	
Goats	F S M	
Poultry	F S M	
Bees (hives)	F S M	
Fish (ponds)	F S M	
Other _____	F S M	

Management System

For each type of animal, indicate the management systems used (FR = free-ranging, H = herding, P = paddocking, SF = stall-feeding). Mark |1' for the most commonly used; |2' for others which are commonly used. Comment on seasonal use of different systems, etc. (see next page)

TYPES OF ANIMAL	MGMT SYSTEM				COMMENTS
	FR	H	P	SF	
_____					
_____					
_____					
_____					
_____					
_____					

Animal Products

Mark with an |X' the most important products used by livestock keepers:

ANIMAL	HOME CONSUMPTION				SALE				SAVINGS	DRAUGHT	SOCIAL USES
	Milk	Meat	Hide	Manure	Milk	Meat	Hide	Manure			
_____											
_____											
_____											
_____											
_____											
_____											

Marketing of Animal Products

For each product listed above, indicate major marketing channels (e.g., local barter/sale, direct sale in village or regional markets, local or outside traders, cooperatives, marketing boards, processing enterprises, etc.), form of marketed product, and marketing problems/constraints.

PRODUCT	MARKETING CHANNELS	FORM	PROBLEMS

Comments:

Sources of Feed

Indicate for each potential type of feed, whether it is used by most (M), some (S), few (F) or none (N) livestock keepers, at what time of the year, and for which types of animal:

TYPE OF FEED	USE	WHEN USED	TYPE OF ANIMAL
Grasslands (local)	M S F N		
Grasslands (outside local area)	M S F N		
Planted pasture (grazed grass/legumes)	M S F N		
Planted fodder (cut grass/legumes)	M S F N		
Conserved fodder (specify _____)	M S F N		
Tree/shrub fodder (browsed)	M S F N		
Tree/shrub fodder (cut)	M S F N		
Plant residues	M S F N		
Purchased feed	M S F N		
Other _____	M S F N		

Management Practices

Feed/pasture management. Describe important characteristics:

Herding of animals

Pasture rotation/management

Fencing

Fodder conservation

Pasture burning

Animal management. Describe important characteristics.

Housing/shelter

Watering

Disease control practices

Tenure Practices

Is there significant renting in or out of grazing land? Describe prevalence and conditions/terms of rent.

Is there significant shared ownership of cattle? Describe prevalence and terms.

Is there significant grazing by others (without rent) on the crop or grazing lands belonging to specific farmers? Indicate when and on which lands.

Labour for Animal Production

Animal production calendar. Attach summary chart showing key aspects of livestock management (purchase, sale, alternate feed regimes)

Which livestock activities are done predominently by men?

Which livestock activities are done predominantly by women?

Is paid hired labour used for any tasks during the year? if so, for what types of work and at what times of the year?

Is group or communal labour used for any tasks during the year? If so, for which tasks and when?

V. TREES IN THE SYSTEM

For each landscape niche accessible to users of this land use system, indicate whether trees are growing there, common species, and agroforestry practices. Differentiate between significant types of cropland, e.g., irrigated and rainfed, annuals and perennials, private and communal (attach sheets if necessary).

NICHE	TREES?		NATURALLY OCCURRING SPECIES	PLANTED (MANAGED) SPECIES	AGROFORESTRY PRACTICES (species, arrang.
	YES	NO			
HOME COMPOUND					
CROPLAND (Type 1, Describe _____)					
CROPLAND (Type 2, Describe _____)					
FALLOW LAND (Differentiate long/short term, private/communal)					
PASTURES (differentiate private/communal)					

NICHE	TREES? YES	TREES? NO	NATURALLY OCCURRING SPECIES	PLANTED (MANAGED) SPECIES	AGROFORESTRY PRACTICES (species, arrang.)
RANGELAND (Differentiate private/communal)					
WOODLOTS (Differentiate private/communal)					
WOODLANDS, FORESTS (Differentiate private, communal, state)					
PROPERTY BOUNDARIES					
FENCES					
ROADS, TRAILS, PUBLIC PLACES					

NICHE	TREES? YES	NO	NATURALLY OCCURRING SPECIES	PLANTED (MANAGED) SPECIES	AGROFORESTRY PRACTICES (species, arrang.)
RIVERBANKS					
GULLIES					
DRAINAGE, IRRIGATION CHANNELS (differentiate private/communal)					
WATERHOLES (differentiate human/animal use)					
FISHPONDS, LAKES, OCEANS (indicate which)					
OTHER _____ (e.g., DUNES, OFF-FARM LANDS)					

Use of Tree Products

List the most important tree and shrub products obtained from species listed above. Indicate whether products are used for home consumption (HC) and/or cash sale (CS). Consider the following types of products: (see next page)

FUEL: fuelwood, charcoal
FOOD: fruit, nuts, edible oils, spices, relish
FODDER: leaves, bark, fruit
SHELTER: building poles, lumber, thatching
CRAFTS: wood for tools, fibers, carving wood
PROCESSING: wattle, resins, cork, industrial oils, medicines, rubber, gums, stimulants
OTHER: honey, caterpillars

PRODUCT	HC	CS	SPECIES

Marketing of Tree Products

For all important tree products which are sold for cash, indicate major marketing channels (e.g., local barter/sale, direct sale in village or regional markets, local or outside traders, cooperatives, marketing boards, processing enterprises, etc.), form of marketed product, and marketing problems/constraints.

PRODUCT	MARKETING CHANNELS	FORM	PROBLEMS

Comments:

Woodfuel Supply

Over-all, in this land use system, is woodfuel (mark one):

__ Abundant __ Moderately abundant
__ Scarce __ Extremely scarce

Do most (M), some (S), or few (F) households in this system:

	FOR DOMESTIC USE	FOR PROCESSING
Gather wood free of charge	M S F	M S F
Gather wood, with payment	M S F	M S F
Pay for transport of wood	M S F	M S F
Pay for wood	M S F	M S F
Use charcoal	M S F	M S F

Other fuels commonly used: _____

Average time/distance required to collect to wood _____

Tenure Practices

Is there significant renting in or out of productive trees, orchards or woodlots? Describe prevalence and conditions/terms of rent.

Are there restrictions on the types of trees which may planted and/or harvested on private lands?

Are there restrictions on the types of trees which may be planted and/or harvested on communal lands?

Is there significant gathering by the poor or landless of tree products on specific farmers' lands? Indicate for what products and at what times of the year.

Labour for tree production

Attach calendar for annual tree production activities

Which tree production activities are done predominently by men?

Which tree production activities are done predominantly by women?

Is paid hired labour used for any tasks during the year? if so, for what types of work and at what times of the year?

Is group or communal labour used for any tasks during the year? If so, for which tasks and when?

VI. OTHER FARM ACTIVITIES

Describe any other economic activities carried out on the farm, including home processing, crafts, skilled trades. Indicate types of activity and major products.

Marketing of other farm products

For each product listed above, indicate major marketing channels (e.g., local barter/sale, direct sale in village or regional markets, local or outside traders, cooperatives, marketing boards, processing enterprises, etc.), form of marketed product, and special marketing/production problems.

PRODUCT	MARKETING CHANNELS	FORM	PROBLEMS

Labour Used in Non-agricultural Farm Activities

Attach calendar of activities

Which activities are done predominently by men?

Which activities are done predominantly by women?

Is paid hired labour used for any tasks during the year? if so, for what types of work and at what times of the year?

Is group or communal labour used for any tasks during the year? If so, which tasks and when?

VII. VARIATIONS WITHIN THE SYSTEM

Describe the most significant variations found within the system.

population density

spatial organization of households

environmental gradients

land tenure

role of livestock

major food and cash crops

proximity to markets

tool and labour use

VIII. DEVELOPMENT POLICY AND INFRASTRUCTURE

Development priorities. What are the major priorities for development in this land use system?

Development activities. List major official development or investment programs in the land use system, and describe target population.

Relative to other land use systems in the ecozone, does this system: (circle one)

1 Receive little national support and investment
2 Receive an average level of development investment
3 Receive priority for national development investment
? Don't know

Transport facilities in land use system: (circle one each)

Trunk road system:	Very good	Adequate	Poor	Very Poor
Farm-to-market road system:	Very good	Adequate	Poor	Very Poor
River transport system:	Very good	Adequate	Poor	Very Poor
Sea transport system:	Very good	Adequate	Poor	Very Poor
Rail transport system:	Very good	Adequate	Poor	Very Poor
Air transport system:	Very good	Adequate	Poor	Very Poor

Rural credit facilities and use:

Indicate whether credit is used by most (M), some (S), or few (F) producers in the land use system, for each type:

SOURCE	USED BY	COMMENTS
Family credit	M S F	
Local stores/businesspeople	M S F	
Local cooperative	M S F	
Regional cooperative	M S F	
Private banks/financial inst.	M S F	
Public banks/financial inst.	M S F	

Regional Agricultural Imports

What important agricultural products are imported, for the consumption of households in this land use system, from other systems or from abroad?

Tree-Planting Activities

Inventory organized tree-planting activities in the land use system. Include official, church, and non-governmental projects.

PROJECT	AGENCY	ACTIVITIES	ZONES/SIZE TARGET POP'N

Regional Research Institutions

Identify institutions and note which have on-going agroforestry research taking place. Document activities, staffing, infrastructure, and biophysical conditions.

Agricultural:

Livestock:

Forestry:

Other: (include Universities, university research sites, international research projects, etc.)

Regional Extension Services Identify services and note major technologies being promoted and zones of concentration.

Agricultural:

Soil Conservation:

Livestock:

Forestry:

Other:

AFRENA WORKSHEETS FOR LAND USE DESCRIPTION

Part 4. Evaluation of the System and Potential Role of MPT

I. MAJOR CONSTRAINTS AND POTENTIALS OF THE SYSTEM

Constraints/Potentials of the Household System (Describe)

Savings/Investment:

Cash:

Food:

Energy:

Shelter:

Raw materials:

Constraints/Potentials of the Production System (Describe)

Crops:

Livestock:

Trees:

Other activities:

Constraints/Potentials of the Macro-Environment (Describe)

Markets:

Infrastructure:

Environment:

II. POTENTIAL ROLES FOR MULTIPURPOSE TREES (MPTs) IN THIS SYSTEM

Briefly check the priority (PR) of the following potential roles for MPT's in this system. Are they: (1) critically needed, (2) needed, (3) not especially needed, or (?) unknown. For all items, indicate specific landscape niches (LN), if identified. For the list of products, indicate priorities for both home consumption (HC) and cash sales (CS).

PRODUCTS	PR	HC	CS	LN	COMMENTS
FOODS (indicate season)					
High-carbohydrate foods					
High-protein foods					
High-vitamin foods					
FODDER (indicate season, type of animal)					
High-roughage fodder					
High-protein fodder					

PRODUCTS	PR	HC	CS	LN	COMMENTS
SHELTER (indicate uses) Sawnwood					
Building poles					
Fiber					
FUELWOOD Domestic use					
Processing					
RAW MATERIALS Tools					
Woodcrafts					
Fibers					
Medicines					
Honey, beeswax					
Chemicals/ind'l oils/resins					
Other _____					
Other _____					

SERVICES	PR	LN	COMMENTS
Soil fertility improvement			
Soil erosion control			
Soil stabilization (bench terraces, riverbanks, drainage canals)			
Weed control			
Water conservation (infiltration, surface drainage, retention)			
Fencing			
Boundary markers			
Wind shelter			
Shade (people/animals)			
Watershed protection			
Forest protection			
Other _____			
Other _____			

III. ADDITIONAL INFORMATION AND COMMENTS

Add any comments which you think are important for evaluating the land use system, its constraints, and agroforestry potential. List any important questions which you feel need to be answered in subsequent stages of research planning.

This land use system description was completed by:

Names	Signatures
_____	_____
_____	_____
_____	_____
_____	_____

APPENDIX B

SAMPLE SKETCHES FOR LANDSCAPE ANALYSIS

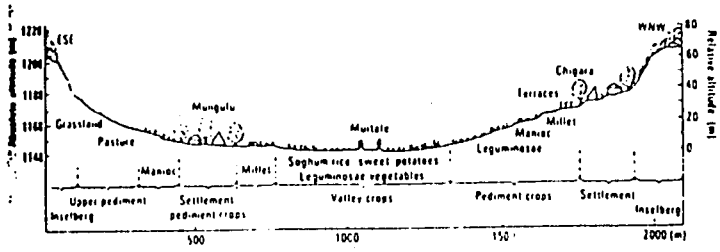
1 - Sample sketches of a "topographical profile"

2 - Sample sketches of a "community layout"

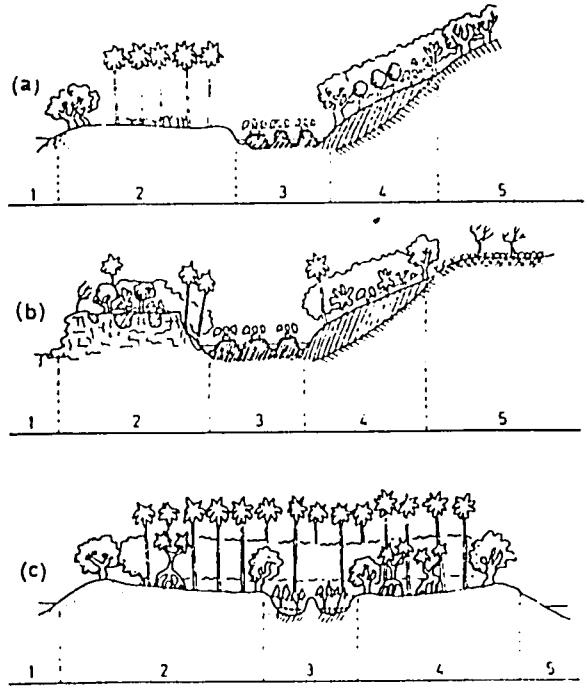
3 - Sample sketches of a "household production unit layout"

SAMPLE SKETCHES OF A

"TOPOGRAPHICAL PROFILE"

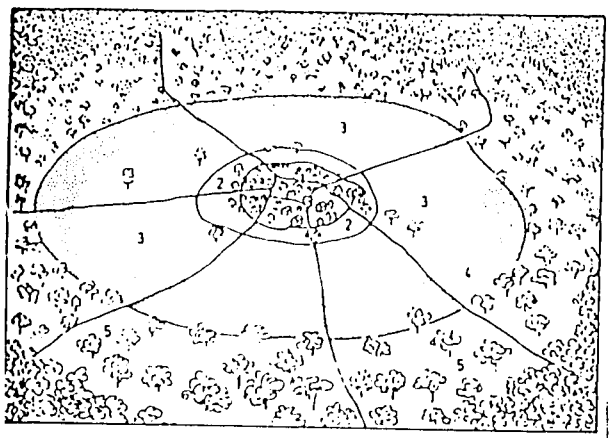


Profile of a valley on Ukara Island, Lake Victoria, showing land use within a catena (from Ludwig 1967, p. 100).

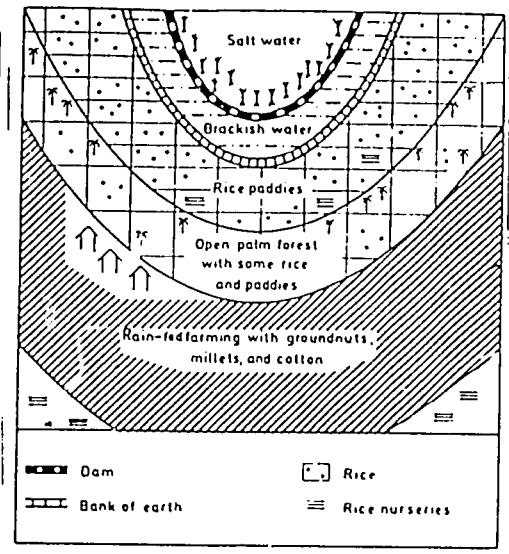


Various types of land use on Polynesian islands. (a) High Island, Rarotonga: (1) ocean; (2) coral calcimorphic soils, growing coconuts, sweet potatoes, tomatoes; (3) hydromorphic soils, taro gardens; (4) colluvium clay loam, citrus fruits and gardens; (5) lateritic soils, scrub and secondary forest. (b) High island, Atiu: (1) ocean, (2) uplifted coral plateau with clay loam in pockets, a few gardens and coconuts; (3) hydromorphic soils, taro gardens; (4) colluvium clay loam, gardens; (5) lateritic soils, ferns and *Casuarina* (c) Atoll, Tarawa: (1) ocean; (2) coral calcimorphic soils, coconut and *Pandanus*; (3) Cyrtosperma pits; (4) coral calcimorphic soils, coconuts and *Pandanus*; (5) lagoon. From Barrau (1961, p. 26)

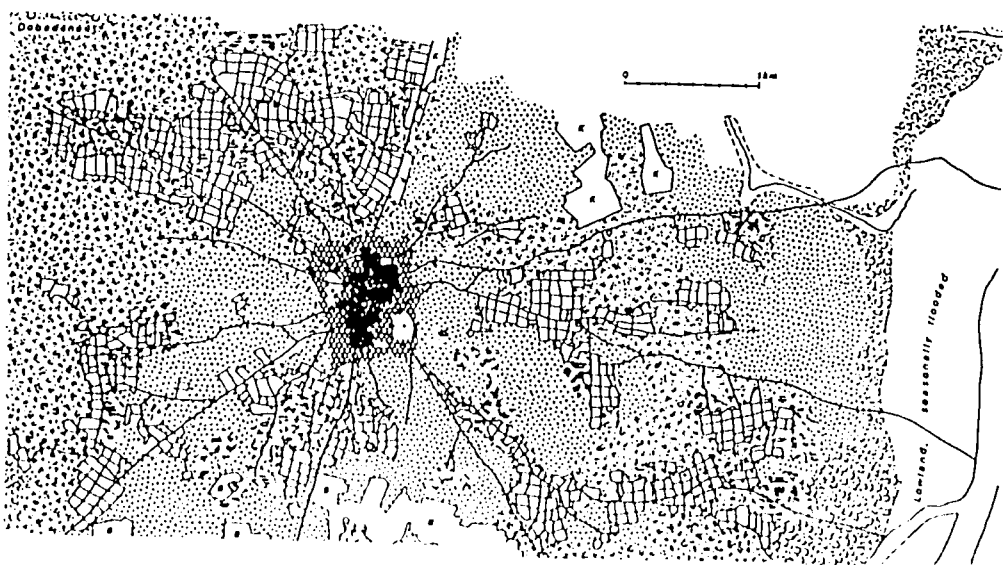
SAMPLE SKETCHES OF A
"COMMUNITY LAYOUT"



Spatial organization of land use in N'Gayène, Senegal (from Pelissier 1966, 474). (1) Houses and gardens; (2) permanent cultivation; (3) intensive fallow systems; (4) intensive shifting cultivation; (5) bush and extensive shifting cultivation.



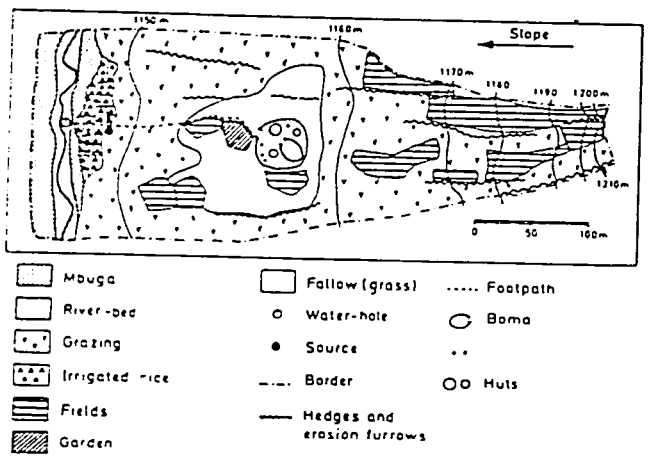
Cropping pattern in the region of the Lower Gambia River



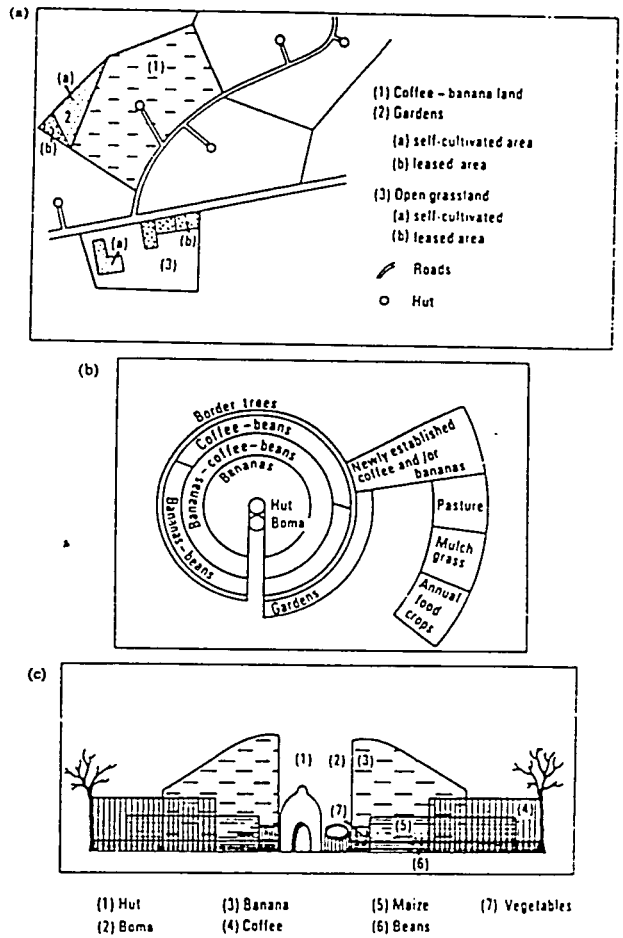
The spatial organization of land use in a semi-arid savanna, Dabedène, Tschad. Source: Gilg (1970)

SAMPLE SKETCHES OF A

"HOUSEHOLD PRODUCTION UNIT LAYOUT



Land use in a Sukuma holding, Tanzania (from Ludwig 1967, p. 104).



Land use in a Bahaya holding, Bukoba, Tanzania: (a) layout; (b) horizontal order; (c) vertical order. From Friedrich (1968, p. 175).

APPENDIX C

USING THE WORKSHEETS FOR AGROFORESTRY DEVELOPMENT ACTIVITIES

The "Worksheets" were designed for "rapid appraisal" for research planning within the AFRENA context. But given that their basic purpose is to systematically characterize the target land use system, in order to match the system with appropriate agroforestry interventions, it can also be used by development agencts interested in immediate extension of agroforestry technologies. As a general rule, one should know the answers to the questions in the worksheets, even if they need not be formally filled out, before initiating any agroforestry program. One advantage, however, in filling out the worksheets properly, is that the document can be circulated among other agroforesters for comment and suggestions.

Individuals who have worked a long time in the target zone, particularly if trained in farming systems analysis, should be able to fill out the questionnaire, from their own knowledge and immediately available secondary materials, in half a day. If any answers are not known with certainty, some field/research time can be directed to answering them. The time commitment involved in this review is in fact quite modest, particularly if the exercise leads to improved project design.

The principal difference between use of these materials for development planning, rather than research planning, is that the latter is more open-ended. If potential interventions are identified, for which field-tested components and prototype designs are not available, then this becomes an issue for the research agenda. By contrast, a development project does not want to begin work with highly experimental technologies. After the initial evaluation and technology identification stages, it may be necessary to identify "best bets" and proven technologies among these for actual dissemination. Of course, some initial adaptive research will almost always be necessary, until the technology has been used locally for some time. The development agency can then make an effort to lobby research organizations to work on other promising technologies, and offer to provide on-farm research support at their development site.

APPENDIX D

GLOSSARY FOR
AFRENA WORKSHEETS FOR LAND USE SYSTEM DESCRIPTION

absolute minimum temperature	- The lowest temperature recorded over the reference period
acid soil	- Soil in which the pH is less than 6.5; often considered problematic for tree and crop production due to negative effect on soil microbal and phizomal activity, alummium toxocity and other factor. Soil may be considered strongly acid, if pH is less than 5.0.
agroforestry potential	- The potential in a given farming system for the integration of trees or shrubs with crop or animal production; refers to potential roles, landscape niches, and arrangements of MPT's
agroforestry	- Collective term for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management unit as agricultural crops and/or animals, either under some form of spatial arraangement or temporal sequence with both economic and ecological interactions
annual crops	- Plants that flower and complete their life cyle in the same year that their seeds germinate
base(alkaline) soil	- Soil in which the pH is greater than 7.5
bench terraces	- Conversion of a steep slope into a series of steps with near-horizontal ledges and near-vertical walls between ledge, using retaining walls (rock) or steep banks (soil) used for intensive cropping
browsing	- The feeding on, buds shoots, and leaves of woody growth, by livestock, Browse is any material browsed or fit for browsing

bush fallow	- A fallow of usually 3-10 years in which the natural vegetation which regenerates is composed principally of shrubs and young trees
check dams	- Structures of stone, wood, or other available material built in a channel, stream, or gully to slow and reduce the erosive force of running water (synonym "gully plug")
clayey soils	- Soils dominated by clay-sized (less than .002 mm) mineral practices. (sandy clay, clay, heavy clay)
compost (vegetable)	- Organic residues, or a mixture of organic residues and soil that have been piled, moistened, and allowed to decompose
conserved fodder	- Treatment of fodder materials so as to conserve them for later use, for example, by making hay, sileage, etc.
contour hedgerows	- Dense, narrow hedges of woody perennials, planted along the contour of the slope, to reduce soil erosion (synonyms: contour vegetation strips, barrier strips or hedges, horizontal hedgerows)
contour ploughing (cultivation)	- Method of slowing surface run-off on gentle slopes, by carrying out all tillage operations on the contours, and forming a series of furrows along the contour
contour ridges (or bunds)	- A series of parallel ridges on the contour of cultivated land which have grass or shrubs planted on them to control soil erosion and improve water management
crop residues	- Parts of a crop which are not harvested (including, for example, the leaves, stem and husks of maize harvested for grain)
crop rotation	- A pattern of using fields for specific crops in a specific sequence, usually to prevent soil exhaustion from a demanding crop or to control pests and disease

crop sequence	- The order and arrangements in which crops are grown in time or space, including fallows
cropping calendar	- The specific times during the year when crop activities take place (land preparation, sowing, weeding, harvest, etc.)
cut off drains	- Ditches which intercept water which would otherwisse flow from higher ground onto arable land which it protects (synonyms: storm drain, diversion ditch, training bank)
cropping patterns	- The yearly sequence and spatial arrangement of crops, or crops and fallow, on any given area
drainage (soil drainage)	- The permeability of a soil to water- due to its structure, depth, position in the landscape, and/or composition- which affects soil moisture status.
encroachment (of forests)	- The illegal use by farmers or others of forest land which is officially protected
fallow	- A period between crops during which land is rested from deliberate cropping; natural vegetation may be allowed to grow, or fallow species may be planted to provide soil cover and/or more rapid regeneration of soil
forest fallow	- A longer fallow, usually of over 10 years, in which the naturally regenerated vegetation is composed principally of larger or mature trees
freehold	- Tenure rights in which individuals or households own land and enjoy exclusive rights of use and disposal
free-ranging	- System of livestock keeping in which animals are allowed to forrage freely for food
gradients	- Gradual changes in the value of a given variable (e.g. rainfall, slope, population density)

grass strips	- Bands of grass either natural or planted on unploughed land along the contour between strips at cropped land, to reduce erosion
grass/short fallow	- A fallow which is limited in length to less than three years, where the natural vegetation which regenerates is composed of grasses or young shrubs
group/communal labor	- Use of unpaid labour provided by a local group with ties of affinity to the individual assisted (church community, extended family), usually with the expectation of later receiving labour inputs in return
gullies	- Short, V-shaped channels formed by erosion, cut rapidly from hillsides on banks by intermittent flows of water; a rill that is too large to be smoothed out by ordinary tillage
head of household	- The individual in a residential household group, who is considered to be the main decision-maker
herding	- System of livestock-keeping in which animal feeding is supervised by an individual who moves them between designated feeding/housing areas
home compound	- The area located immediately around the household residence
homegarden	- Small, intensively-cultivated, multi-storey plot located in or near the home compound
hydrology	- The pattern of water-flow in a given region or basin
hydrological	- Referring to characteristics such as surface water logging, depth to groundwater, and flows of surface water (rivers, streams etc)
immigration	- Influx of population into the region from other areas of the country or from other countries; "net" immigration is the total number of people moving into the region minus the number which are moving out

infrastructure	- The system of institutional support and/or physical facilities which can be utilized by the area or group concerned (e.g. extension services, highways, marketing facilities)
intercropping	- Growing two or more crops on the same field at the same time
irrigated cultivation	- Crop production which relies on water supplies other than natural rainfall, either pumping of groundwater,or diversion of water from rivers or lakes
land use system	- A group of producers with a roughly homegeneous environmental resource base, and similar management systems for soil, water, crops, livestock and trees. Similar to a "farming system", but including other forms of land management such as forestry and rangeland. A given physical region may have several land use system. In agroforestry, land use systems are differentiated on the basis of agroforestry potentials
landforms	- Features of geomorphology, such as slopes, hills or mountains, scarps, etc.
loamy soils	- Soil with approximately equal proportions of sand, silt, and clay-sized particles (.2-02 mm, .02-002 mm, .002 mm) (include: sandy loam, clay loam, medium loam, silty textures)
macro-environment	- Features which affect the land use system, but which stem from forces operating on a larger scale, particularly regional environmental factors and the regional economy
mean	- The statistical average, i.e., the sum of all measurements divided by the number of measurements

mean annual rainfall	- The statistically "average" amount of precipitation which falls in a given location in a year
microcatchments	- Small bunds, usually trapezoidal or semi-circular, designed to trap and concentrate run-off water from a small catchment area, so that it infiltrates the soil in a limited area. Used on 3-5% slopes
mixed farming	- Farming involving crop and animal production which are functionally linked (e.g, use of manure on crops, use of ox-plough)
mulch	- Crop residues or other organic litter used to cover the exposed soil between growing crop plants. Used to reduce erosion from rainfall and wind, to suppress weeds, and add organic matter to the soil
neutral soil	- Soil in which pH ranges from 6.5 to 7.5
niches	- Specific physical places in the landscape (e.g., boundaries, riversides, crop fields, forests)
nomadic	- A system of livestock management in which the house hold moves from place to place to find water and pastures, without a permanent settlement
non-farm employment	- All types of paid work which are not related to agriculture, including crafts, skilled trades, manufacturing, office work, government
off-compound gardens	- Vegetable or fruit gardens which are located outside the home compound area, for example along river banks or near depressions
off-farm employment	- All types of paid work which take place off the farm by farm household members; may include wage labour on other farms

outmigration	- The total number of people from the region who have moved permanently outside the region; "net" outmigration is the total number who have moved out minus the total number who have moved in, or immigrated
paddocking	- System of livestock management in which animals feed in fenced pastures with controlled access
pasture reseeding	- Rehabilitation of an existing pasture which has become too sparse to offer affective soil cover, by re-seeding of the pasture to produce a denser stand
perennial crops	- Crops that continue their growth from year to year (e.g. tree crops, sugar cane, pineapple)
population density	- The degree of "crowdedness". Calculated by dividing the total population of a given region by the total area of the region
'R' factor	- An estimate of how intensively land is used. R = the number of years a piece of land is cultivated multiplied by 100; divided by the total number of years the land is cultivated plus the number of years of fallow
rainfed cultivation	- Crop production which depends entirely on natural rainfall to satisfy plant moisture requirements
reliability (rainfall)	- The probability that rainfall will reach a given level in a specific number of years
renting	- The exchange of land use rights for a fixed payment
sandy soils	- Soils which are dominated by sandy-sized (.2-,.02 mm) mineral particles (including sand, loamy sand)

seasonal migration	- Movement of people from one residence to another at particular times of the year, e.g. for seasonal employment or to herd livestock at seasonal grazing areas
settlement patterns	- The spatial arrangement of houses, home compounds, and villages. These may be, e.g., dispersed or concentrated; linear along ridges, or in circular bomas
sharecropping	- The exchange of land use rights for a fixed percentage of the harvest
shared ownership of cattle	- Practice by which particular animals are owned and controlled by more than one individual or household
shelterbelts	- A type of windbreak composed of multiple rows of trees, usually on a large scale
shifting cultivation	- System of land use in which the site of cultivation is regularly changed, with older sites reverting to forest or bush fallow
specific rights of use	- Land tenure conditions in which a particular piece of land (whether private or communal) is allocated to the exclusive use of one individual or household
stall-feeding	- Intensive system of livestock feeding where purchased or "cut and carry" feeds represent a high proportion of total feed, and where animals are not often permitted to graze or browse directly
tenure	- The body of laws, regulations and customs which govern the rights of individuals, households and communities over land

terraces (channel terraces)	- Terraces; earthworks at right angles to the steepest slope, used to intercept surface water run-off; includes an excavated channel and a bank formed on the downhill side
tied ridges	- Closely spaced ridges covering the cultivated surface in two directions at right angles, so the ground is formed into a series of rectangular depressions which retain water and limit soil erosion (principally used on level land and in deep soils)
topography	- See "landforms"
windbreaks	- Narrow strips of trees, shrubs and/or grasses usually planted perpendicular to the prevailing wind to protect fields, homes, canals, etc. from wind or blowing sand. Reduces wind velocity in protected area and can improve the microclimate for plant growth
tree planting for soil conservation (orchard terraces)	- Small, level or reverse-slope terraces, each carrying one line of trees, with land between terraces planted to a vigorous cover crop (usually on slopes too steep for bench terraces)
woodfuel	- All sources of energy derived from the combustion of woody materials, including fuel wood, charcoal, ethanols, etc.
woody perennials	- Trees, shrubs, bamboos and other plants which become woody and which have a reproductive cycle which continues for more than one year