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SETTING PRIORITIES FOR AGROFOPESTRY RESEARCH AND DEVELOPMENT:

Potential Contributions of Economics Research

Sara J. Scherr

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International Council for Research in Agroforestry (ICRAF)

P.O. Box 30677, Nairobi, Kenya

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SETTING PRIORITIES FOR AGROFORESTRY RESEARCH AND DEVELOPMENT: Potential Contributions of Economics Research

1. INTRODUCTION

During the 1970s, international attention began to focus on agroforestry as a land use alternative with potential for increasing land productivity and sustainability in the tropics. Agroforestry can be defined as the intentional growing of multipurpose trees and shrubs (MPTS) on farms together with crops or livestock, with which they interact ecologically and/or economically. MPTS may provide either products such as food, animal fodder, or fuelwood; or services such as improved soil fertility, erosion control, or fencing. MPTS may be arranged and managed in a large variety of ways. Some examples include: alley-cropping, where crops are grown in the alleys between hedges of MPTS which provide green manure for soil fertility; fodder banks of MPTS providing nutritious leaf and pod fodder for animals; mixed intercropping of MPTS with crops to provide shade (as in cocoa); and boundary plantings to provide wood products or windbreaks.

The International Council for Research in Agroforestry (ICRAF) was created in 1977 to support research on agroforestry around the world, especially for low-resource farmers in the tropics. Its early roles were principally in methodology development and research support. In 1985, ICRAF initiated large-scale collaborative research activities with selected African countries in four major ecological zones: the humid lowlands of central/west Africa; the unimodal upland plateau of southern Africa; the humid and sub-humid highlands of east Africa, and the semi-arid Sahel. The program is referred to as AFRENA, the Agroforestry Research Network for Africa.

The first objective of AFRENA is to institutionalize agroforestry research in all activities from national agroforestry research planning to research implementation to initial dissemination of research results. Its second objective is to identify priority agroforestry techologies for research and development in each target ecological zone, and to share responsibility within the network for carrying out the needed research to develop some of those technologies (Torres 1985, 1986; SACCAR and ICRAF). A key problem faced by ICRAF, like other institutions mounting agroforestry research programs, has been the selection of priority agroforestry technologies and topics for applied research.

This paper discusses the process and problems of setting agroforestry research priorities, and the current and potential contributions of economic research in improving agroforestry research planning and implementation. Section 2 introduces ICRAF's "diagnosis and design" approach to selecting priority technologies, and explains the substantive basis for

selecting research or recommendation domains for specific technologies. Section 3 describes the research planning process used in ICRAF's collaborative projects and the role of economic analysis in that process. Section 4 identifies priority economic research needed to improve both our methodologies and the empirical basis for decision-making. The concluding section 5 indicates some requirements for good economic research for agroforestry.

2. IDENTIFYING RESEARCH/RECOMMENDATION DOMAINS FOR AGROFORESTRY

Despite their historical importance in farming systems throughout the world (Nair 1987), agroforestry practices have only recently become the object of formal scientific research or official development programmes (see, e.g., FAO 1985). The sheer number of potential agroforestry components, combinations, and spatial arrangements, and the relative scarcity of scientifically validated information, have made it very difficult to carry out systematic research planning.

The "Diagnosis and Design" Approach

One of ICRAF's early concerns was to develop a methodology for determining the most promising and highest priority agroforestry research lines for a given site, and to identify approaches for multi-disciplinary and multi-institutional research planning and implementation. The outcome was ICRAF's "agroforestry diagnosis and design" ("D&D") methodology. Developed and tested for use on specific sites, the "D&D" was rapidly expanded for use at the community, watershed, and land use system levels (Raintree 1984, Raintree 1987b, Raintree 1986a, Rocheleau and van den Hoek 1984; Hoekstra 1985b; Raintree and Torres 1986; Huxley and Wood 1984; Scherr 1987b).

The "D&D" methodology attempts to choose priority agroforestry techologies by evaluating problems of land use productivity and sustainability from a "user perspective," (Rocheleau 1987) as well as a "public policy perspective". The choice and design of agroforestry interventions must directly reflect the particular needs and constraints facing farmers and other land users in a particular environment. Evaluation of a particular land use system is expected to provide detailed specifications for the technologies to be generated through research, in terms of the MPTS products and services needed, landscape niches where the technology would be utilized, and appropriate spatial arrangements and management practices.

Much of ICRAF's early work focused on finding unique sets of agroforestry solutions to specific problems in specific land use systems. But with the growing body of knowledge and experience in agroforestry diagnosis and design, it is becoming possible to specify and quantify ranges for particular land use conditions, which would suggest or preclude the use of certain technologies, i.e., to identify their research and recommendation domains.

Criteria for Evaluating Recommendation Domains

Recommendation domain classification for agroforestry remains substantially broader than that for single commodities (e.g., the excellent work at CIAT discussed by Carter 1986). This is due to the potential for multiple roles of MPTS, as well as the limited scientifically validated information available on agroforestry technologies.

We can identify five major factors which affect the selection and specification of agroforestry technologies for a particular system: 1) biophysical conditions, 2) organization of the production system (components, resource use and intensity, and management practices), 3) specific system constraints, 4) landscape organization, and 5) socioeconomic environment. These are summarized in Table 1 and briefly discussed below.

1) Biophysical conditions. Biophysical conditions affect both the choice of MPT species for use in agroforestry interventions, and their expected performance in terms of biomass production, expected tree/soil interactions, etc. The most essential variables are climate and soils, then landforms and differential land use along soil/landform catenas. Supplementary information is needed on hydrology, vegetation, geology, and fauna/disease. Specific approaches to environmental and land use evaluation for agroforestry are described in Young (1983, 1985, 1986).

2) Organization of the production system. The production system (for crops, livestock, and trees) affects choice and design of techologies, according to system components, resource intensity, and management practices. The specific components may determine the choice of MPTS (e.g., hedgerow intercropping to include fodder MPTS for mixed farming systems), or the design (hedgerow intercropping can be utilized with most grains, but rotational fallows may be preferred for tobacco or cotton to help break the nematode cycle).

Identical environmental conditions often call for quite different agroforestry interventions under different conditions of land use intensity. In the humid lowlands, farmers in low density areas might be willing to increase area under production by establishing permanent tree crop plantations in forest areas. Farmers in areas where fallow length is declining may need biologically improved tree/shrub fallows. Farmers in high-density areas may be willing to intercrop with soil-improving trees to increase yields per unit area (Raintree 1986a; Raintree and Warner 1986).

Existing farm management practices may offer the opportunity for introducing certain agroforestry technologies, while precluding others. Of special importance are existing agroforestry practices, land preparation, rotation sequence, use of fallows, fertility improvement, soil erosion control, and animal feeding and penning.

TABLE 1. CRITERIA FOR SELECTION OF AGROFORESTRY TECHNOLOGIES

- BIOPHYSICAL CONDITIONS
  - Climate
  - Soils
  - Landforms
- ORGANIZATION OF THE PRODUCTION SYSTEM
  - Land use intensity
  - System components
  - Specific management practices
- SPECIFIC SYSTEM CONSTRAINTS
  - Needs for MPTS products
  - Needs for MPTS services
- LANDSCAPE ORGANIZATION
  - Land and tree tenure
  - Spatial land use arrangements
- SOCIOECONOMIC ENVIRONMENT
  - Markets and marketing infrastructure
  - Organization of extension and other services
  - Public policies
  - Availability of farm labour/land/capital/inputs

3) System constraints. Specific land use system constraints will call for specific types of MPTS products or farm services. For example, the species and management characteristics of MPTS 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. Products which may be provided by MPTS include cash, food, sawnwood or polewood, fiber for building or crafts, wood for tools or woodcrafts, livestock feed, fuel, medicines, chemicals, resins. Possible service functions include: soil fertility, soil erosion control, weed control, water absorption/retention, on-farm drainage, watershed/floodplain management, fencing, boundary markers, wind shelter, shade, and staking (Raintree 1986a).

4) Landscape organization. Organization of the landscape influences the choice and design of agroforestry technologies by determining where in the system trees can be established. This is determined by the local geography of production, and by land tenure and land use rules.

For example, farming systems with disperse homesteads may have a greater potential for multi-strata homegardens than those with densely-clustered villages. Distance to fields may affect the attractiveness of technologies requiring close supervision or high labour inputs. Rules of land use and tenure may limit rights to plant, protect, or harvest trees in particular places in the landscape. Tree establishment in crop fields may be difficult, e.g., where communal grazing of crop residues is customary (Fortmann and Riddell 1985, Raintree (Ed.) 1987a).

5) Socioeconomic environment. The socioeconomic environment within which producers operate offers potentials and constraints for particular technologies in particular regions. Key variables for agroforestry include availability of farm labor, land, and capital; markets and distribution networks for farm/agroforestry inputs and outputs; and transport or service infrastructure. Chronic labour shortages will restrict the potential for labour-demanding alley-cropping systems; market access will affect the MPTS products chosen to generate cash income. Access to chemical fertilizer may affect adoptability of agroforestry alternatives for soil improvement.

Raintree (1986a) has initiated a computerized database to illustrate the "matching" principle for agroforestry technologies, which tentatively classifies 56 different agroforestry technologies by landscape niche, relevant production system, and land use intensity. This system is summarized in Table 2. Table 3 provides an example showing how specific agroforestry technologies were selected to address specific land use problems and farmer groups in the case of the AFRENA project in the southern plateau of Cameroun (CATF and ICRAF 1986).

TABLE 2

MATCHING AGROFORESTRY TECHNOLOGIES TO LAND USE SYSTEMS

LANDSCAPE NICHE	BASIC PRACTICE	SPECIFIC INTERVENTION	LAND USE INTENSITY* I	II	III	IV	V	COMMENTS & EXAMPLES
			FORESTRY					
FOREST	FOREST ENRICHMENT	w/MPTs	•	•				To diversify production
		w/herb.crops	•	•				Food vs. high value cash crops
		w/livestock	•	•				Cattle,sheep,pigs
	TAUNGYA	"Departmental"	•	•				Advantage for forest dept.
		"Integral"	•	•				Thai Forest Villages
			SHIFTING CULTIVATION					
FALLOWED CROPLAND	FALLOW ENRICHMENT	Economic enrichment	•	•	•			Cash crops(trees,rattans,etc)
		Biological enrichment		•	•			Fast growing nitrogen-fixing trees for accelerated or more complete fertility restoration
	TRANSITION TO PERMANENT INTERCROPPING	To mixed intercropping			•	•		Dispersed trees as intercrop for production and/or service roles
		To hedgerow intercropping		•	•	•	•	Coppicing fallow trees in hedgerows; gradual intensification/transition from conventional 'bush'fallow to alley cropping w/partial fallow to permanent alley/cropping(#18)
		To multistorey intercropping					•	to dense,multistorey intercropping (see also #-20-24,41)
	PLANTED ROTATIONS	Agrosilvicultural		•	•			Cropping under compatible forest trees
		Silvopastoral		•	•			Fodder trees and shrubs browsed in fallow vegetation
		Agrosilvicultural		•	•			Fruit trees, root crops,planted in fallow for food and pig feed
	TRANSITION TO TREE CROP SYSTEMS	Commercial trees	•	•	•			High value,labour-saving, marketable tree crops (established by taungya method)
		Subsistence food trees		•	•			Yield/nutritive value greater than field crops (taungya,field crops to tree crops)
			PERMANENT FIELD AGRICULTURE					
PERMANENT ARABLE FIELDS	MPTs HERBACEOUS CROPS	Mixed intercropping						
		- dispersed trees			•			Shade for crops,economic trees
		- dense mixtures			•	•		Multistorey intercropping
		Line/strip planting						
		-contour lines				•	•	Hedgerow intercropping
		-on terraces & bunds				•	•	(alley cropping)
		-dense,complex multistorey					•	May begin to resemble intensity of homegarden system

* Prepared by John B. Raintree in April, 1986 for computerized data base "Land use systems and matching agrofore 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 practice are most likely to be applicable. (This is Based on the occurance of appropriate landscape niches, compatibility wit existing land use traditions vis-a-vis labour intensity, and other factors associated with the "adoptability" of th 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 densit

TABLE 3

LAND USE EVALUATION AND AGROFORESTRY POTENTIALS FOR THE COCOA/FOOD CROPS LAND USE SYSTEM OF SOUTHERN CAMEROON

LAND USE PROBLEMS	DEVELOPMENT STRATEGIES	AGROFORESTRY PROTOTYPES
FOOD PLOT Declining food crops production due to: - reduced fallow - low fertility - high acidity - weed problems - pest/disease problems	Increase food production by improving soil fertility - Producers with 2 - 5 year fallow - Producers with less than 2 - year fallow	* SIMPLE IMPROVED FALLOW * HEDGEROW FALLOWS MIXED INTERCROPPING WITH FERTILITY MPTS * CONTINUOUS HEDGEROW INTERCROPPING
HOME COMPOUND Underdeveloped niche Crop damage from free - ranging small stock	Intensify home compound production	* FEED BANKS FOR SMALL STOCK LIVE FENCING OF HOMEGARDENS MULTISTRATA HOMEGARDENS
COCOA PLOT Low cocoa yields Limited diversification of cash income	Diversify cocoa plantations	INCORPORATE MPTS FOR FERTILITY IMPROVEMENT AND PRODUCTS FOR CASH/HOME USE
LABOUR CONSTRAINTS High non-farm employment High labour requirements for cocoa, forest clearing, weeding	Introduce labour-saving tools	* IDENTIFY LABOUR-SAVING TOOLS FOR AGROFORESTRY TECHNOLOGY

+Adapted fromCATF and ICRAF
*Priority agroforestry technologies for research.

3. ECONOMIC ANALYSIS IN AGROFORESTRY RESEARCH PLANNING

Because so many aspects of the "matching" process between land use systems and agroforestry technologies require skills in farming system, regional economy, and policy analysis, social scientists play a leading role in AFRENA planning activities. Four of the ten ICRAF professionals principally involved during 1986-87 in planning AFRENA research activities with national collaborators were social scientists: two economists, an anthropologist, and an extension specialist. Two additional economists joined the program in the last half of 1987.

Table 4 outlines the six major stages in national research planning, as carried out by ICRAF and national collaborating institutions in AFRENA. The principles and sequence of planning steps would be similar for projects of a different scale, although stages B and C would be far simpler for a more location-specific project. The section below describes each of the stages, and the specific inputs which economic research and analysis can provide.

A) Institutional Arrangements for Research Planning

Planning begins with appointment of a National Agroforestry Committee (NAC) composed of policy-makers in agricultural research and development institutions, whose role it is to make decisions regarding priority land use systems and priority agroforestry technologies for agroforestry research. This committee in turn appoints a multi-disciplinary, multi-institutional National Agroforestry Task Force to carry out planning activities with ICRAF.

Analysis of the institutional framework for rural development may help to identify key institutions to be included in these committees.

B) Description of the Target Zone

The target zone for research is described generally. This includes a biophysical description, summary of common socioeconomic characteristics, review of land use policies and programs affecting agroforestry priorities, and review of institutional resources for agroforestry research.

Agricultural sector analysis is used to evaluate key land use and rural development problems and constraints in the zone, and to identify general economic constraints to adoption of specific technologies. Economic policy analysis focuses on the "public policy perspective" to identify priority functions and locations for agroforestry technologies in terms of current development policy priorities and programmes.

TABLE 4. STAGES OF THE AFRENA RESEARCH PLANNING PROCESS

A) INSTITUTIONAL ARRANGEMENTS

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

B) 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 research, and development institutions which could collaborate in on-farm research.

C) 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").

D) 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 (document: Blueprint for Agroforestry Research).

E) 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, institutional responsibility and possible research complementarity (for zonal programs).

F) DESIGN OF SELECTED RESEARCH PROJECTS

12. Prepare for "micro D&D" mission : choose representative 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 and quantify "macro D&D" analysis, and finalize specifications for proposed interventions (document: Micro D.&.D Report).

14. Organise research design workshop to develop research guidelines, experimental sequence, tentative research designs, and division of labour among research institutions (document: Proposal for Agroforestry Research).

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

C) Description of Major Land Use Systems

Once the zone has been delineated, major (smallholder) land use systems in the zone are identified and described, according to agroforestry criteria (those discussed in the Section 2). This is based on evaluation of secondary data and rapid field appraisal.

Economic information must be collected on the availability within each land use system of land, labour, capital and other inputs for farming and for agroforestry. The basic production system for each land use system is analyzed, focusing on problems in household food, cash, fuel, savings and shelter sub-systems (Scherr 1987b).

D) Evaluation of Agroforestry Potentials

For each important smallholder land use system, candidate agroforestry technologies are identified through the process of biophysical and socioeconomic "matching" with land use system conditions described in Section 2.

Potential agroforestry technologies must be screened for suitability to local economic conditions and resources expected over the medium term time horizon. Ex-ante economic evaluation of promising agroforestry technologies may be carried out, based on best estimates of technology productivity in that ecozone and expected costs and returns under local conditions. This may be based in part on evaluation of existing agroforestry practices.

E) Prioritization of Systems and Technologies

A tentative evaluation of priority land use systems and priority agroforestry technologies for research may be made by the agroforestry Task Forces. The actual decisions are taken by the National Agroforestry Committee for country-specific projects, and by the zonal network conference for zonal projects.

It may be desirable to roughly estimate expected return on investment in research for different technologies in each system, to establish an "objective" criterion for allocation of research resources.

F) Design of Selected Research Projects

The final stage of the research planning process is the development of a detailed research programme focused on priority research topics, with appropriate research designs and assessment methodologies, and a logistically rational program of work.

First, it is necessary to develop detailed specifications for each selected agroforestry technology, through a "micro" diagnostic and design exercise in representative sites and farm households of the client land use system. Specifications for

technology design should include:

- priority technology functions and expected outputs
- location or niche and site characteristics
- desirable MPTS component characteristics
- appropriate spatial arrangements of components
- appropriate technology management practices and approaches
- extension considerations.

Careful analysis of the household economy, community resource constraints, and farm management practices and objectives is essential in order to develop these specifications.

There follows a systematic review of relevant information about the proposed technology and requirements of the client farmers, and then selection of priority research topics. (See, for example, Flores, Scherr, Duguma and Tonye 1987). The basic types of research planned within AFRENA generally include: multipurpose tree/shrub germplasm selection; tree-crop-soil management studies; development of prototype technologies; and extension research (i.e., the infrastructural requirements for technology dissemination).

Through focused farming system and management analysis, economists can contribute to actual research design. They can identify priority research objectives in terms of prototype development and adoption, describe "control plot" conditions, suggest relevant treatments and non-treatment factors in experiments, identify key variables for socioeconomic assessment of prototypes, and help design on-farm surveys and experimental research. They may subsequently be involved in monitoring and evaluation, to ensure that research continues to address client specifications, and is directly linked to improved prototype technology design.

5. PRIORITY ECONOMIC RESEARCH FOR AGROFORESTRY

The central problem of the above methodology for research planning is that the process of selecting appropriate agroforestry technologies and land use system-specific designs is now based principally on the intuitive judgement of experienced agroforesters. While we know what factors can be important, there is little empirical basis for generalities about agroforestry needs and potentials in different types of farming systems, nor for evaluating expected technology performance under different conditions.

In developing and using a technology "matching" system, research by economists is essential. Their input is needed in both methodology development and empirical data collection and evaluation. But, as is illustrated by an economic literature review for agroforestry published in 1985 (Hoekstra 1985a), very little work has yet been done. Far more research is needed in four broad areas (summarized in Table 5): 1) agroforestry needs,

TABLE 5. PRIORITY TOPICS FOR ECONOMICS RESEARCH IN AGROFORESTRY

- AGROFORESTRY NEEDS

  Quantify specific MPT product/service needs in predominant/ typical farming systems

  Compare agroforestry potentials in different farming systems

  Identify agroforestry research/recommendation domains

- TECHNOLOGY PERFORMANCE

  Evaluate the economic role of MPTS in farming systems

  Evaluate economic efficiency of agroforestry systems in terms of land, labour and capital utilization

  Evaluate economic viability of existing and new agroforestry technologies and practices

- TECHNOLOGY DISSEMINATION AND ADOPTION

  Determine the potential impacts and implications of introducing agroforestry technologies

  Identify key determinants, mechanisms, and incentives for adoption and dissemination of specific technologies

  Develop practical methods for monitoring and evaluation of technology adoption and impact

  Evaluate the infrastructural and service support requirements of specific agroforestry technologies

  Evaluate effects of policy environment on adoptability of specific technologies

  Evaluate market potential and infrastructure requirements for non-traditional MPT products

- IMPLEMENTATION OF CLIENT-FOCUSED RESEARCH

  Help identify priority technologies and research topics, and to design efficient research programs

  Help develop practical prototype designs that respond directly or indirectly to target farmers' priorities

  Help design and implement on-farm research to adapt agroforestry technologies to the technical and socioeconomic context of target farmers

2) technology performance, 3) technology dissemination and adoption, and 4) implementation of client-focused research.

Agroforestry Needs

The first major area is empirical evaluation of agroforestry needs and roles in different farming systems. We need to carry out comparative farming systems analysis for agroforestry, to identify research/recommendation domains for commonly needed functions of multipurpose trees and shrubs. ICRAF's AFRENA programme has begun to do this in a largely qualitative way in its ecozonal planning activities, but these activities need to be expanded. We particularly need quantitative analyses of agroforestry product/service needs under different economic and environmental conditions. Well-designed formal surveys are needed, and existing instruments for collecting rural consumption data need to incorporate more information about multipurpose tree and shrub products.

Technology Performance

The second major economic research need is empirical evaluation of agroforestry technology performance under different environmental and socioeconomic conditions. We need to promote more systematic evaluation of MPTS in farming systems, including incorporation of relevant questions into standard survey and census forms (for example, data on "unused," fallow, homegarden, and communal lands; and on MPTS product production and distribution). We need to evaluate the economic efficiency of specific agroforestry technologies in different economic and environmental conditions, in terms of land, labour and capital utilization, and to compare their performance to alternative land use practices and farmer options. (For a fuller discussion of some of the economic and social criteria for farmer adoption of agroforestry technologies, see Arnold 1987 and Hoskins 1987; for a development banking perspective, see Spears 1987.)

One tool for ex-ante economic analysis of agroforestry technologies is the MULBUD computer package for analysis of multi-period and multi-enterprise farm budgets, developed by ICRAF and the Australian National University (Etherington and Matthews, Hoekstra 1984). ICRAF has worked in the past on general guidelines for economic evaluation of technologies (Hoekstra 1985b), and is planning to develop simple economic assessment guidelines for major agroforestry prototypes over the next year. These are largely simple tools designed for application by the non-economist. But we also need much more sophisticated tools and approaches, including innovative systems of modelling and evaluating the long-term benefits, costs, and constraints of specific agroforestry technologies.

Technology Dissemination and Adoption

A third major topic for research is evaluation of the processes and problems of adoption and dissemination of specific

agroforestry technologies. There has recently been an explosion of agroforestry extension projects on the ground around the world, with little documentation of dissemination approaches and their effectiveness or efficiency, and very little differentiation between approaches required for different types of technologies.

The literature on monitoring and evaluation of agroforestry technology dissemination and adoption in a project context is minimal, except for more traditional forestry-type interventions such as woodlots or windbreaks. ICRAF has recently begun joint projects on monitoring and evaluation methodologies with the CARE/Kenya Agroforestry Extension Project (Scherr 1987a), and with the Machakos Dryland Agroforestry Research Project in Kenya (Sang and Hoekstra 1987).

We also need to evaluate the broader impacts of introducing specific agroforestry technologies into different land use systems. Little work has been done to assess the socioeconomic impact of agroforestry development programmes, or even to develop what could be rather complicated methods for doing so, given multiple products and services, differential farmer management of MPTS, parallel tenure changes, etc. A nice example of a broadly conceived project impact assessment is the study of the Jala-Jala agroforestry area of the Philippines by Rola (1987). An example of a comprehensive historical evaluation of an evolving agroforestry system is May's fascinating study of the babassu palm system in Brazil.

Another largely untouched research area is the effect of the policy environment on the adoptability of specific technologies. This would require examining the effects of: rural development policies and land use legislation; institutional arrangements for training, extension, and input distribution; markets and pricing of MPTS products; and land/tree tenure arrangements. Examples are the recently initiated World Bank/Oxford Forestry Institute comparative project of the effectiveness of different incentive schemes for rural tree-planting (Schuh 1987); and a current ICRAF review of the policy context for agroforestry development in Kenya (Scherr forthcoming).

Implementation of Client-focused Research

Finally, there is an important role for agricultural economists within the research process itself, in implementing client-focused research. As at ICRAF, economists can become intimately involved in the development of research plans, to try and ensure the explicit linkage between system diagnosis and the structure and content of research. Economists could also be helpful in the reassembly of scientific results into practical prototype technology designs.

Economists have a particular role to play in the design and implementation of on-farm research for agroforestry, and in the evaluation of prototype technology trials. New methodologies for

evaluating on-farm agroforestry trials are being developed (e.g., Okali and Cassaday, Okali and Berry). ICRAF has carried out research on participatory on-farm research at its Kathama project (Rocheleau and van den Hoek), and is now beginning to work on methods to be applied in its AFRENA projects and in locally managed agroforestry extension projects, but far more is needed.

5. CONCLUSION

Successful promotion of agroforestry land use systems in the tropical world will depend not simply on the improvement and development of technically functional systems. To be viable in the field, agroforestry systems must meet the economic needs of farmers and communities as well. Economists can play a critical role in improving our ability to select, design, develop, and disseminate technologies which will meet those needs.

High quality research in economics for agroforestry requires farming systems perspective and expertise, multidisciplinary knowledge and interaction, and skill at linking farm-, community- and regional-level analyses to discover explanatory variables and relationships in this relatively new field of enquiry, as well as to measure them. The field of agroforestry economics is wide open for major theoretical, methodological, and empirical advances to be made, which could offer immediate benefit to agroforestry research and development efforts around the world.

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