Conservation for Development in Botswana, Kenya, Somalia, Sudan

Rural Energy in an Arid Sub-Location of Meru District, Kenya

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African-Caribbean Institute

Mohamud Abdi Jama received an honors baccalaureate from the University of Nairobi. Subsequently, he was awarded a Fulbright graduate fellowship in agricultural economics at Washington State University, where he earned both the M.A. and Ph.D. degrees. He is currently employed as a research associate in the Institute of Development Studies, University of Nairobi. Dr. Jama's fellowship research centers on the ways in which energy costs and policies influence fuelwood consumption, standards of living, overall economic performance, and environmental standards on the arid and semi-arid lands of Kenya's Meru District.

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FOREWARD

This publication is a part of a larger body of materials from eight authors in eastern and southern Africa that have been sponsored by the African-Caribbean Institute's Natural Resource Project. The combined works are in three main sectors. Papers by Betty Wamalwa and Mutasim El Moula focus on traditional institutions in environmental management in Kenya and Sudan. Papers by Mohamud Jama, Ahmed Yasin, Ahmed Hassan, and Amina Warsame are concerned with specific sector issues in energy, dry land fishing, camel husbandry, and women in forestry in Kenya and Somalia. The final section by Eagilwe Segosebe and Alawiyya Ahmed concerns modern industrial waste management problems in Botswana and finally the important issues of environmental education in Sudan.

Further studies will focus on issues of forestry and women and the preservation of biological diversity in eastern and southern Africa. As with the projects that are nearing completion or currently underway, the African-Caribbean Institute will edit, publish, and disseminate the works. This commitment and all other aspects of the African Fellowship Program are intended to serve ACI's ultimate goal of assisting in the quest for genuinely African solutions to African problems of resource conservation and development.

In addition to those who participated in the project, the African-Caribbean Institute wishes to thank Dr. Richard Ford of Clark University who served as Senior Natural Resources Advisor and the national advisers in each country. We are also grateful to John Gaudet and John Kochring at USAID and to Diane Rocheleau and Eric Rusten of the Ford Foundation for advice and support.

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RURAL ENERGY IN AN ARID SUB-LOCATION OF MERU DISTRICT, KENYA

INTRODUCTION

Until about 12 years ago, the role of traditional fuels in the economic development of Kenya occupied a back seat. Energy researchers and economists either neglected, or did not recognize traditional sources of fuels as a variable in overall energy equations, even though they are generally the major energy sources available to rural dwellings and urban slums. For instance, it was only in about 1980 that "...use of biomass-fuels by ordinary households for cooking, space heating and even lighting also began to be accepted as "energy" (O'Keefe, et al. p. i). In order to understand the reason for this situation, it is imperative to examine the developmental policies pursued by Kenya shortly after attaining independence in the early 1960s.

Prior to the late 1970s, development had been considered to be synonymous with economic growth in Kenya. The basis for "development" was assumed to be the modernization of the industrial sector. The modern industrial sector was given dominant consideration in plans, programs, and potential projects to be undertaken. As a testimony to this popular faith in the efficiency of the industrial sector, the United Nations set the goal of a 5% annual increase in GNP for developing countries in its first Development Decade (1960-1970). To attain this growth rate, heavy industrialization was thought to be the key, and construction of factories, power plants, and modern industrial infrastructure was promoted on a grand scale. Energy intensive technology was stressed on the grounds that it was the most effective means of increasing industrial output.

In Kenya, the industrial sector thus captured most attention, both in the developmental literature and in governmental policy decisions. Rostow's idea of the process of transformation from the initial state of "traditional society" to a "take-off" state formed the basis for this model. Arthur Lewis' model, later modified by John Fei and Gustav Ranis, exercised further influence on this school of thought. This "industry-first" strategy either ignored or subordinated the rural sector. It exacerbated an already dualistic Kenyan economy, featuring a developing modern sector, a neglected traditional sector, and an urban/rural disparity.

The dualism that existed in Kenya's economy during the period from 1963 to 1973 parallels the dualistic nature of Kenya's energy plans and policies. Energy policy focused mainly on commercial fuels, especially oil and electricity. Traditional sources of fuel, fuelwood, charcoal, etc., on which over 80 percent of the populace depend, attracted much less attention and was often treated only spuriously in the country's energy policy.

As a result of the 1973/74 oil "shocks" and consequent price increases, Kenya relaxed its long-term development programs and concerned itself with economic survival. A more balanced energy policy soon assumed a prominent role in development policy. Its importance was reflected in the creation of a new Ministry of Energy in late 1979. The Kenya Government showed interest in managing locally available energy resources, including forest products. In its broader objective, the Ministry of Energy expressed concern, at least on paper, about rural households' energy problems. However, even after the establishment of the Energy Ministry, the same problem of energy imbalance afflicting rural and urban sectors was still apparent. In particular, the largely rural arid and semi-arid areas (ASAL) received disproportionately less consideration with regard to the "other energy crisis." Policy makers, energy researchers, and economists are still largely concerned with issues such as geological surveys and oil explorations in the Kenyan ASAL.

One legacy of this neglect is that comparative data on rural energy in the the ASAL are woefully insufficient. Although research on this urgent topic has begun in the last few years, empirical knowledge and a conceptual framework are still lacking. The object of this paper is empirically to examine ASAL energy use and thereby contribute to an

understanding of Kenya's energy situation and needs.

PROBLEM SETTING

Energy cost and availability are potential constraints on economic growth. In Kenya, which faces one of the world's highest population growth rates along with structural transformations that imply a rise in fuel use, energy cost and the security of supply have become issues of major concern. With the rapid increase in energy prices and the general world economic recession that followed the 1973/74 oil crisis, this concern has assumed greater intensity.

The "other energy crisis" also afflicts Kenya, especially the rural communities. Among the rural communities, those located in areas endowed with fewer natural resources face particularly severe impacts from the "other energy crisis," on account of fragile ecosystems and an increasing population. Households in the drier parts of the country do not have much option in their choice of fuel because of constraints on income, time, and accessibility to conventional fuels.

As population pressures create wood scarcities, the satisfaction of a family's basic cooking and heating energy needs in the marginal areas tends to require more labour time. Peasants and other poor people are now forced to venture farther afield for fuelwood. As Eckholm notes: "A recent survey in rural Kenya found some women spend up to 20-24 hours per week collecting fuelwood" (Eckholm et al., p. 14). Walking longer distances to cut, collect, and carry fuelwood is not only tedious and menial, but also imposes an additional burden on families already living subsistence lives. Furthermore, time spent on fuelwood collection by residents of arid areas reduces their time for other productive purposes.

Fuelwood problems result from low incomes. The poor in the marginal areas cannot afford conventional fuel at current prices, let alone the appliances required to make electric and gas cooking possible. Since the poor in the marginal areas cannot afford alternative fuels, they rely heaviiy on fuelwood - thus exacerbating fuelwood shortages. In a well-developed monetary market, scarcity of fuelwood means increases in price; and a price rise exerts forceful impact on the marginalized rural families in the marginal rainfall areas. Relatively wealthier households are generally expected to switch to commercial fuels, but most still use some fuelwood. Dunkerley, et. al., notes that even some of those enjoying sufficient incomes will not substitute commercial fuels for the traditional open fire. Such pressures on fuelwood and its inefficient use may have assumed such a proportion that they inevitably imply continuing, even accelerating, deterioration of the physical environment.

Another problem of households' reliance on fuelwood in a fragile ecosystem is the association between food shortage and fuelwood shortage. Excess wood cutting degrades the ecosystem, thus affecting its food-production capacity and placing additional hardships on families in marginal areas. With fuelwood scarcity and consequent food shortage, cooking habits in such areas may change, which means cooking fewer meals a day. Such a move will adversely affect families in arid areas, especially the poor. Households in marginal parts of the country are caught in a vicious circle, and face enormous hurdles in order to meet their basic food, fodder, and fuelwood needs.

Briefly then, ASAL low income households endure physical health problems and long distance walks to gather firewood due to increased fuelwood scarcity. Policy makers face a dilemma. On the one hand is the problem of ecosystem destruction that accompanies indiscriminate fuelwood use. On the other hand is the need for cheap and easily accessible energy for the rural people. A policy of trying to divert pressure on fuelwood by making commercial fuels available would have adverse effects on national economic conditions.

In light of these problems, this study is designed to look at fuel consumption patterns among households in five villages in Nithi Division of Meru District. The study will examine energy use and factors affecting use. Interaction and potential substitution among commercial and non-commercial energy sources will be investigated. In looking at these issues, the focus will be on the problem of choosing policies relating to some of the variables used,

such that they will bring a better pattern of energy use, minimize environmental destruction, and minimize adverse impact on low-income ASAL households. Specifically, this study will look at questions such as how improved education, family size, and improved purchasing power of the ASAL families affect energy use.

STUDY OBJECTIVES

The overall purpose of this study is to determine how energy costs and policies affect energy consumption, level of living, and economic activity in ASAL areas of the country. Specific objectives are:

1. To determine energy consumption patterns in a cross-section of rural ASAL households in Meru District;

2. To analyze how energy-use patterns are related to socioeconomic, demographic, institutional, and energy market factors;

3. To assess how various energy policy measures would be likely to affect energy use and household economies in the ASAL areas.

BACKGROUND TO MERU DISTRICT

Location and Size. Meru District is a relatively productive area of Eastern Province. It is bordered by Embu, Nyeri, Laikipia, and Kirinyaga Districts as well as the ASAL Districts of Isiolo and Kitui (Figure 1). Prominent landmarks of the district are the Nyambene Hills to the north-east and Mount Kenya to the west. The district lies at about 1° on either side of the equator, and at between 37° and 38° east longitude. The total area of Meru District is approximately 9,900 sq. km and the district headquarters, Meru Town, lies about 250 km from Nairobi.

Administration. Administratively, Meru District is made up of seven divisions. These divisions are divided into 38 locations which in turn are subdivided into 137 sub-locations. The names of the divisions, and the numbers of their locations and sub-locations, are indicated in Table 1.

Table 1. Administrative Breakdown of Meru District

Division	Location	Sub-Locations
Nithi	6	30
South Imenti	6	15
Tharaka	3	11
Igembe	7	20
Tigama	8	22
North Imenti	7	34
Timau	1	5
Total	38	137

Source: Meru District Development (1984-88).

Topography. The environmental and agricultural potential of Meru District is greatly influenced by the two dominant topographic features, Mt. Kenya and Nyambene Range. The land slopes gradually from an easterly to a westerly direction. Both the slopes of Mt. Kenya and Nyambene Range have streams that have carved deep incisions into igneous bedrock, especially in the south. The altitude of the district varies from approximately 17,000 ft (5,300 m) above sea level at its highest point, to about 1100 ft (330 m) close to the Tana River. As a result of these physical features and variation in altitude,

the district contains diverse climatic and agro-ecological zones. Climatic and soil conditions conducive to growing tea, maize, and coffee rapidly change into arid and semi-arid areas which are very difficult for agriculture.

Although a large portion of Meru District is productive, the entire area faces potential ecological problems because of accelerated denudation of forests, increased population growth, and increased land fragmentation. These problems bear the potential for severe damage to the environment and its flora and fauna, as well as to agricultural productivity and the provision of infrastructural services. In particular, the ASAL areas of the district must contend with an already precarious ecosystem. Because of these features, lower Meru District seemed quite suitable for our rural energy study. A further motivation to undertake fuelwood survey here was the convenience of the location and the cooperation extended by the local people as well as the local authorities.

The district can be divided into four major agro-ecological zones (Figure 2). Table 2 indicates the size of each agro-ecological zone.

From the table it can be seen that, of the total number of agro-ecological zones, about one third (192,000 ha) consists either of marginal farming areas or of rangeland. High potential areas in agro-ecological zones, Upper Midland (UM) and Tropical Alpine (TA), have fertile soils and plentiful water. These areas are, therefore, suitable for small-scale farming. Crops such as tea, coffee, maize, and potatoes grow well in these areas. Grade cattle also do well. It must, however, be noted that some parts of these agro-ecological zones' upper highland and tropical alpine locations are excessively cold and wet, and hence are less suited to cropping. In the marginal zones - mainly the Lower Midland (LM) and Inland Lowland (IL) - there is too little rainfall and too much heat for tea and coffee cultivation. However, crops such as millet, sorghum, and cotton can be found in this drier area. It is also suitable for native cattle. It is important to note that most of these marginal areas are in the Nithi, Tharaka and Igembe divisions. Tables 3 and 4 depict these conditions.

Table 2. Land Classification of Meru District

Category	Agro-Ecological Zone	Area (ha)
High Potential	Agro-Ecozones 1 & 2	155,000
Medium Potential	Agro-Ecozone 3	250,000
Marginal Potential	Agro-Ecozones 4 & 5	124,800
Rangeland Potential	Agro-Ecozones 6 & 7	67,200

Source: Meru District Development (1984-88).

METHODS AND SURVEY RESULTS

Sampling and Data Collection. The survey was designed to examine energy consumption patterns in a marginal area of Meru District, Kenya. Data were obtained through interviews with a sample of eighty households in Mutino Sub-Location, Kanjuki Location, Nithi (Tharaka) Division of Meru District (Figure 3). Five villages in Mutino Sub-Location were identified, namely: Kathwana, Yuumu, Ntoro, Munguni, and Kawangasege. Sixteen households were selected at random in each of these village enumeration areas. At the time of the survey, there were a total of 198 households in the five villages. A few uncooperative households were dropped from the survey, while three questionnaires that showed data either lacking or unreliable were deemed unfit to be included in the analysis. The effective sample size for this study is, thus, seventy five households, representing a 37.9% random sample selection of the total number of households in the five villages.

The questionnaire was designed to obtain socio-economic, demographic and institutional information. The information gathered included source of fuel and amount of fuel used, consumption habits, cooking facilities, family size and occupation, family economic status and

Table 3. Availability of Agricultural Land Within Six Divisions of Meru District

Division without Township	Total Area (1979)	Non-Agricultural Land			Total Agricultural Land	Area in Agro-Ecological Zones (AEZ)						Available Agricultural Land per Household	Available Agricultural Land per Person
		Unsuitable (steep slopes)	Forest Reserves	Others (roads, rivers, homesteads)		TA	UH	LH	UM	LM	IL		
	(sq. km)	-------(sq. km)-------			(sq. km)	-------(sq. km)-------						---(ha/unit)---	
North Imenti	1,576	28	14	157	1,377	9	331	283	417	337		5.10	0.92
South Imenti	390			65	325			52	171	102		1.80	0.32
Nithi	637	16	25	98	498			20	162	314	2	2.07	0.36
Tharaka	1,495	37	89	92	1,277*					381	896	13.46	2.53
Tigania	650	54	47	88	461			9	136	316		1.78	0.33
Igembe	1,698	87	54	173	1,384			6	242	1079	57	4.70	0.83
TOTAL RURAL AREA	6,446	222	229	573	5,322	9	331	370	1,128	2,529	955	3.97	0.71

Note: * A computational error in the source material was adjusted
Source: Kenya Ministry of Agriculture and Livestock, 1983.

Table 4. Agro-Ecological Zones and Agricultural Potential in Meru District

Agro-Ecological Zone (altitude in meters)	Very Good & Good Yield Potential	Fair & Poor Yield Yield Potential	Livestock, Pasture, & Forage
Tropical Alpine Zones			
TA 0 : rock/glacier	No land use.		
TA I : cattle/sheep	National Park.		Limited grazing.
TA II: sheep	National Park.		Limited grazing.
Upper Highland Zones			
UH 0: forest	Forest reserve, bamboo thickets.	Catchment area.	Sheep, dairy cattle.
UH 1: sheep/dairy	Forest reserve, valuable timber.	Catchment area.	Sheep, dairy cattle.
UH 2: pyrethrum/wheat (2,440-2,740 m)	Forest reserve, wheat, barley, peas, vegetables, pyrethrum.	Maize, potatoes, plums, apples.	Kikuyu grass, rye, oats, clover, sheep, dairy cattle.
UH 3: upper wheat/barley (2,230-2,900 m)	Wheat, barley, green onions, cabbage.	Sunflowers, potatoes, peas.	Natural grassland, clover, barley, sheep, beef cattle.
UH 4: ranching	Not suitable for rainfed agriculture.		Natural grassland, clover, sheep, beef cattle.
Lower Highland Zones			
LH 1: tea/dairy (1,830-2,200 m)	Forest reserve, cabbage, peas, kale, potatoes, carrots, tea, loquats.	Beans, plums, maize, pyrethrum.	Kikuyu & Napier grass, clover, beets, dairy cattle.
LH 2: wheat/maize/pyrethrum (1,890-2,130 m)	Wheat, barley, sunflowers, linseed, potatoes, peas, pyrethrum, wattle.	Beans, plums, maize, rapeseed, apples, pears, strawberries.	Kikuyu & Napier grass, Nandi setavia, clover, beets.
LH 3: wheat/maize/barley (2,070-2,220 m)	Wheat, barley.	Beans, peas, linseed, sunflower, potatoes, kale, green onions, avocadoes, maize.	Natural grassland, Rhodes grass, Nandi setavia.
LH 4: cattle/sheep/barley (2,070-2,210 m)		Barley, wheat, green onions, maize.	Natural grassland, barley.
LH 5: ranching	Not suitable for rainfed agriculture.		Short-grass savanna. Severe erosion if overgrazed.

Upper Midland Zones			
UM 1: coffee/tea (1,520-1,800 m)	Cabbage, kale, maize, millet, beans, potatoes, sunflower, onions, tomatoes, tea, coffee, bananas, yams,pawpaws, passion fruit, avocadoes, wattle, miraa.	Citrus, sweet potatoes.	Napier grass, banana, potatoes.
UM 2: coffee (1,280-1,680 m)	Millet, sorghum, beans, sweet potatoes, sunflowers, cabbage, kale, tomatoes, onions, coffee, bananas, pawpaws, loquats, avocadoes, citrus.	Maize, cassava, yams, sugar cane.	Star grass, Napier & Bana grass, bananas, sweet potatoes, maize.
UM 3: marginal coffee (1,280-1,520 m)	Maize, sorghum, beans, sunflowers, onions, cabbage, pineapples.	Sweet potatoes, pigeon peas, kale, citrus, tomatoes, coffee, cassava, bananas.	Napier & Bana grass, sweet potatoes.
UM 4: sunflower/maize (1,520-1,770 m)	Sorghum, beans, sunflowers, sisal.	Maize, millet, tobacco, tomatoes, onions, cassava, pineapples, sweet potatoes.	High-grass savanna, Bana grass, legumes, saltbush.
UM 5: livestock/sorghum (1,520-1,770 m)		Sorghum, maize, beans.	Mixed grassland, hay, silage, sorghum.
UM 6: ranching	Not suitable for rainfed agriculture.		Short-grass savanna, saltbush.
Lower Midland Zones			
LM 3: cotton (910-1,280 m)	Millet, sunflower, katumani maize, sorghum, cowpeas, green grams, soya beans, chick peas, beans, sweet potatoes, tobacco, cotton, sisal, cassava, castor, pineapples.	Katumani maize, onions, mangoes, macadamia nuts.	High-grass savanna, Bana grass.
LM 4: marginal cotton (760-1,220 m)	Millet, sunflowers, maize, sorghum, beans, castor.	Green grams, groundnuts, sweet potatoes, cotton.	Mixed med.-grass savanna, oats, Makueni guinea grass
LM 5: livestock/millet (700- 910 m)	Millet, beans, sunflowers.	Green grams, pumpkins, onions, groundnuts, sisal, cow peas, Jojoba.	Mixed short-grass savanna, saltbush, silage, sorghum.
LM 6: ranching	Not suitable for rainfed agriculture.		
Inner Lowland Zones			
IL 5: livestock/millet (610- 700 m)	Millet, beans, sunflowers.		
IL 6: ranching	Not suitable for rainfed agriculture		Game cropping, game ranching of eland, oryx, gerenuk, Grant's gazelle.

Source: Kenya Ministry of Agriculture and Livestock Development, 1983.

level of education, and family attitudes toward scarcity and conservation. Information was also obtained regarding the energy supply side, including whether households buy or collect fuelwood themselves and from what areas, time spent to collect fuelwood, and distance walked to obtain fuel.

Field work began with the initial pretesting of the questionnaire, in early December 1988, on nine households. The final questionnaire was administered from early February 1989 to mid-April 1989.

Three enumerators were engaged to assist in the survey. One was an extension officer in the Ministry of Agriculture, while the other two were secondary school graduates with substantial experience in survey work. The three enumerators were from Mutino Sub-Location and their knowledge of the Tharaka language and personal acquaintance with the majority of the households facilitated the study. A training program was carried out for about two and a half weeks for these enumerators, in order to establish basic interviewing techniques. The initial two weeks of household interviews were conducted in such a way that the enumerators worked in pairs, in close proximity, so that the study director could easily monitor the interviews. Later, one of the pairs was disbanded and each enumerator carried out the interviews independently. The study director maintained close supervision not only by deciding what areas were to be covered each day by the enumerators, but also by visiting them often. Repeat visits were made to about twenty households as a counter-check measure to previous responses.

It is worthy of note that two of the enumerators were women, and their presence made interviews relatively easy. The majority of those interviewed were also women, who seemed more comfortable with women enumerators. The choice to interview housewives (mostly in the absence of their husbands) was deliberate. Fuel related activities (fuelwood procurement, cooking, etc.) are predominantly or exclusively women's responsibilities among the Tharaka people in Mutino Sub-Location. Hence, it made sense to target women for this particular study.

Informal discussions were also held with government officials in the Sub-Location as well as those at the district headquarters, Meru Town. In particular, the chief and officers representing the ministries of agriculture and forestry provided valuable information. Views were likewise exchanged with the coordinators of an Embu-Meru-Isiolo ASAL development project. Finally, a deliberate effort was made to conduct discussions about fuelwood with a number of male and female elders in all of the villages. Sessions with these elders were often lively, and educational.

Household Characteristics. Households in Mutino Sub-Location are characterized by large families. In many instances, household members comprise not only the immediate family, but also members of the extended families. All members of the household, save for the very young, contribute income or provide services. Those working outside remit some money. Traditionally distinct sex roles are adhered to in all Mutino villages.

Most of the women are housewives and farm operators. They tend to children and perform several domestic activities. In the five villages surveyed, it is common to see women, with babies strapped to their backs, walk a distance of four to seven kilometers to fetch water and forage for fuelwood. As most households seldom purchase fuelwood, it is invariably the responsibility of women to provide it for the family. In some cases they are assisted by children on weekends and after school on weekdays. Often one comes across several women and children with heavy bundles of firewood strapped to their backs or carried on their heads. Walking long distances to cut, gather, and carry fuelwood is not only tedious but detrimental to the women's physical health. In addition, some women walk to Kathwana Market to sell their farm produce on market days. They typically work 13 to 15 hours daily and many complain of physical ill-health. Although men and women both participate in the full range of subsistence agricultural activities, cooking, fetching firewood, and preparing children for school remain the exclusive responsibilities of women. Indeed, women vigorously opposed any suggestion to let their husbands look for fuelwood, because traditionally this was unacceptable.

Subsistence agriculture is the dominant mode of farm production for virtually all the villagers. Between 85 and 95 percent of the total crop grown is intended for family use. Sorghum, cow peas, maize, and green gram are grown by almost all households during the November-to-December short rains and the March-to-May long rains. Intercropping is quite common and many families plant their crops just before the beginning of the rains as a way of insuring against crop failure.

Fuelwood is the predominant source of energy for about 92 percent of sample households. The primary use of fuelwood is for cooking and to some extent heating. A few households use charcoal for ironing as well as cooking and heating. These families are mainly headed by shop owners in Kathwana Market, administrative officers, and teachers. Ironing is performed almost exclusively with charcoal heat. Approximately 96 percent of the surveyed families use kerosene for lighting, while only 12 percent use the same fuel for cooking.

Virtually every family in the sample survey uses the three-stone method for cooking. This is the oldest form of cooking in which three reasonable sized stones are placed in a triangular fashion, and a clay cooking pot is placed on top of the three stones. For the three-stone method, fuelwood is suitable and is used by all households in the villages. Less than 10 percent of the families visited own traditional metal stoves, while only one household possesses a new energy-saving stove. This type of stove uses charcoal and in some cases wood splinters and maize cobs. A schedule of two to three meals a day is quite common, although balanced nutrition and daily caloric intake are visibly inadequate. The main types of food are sorghum and millet, with tea as the preferred beverage.

Women grind sorghum and millet into flour by using traditional grinding stones. From the flour women make ugali, a porridge-like meal, and beer. One observation about these households is that they often prepare extra food for unexpected visitors and consume leftovers for the next meal or the next day.

It is no exaggeration to assert that the majority of the families in the Sub-Location are economically deprived and are only marginally involved in the cash economy. Their source of income is basically from small amounts of marketed millet, sorghum, and green gram. For some households, when there is a pressing need for money to pay school fees or buy clothes, either cattle or goats are sold. A few members of some households are formally employed, and some households receive remitted income from family members who live outside the study area. As in many parts of arid and semi-arid Kenya, women in this location have limited access to formal employment because of their lack of education and child care alternatives. Considering that women spend more hours than men on menial work, the opportunity cost of a woman's time is less accurately known and probably less well understood.

Families in Mutino Sub-Location are not well endowed with wealth. Many own very simple houses made of traditional grass-thatched roofs and walls made of thin poles and sticks plastered with a mixture of mud and cow-dung. Many of the villages keep limited numbers of cattle, goats, sheep, and chicken, but none officially owns the land on which to graze livestock. Land is still commonly owned and anyone can settle in any vacant place. Families own very simple implements and material amenities, as indicated by the absence of metal stoves and the infrequent use of kerosene and other commercial fuels for cooking.

Education is very important to each of the families. This was reflected in their concern for school fees for their children and their readiness to sell a few of their highly valued livestock.

The respondents' attitudes toward conservation were positive. A number of local residents took the researcher around the compound to show trees that they had planted with seedlings bought from the forestry department and from Embu-Meru-Isiolo ASAL project. An overwhelming majority of those interviewed, including the elders of the village, expressed fear that it was only a matter of time before a fuelwood crisis would occur. Already, they believed, there was scarcity because scavenging took more hours and longer distances than were required five to ten years ago. Respondents pointed out that in the past it took about half an hour or less to obtain bundles of fuelwood, whereas now it takes at

least three to four hours. They also noted that people now cut down live trees while in the past collection of dead branches was the norm.

FUELWOOD USE AND ENVIRONMENTAL DEGRADATION

The households of professionals, such as teachers, administrative officers, and businessmen, use less fuelwood than the average household. They use charcoal and kerosene for cooking. This group of households forms a social class within the community and its use of these commercial fuels is made possible by the relatively high income that accrues to it. This class is also one that averages 11 to 13 years of formal education and is, presumably, aware of the long-term negative repercussions of excessive fuelwood use in a marginal ecosystem.

The number of meals cooked per day has a significant effect on the amount of fuelwood consumed. Families that cook two meals a day consume up to 10 kg of fuelwood, while those who cook three meals a day use up to 14 kg. Costs per meal using fuelwood are lower than for kerosene, if one takes into account the appliances required to use kerosene for cooking. The initial outlay for stoves puts kerosene cooking out of reach for a great majority of the villagers.

Income was found to have little or no effect on fuelwood use because the fuelwood monetary market is negligible. As already mentioned, the bulk of the families have low income and, therefore, gather their own fuelwood. Even those who may have relatively higher income may not want to switch to commercial fuels when fuelwood is "freely" available.

Another socio-economic factor considered to influence the consumption decision of the family is the distance walked to fetch fuelwood. Since the fuelwood monetary market is limited, distance as a variable may provide a partial indicator of the cost of fuelwood. In particular, cost is viewed in terms of alternative opportunities lost by household members that go to look for fuelwood. Our results indicate that 67 percent of the sample households is increasingly frugal in its use of fuelwood energy because of the longer distance factor. In other words, an average family in a fragile ecosystem will decrease its fuelwood consumption in proportion to the distance walked to obtain the fuelwood.

Similar to the distance factor, the time variable in the survey result indicates that with more time required to procure fuelwood, an average family will reduce its consumption. Seventy-one percent of sampled families now economize on their use of fuelwood in view of the time constraint.

Historically, land was controlled as a communal resource and rights to land were collectively determined. With Kenya now going through a period of rapid socio-economic transition, population growth, and administrative interventions, land-use conflicts are emerging at the village level.

Further demographic pressures, created by an influx into these villages of land hunting migrants from the medium and high potential zones of the district, have resulted in an additional reduction of land available for grazing livestock, and in more interference with traditional patterns of resource utilization.

An increasing number of commercial hewers of trees for charcoal sets a dangerous precedent in this precarious environment. In the short run, they will swell their pockets without regard to the extreme peril to which they will expose the rest of the community and posterity.

Interference with traditional patterns of resource management, indiscriminate cutting of trees for both charcoal and fuelwood, and less rigidly defined land rights can best be illustrated by a common property principle. Because ownership rights have not been assigned to fuelwood and other resources, and because many families gather wood, use of this environmental asset is not accurately reflected in the price system. Economists have described the harms caused by such use as "externalities" because the environmental burden of fuelwood and charcoal consumption falls on society at large, not just on the individual consumer. The result is sub-optimal use of woody vegetation, soil degradation, and erosion. Each household, pursuing its own best interest, inexorably works toward the ruin of all - a situation that has been termed the "tragedy of the commons." This situation will likely have a deleterious effect on long-term sustainable development in this

study's sample villages, and in others like them.

CONCLUSIONS

Summary. Although over 80 percent of Kenya's population depends heavily on traditional sources of fuel, the country's energy policy has, until recently, focused on commercial energy sources such as kerosene and electricity. A fundamental flaw in the dualistic development policies pursued by Kenya provides the underlying reason for neglect of the energy needs of semi-arid rural households. This dualism has emphasized the modern sector and neglected the arid and semi-arid sector; it has emphasized the urban areas at the expense of the rural dwellers; it has emphasized geological exploration and technologies that use commercial energy and neglect supply and demand in traditional rural fuels. However, the important role of fuelwood and charcoal in the welfare of the rural people and the urban poor, and in the overall development of the country, came to light after the oil crisis of 1973/74. As the government explored the potential for utilizing available local energy resources to substitute for the high cost of imported fuel, it came to understand the extent of rural energy problems. These include loss of trees and vegetative cover, soil erosion, and more time and longer distances walked by rural people to collect fuel. A new ministry to coordinate all energy policies, including the "other energy crisis," was created in 1979. In a major shift, energy policy now looks quite closely at the rural energy problem. Recently, a new Ministry of Arid, Semi-Arid and Wastelands was established to look into the unique developmental problems of the Kenyan areas.

It does not appear that substitution of commercial for traditional fuels can be a solution to the fuelwood problems in the ASAL areas of Kenya for the foreseeable future. Commercial fuel, which accounts for only about 18 percent of total energy, already makes up 35 percent of Kenya's total imports. With the rapid increase in energy prices and recent decline in Kenya's major agricultural exports, energy costs and security of supply will remain out of reach of the ASAL. It is, therefore, imperative to arrive at a fairly good understanding of the complex interaction of population, land-use and other local energy factors in an environment characterized by a diminishing natural resource base.

Causes of the Fuelwood Crisis. One of the striking features of the majority of families in the area surveyed is their level of poverty. This could be partially attributed to the poor resource base of the sub-location. With such a resource base, economic activities are likely to be sluggish and weak. Farm and livestock productivity and other commercial activities are at a low level because of the inadequate availability of capital and a lack of disposable income, producing weak multiplier effects. Because their incomes are meager, most households are left with no choice but to depend on wood to satisfy their basic energy needs. They simply cannot afford to buy even the least expensive of the commercial fuels, kerosene.

Fuelwood problems in Mutino Sub-Location can be viewed in terms of demography. The population of this area has been rising rapidly as a result of natural increases and an in-flow from other parts of Meru and other districts. A large number of impoverished and landless peasants have migrated into this sub-location and other marginal parts of the district because high and medium potential agro-ecological zones have reached virtual saturation. The implications of this demographic pressure, at the household level, is that there are now more people to be fed, more food to be prepared and cooked, and thus more fuelwood consumption in an environment whose carrying capacity is extremely limited. At another level, ill-suited farming practices, indiscriminate tree-cutting, and a lack of proper resource management on the part of recent arrivals have visibly accelerated degradation and decreased fuelwood supplies. Landlessness is acute in the district and shows every possibility of getting worse with continued population growth, further worsening fuelwood scarcity.

Another contributing factor to fuelwood shortages is drought. As in the rest of the districts in the country, Meru District experienced severe droughts in the 1970s and early in the 1980s. Under the impact of

drought, a large number of trees perished. The result was an increased fuelwood problem that is still being felt by local communities.

Although commercial charcoal production is a relatively recent activity, it can have serious repercussions for household fuel supplies. At the time of this study, only a few people were engaged in the fuelwood market. Charcoal burning is done through highly inefficient traditional methods. Observations and discussions with many housewives in the four villages surveyed revealed a serious concern at the rate at which whole trees were cut down for charcoal. Charcoal burning was seen as a slow but sure means of depleting the villagers' source of fuel.

A most significant cause of the fuelwood crisis and related environmental degradation was a land tenure pattern in which land ownership is communal. In the absence of traditional safeguards, such a tenure pattern attracts people from other areas to an environment characterized by diminishing resources. Furthermore, it allows each household to develop a strong economic incentive to maximize the use of available limited resources lest another household use the same resources to which it has free access. This forms the classic economic problem of over exploitation of a common property leading to removal of vegetation including whole trees, soil erosion, and environmental abuse. Again, the resulting effect is less fuelwood for the residents of local villages. In some areas, the damage appears irreversible. The long-run cost is high and is borne by society.

RECOMMENDATIONS

Research & Information. The study showed that Mutimu Sub-Location, like other arid and semi-arid areas, faces complex and multifaceted problems, for which there is no "pat" solution. A multi-pronged approach is required to alleviate these problems. In order to provide appropriate policy recommendations one needs in-depth information on economic, social and ecological systems, including resource inventories and knowledge about the interactions of socio-economic, geographic and institutional factors. Such knowledge would provide a basis for policies and programs relating to the villages surveyed and to other ASAL areas.

The arid and semi-arid zones in Kenya received little or no research attention prior to independence. For many years after independence the same neglect was apparent. An important reason for this was that the economic potential of these areas appeared quite negligible. There was a notable absence of research on available resources and how their availability changed over time. In the face of such paucity of information, there is an immediate need for sound multidisciplinary research into the semi-arid lands, including Mutino Sub-Location.

Education. The accelerated degradation of fuelwood supplies heightens the need to enhance people's awareness of resource over-use. Education should also aim at changing peoples' attitudes toward ecological destruction by persuading them to adopt conservation practices. To do this, the government should initiate and encourage popular education and extension programs, as well as introduce environmental education into school curricula. This course of action is likely to lead to better resource use.

Tree Planting. Tree seedlings are available to the people of the four villages surveyed through the Embu-Meru-Isiolo ASAL project and the Ministry of Environment and Natural Resources. Although a few households have shown the initiative to purchase seedlings from these two sources, for many families the price is simply out of reach. In order to ensure adequate firewood supplies in the long-run, it is necessary to promote afforestation and deliberate tree planting on a massive scale. Each year, the Government of Kenya provides thousands of free seedlings during National Tree Planting Day, but this program is insufficient to meet current and future requirements for fuelwood and charcoal. The provision of free seedlings once every year does not go far enough; there is a need to provide poor communities with suitable free tree seedlings more often. Trees embody multiple uses, thus growing and rationally managing them is essential for suitable development.

Improved Cooking Stoves and More Efficient Kilns. Households in Mutino overwhelmingly cook over the three-stone hearth, while charcoal dealers burn using traditional methods. Both of these techniques are inefficient. Improved stoves and kilns would help to conserve rural energy. According to Kinyanjui and Childers, the ceramic stove enjoys the potential of reducing fuel consumption by up to 50 percent per meal cooked. In this regard, policy makers perhaps need to further support Kenya's mass needs. Resources that are used for importing luxury items might better be utilized to subsidize energy-saving stoves to allow poor communities to afford them and to develop controlled market channels for fuelwood and charcoal. Pursuit of such a policy would not only provide employment in the stove industry and a more efficient use of traditional fuel, it would also help curtail the insecurity of energy disruption for basic needs in Mutino and other ASAL areas.

Family Planning. Another area of policy recommendation concerns family size. As already noted, population growth has placed heavy pressure on the natural resources of arid and semi-arid ecologies. Family planning is an obvious way of mitigating this pressure. A significant reason for the government to intensify its family planning program is that ASAL areas have perhaps reached the limit of their human carrying capacity.

Local Participation. Any approach to solving Mutino's fuelwood and other developmental problems must incorporate the crucial human element. The Mutino community is fully cognizant of the opportunities and constraints within its environment. It is, therefore, important that policy makers, non-governmental organizations, and others incorporate traditional knowledge into resource and environmental management programs. A particular point to note is that decisions regarding fuelwood supply and consumption are generally made by women. In light of this, special efforts should be made to involve women in any fuelwood programs at the planning stage.

Society's insatiable desire for land, compounded by ill-conceived developmental programs, have undermined the capacity of the people in our survey area to obtain a reasonable living from their environment. Policy responses to ASAL problems must be viewed critically, with an understanding of their root causes rather than just their symptoms. However well designed, energy policy per se will not offer a solution to ASAL problems. Mutino's energy problem is intrinsically intertwined with the whole gamut of underdevelopment, including access to resources. A first step towards solving ASAL energy problems would be through systematic and holistic approaches to the analysis of rural energy from ecological, economic, social, and institutional perspectives; eliciting effective community participation, especially among women in fuelwood programs; increased tree planting; and better resource management for environmentally sustainable development. Equal opportunity and accessibility to resources would go a long way to solving Kenya's energy problems. The long term goal is the kind of economic development that will improve the standard of living of people in the country's drier areas, so that they may be able to satisfy their energy needs on a sustainable basis.

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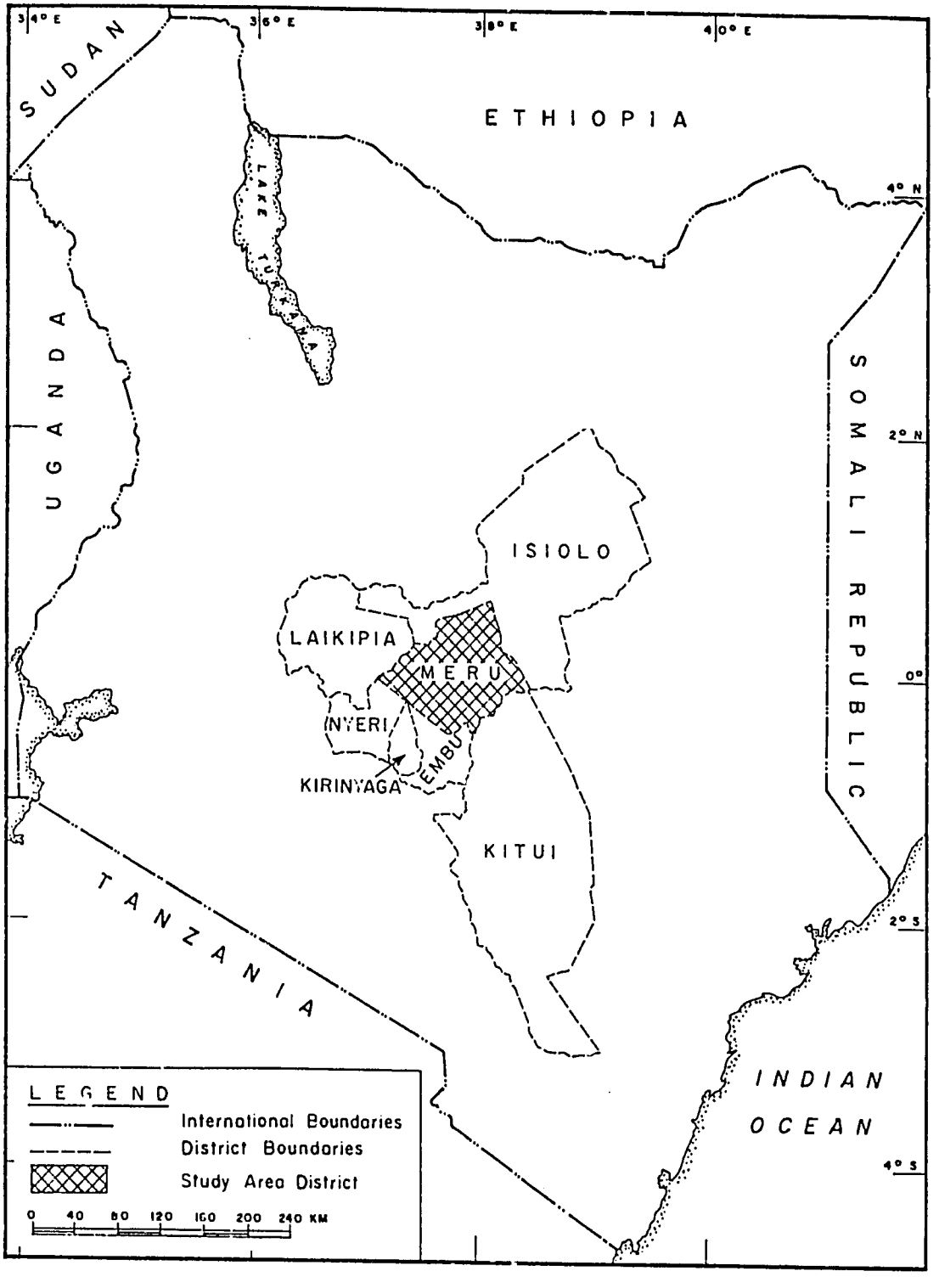

Figure 1. Location of Meru District

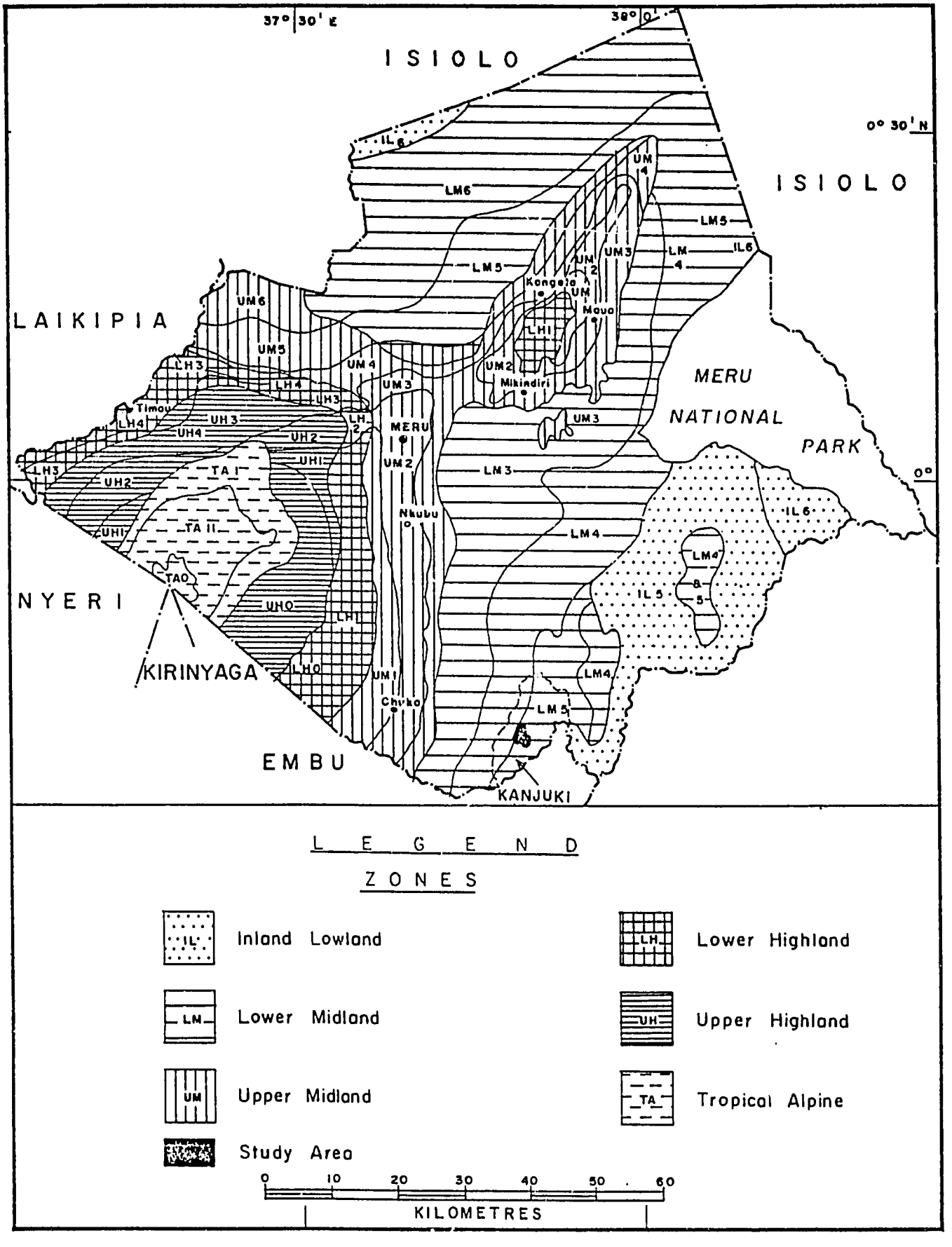

Figure 2. Agro-Ecological Zones, Meru District

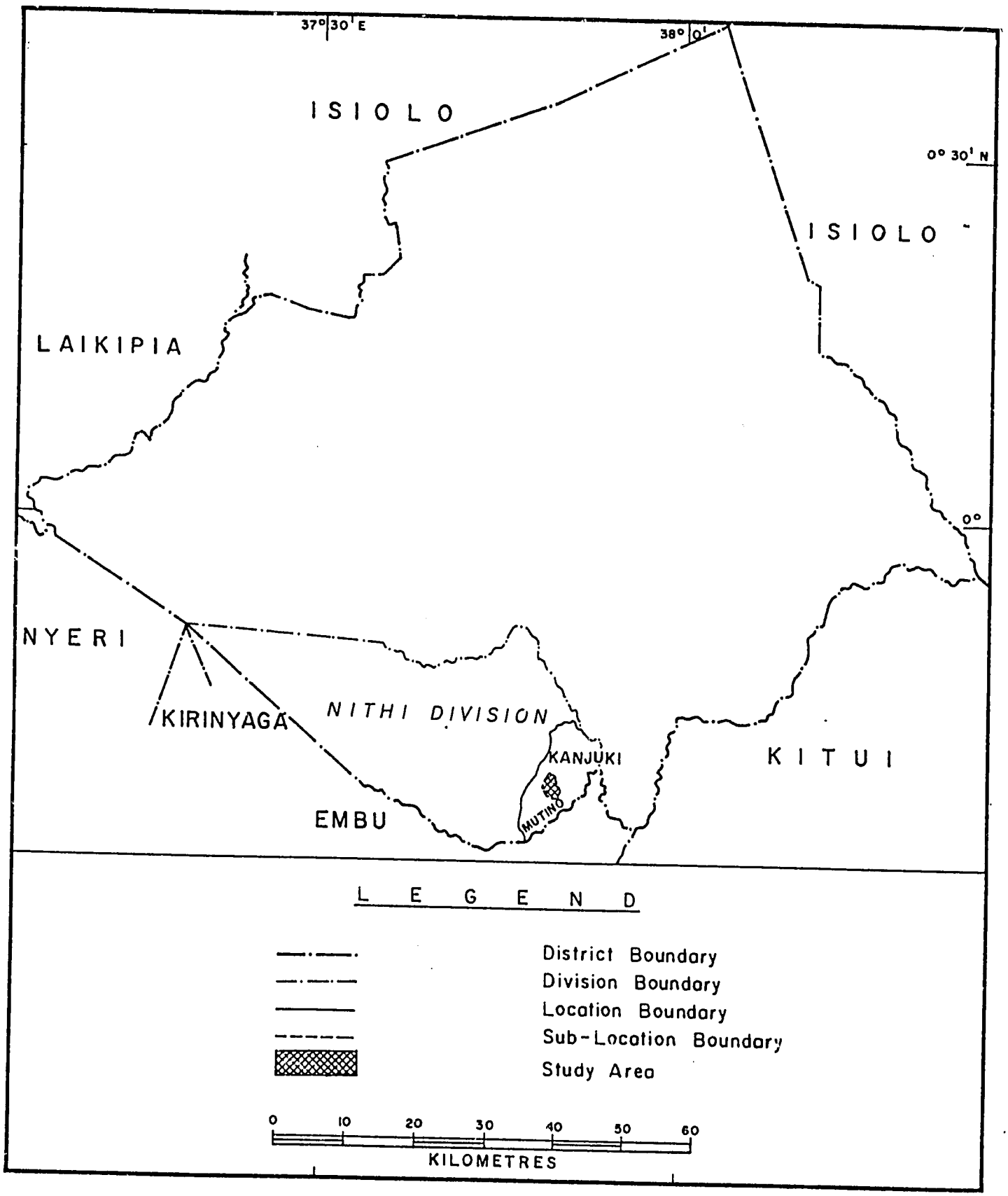

Figure 3. Location of Mutino Sub-Location in Meru District