ECOGEN CASE STUDY SERIES

Gender, Ecology and Agroforestry: Science and Survival in Kathama

Dianne E. Rocheleau
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Ecology, Community Organization and Gender (ECOGEN) is a joint project of Clark University and Virginia Polytechnic Institute and State University established for the purpose of examining the role of gender in rural livelihood systems.

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Dianne E. Rocheleau

Preface

Kathama is a market center that currently serves two sublocations, Ulaani and Katitu, in Mbiuni Location, Machakos District, Kenya. It is an Akamba farming community in a dry forest and savanna zone, nestled between the ridge of the Kanzalu Range, the Athi River which traverses the valley 300m below, and the Yatta Plateau which rises to 60m in a gradual slope from the far side of the river. The area covered by the study encompasses just under 50 km^2 and embodies many of the problems and opportunities of the transition from agropastoral to mixed farming land use systems, a process which has occurred over the past seventy-five years. The current landscape is a densely settled, complex matrix of dry forest, bush, pastures, croplands, and homesteads, criss-crossed by hedges, fencerows, terraces, drainage works, seasonal streams, gullies, footpaths and roads.

The farmers who live and work in Kathama are primarily women. Over one third of the households are headed by women and another third are legally headed by absentee men and largely managed by women. Kathama represents a growing trend in rural areas where land is more scarce than labor, and where urban employment, at least for the present, provides greater returns for men's labor than alternative, more intensive agricultural systems. The gender division of labor has shifted from complementary tasks and distinct but overlapping domains at farm and community levels to a rural/urban division. Many of Kathama's households have rural roots and urban branches, with women responsible for subsistence and commercial farming while men work for wages in the cities. Women are increasingly responsible for the the care of complex landscapes that sustain both livelihoods and life support in their community.

The objectives of on-going research in Kathama are: 1) to understand connections between gendered work, knowledge, rights and responsibilities in rural landscapes and rural peoples' lives; 2) to clarify the relation of gendered work and knowledge to integrating livelihood and life support in rural life; 3) to identify the points of convergence between ecological science, gender, and development that warrant explicit treatment in research and development agendas; and 4) to explore approaches to support both women's and men's knowledge and vision in shaping future lifeways and landscapes in areas undergoing similar processes of social and environmental change.

This case study is one of five undertaken in rural communities in Kenya by Ecology, Community Organization, and Gender (ECOGEN). ECOGEN's underlying premise is that it is essential to understand the gendered nature of work, knowledge, rights, and responsibilities as well as the role of gender in organizations which shape, nurture or constrain rural economies and ecologies. "Sustainable production", interpreted broadly, will require attention to the particularities of local ecosystems and livelihoods, to the roles of women and men within local institutions, and to the nature of their connections with larger regional, national and international systems. ECOGEN seeks to expand our understanding of the ways that women and men share and divide the work of earning livelihoods and maintaining the rural ecosystems that are home to their families and communities.

I. Ethnoscience, Gender, and Agroforestry

In rural landscapes throughout the world, women have increasingly taken responsibility as the "daily managers of the living environment" (Dankelman and Davidson, 1988). A steady stream of field research and informal reports as well as historical research indicates the gendered nature of ecological science and practice in most cultures (Chavangi, 1984; Hoskins, 1983; Moore and Vaughan, 1987; Meyerhoff, 1982; Rocheleau, 1985, 1987, 1988, 1989; Merchant, 1980, 1989; Fleuret, 1979; Shostak, 1981; Murphy and Murphy, 1974; Fernandez, 1988; King, 1989; Shiva, 1988). Many of the same researchers have documented the changing rights, responsibilities and tasks of poor rural women, and the imbalance of women's rights and responsibilities as resource managers (Agarwal, 1991). Yet very little of the literature on sustainability has treated gender as an issue (Thomas-Slayter et al, 1991). The implication is that half or more of indigenous ecological science has been obscured by the prevailing "invisibility" of women, their work, their interests, and especially their knowledge to the international scientific community.

The new wave of enthusiasm for "sustainable" agroforestry development and the concurrent upwelling of interest in biodiversity and indigenous knowledge warrants a deeper look into the place of rural women's ecological science in this new trend within the development process. We can also reverse the question and consider the possible consequences of this new direction for rural women's futures and those of their communities (Redclift, 1987). We speak to both concerns by exploring the gendered nature of rural peoples' own science of survival.

Half or more of indigenous ecological science has been obscured by the prevailing "invisibility" of women, their work, their interests, and especially their knowledge to the international scientific community.

II. The Kathama Project: People and Place

The Kathama Agroforestry Project was in itself a very modest effort to develop collaborative research methods for farmer participation in agroforestry research. Rather than a major effort to transform the landscape in Kathama, the project was meant to produce methods to be widely applied elsewhere after initial testing. However, the farmers and community groups involved in the initial project pursued traditional and experimental agroforestry practices in earnest and allowed researchers to document their own independent efforts long after the first project was over.

The account of the formal project and related research efforts, as well as independent local efforts, provides several examples of gendered knowledge, work, rights, and responsibilities in rural land use and resource management at household and community level. The experience of interdisciplinary research teams over several years illustrates the changing terms of the gender division of labor and knowledge, as well as the increasing imbalance in women's rights and responsibilities. However, the story of community responses to drought and famine in 1984, and the use and expansion of gendered knowledge in that difficult time, can teach us much about the resourcefulness of rural women's organizations and the complexity of rural peoples' science of survival (both ecological and political). The application of that knowledge to the continuing process of agroforestry innovation in Kathama also demonstrates the importance of both men's and women's participation, across class and other groupings, in the research and development process in forestry, agriculture, and other fields that address rural resource management and production concerns.

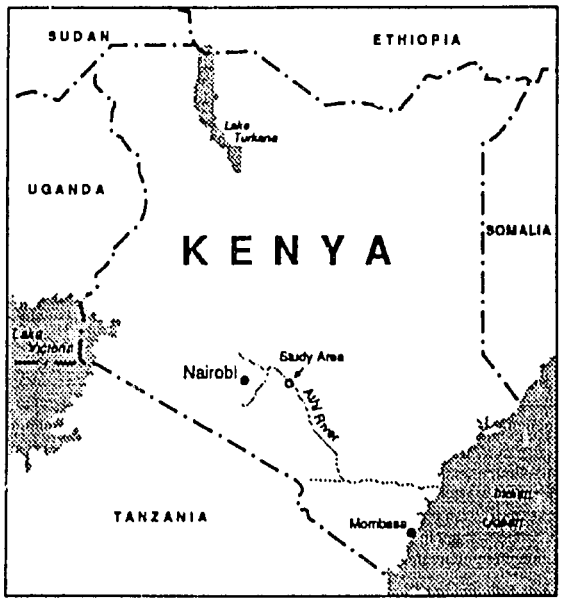
In 1981 the International Council for Research in Agroforestry and Wageningen University began an exploratory on-farm agroforestry research project in a cluster of five villages in the semi-arid farm and rangelands of Machakos District Kenya. The study site (< 30 km^2) encompassed the area served by Kathama market center, of Mbiuni Location, in Mwala Division. The Kathama market place is approximately 100 km east of Nairobi, within the watershed of the Athi River (Figure 1), situated between the Kanzalu Range and the Yatta Plateau (Rocheleau, 1985).

The story of community responses to drought and famine in 1984, and the use and expansion of gendered knowledge in that difficult time, can teach us much about the resourcefulness of rural women's organizations and the complexity of rural peoples' science of survival.

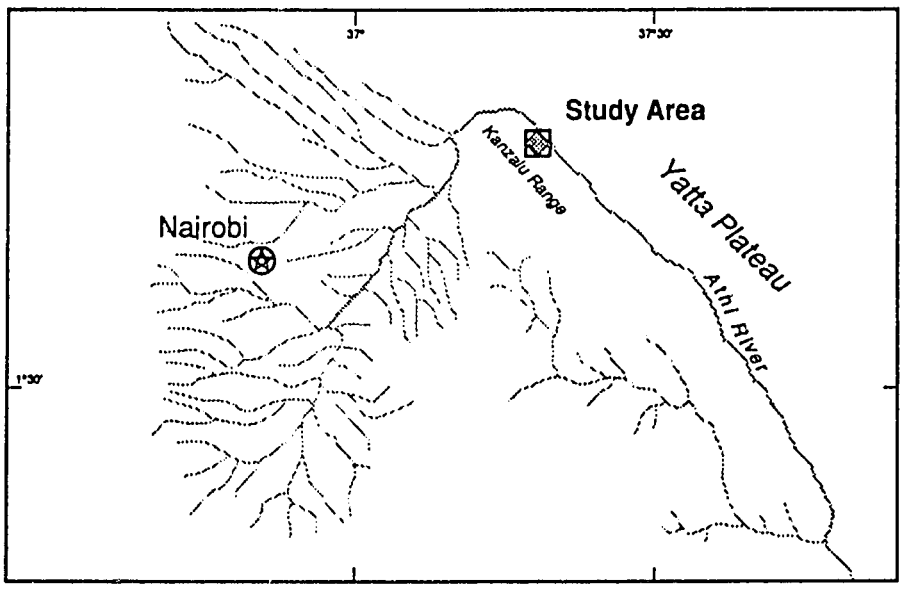
A. The Land

The climate is transitional from sub-humid to semi-arid, with a mean annual temperature of 21°C (range 13° - 27°C). Rainfall is extremely unpredictable both

Figure 1. Map of Kenya: Athi River Basin and Study Area



STUDY AREA



ATHI RIVER WATERSHED

Source: Rocheleau & Hoek, 1984: 17.

within years and between years; seasonal rainfall can vary between 140mm and 730mm (Vonk, 1983a). Ecological conditions vary dramatically over short distances, with agricultural potential ranging from coffee-growing to ranching, according to planning documents. The six kilometer transect from the top of Kanzalu Range across the Athi River Valley, to the Yatta Plateau, spans Agro-ecological Zones 3, 4 and 5, as classified by Jaetzold (Figure 2 & 3). Slopes are gentle over most of the area (5%), however, the upper slopes of the escarpment exceed 50% and farmers increasingly cultivate slopes in excess of 30% and even 40% (Figure 3). The lower slopes are densely populated and intensively cultivated relative to the rest of the area. The slopes of the Kanzalu Range and the slopes to the Athi River are both valued as homesites because of proximity to permanent water sources (springs and Athi River, respectively). The same is true for the slight depression at the foot of the Kanzalu Range where temporary wells are made in the dry river beds and permanent shallow (open) wells can be found on farmlands (Figure 3). Most of the soils are relatively infertile sandy clays with some ultisols (Collinson, 1979), with a strip of pellic vertisols ("Black Cotton soil") in the center of the area (Vonk, 1983a).

The diverse landscape is home to a wide variety of plant and animal species. The natural vegetation on the site is described by Fliervoet (1982) as Acacia-Combretum woodland. The dominant species are Acacia tortilis, Combretum Zeyheri, Terminalia brownii, and Lantana camara. Large mature trees are rare, particularly in the case of Acacia tortilis which has been felled extensively for charcoal-making. Wildlife includes hares, small antelope, wild pigs, baboons, several species of birds and squirrels as well as turtles, frogs, toads, lizards, and snakes. Termites are widespread, and along with the hare and antelope, impose constraints on the species selection and/or management practices for agroforestry systems.

B. People

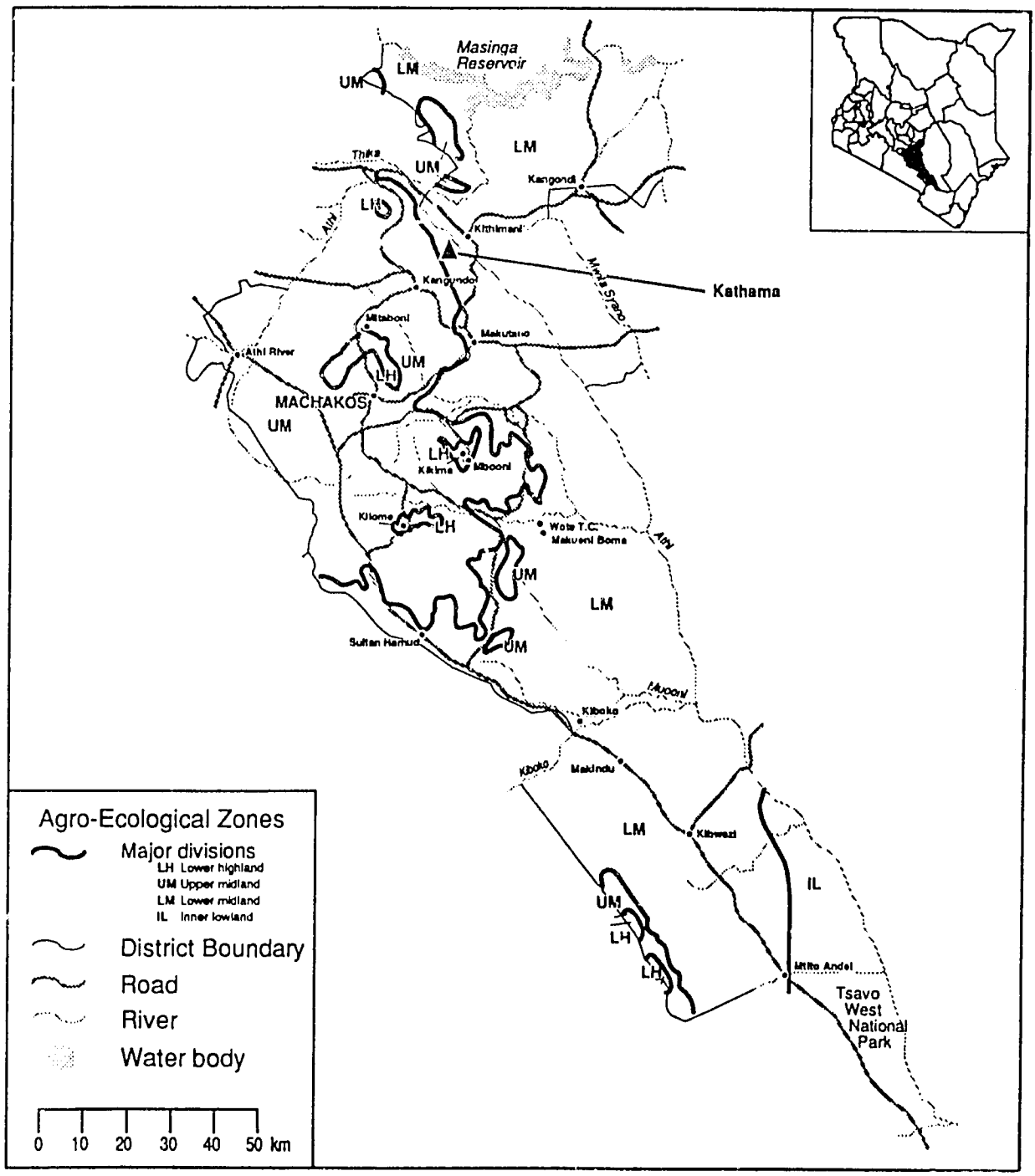
The Akamba people have occupied this region (Machakos and Kitui Districts) for several generations, and although the oral history varies with respect to the area of origin, there is strong evidence that the Akamba migra-ted to this area roughly four hundred years ago from the plains just south of Mt. Kilimanjaro, in Tanzania.[1] The group is in transition from pastoralism with some agriculture (agropastoralism) to permanent cultivation with some animal production (mixed farming). Kathama is on the ag-ricultural end of this spectrum with a mixed farming sys-tem dominated by crop rather than livestock production.

Within the region occupied by the Akamba, Kathama presents a relatively densely populated site with 172 persons km^2 (Table 1). The access to water along the Kanzalu Range and the Athi River probably accounts for the relatively high concentration of people. Population pressure has already caused some families to leave the area for the more sparsely populated Yatta Plateau and the dry woodlands of Kitui District. Others have moved into more marginal areas within the study site: upslope on the range or out onto the valley and away from the water sources (Rocheleau, et al., 1992).

The people who reside continuously in this area (5,000) are almost all farmers (participating members

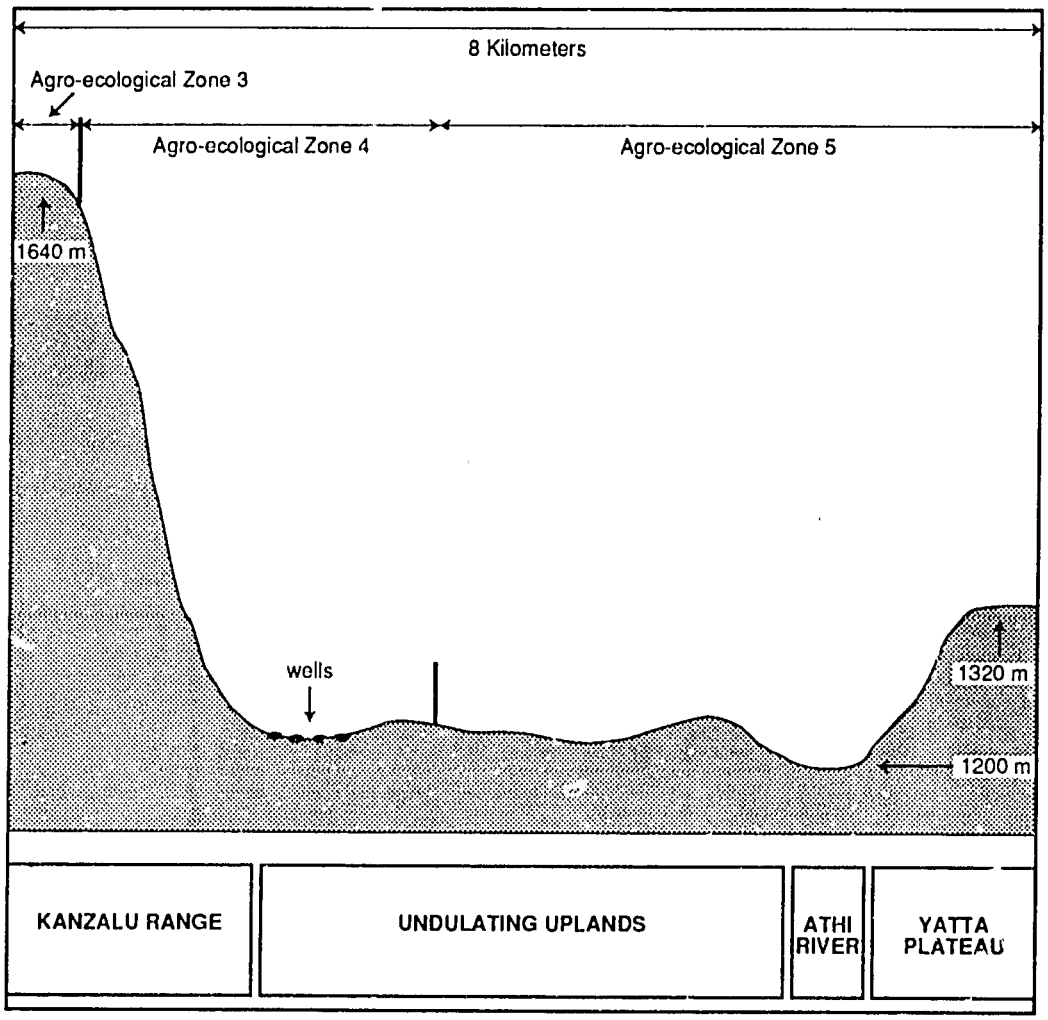
[1]While academics most often use the name "Kamba," the people of the region prefer the usage of "Akamba" to identify their ethnic group (Muthiani, 1973).

Figure 2. Map of Machakos District



Source: Jaetzold & Schmidt, 1983.

Figure 3. Topographic Profile with Agroecological Zones



Source: Hoek, 1983.

of farm households), with relatively few people (50) engaged in trades or small businesses as their main occupation. Both men and women engage in cultivation, with women responsible for most tasks other than plowing. Most women make sisal baskets and rope for cash income and many men burn bricks or charcoal for home use and sale (Winjngaarden, 1983; Jill Cantor, personal communication, 1985). For most households the main source of income other than farming is remittance income from people employed off-farm (usually men, residing in cities). Nearly half of the households in the Location (Mbiuni) earn incomes below the national poverty level (Wallis and Waning, 1976; Vonk, 1983a).

The natural rate of increase in Kathama is 4% (Ginneken, 1981), but the population growth rate is only 3% due to the high rate of emigration. Those who leave are mostly men from 20 to 50 years of age seeking employment in Nairobi or large towns. Increasingly, young families are emigrating to drier zones in search of cheap land, in hopes of maintaining or increasing livestock herds on larger parcels of land. Large numbers of men have left during drought years (Ginneken and Muller, 1984; Gielen, 1982; Vonk, 1983a). Crop failure due to drought is common (at least one season in five) and periodic famines are offset by food relief.

The high rate of natural population increase and the emigration of young men has resulted in a high proportion of women-headed and women-managed households with a high ratio of dependents to "producers" (children[2] to adults). This subjects the women of the area to double, and often conflicting, pressures to produce more crops than before with less adult labor than was previously available. The average household size is 7 persons, with a wide variation in available labor force depending on family composition.

The high rate of natural population increase and the emigration of young men has resulted in a high proportion of women-headed and women-managed households who must produce more crops than before with less adult labor.

C. Land Use

The Akamba people who settled Kathama in 1911 were agropastoralists with 100-200 head of cattle per extended family household. Most residents now practice permanent cultivation of food crops with some livestock. Most farmers raise two crops per year of intercropped maize, beans, cowpea, and pigeon peas, for both subsistence and sale. Some fruit crops (citrus, mango, banana, papaya, guava) are grown around the home compound or interspersed with annuals on the cropland. Small quantities of fruit, as well as sunflower seeds and cotton, are sold as cash crops; mango and papaya are the most widespread as small-scale cash crops[3] (Vonk, 1983a; Rocheleau and van den Hoek, 1984; Jama and Malaret, 1992).

[2]While children do participate in herding, gathering and other tasks, the small children have limited capabilities and the older ones are in school.

[3]Charcoal is widely used during the rainy season and is a minor but strategically timed source of cash at the end of the dry season. It also assumes more importance as a "cash crop" when crops fail.

Over 25% of the area is in cropland and more than 50% is devoted to grazing. Of the remainder, most is bush regrowth or woodland (including gully and ravine vegetation) that is at least occasionally subjected to grazing and browsing. The woodland serves as a source of fuelwood (usually cuttings, sometimes whole trees) and wood for charcoal and brick-burning (whole trees, usually larger hardwoods). The denser woodlands are concentrated in inaccessible areas or on sites extremely unsuitable for cropping or grazing. These sites serve a number of households as sources of stickwood although most of the land is privately owned. The same is true to a lesser extent of the more open grazed woodlands in the valley.

Labor, manure and seed are the major inputs to cropland with very little use of chemical fertilizer (cost limits use) or other agro-chemicals. Almost all of the cropland is terraced, even in slightly undulating topography. Most farmers use draft animals for plowing, usually just after the onset of the rains. The cropping calendar shows peak labor demands at planting and weeding times (April/May; October/November) and at harvests (December/January; June/July)(Figure 4). Each household plows and plants concurrently on their respective plots, but self-help groups (rotating labor exchange) often help with weeding, terrace construction and repair, tree crop planting and fencing on farms of group members.

Cattle and goats are the most important domestic animals in this system (Table 1). Oxen serve as draft animals and also as an investment. Many families keep one or two cows for milk. Goats represent smaller, more flexible investments and a periodic source of ready cash. They also provide milk and occasionally meat for the farm household. Both cattle and goats are confined in corrals at night; farmers collect the manure and apply it to one bench terrace per season, in rotation (Nijssen, 1983; Vonk, 1983a). Management of grazing and browsing varies from tethering to careful herding to almost free range, depending on landholding. Social pressure to control grazing is strongest when grain crops are vulnerable to attack, but these "social fences" fade during the dry season, when animals are driven long distances to water holes or to the Athi River. Off-farm fodder sources play an important role during this period. Roadside and gully sites provide grass, shrubs and high protein Acacia tree pods to supplement on-farm fodder. Many larger land holders also grant grazing and browsing rights on private woodlands to several other households, based on kinship or other social ties or in exchange for cash or services.

D. Land Tenure, Use Rights and Water Rights

Most of the land in the study site was adjudicated in 1972 with the exception of the woodlands just across the Athi River on the Yatta Plateau and a very limited area of government land on the Kanzalu Range. However, exclusive use by one household is applied only to cropland (permanent, terraced), home compounds and small grazing plots. Woodland and large holdings of wooded grazing land are controlled by single households but are perceived as conditionally available to the larger community or to sub-groups thereof. The same plots, now available for restricted common use, are the main source of land for future conversion to cropland, subject to exclusive use by the owners. Since the demand for food is less elastic than the

Since the demand for food is less elastic than the demand for grazing, cropland parcels have tended to remain the same size from one generation to the next, while the total grazing and woodland dwindles.

Table I. Population and Land Use Distribution for Machakos District, Mbiuni Location and Research Area

		District[1]	Agroecological Zone 5 Machakos[1]	Agroecological Zone 4 Machakos[1]	Mbiuni Location[1]	Kathama Res. area[2]
Total Area	KM	14,245	998,000	156,000	144	14
Population	Pers	1,109,200	456,000	376,000	19,900	2,415
Population Density	Pers/ KM²	72	47	147	69	172
Cropland	%	6	14	19	14	27
Cropland/Household[3]	ha	1.3	1.9	0.4	1.1	1.1
Grazingland	%	80	71	59	72	52
Grazingland/ Household	ha	6.7	9.1	2.4	3.1	2.1
Animal Units[4]/ha Grazingland	AU/ ha	–	–	–	–	3.3
Animal Units/ Household	AU/ hsld	–	–	–	–	6.9

1. a) Data on Machakos district ecological zones 4 & 5 and Mbiuni from Ecosystems Ltd. (1981).

   b) An agro climatological zone defined by the rainfall potential evapotranspiration ration; zone 2: PP: PE 66%; zone 3: 5%2 - 67%; zone 4: 37% - 52%; zone 5: 22% - 37% (Braun, 1981).

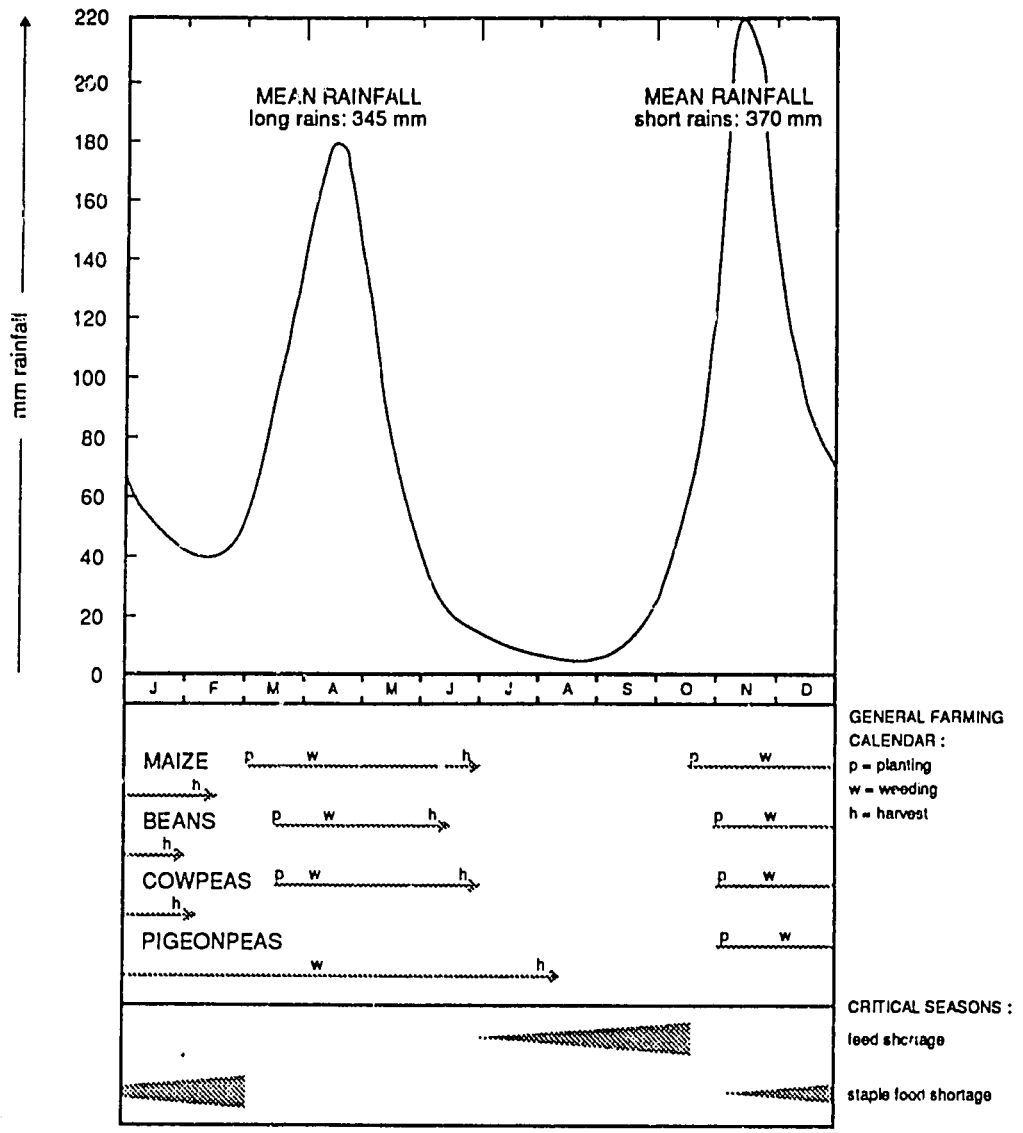
2. Data on Kathama research area from H. Gielen (1982).

3. A household is assumed to be comprised of six (6) members (Hoekstra, 1983), except for the Kathama area, where it is 7 members (Gielen, 1982).

4. Most households have 10 goats, up to 7 cattle: 1 animal unit = 5 goats; 1 adult cattle; 2 cattle < 1 year; 1.3 cattle 1 - 3 years (Rakandema, et al. 1981).

Source: Vonk, 1983.

Figure 4. Cropping Calendar



Source: Till Darnhofer, ICRAF, 1984

demand for grazing, cropland parcels have tended to remain the same size from one generation to the next, while the total grazing and woodland dwindles.

Water rights in the area range from private ownership and exclusive use of open shallow wells on-farm, to free public access to hillside springs and flowing rivers, to temporary shallow wells in dry river beds dug and fenced by small ad hoc groups that may also share water collection and stockwatering trips. Access to water is a major determinant of location preference and is reflected in the location of the largest and or most prosperous landholders (Figure 3).

E. Government Services and Organization

The chief of the location (Mbiuni) represents the government in the area. He exercises his authority in Kathama through direct decision making and through delegation of authority to the sub-chiefs of sub-locations and through village elders with ties to local government. The self-help (Mwethya) groups at the study site are legally registered non-governmental organizations answerable to local authorities. In Kathama, the group members are mostly women (80-100%), and the organizations are based on traditional labor exchange groups. Leaders may be men or women and span a broad range of income or status. Speaking ability, integrity and natural leadership qualities are major criteria, and often one leader (or two) will also be a large landholder. These mutual aid societies have been actively encouraged and registered (formalized) throughout Kenya since 1981.

The groups in Kathama range from traditional older women's agricultural groups to mixed men's and women's public works groups, to women's craft and marketing associations. All of these are designated as self-help groups and, in Kathama, most of these engage in public works (road and gully repair) one morning per week during the dry season. Some groups meet to work as often as 3 days per week. A few groups are limited almost exclusively to sisal rope production and sales, and to farm-level work.

Churches provide a strong focus of community organization and service. However, the influence of the churches is often mediated through the self-help groups rather than into separate direct-action projects. The churches sometimes channel food aid and construction materials for self-help projects, and the self-help groups often have some religious affiliation in common among members.

The University of Nairobi operates a weekly medical clinic for mothers and young children (infant and mother health care, and family planning). Most residents travel to Kabaa (10 km) or Kangundo (> 10 km) for both routine and emergency health care. The clinic at Kathama marketplace has become the focus of a community-based health care and family planning team that constitutes a major influence on daily life in Kathama (Ginneken and Muller, 1984).

Although Kathama is included in government extension services, the difficulty of transportation to and within the Location makes it a low priority site for overworked extension agents headquartered at 7 km distance in Mbiuni. Consequently, access to new technologies and social services is rather limited in Kathama.

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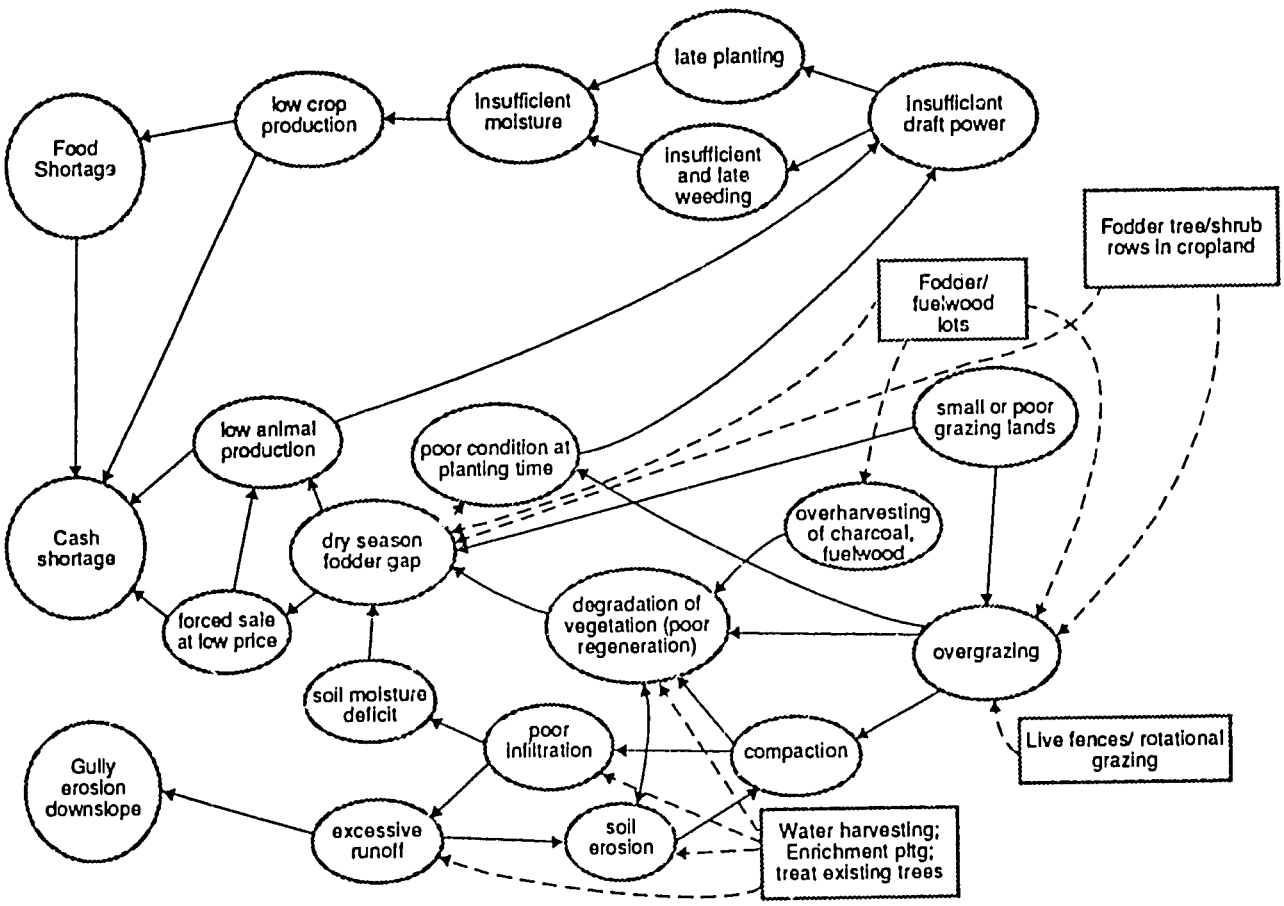
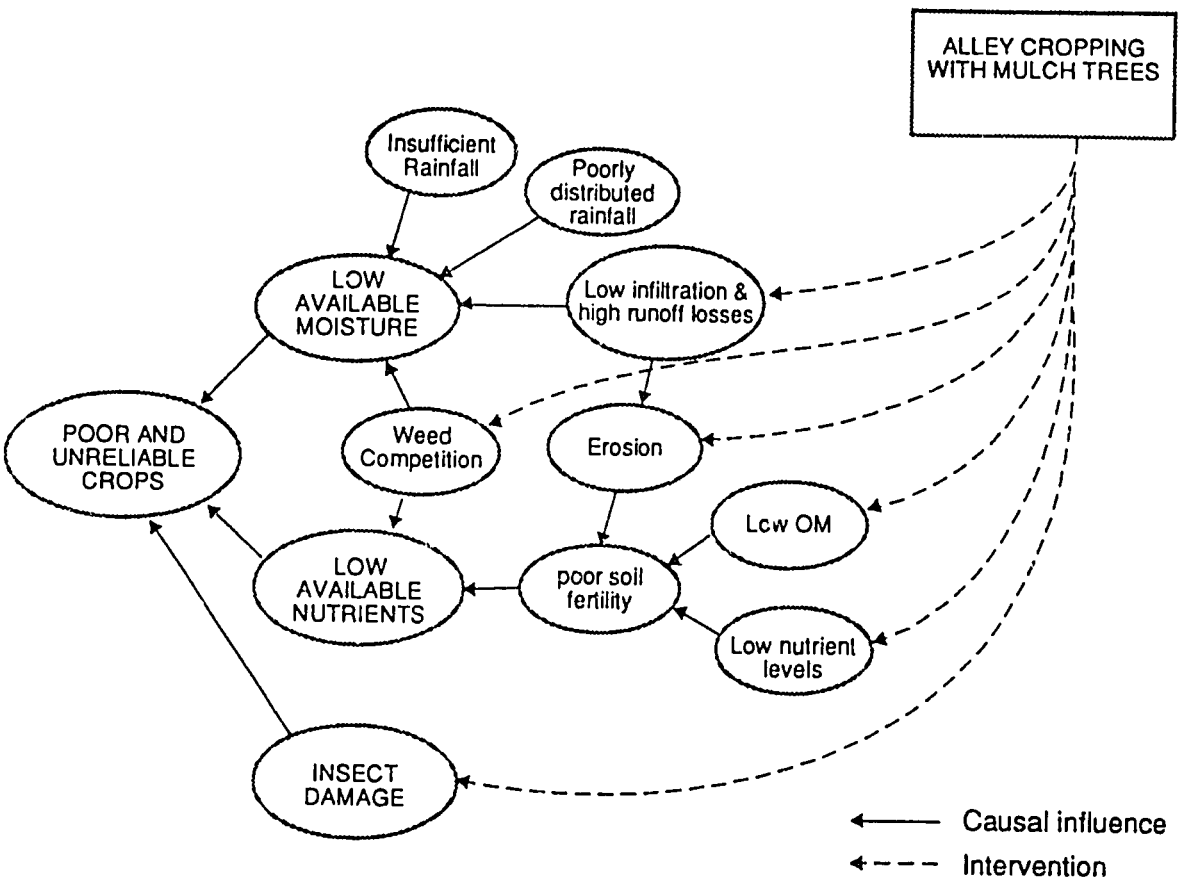
Figure 5. Causal Diagram of Animal Production Problems



Adapted/Updated from Vonk, 1983a & Raintree, 1984.

Figure 6. Causal Diagram of Food Production Problems



Potential Mulch Trees

H-fixing	Insect-repellent
Leucaena leucocephala	*Azadirachta indica*
Mimosa scabrella	*Derris indica*
Sesbania bispinosa	*Gnidia latifolia*

Potential Interventions

1. Improved infiltration, reduced runoff
2. Weed control with reduced labor
3. Reduced splash and runoff erosion
4. Increased organic matter
5. H-fixation and nutrient pump action of deep penetrating roots
6. Use of insect-repellent mulch species

Source: Raintree, 1984.

Market place facilities are limited to collection points for charcoal, a small area for vegetable, fruit and grain sales, a maize mill and storage building, a hide tannery, a tailor's shop, a furniture shop, a few small tea shops, and two shops with a limited selection of household goods. The district level grain storage and agricultural supply centers are not widely used by Kathama residents. Marketing depends heavily on individual connections with middlemen and haulers, and on informal networks among producers within Kathama sub-location.

F. Farming Systems Problems and Potentials

During the course of a rapid appraisal in 1981, conducted to diagnose farming systems problems and potentials, residents identified two key points limiting cash income and food production. The dry season fodder gap limited animal production, which was a major source of ready cash (especially when food stores were depleted), and functioned as a bank for savings/investment (Figure 5). Soil fertility, soil moisture and soil erosion problems limited production on cropland, causing both food and cash shortages (Figure 6) (Raintree, 1984).

Several technologies (agroforestry and non-agroforestry) were evaluated for overall feasibility and problem-solving potential. The subsequent farm trials included: alley cropping (hedgerow intercropping) with woody perennials in food crop plots, and enrichment planting and treatment of existing vegetation (and site) in small plots of degraded grazing land.

By late-1983, preliminary results from the grazing land trials (Vonk, 1983a) indicated a need for improved methods of direct-seeding and other low-input methods of plant propagation and establishment. Where nursery seed-lings were successfully established, there was a need for low-input pest control technologies and/or more rigorous selection of pest-resistant species. Termites were a major problem at these sites. Better protection and/or preventive design against browsing were also necessary, given the damage sustained in several plots (Vonk, 1983a).

The alley cropping trials in croplands had also been established with seedlings (after direct seeding failures). In 1982 researchers and farmers planted closely spaced hedgerows of Leucaena leucocephala (Var. Peru) and Cassia siamea trees at 2m intervals in plots of intercropped maize (Zea mays), pigeon peas (Cajanas cajan), cowpea (Vigna sinensis), and red beans (Phaseolus vulgaris) (Vonk, 1983b; Raintree, 1984). The hedgerows (Figure 7) were coppiced once each season at 30 and 60 cm heights, starting in 1983. The mulch had not shown any discernible effect, but both stickwood and mulch had been harvested and the hedgerows exhibited vigorous growth **considering the dry environment**. The growth and vigor of these plants was, however, substantially less than in well-known experimental trials on more favorable sites (Kang and Wilson, 1987).

By mid-1983 a team of social and ecological scientists sought to broaden the scope of the research design from agroforestry technology trials on ten farms to include the larger landscape and the community at large. They began by monitoring the original trials of "alley cropping," which were intended to produce mulch, nitrogen, and fuelwood in croplands. They soon confronted problems rooted in the gender division of rights, responsibilities and knowledge at household and community level (Rocheleau, 1985, 1988).

Figure 7. Hillside Alley Cropping System

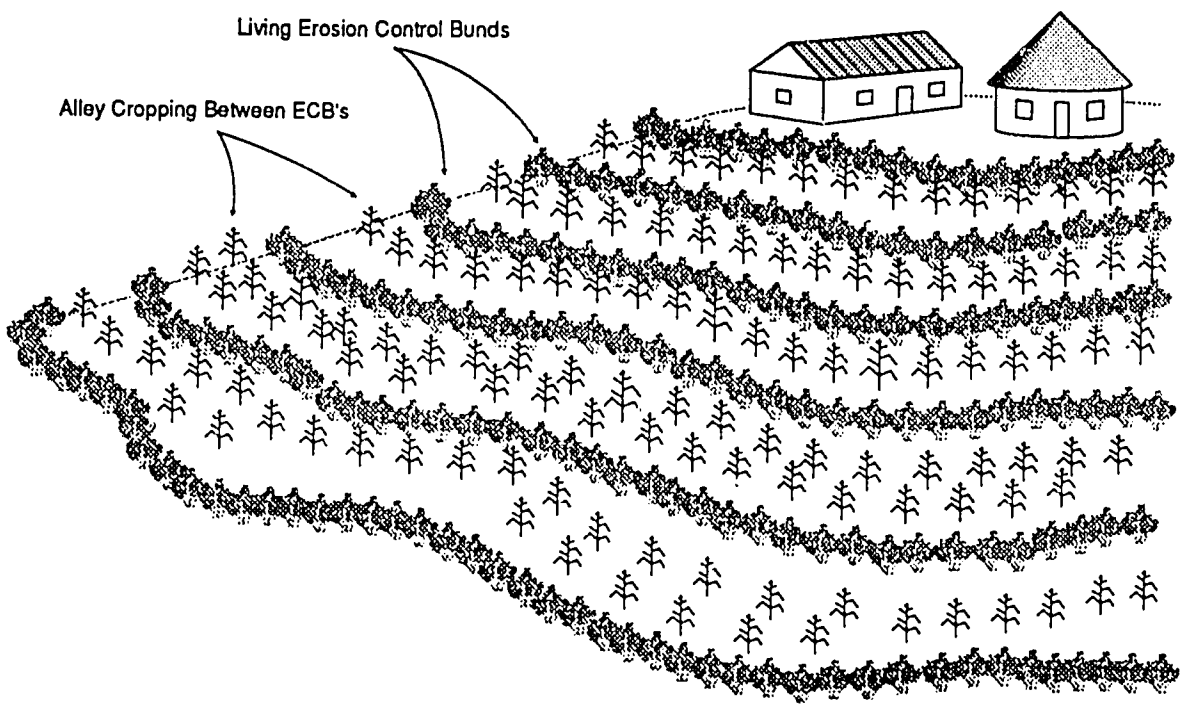
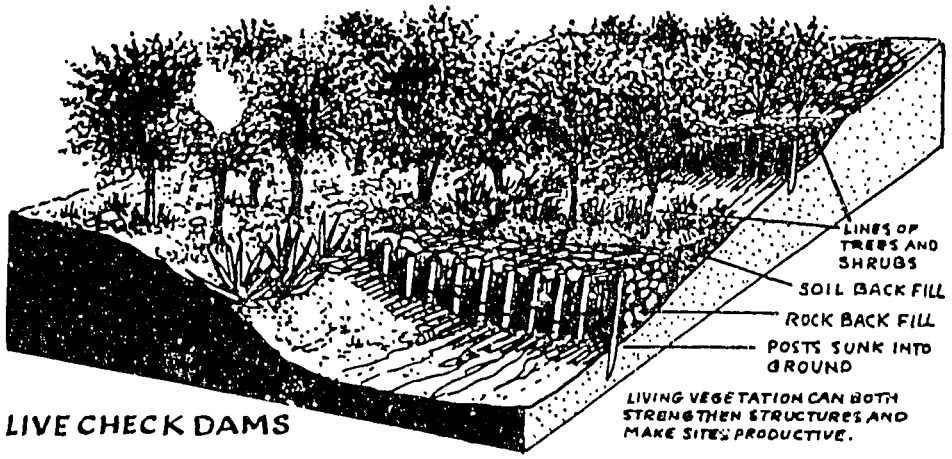


Figure 8. Agroforestry Gully Repair Sites



Source: Rocheleau, Weber & Field-Juma, 1988: 147 (Reproduced with permission from ICRAF).

III. The Kathama Project: The Gender Division of Labor and Interests in Agroforestry

In the ten on-farm trials, nine with men heads of household and one with a couple, the project team encountered two key problems which derived from the absence of women in design and management of new technologies. First, some men who wished to expand their ally cropping trials, failed in their efforts to grow their own seedlings in home nurseries due to lack of sufficient water. Although women were responsible for providing water, they had not been consulted about the decision to grow seedlings at the household level. As it turned out, they were unwilling to carry extra water on their backs from distant sources over a period of four months.

Secondly, the proposed agroforestry practice that men were testing on farm (alley-cropping) responded primarily to women's problems with fuelwood supply and soil fertility for staple food production. The women, who had not been directly involved in planning on most of the trials, were unimpressed with the amount and quality of firewood produced by the seasonal pruning of the young tree rows of Leucaena leucocephalla and Cassia siamea. These compared poorly with pigeon peas (Cajunus cajan), a woody perennial that produced food and fodder as well as fuelwood and was already well incorporated into the existing system. Men's interests in timber and poles for construction or for sale were not addressed at all, which led them to trim the intended "green mulch" and fuelwood trees to produce poles, or to allow their goats to browse the trees, both at the expense of the researchers' intended products.

Thus neither men nor women obtained what they could have from a research design involving both as full participants. This experience illustrated that men's and women's labor and interests matter for technology design and testing, and that men's and women's domains are distinct at household level (Rocheleau, 1985 and 1991).

A. "Public Works" and the Proper Work of Women's Groups

At the same time, researchers "discovered" the importance of women's self-help groups and their role in community level soil and water management work. In response to the limitations of the previous farm trials and the presence of the women's groups they initiated a small participant observation project to introduce agroforestry skills, species, and planting arrangements into the community-based soil conservation work of the women's groups. Researchers and trainees joined the groups in their weekly soil conservation work sessions, mostly devoted to plugging of active gullies, and began to raise the possibility of using trees and grasses to stabilize the sites and to provide fuelwood and fodder cuttings (Figure 8) (Rocheleau and Hoek, 1984).

The groups agreed in principle but seemed uninterested. Researchers tried on numerous occasions to elicit women's groups' preferences for particular species or for particular tree products and services, without suggesting specific options, but with no success.

As foresters had warned, people seemed to have little interest in trees and no strong preference for particular species or tree products.

Finally, as the field team repeated the question for the fourth time in four weeks, some group members asked them to list exactly what they could offer. Once they heard that the range of options included fruit and fodder trees, the participants realized that their choices were not limited to men's timber trees or foreign forester's woodfuel trees (as expected). They asked why anyone would want to waste good trees on such an obviously degraded site as the gully at which they were working. The participants in the soil conservation work requested trees to plant at home, and considered themselves to be earning the trees through the group work (Rocheleau, 1985).

Moreover, the groups gradually revealed themselves as associations of individuals and households, formed as reciprocal work groups and mutual aid networks rather than public works organizations. While five groups were at one point "mobilized" by local officials to work together at a site chosen by the project, the participating groups prevailed upon the field team to work with them separately in the next season's activities. Based on prior experience the women noted that the multi-group situations stretched social networks too thin and over too large an area. The individual groups had developed their own means of mutual accommodation and accountability among members and shared an interest in the same geographical space.

Through a series of subsequent discussions participants explained that their groups each counted from 50 to 100 official members and usually drew a work force of 20 to 30 women and sometimes a few men, for any given task. Their "real" work was reciprocal weeding and terrace repair labor on each other's cropland, which was then limited to one day per week, with two days devoted to road and gully repair. They pointed out that in most cases the road and gully work was an onerous duty performed to comply with public service demands from public officials.

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Finally, the project's entry into this work coincided with the onset of the drought and subsequent famine of 1984, which began early in the drier parts of Machakos. The self-help groups had acquired greater importance due to the drought, as access to public relief food and/or "food for work" projects was expected to depend on individual wealth and influence or on group membership and participation. The flurry of group soil conservation work at sites chosen by local officials had more to do with drought and famine "insurance" than with specific community priorities for soil and water conservation. Most participants were concerned about soil erosion, damaged roads and degraded stream channels. However, their public work sites, the time, place and public image of group work did not reflect the group's larger purpose and women's interests.

B. Changes in Gendered Knowledge and Practice

As the drought set in, the project distributed the first set of 15 "sample" trees to members from five groups. They planted the seedlings at their respective homes, which for most women was a first. While a

few influential men had planted numerous citrus and timber trees in the past, and many men had purchased or collected an occasional tree for plot boundaries or home compounds, this was a new activity for women. The project team monitored the placement and performance of the trees and found the women to be undaunted by the poor performance of the mostly exotic trees in the face of drought, hungry cattle and termites.

When they met to plan the next season's work the five participating groups requested that researchers abandon the soil conservation sites to devote their efforts to group tree nurseries, with provision of additional seedlings from outside to supplement the groups' first efforts. In effect, the women's primary concern was to get the process of tree domestication into their own hands and their own heads within the context of self-help groups. The project team monitored people's choice of species, their choice of nursery sites, their subsequent construction and management of the nurseries, and group members' planting and management of trees. Through their participation, people taught the research team much about their ability and motivation not only to adopt innovations but to innovate independently and in groups. The participants developed alternatives both to their existing systems and to prepackaged "scientific" agroforestry technologies.

The same process of group tree propagation and individual tree planting also demonstrated the clear gender division of control over land and water, as well as the women's substantial skill in negotiating with men for rights of access and use. Each women's group had to prevail upon a wealthy head of household, usually a group leader's husband or relative and in one case the group leader herself, for secure long term access to a site with a reliable water source. All but one of the five groups succeeded in securing a suitable tree nursery site. Likewise individual women negotiated time and space at household level for the planting of their own tree seedlings (Rocheleau, 1991).

After two full seasons of planting trees some group leaders raised questions about the newly introduced exotic species, especially their performance and management over time and in larger scale plantings. In spite of misgivings about the advisability of alley cropping, the researchers arranged a visit by group leaders and interested men and women to the most successful of the original 10 farm trials, to serve as a focus of discussion. Not only did the group members critique the technology as a package, they also chose specific elements (species, planting arrangement, tree management) that appealed to them. Men and women had somewhat different priorities: timber for men and soil fertility and crop production for women. However, elder women heads of household shared the men's interest in timber for home use and for sale, since they needed cash and building material for their households and would have control over both. Women with non-resident (migrant) husbands also expressed strong interest in fodder trees, since they managed livestock.

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Participating group members questioned the field team at length about the rationale and principles of the alley cropping design. Later some women returned to the project extensionist with examples of local practice and individual innovations that constituted more ap-

propriate application of the same principles to serve the purpose of soil fertility improvement with plant biomass. They reported adding leaves and twigs to cattle pens to "bulk up" the manure supply to fertilize cropland. They collected most of the biomass from fencerow trees (including Euphorbia terucalli) and dispersed trees in grazing land (Combretum and Terminalia species). Subsequent discussions with groups revealed widespread experimentation and experience with these recently developed cattle-pen-composting techniques. Many women used leaves of both exotic and indigenous trees common in the area, all of which were resistant to termites and drought.

Through the farm visits and group discussions, researchers learned that women and men in this farm community have ongoing experiments of their own, including women's exploration of formerly male domains of management. They both have much to gain as well as to contribute by participating in formal research with outsiders. Given the experience of group work in private sites, men and women are most likely to contribute effectively to research activities on individual farms, with group participation.

C. Farming and Land Use As If Famine Mattered

As the drought wore on, the project team expected a decreasing interest in trees. Many women faced the over-whelming reality of hunger, water shortages, and fodder shortage, threatening the well-being of their families, and the survival of their draught animals and small stock. However, the famine and fodder shortage spurred a resur-gence of interest in a wide variety of indigenous trees as reserve fodder sources, in tree crops rather than livestock as assets, and in a diversity of wild fruits and vegetables. Wild foods were said to provide nutritious snacks, combat the effects of malnutrition and serve as substitutes for other foods (Rocheleau et al, 1985; Wachira, 1987).

Whole extended families took to the woodlands, bushlands, and in-between places (fencerows, roadsides, and streambanks) in search of possible fodder sources. Some people tested leaf samples of several tree species on their cattle. The elders in the community made a concerted effort to recall which tree leaves had served in the past as drought reserve fodder. However, unlike the last drought and fodder shortage of similar magnitude in 1946, there was less grazing land, less flexibility of livestock movement within the region, and in over 60% of the households women, not men, were responsible for livestock management (as supervisors or directly, as herders). Women relied heavily on their prior knowledge of wild foods and acquired new knowledge about fodder plants through hearsay and widespread experimentation with trees and shrubs in range and woodlands.

Given the role of wild foods and indigenous plants in general as poor people's drought and famine reserves, researchers approached women's groups with the possibility of protecting and managing some of these plants in-situ or domesticating them on-farm within agroforestry systems. While group members were at first incredulous of outsiders' interest in "primitive practices" and "poor people's food", they gradually rallied around the idea. Moreover, they insisted on including medicinal plants, an unexpected turn for two reasons. While the project team had associated traditional medical practice with men, there was a well developed practice by specialized women herbalists (mid-wives and general practitioners) as well as widespread knowledge and practice of basic herbal medicine among women over thirty years of age ("unschooled" and taught by mothers and elder women). The researchers encountered a widely shared concern

over the local disappearance or scarcity of particular medicinal herbs as well as specific indigenous fruits and vegetables.

The subsequent ethnobotanical survey of men and women in the five villages started with the "general public", proceeded to the specialists and went back again to the women's groups and their children (Rocheleau, et al., 1985 and 1989; Wanjohi, 1987; Munyao, 1987; Wachira, 1987). Together they identified 118 indigenous or naturalized wild plant species used for medicine and 45 for food. Of these, participants selected five fruit trees, three vegetables and three medicinal plants for potential domestication in agroforestry systems or small gardens. They also named several fruits, vegetables and medicinal plants as candidates for special protection in place, although women were quite cynical about their ability to enforce management rules in public and shared lands.

While men's and women's priorities varied they knew many of the same places, classes of ecosystems and plant associations. They tended to know and use different species and different products from the same species. Whereas men's widely shared traditional knowledge of indigenous plants had been most developed in rangeland food and fodder, their out-migration, sedentarization and formal schooling had militated against the transmission of this gendered science and practice to the young. Some men knew a great deal about specific classes of wild plants for specialized purposes (charcoal, brick-making, fuel, carving, local timber, bee fodder, and medicine), but the knowledge was unevenly dispersed and decreased markedly among younger men in the community. Among women there was a widely shared, high level of general knowledge about wild food, craft, and medicinal plants, but an overall reduction in scope and depth of proficiency among younger women. However, the knowledge gap between generations of women was not nearly as pronounced as that for men.

Some members of the community attributed the persistent decline in indigenous knowledge to formal schooling and rejection of "primitive" traditions by the young. Moreover men's outmigration had removed adult men as tutors and created a labor shortage and double workload for women, leaving little time for traditional education in multi-generational groups of either sex. Women now had different rights and responsibilities than in the past and had to acquire and maintain an ever broader range of new knowledge and skills (Rocheleau, 1991).

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The differential erosion of local ecological science among men and women may also reflect their respective rights, responsibilities and opportunities in farm versus wage labor sectors. While women maintain livelihoods and retain their rights of access to land through residence and agricultural production, young men can aspire to leave home and to succeed as wage laborers in nearby cities and towns, without fear of sacrificing their long term access to land. The feminization of famine and drought response and the requisite science of survival reflects the new spatial division of labor between men and women into rural and urban domains. This experience also demonstrates that the boundaries of gendered knowledge are neither fixed

nor independent. Content and distribution of gendered knowledge influences and is influenced by the gender division of rights and responsibilities in national, regional and local context (Rocheleau, 1991).

D. One Man's Field Becomes a Women's Group Commons

The importance of wild plants during the drought was obvious, as was the increasing responsibility of women to maintain the knowledge about them for the community at large. The ethnobotany survey also confirmed that most women normally drew upon fodder, fuelwood and sometimes wild food sources beyond the boundaries of household land, as did their children. However, those most reliant on resources outside their own land stated that their children were unlikely to enjoy the same facility of access to shared lands[4] in the future. They noted that community level land tenure, land use and vegetation changes proceeded on their own momentum, outside the control of individuals and small groups.

Since small-holders and legally landless women relied on the shared use of private lands to make use of wild plants (Rocheleau, 1989; Rocheleau and Fortmann, 1988), they had every reason to focus on social strategies to secure and maintain access to wild plants or on alternative ecological strategies for meeting contingencies. Their future access to these resources on shared lands would depend on careful cultivation of social and political networks, as would their influence on soil, plant and water management decisions taken by largeholders and male owners of family plots. Poor women's experience during the drought exemplified the careful interweaving of social and ecological knowledge to survive in the cross-currents of erratic environmental conditions with uncertain terms of resource use, access and control.

As the drought persisted peoples' terms of access to "off-farm lands" acquired increasing importance and their domains of use and access became clearer as individuals and groups relied more and more on shared resources as reserves. The map of actual land use and source areas which emerged from their activities bore little resemblance to the formal survey maps that denoted ownership, yet was in large part circumscribed by these legal boundaries established in 1972.

Off-farm lands as used here denotes any land outside the household property of the user. In Kathama, it includes roadsides (public land), stream banks and riversides (a combination of public and private property), hillslope woodlands (mostly private land), the dry forest across the river (national government land) and most importantly, the grazing lands, woodlands, fencerows and gullies of other farmers (private holdings, small, medium and large). The latter category became increasingly significant as grazing and browsing animals and individual collectors depleted the reserves in less protected areas. Moreover, the private holdings were usually much closer to the users' homes and farmlands, which reduced the long treks for both people and their livestock when both were already weakened by hunger and malnutrition.

When drought gave way to famine the women's groups emerged as a critical link to shared use of private lands. As the community tacitly declared a state of emergency, so did they call upon those with

[4]The term "shared lands" is used as an alternative to common land since the formal definition of the latter (Bromley, 1986) excludes the complex pattern of use, access and control described here.

greater resource endowments to share an increasing proportion of those resources with others. However, this social pressure applied to the act of sharing, not to the naming of the beneficiaries; in fact, participants would be a more apt term, since those in need were recognized by largeholders according to longstanding relationships of reciprocity, most often and most predictably in the context of kinship or women's self help groups (Rocheleau, 1991).

In effect, the community peeled back the survey map to reveal another map of potential use and users, derived from traditional rules of reciprocity and mutual aid. Yet the power to determine exactly who could use exactly which resources, and where, had shifted from the community and large kin groups to the individuals who controlled the legal boundaries. Thus a third map emerged which combined traditional norms with new loci of power, at both community and household level. The fact that men actually owned most of the private plots and formally controlled the public lands, set the stage for a gendered struggle for access to resources no less serious for its finesse and skillful manipulation by individual women and self-help groups (Rocheleau, 1991).

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Poor women's new and traditional knowledge of ethnobotany was necessary but not sufficient for coping with drought and famine. They also required access to resources controlled by men at household and community level. Women's groups and individuals mobilized substantial political skill to legitimize and tap their "social credit" at household, group and community levels.

E. The Name of the Famine

All subsequent discussions of species preference, tree management and land use for the next two years were influenced by the experience of the drought. Not only had people re-discovered trees and wild plants as sources of food, fodder and medicine, they had observed the diminished but still substantial yield and the survival of one man's citrus orchard in comparison to the death or distress sale of their livestock. Moreover, there was widely shared interest in planting fodder trees and in the introduction of fruit trees for both home use and sale (Figure 9). Many people had acquired a healthy skepticism about over-reliance on cash income to offset the effects of famine.

In fact, this last point illustrates an oft-neglected dimension of indigenous knowledge: the learning, storage and transmission of knowledge about social, political, economic and environmental change in the form of oral history, particularly in the naming of events. In the case of Kathama, most men now relate historical events to years, by number or to the major wars of the twentieth century; World Wars I and II and Kenya's own Independence struggle. Women, by contrast, "reckon time in famines, and remember them by name" (Alice Mwau, personal communication, 1989). While all people in the area formerly used famines and similar events to mark historical periods, the men have increasingly adopted the numbers and categories of outsiders, while women retain the more traditional, local categories for recounting the past. The name of the last famine, as reported by an elder women's group leader, captures the painful irony of the changing times: "I shall die with the money in my hand" (Alice

Mwau, personal communication, 1989; Rocheleau and Jama, 1989). Distress sale of major assets such as teams of oxen, cattle and small livestock provided small amounts of cash which were grossly inadequate in the face of a national scale food shortage. Poor rural people learned that the terms of the exchange with the national market could fluctuate markedly and unpredictably. The famine name suggests that the Akamba people of Machakos and Kitui Districts reconsidered the terms of their integration into national markets and came away with renewed resolve to maintain a greater degree of food self-sufficiency.

The codification of knowledge in the form of famine names records the central surprise of the last famine, makes sense of the experience, preempts the surprise of similar incidents in subsequent years and informs practical, popular planning measures to prevent future famines altogether. As exemplified by the name of the last famine, rural women's indigenous knowledge extends well beyond the confines of botany and agriculture, and well into the domains of environmental history and practical political economy. Moreover, it is not a knowledge guarded exclusively by women, but rather, is increasingly carried and nurtured by them on behalf of the community at-large.

The name of the last famine, as reported by an elder women's group leader, captures the painful irony of the changing times: "I shall die with the money in my hand"

Figure 9. Women's Terraced Croplands with Fruit and Fodder Trees

IV. Gendered Knowledge and Practice

Perhaps the most salient feature of ethnoscience research with rural women and men is that it can "buy time" and "create space" for each to take stock of the larger scale processes working against ecological, economic and cultural diversity in their rural landscapes. If research results in documentation and discussion of gendered ethnoscience at the community level, then both rural women and men may make more informed choices about which species, which skills and which visions of nature and society to carry into the shaping of their emerging ecological and economic futures. One clear implication for policymakers is the need to recognize and document gendered local science and practice within existing research and development programs as well as in special efforts focussed on indigenous knowledge.

The international scientific and development communities have tended to ignore rural peoples' science or have separated it from the larger context of daily life, labor and livelihoods. Social scientists and ecologists alike often recast "indigenous knowledge" as an ethnographic artifact, as "unconscious ecological wisdom" or as part of the "environment" for the generation and introduction of new technology. Even these very partial and objectified views of rural peoples' science have not often been studied and understood as gendered knowledge and practice. We face the double task of re-shaping the terms of discourse about popular, local ecological science (Thrupp, 1989; Bebbington, 1990) and introducing women's science and women's interests into the larger domain.

There is little doubt as to the utility of cataloging some discrete bits of rural women's ecological knowledge. An encyclopedic compendium of wild and cultivated plants can improve our collective ability to survive and flourish and our contributions to "sustainable" and equitable development elsewhere. Even extractive documentation and conservation of such knowledge is preferable to complete loss of the information. However, there is even more to be gained by an ethnoscience research approach based on empowerment of rural people rather than simple extraction of their knowledge.

For example, an action research program might facilitate the discussion and transfer of knowledge between men, women and children, as their roles, responsibilities and interests change[5]. This process

An action research program might facilitate the discussion and transfer of knowledge between men, women and children, as their roles, responsibilities and interests change[5]

[5] For a separate discussion of the methods used in the field work and those appropriate for further action research see Chambers, et al., 1989; ILEIA, 1988; Jiggins, 1986; Rocheleau, et al., 1988; Rocheleau, 1991.

could result in re-negotiation of the division of rights and responsibilities as well as domains of knowledge and skill, though not without substantial struggle over conflicting interests at household, community and larger units of organization. The mere recognition and documentation of survival as a gendered science in harsh and unpredictable environments (political, economic, ecological) could also effect change at local and national level. Such a process could serve to legitimize and strengthen rural women's and men's separate, shared and interlocking knowledge as tools to shape their own futures.

In summary, the interests of both women and men in agroforestry projects and practices can best be served by the adoption of a user-focussed approach to technology design and land use planning, with special attention to the gender division of resources, knowledge, work and benefits. Once the existing gender division of land use and interests is understood, then fieldworkers and policymakers alike may build upon this to reinforce complementarity, resolve conflicts and restore the balance between the rights and responsibilities shared between men and women in traditional, evolving or experimental land use systems. Such an explicit and flexible treatment of the gender division of land use could help to reconcile the objectives of environmental sustainability, social equity and economic productivity from individual to national level.

Bibliography

Agarwal, B. 1991. "Engendering the Environment Debate: Lessons from the Indian Subcontinent." CASID. Distinguished Speaker Series No. 8. Michigan State University. Fast Lansing.

Bebbington, Tony. 1990. "Farmer Knowledge, Institutional Resources and Sustainable Agricultural Strategies: A Case Study from the Eastern Slopes of the Peruvian Andes." Bulletin of Latin American Research. Vol. 9. No. 2.

Bromley, D. 1986. "The Common Property Challenge." In National Academy of Science Proceedings of the Conferences on Common Property Resource Management. National Academy Press.

Chambers, R., A. Pacey and L.A. Thrupp (eds.). 1989. Farmer First: Farmer Innovation and Agricultural Research. London: Intermediate Technology Publications.

Chavangi, N.A. 1984. "Cultural Aspects of Fuelwood Procurement in Kakamega District." KWDP Working Paper No.4. Kenya Wood Fuel Development Project. Nairobi.

Collinson. 1979. "Research Planning Study. Data presentation: Parts of lower, drier areas of Northern Division, Machakos." Nairobi: CIMMYT/Medical Research Centre.

Dankelman, Irene and Joan Davidson. 1988. Women and Environment in the Third World: Alliance for the Future. London: Earthscan Publications Ltd.

Fernandez, Maria. 1988. "Technological Domains of Women in Mixed Farming Systems of Andean Peasant Communities." In S. Poats, M. Schmink and A. Spring. (eds.). Gender Issues in Farming Systems Research and Extension. Boulder: Westview Press.

Fleuret, Ann. 1979. "Methods for Evaluation of the Role of Fruits and Wild Greens in Shambaa Diet: a Case Study." Medical Anthropology. Spring.

Fliervoet. 1982. "An Inventory of Trees and Shrubs in the Northern Division of Machakos District, Kenya." Nairobi: ICRAF. Wageningen: Wageningen Agricultural University.

Gielen. 1982. "Report on an Agroforestry Survey in Three Villages of Northern Machakos." Nairobi: ICRAF, Wageningen: Wageningen Agricultural University.

Ginneken, J. van. 1981. "Second Progress Report on Analyses of Demographic Data of Joint Project, Machakos, Between 1974 and 1980." Nairobi: Medical Research Centre.

Ginneken, J.K. van and A.S. Muller. 1984. Maternal and Child Health in Rural Kenya. An Epidemiological Study. Kent: Croom Helm Ltd.

Hoek, Annet van den. 1983. "Landscape Planning and Design of Watersheds in the Kathama Agroforestry Project, Kenya." Master's Project Report. Department of Landscape Architecture and Planning. Wageningen.

Hoskins, Marilyn. 1983. Rural Women, Forest Outputs and Forestry Projects. Rome: FAO.

ILEIA. 1988. "Participative Technology Development." ILEIA Newsletter. Vol. 4. No. 3. October.

Jaetzold, R. and H. Schmidt. 1983. Farm Management Handbook of Kenya, Vol II, Part C, East Kenya. Nairobi: Government of Kenya, Ministry of Agriculture.

Jama, M. and L. Malareh. 1992. Farmer/Researcher Collaborative Approach to Rural Development. Final Project Report to IDRC, Nairobi.

Jiggins, Janice. 1986. "Problems of Understanding and Communication at the Interface of Knowledge Systems." In S. Poats, M. Schmink, and A. Spring. (eds.). Gender Issues in Farming Systems Research and Extension. Boulder: Westview Press.

Kang, B.T. and G.F. Wilson. 1987. "The Development of Alley Cropping as a Promising Agroforestry Technology." In H.A. Steppler and P.K.R. Nair (eds.). Agroforestry: A Decade of Development. Nairobi.

King, Ynesta. 1989. "The Ecology of Feminism and the Feminism of Ecology." In Judith Plant (ed.). Healing the Wounds. Philadelphia: New Society Publishers.

Merchant, Carolyn. 1980. The Death of Nature: Women, Ecology and the Scientific Revolution. San Francisco: Harper and Row.

Merchant, Carolyn. 1989. Ecological Revolutions: Nature, Gender and Science in New England. Chapel Hill: University of North Carolina Press.

Meyerhoff, Elizabeth. 1982. "The Socio-economic and Ritual Roles of Pokot Women." Anthropology Ph.D. Thesis. Cambridge University.

Munyao, P. 1987. "The Importance of Gathered Food and Medicinal Plant Species in Kakuyuni and Kathama Areas in Machakos." Annex 1 in K.K. Wachiri (ed.). Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials. Final Project Reports. ICRAF. Nairobi.

Moore, Henrietta, and Megan Vaughan. 1987. "Cutting Down Trees: Women, Nutrition and Agricultural Change in the Northern Province of Zambia, 1920 - 1986." African Affairs. Vol. 86. No. 345: 523-40.

Murphy, Yolanda and Robert Murphy. 1974. Women of the Forest. New York: Columbia University Press.

Muthiani, L. 1973. Akamba from Within: Egalitarianism in Social Relations. New York: Exposition Books.

Nijssen, O. 1983. "Nutrient Cycle Study of the Cultivated Area and a Study on the Use of Manure in the Kathama Research Areas." M.Sc. Thesis for the Department of Soil Fertility and Plant Nutrition. Wageningen Agricultural University. Wageningen.

Raintree, J.B. 1984. "A Diagnostic Approach to Agroforestry Design." In K.F. Wiersum (ed.). Strategies and Designs for Afforestation, Reforestation and Tree Planting. Wageningen: PUDOC.

Redclift, Michael. 1987 Sustainable Development: Exploring the Contradictions. New York: Methuen and Co.

Rocheleau, Dianne. 1991a. "Gender, Ecology, and the Science of Survival." Agriculture and Human Values. Vol. 8, No. 1: 156-165.

_____. 1991b. "Participatory Research in Agroforestry; Learning from Experience and Expanding Our Repertoire." Agroforestry Systems. Vol. 9. No. 1.

_____. 1990. "Gender, Conflict and Complementarity in Social Forestry: A Land User Approach." Paper presented to the Sub-Plenary on Social Forestry, IUFRO Quinquennial Congress. Montreal. August.

_____. 1989. "The Gender Division of Work, Resources and Rewards in Agroforestry Systems. In A.E. Kilewe, K.M. Kealey and K.K. Kebaara (eds.). Agroforestry Development in Kenya. Nairobi: ICRAF.

_____. 1988. "Women, Trees and Tenure." In L. Fortmann and J. Bruce (eds.). Whose Trees? Proprietary Dimensions of Forestry. Boulder: Westview.

_____. 1987. "A Land User Perspective for Agroforestry Research and Action." In H. Gholz (ed.). Agroforestry: Realities, Possibilities and Potentials. Dordrecht: Martinus Nijhoff.

_____. 1985. "Criteria for Re-Appraisal and Re-Design. Intra-Household and Between-Household Aspects of FSRE in Three Kenyan Agroforestry Projects." Working Paper No. 37. Nairobi: ICRAF. November.

Rocheleau, D., P. Benjamin and A. Duang'a. 1992. "Single Perspectives on Separate Realities: A Century of Recurrent Crises in Ukambani, Eastern Kenya. In J. Kasperson, R. Kasperson and B.L. Turner (eds.). Critical Zones in Global Environmental Change. Tokyo: UNU Press. (forthcoming).

Rocheleau, D. and L. Fortmann. 1988. "Women's Spaces and Women's Places in Rural Food Production Systems: The Spatial Distribution of Women's Rights, Responsibilities and Activities." Paper presented to the 7th World Congress of Rural Sociology. 25 June - 1 July. Bologna, Italy.

Rocheleau, D. and A. Hoek. 1984. "The Application of Ecosystems and Landscape Analysis in Agroforestry Diagnosis and Design: A Case Study from Kathama Sublocation, Machakos District, Kenya." Working Paper No. 11. Nairobi: ICRAF.

Rocheleau, D. and M. Jama. 1989. "Annual Report of Farming Systems and Ethnoecology Research Project." Summary of interview with elders at Kathama. Manuscript. Nairobi: IDS.

Rocheleau, D., P. Khasiala, M. Munyao, M. Mutiso, E. Opala, B. Wanjohi and A. Wanjuana. 1985. "Women's Use of Off-farm Lands: Implications for Agroforestry Research." Project report to the Ford Foundation. Mimeo. Nairobi: ICRAF.

Rocheleau, D., K.K. Wachira, L. Malaret and B. Wanjohi. 1989. "Ethnoecological Methods to Complement Local Knowledge and Farmer Innovations in Agroforestry." In A. Pacey, R. Chambers and L. Thrupp (eds.). Farmer First. London: Intermediate Technology.

Rocheleau, D., F. Weber, and A. Field-Juma. 1988. Agroforestry in Dryland Africa. Nairobi: ICRAF.

Shiva, Vandana. 1988. Staying Alive: Women, Ecology and Development. London: Zed Press.
Shostak, Marjorie. 1981. Nisa: The Life and Words of a !Kung Woman. New York: Vintage Books.

Thrupp, L.A. 1989. "Legitimizing Local Knowledge: From Displacement to Empowerment for Third World People." Agriculture and Human Values. Vol. 6. No. 3: 13-24.

Vonk, R.B. 1983a. "Report on a Methodology and Technology Generating Exercise." Wageningen Agricultural University. Wageningen.

Vonk, R.B. 1983b. "A Study of Possible Agroforestry Tree Species for the Kathama Area." M.Sc. Thesis. Department of Silviculture. Wageningen Agricultural University. Wageningen.

Wachira, K.K. 1987. "Women's Use of Off-farm and Boundary Lands: Agroforestry Potentials." Project report to the Ford Foundation. Mimeo. Nairobi: ICRAF.

Wanjohi, B. 1987. "Women's Groups' Gathered Plants and Their Potentials in the Kathama Area." Annex 1 in K.K. Wachira (ed.). Women's Use of Off-Farm and Boundary Lands: Agroforestry Potentials. Final Project Report. Nairobi: ICRAF.

Wijngaarden, L. van. 1983. "Patterns of Fuel Gathering and Use." M.Sc. Thesis. Department of Forestry Management. Wageningen Agricultural University. Wageningen.