

PLANNING FOR RURAL ENERGY WITH A SPECIAL REFERENCE TO
KIKUYU DIVISION

BY

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ABSTRACT

The importance of the traditional sources of energy, foremost among them, woodfuel, and the serious consequences of its shortage ⁱⁿ terms of supply and demand, has made it necessary to assess the woodfuel situation in many parts of the world. Until recently, our National Development plans were not based on a conscious energy policy. The 1970's brought into focus a general realization that the era of cheap energy was over and that all economies had to adopt to high energy prices. This created the awareness and determination to explore the traditional energy policy.

This study examines the nature and extent of the woodfuel crisis in Kikuyu Division of Kiambu District. The study has found that there are a number of factors that have contributed to woodfuel shortage in the Division. Critical among these factors are, rapid population growth, deforestation, small land sizes and low energy conversion efficiency methods.

Against this background, the study therefore has recommended that appropriate measures must be undertaken to alleviate the shortage. The measures considered practicable are aimed at energy conservation, energy diversification and increasing energy supply by growing

more trees.

The study has concluded by proposing a short-term strategy aimed at conservation and diversification and long-term strategy directed towards increasing energy supply and population control.

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CHAPTER ONE

INTRODUCTION

:1 NATURE OF THE PROBLEM

In Kenya the search for alternative sources of energy has included programmes to develop locally available sources of renewable energy. The purpose of the proposed research is to assess and formulate recommendations aimed at promoting the development of community energy resourcebase in Kikuyu Division.

The energy issue had taken a very low profile in the country until the creation of the Ministry of Energy in 1979. At that time, there was a growing world wide concern about the availability and cost of energy which had led to a growing interest in national patterns of energy consumption in the hope that wiser policies for energy will emerge from a better understanding of existing patterns of energy consumption within and among nations. The energy issue became critical with the 1979 - 1981 oil crisis which prompted the governments to look into:-

- (a) Energy conservation
- (b) Energy substitution

(c) Energy related technologies

(d) Alternative and Renewable sources of Energy

In recognition of the importance of energy as a key factor in overall development, many countries have begun to examine their energy situation in order to develop a coherent energy policy which would help them to meet several possible goals.

Kenya, along with many other developing countries is facing a double-edged energy crisis which seriously affects both the modern, industrial sector and rural sector. Less developed countries need energy for survival. But increasingly they find that the energy crisis fueled by shrinking resource base, cripples efforts to meet development goals and fails to ensure reliable rural energy supplies. The oil crisis of 1973 and 1979 -81 which made oil the largest single drain of foreign exchange earnings made the country to embark more seriously on researches of indigenous sources of energy.

Kenya's indigenous energy resources are basically biomass, hydroenergy, solar, wind and geothermal. Traditionally, most Kenyan's have depended on woodfuel

as their major source of energy. Rural energy is, and continues to be primarily solar energy available through photosynthetic conversion of crops, woodfuel, animal dung and crop residue. Over 90% rural energy in Kenya is derived from wood, animal and agricultural wastes and is primarily used for cooking, heating and crop drying.⁽¹⁾

In many places with rapid population growth, forest resources have been heavily depleted bringing not only a serious shortage of energy for rural people but also diverse environmental effects which threaten the agricultural potential over wide areas. The search for cultivable lands have sent subsistence farmers into forests and slopy areas resulting in deforestation, soil erosion and disrupted hydrological cycle.

The shortage of woodfuel, has become an alarming problem forcing people to spend more time in fuelwood procurement and less time in improving their agricultural output hence declining production and lowering the quality of rural life (famines).

A reconnaissance survey of the fuelwood situation in developing countries prepared by F.A.O. for United Nations Conference on new and Renewable sources of energy indicates that in 1980 about 1,000 million rural people were living in areas where there was already an acute scarcity, another 1,050 million were in situations of growing deficit where minimum woodfuel needs were met at the cost of depleting existing resources.⁽²⁾

The rural energy crisis can be described as a women crisis (Wisner 1980).⁽³⁾ Women are closely connected with energy generation and use in rural areas. They do much agricultural work, repair houses, collect fuelwood, draw water, cook and bear the burden of managing the family. They have to travel farther and farther to collect fuelwood. Many cook one meal a day because energy is too expensive. They boil water less often and in the worsening crisis they are forced to have more children who can help them with this crushing burden. Fuelwood is being used in excess of its rate of natural replenishment. Projecting present trends forward shows the position rapidly worsening and reaching dimensions of a true and widespread rural energy crisis by the end of the century (FAO 1980).⁽⁴⁾

The pervasive nature of the crisis has become of utmost concern and calls for a systematic solution to the problem, a need to develop land-use systems that sustain energy production in order to promote development and human welfare. The study aims at surveying the current household energy demand and supply in Kikuyu Division and contribute to the knowledge of energy situation in the Division. The research focuses on woodfuel energy for it is the major source of household energy in the Division and rural Kenya as a whole.

2 OBJECTIVES OF THE STUDY:

The overall purpose of the study is to examine how Kikuyu Division can be self sufficient in Energy Production. Specifically the objectives are:-

- (i) To identify and describe energy consumption and supply patterns in Kikuyu Division.
- (ii) To investigate the opportunities for strengthening and expanding the resource base and highlight the appropriate technologies that could minimise the energy crisis.
- (iii) Make recommendations for alleviating woodfuel shortage.

3 SCOPE OF THE STUDY:

The study is mainly concerned with the analysis of household energy in Kikuyu Division, its production and utilization. It aims at highlighting the woodfuel shortage and making recommendations to alleviate the shortage. Since this can not be done in isolation from the rest of rural development aspects, it becomes essential that an appraisal of the physical and social economic aspects be undertaken as a background of the study. A survey of household energy resources and a focus on woodfuel will form the body of the study.

Chapter one will be the general introduction of the study. Chapter two will be the background study of the study area, its location and size, physical characteristics, climate, vegetation, soils and social economic characteristics. Chapter three will be an inventory of the household energy resources in the Division.

Chapter four will be the analysis, highlighting the woodfuel situation in the Division. It will deal with the factors affecting woodfuel production distribution and consumption. Chapter five will be the findings and recommendations while the last chapter six will be the summary and conclusion.

4 LITERATURE REVIEW

A number of studies have been undertaken to review the energy situation in Kenya as a result of awareness of its scarcity and the dangers posed therein. Both the commercial and non-commercial energy situations have been investigated, their conversion efficiency have been highlighted and the need for urgent government action have been proposed.

The Beijer Institute, has carried out a nationwide commercial and non commercial energy surveys which have contributed substantially to the government's understanding of the energy situation. They have thorough explored the National Wood energy stock and have highlighted the acute shortage of the resource that was once considered inexhaustible. They have contributed greatly to the timely energy planning process in Kenya. They have revealed the severe stress put on the economy of the country as collection times and efforts rise due to increasing inaccessibility of fuelwoods. (5)

Western, D. and Ssemakula, J. (1980) (6) have also exhaustively analysed fuelwood demand and supply in

Kenya basing their analysis on different regions of the country. They have examined the consumption of fuelwood in various sectors including large and small firms and urban and rural fuelwood domestic requirements.

These two most exhaustive studies have based their analysis at the national level. Their studies have taken a macro-level approach to energy situation in Kenya. They therefore give a very generalised energy situation because at that level, they can not afford to be specific. A micro-level woodfuel survey is essential to bring out a true picture of the domestic energy consumption at the village level where the majority of Kenyan rural population live.

To try and bridge this gap are the studies that have been undertaken to evaluate the potential demand for charcoal in Kenya. (Arnold, et al, 1962, ⁽⁷⁾ Uhart, 1975 ⁽⁸⁾, Kabagambe 1976 ⁽⁹⁾) have gone further to examine household energy use in urban areas. In general these studies have only assessed the charcoal demand in urban areas. Thus a gap still exists of a similar survey in rural households.

At the same time, a number of studies on the per capita consumption of wood among rural population have been made. Arnold et al, 1962⁽¹⁰⁾, Opershaw, 1976⁽¹¹⁾ have carried out such studies but like their predecessors, have taken a macro-level approach; with the result that their studies are generalised.

Castro, A 1983⁽¹²⁾, has gone further to examine household energy use and tree planting in Kirinyaga District. This study has thus been focused on a smaller geographical area, a District compared to all the other studies assessing rural energy. But a District is still quite a large geographical area and the consumption of energy from one District to another varies greatly. A systematic micro-level woodfuel survey is thus crucial if the consumption habits of rural households is to be understood. This study aims at undertaking such a survey. It focuses on an even smaller geographical area, the Division, and aims at providing recommendations and highlighting the problems experienced by the rural population in procuring fuelwood for their domestic requirements. This study, it is hoped, will be a contribution to the Ministry of Energy's efforts to devise efficient and effective policies for alleviating woodfuel problems from the micro-level perspective.

RESEARCH METHODOLOGY AND STUDY LIMITATIONS

Since data availability for rural energy sector in Kenya is scant, the preliminary information was obtained from the published documents of the Ministry of Energy and Regional Development and the relevant working papers from the Institute of Development Studies. Other sources included the publications and personal discussion with the experts of organizations which have involved themselves with all aspects of "New and Renewable sources of Energy" and the appropriate energy conservation technologies. The organizations include among others:

- (a) International Council of Research in Agroforestry (ICRAF)
- (b) Kenya Energy Non-governmental Organization (KENGO)
- (c) Kenya Renewable Energy Development Programme (REDP)
- (d) Kenya Woodfuel Development Programme (KWDP)

- (e) Energy Initiatives for Africa (EIA)
- (f) Kenya Rangeland Ecological Monitoring Unit (KREMU)
- (g) National Council of Women of Kenya (NCWK)
- (h) National Council for Science and Technology
- (i) Mazingira Institute

The primary data was obtained through discussions with various women groups from different parts of each location. Initially, the author hoped to carry out energy survey through administering a questionnaire to 1% of households of every location in the Division. But due to negative political atmosphere existing at the time, the author was advised by the Divisional Administration to interview the women groups. And even then, the author had to be introduced to the informants by the administrators of the area, usually the Assistant Chiefs. Thus group interview method was resorted to instead of the individual questionnaire. The questionnaire

was used as a guideline. Although there was that initial inconvenience, the women in every location enthusiastically gave information on household energy consumption and the author was able to understand the existing energy situation.

Unfortunately it was not possible to obtain information on the family sizes and the general economic level. Personal observation of the Divisions woodstock added to the authors knowledge of the Divisions fuelwood availability.

However the study was plagued with a number of limitations. Fuelwood consumption is never recorded and daily and seasonal consumption varies considerably. At the same time, fuelwood consumption varies with the type of food prepared, the type of wood used and its characteristics its physical availability and the season of the year. In order to get a good idea of consumption, recording of usage should take place daily throughout the year. _ As it is, this survey was only for a period of one month. In one month's time, only general descriptive characteristics can be obtained.

A lot of data is also required to establish the energy demand and supply gap. Knowledge of food type, cooking devices (e.g. pots and sufurias); cookstove devices and their conversion efficiencies; whether cooking is done outside or inside the house, whether the cooking device is wet or dry, soft or hard and its diameter thickness are all crucial in estimating fuelwood consumption.

The financial resources available to the author were very limited. In order to arrive at a good estimation of the fuelwood consumption per day, weighing of the quantity of wood consumed was essential, but the author had no access to a spring or bathroom weights to take these measurements. But even if they were available, the discussion method used in data collection would not have allowed this type of data to be collected.

But despite these limitations, the study gives a qualitative description of woodfuel situation in the division. It highlights the major problems and the recommendations to minimise the problem.

The author hopes, however that if this study will arouse a sufficient awareness of the woodfuel scarcity

and the resultant problems thereupon, and means to alleviate these problems, then the study will have achieved its objectives.

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CHAPTER TWO

THE STUDY AREA

2:1 LOCATION AND SIZE

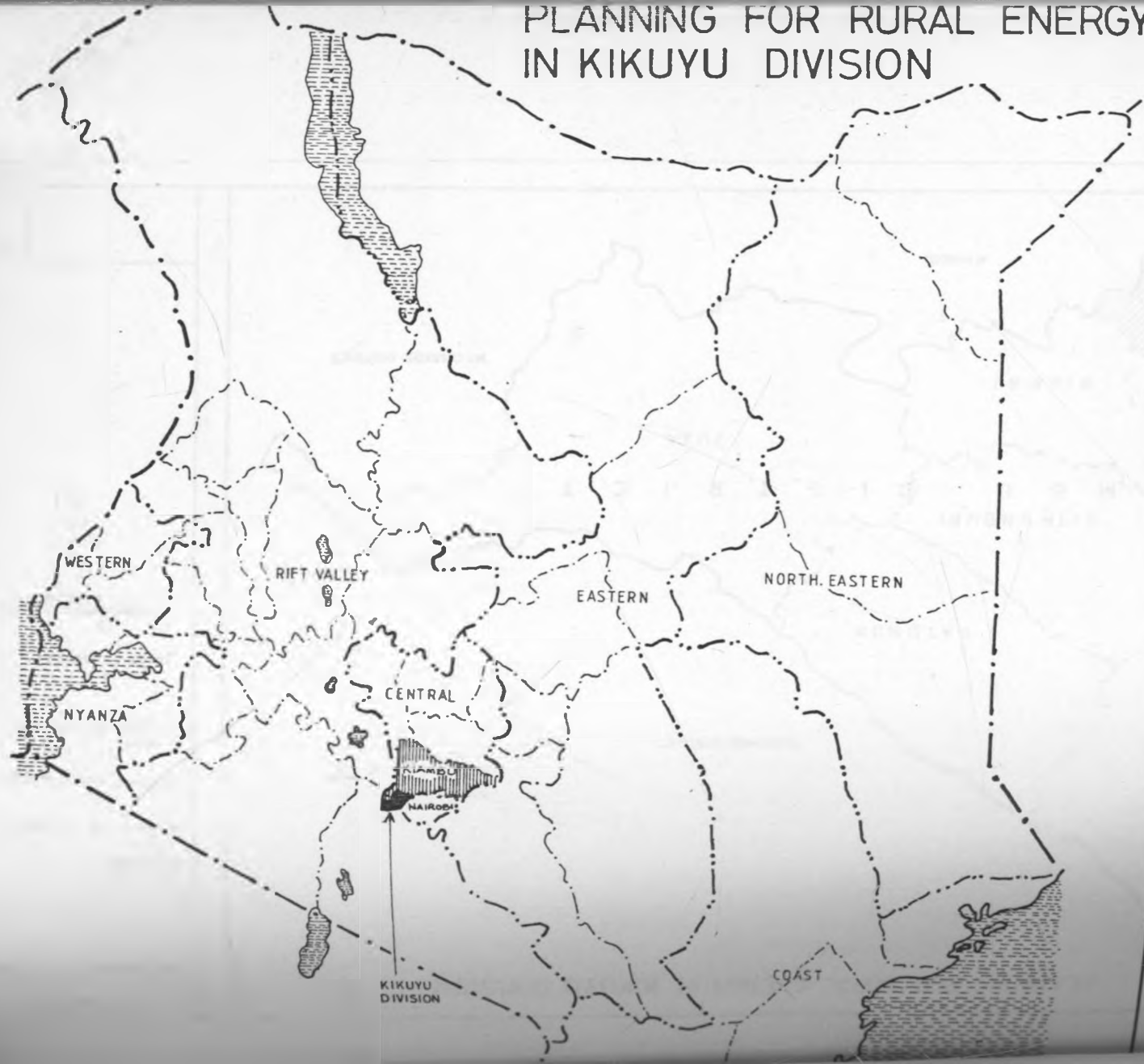
Kikuyu Division is situated in the South-Western part of Kiambu District of Central Province of Kenya, (Map I). It is located North-West of Nairobi and lies $36^{\circ}30'$ East and $36^{\circ}45'$ E, and between latitude $1^{\circ}15'$ and $1^{\circ}4'$ South of the Equator. The Division covers a land area of approximately 170 square kilometres. (1) It is one of the seven Divisions that make up Kiambu District, (Map 2), the others being Kiambaa, Gatundu, Githunguri, Limuru, Thika and Lari. The Divisional headquarter is in Kikuyu township which occupies a fairly central location in the Division, (Map 3), and is located approximately eighteen kilometers from the Centre of Nairobi City - off the Nairobi - Nakuru Highway.

2:2 BRIEF HISTORICAL BACKGROUND

Kikuyu Division is inhabited by the Gikuyu ethnic group. Its occupation is of recent making in the Gikuyu history. During 1980's the Gikuyu migration expansion had taken them in the areas between the Karura and Nairobi rivers and also towards Muguga. None of the pioneers had gone beyond the Nairobi river by the time Lugard established his Fort at Kiawariua (Dagoretti) in 1890. (2) There were no signs of cultivation around the

PLANNING FOR RURAL ENERGY IN KIKUYU DIVISION

KIKUYU DIVISION:
NATIONAL SETTING



LEGEND:

- INTERNATIONAL BOUNDARY
- PROVINCIAL BOUNDARY
- DISTRICT BOUNDARY
- KIKUYU DIVISION

KIAMBU DISTRICT

LAKE/OCEAN

SCALE 1:3,500,000



PLANNING FOR RURAL ENERGY IN KIKUYU DIVISION

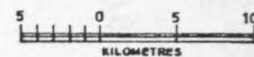
KIKUYU DIVISION REGIONAL SETTING



LEGEND:

- DISTRICT BOUNDARY
- - - - - DIVISION BOUNDARY
- ////// KIKUYU DIVISION

SCALE 1:250,000











Map No.
2

area and Thogoto was at that time a thick forest. Westwards, the pioneers had just approached Limuru.

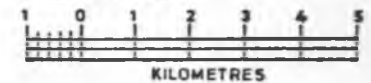
Immigration continued unabated with increase of population and this took the Gikuyu people Westwards into Nyandarua region. The Gikuyu pioneers in general seem to have been a fringe community of hunters who trapped wild animals, collected wild honey or hung bee-hives on trees in the forest. They were followed by pastoralists and agriculturalists at a later stage. When agriculturalists appeared on the scene, they cleared the virgin forests for cultivation. Clearance of the virgin land (Kuna Githaka) was the basis for land acquisition. The influx was going on even after 1900.

In 1945 some muslims were given land in Karai Muslim area. This was in order to reward those African Soldiers who had fought for the British during the Second World War. This was also a step to move Africans from Nairobi for those who were given land in Karai Muslim area were formally living in Pangani. By 1945, Nairobi was only meant for those Africans who worked as Servants in the houses of the settlers. The Africans who tried

LEGEND:

-  DISTRICT BOUNDARY
-  DIVISION BOUNDARY
-  LOCATION BOUNDARY
-  SUB-LOCATION BOUNDARY
-  TOWNSHIP
-  RIVER
-  ROADS
-  RAILWAY

SCALE: 1 100,000



to settle in any part of Nairobi were repatriated to their home areas, for Nairobi was not meant for Africans.

The occupation of the white highlands by the settlers necessitated some Africans being removed from their lands and were concentrated in small areas. As early as 1910 the land shortage problem had become noticeable. This problem was exacerbated by some squatters from the highlands being resettled in Jet Scheme of Kikuyu Location. After independence, some squatters were settled in Ndeiya Sublocation making the land problem even more acute.

From the foregoing history it can be seen that Kikuyu Division was only occupied after 1900. The process of colonialism affected the settlement pattern by concentrating people in small areas forcing them to overexploit their resources of forests and land which is the root cause of the present day woodfuel and land shortage crisis.

2:3 PHYSICAL CHARACTERISTICS

Kikuyu Division lies at the Southern foothills of Aberdare ranges. It is characterised by undulating landscape, intercepted by river valleys and low lying

swampy areas which are mainly found at the South-Western part of the Division in Ndeiya-Karai area. To the north the Division is characterised by parallel rivers with a well drained surface (map 4). The central and eastern parts are characterised by a combination of rolling hills and fairly level land.

2:4 CLIMATE



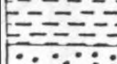
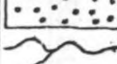

Kikuyu Division is situated at a highland Equitorial tropical region with average rainfall varying from 1100 mm in the highland areas to well below 850 mm in the dry Ndeiya - Karai area. The rainfall pattern is uneven bimodal with the heavy long rainfall season starting normally at the end of March to May and the short rainfall season during November and December. (See table I and bargraphs). About 75% of the annual rainfall is received during the March - May period which is the long rainfall season. The amount of rainfall decreases markedly as one travels South-Westwards towards Ndeiya-karai area. . Year after year the rainfall is highly variable. Monthly rainfall comparison for a number of years is as follows:-

...../21

LEGEND:

--- DISTRICT BOUNDARY

..... DIVISION BOUNDARY

-  FOREST
-  GRASS LANDS
-  SWAMP
-  AGRICULTURE
-  RIVER

SCALE 1:100,000

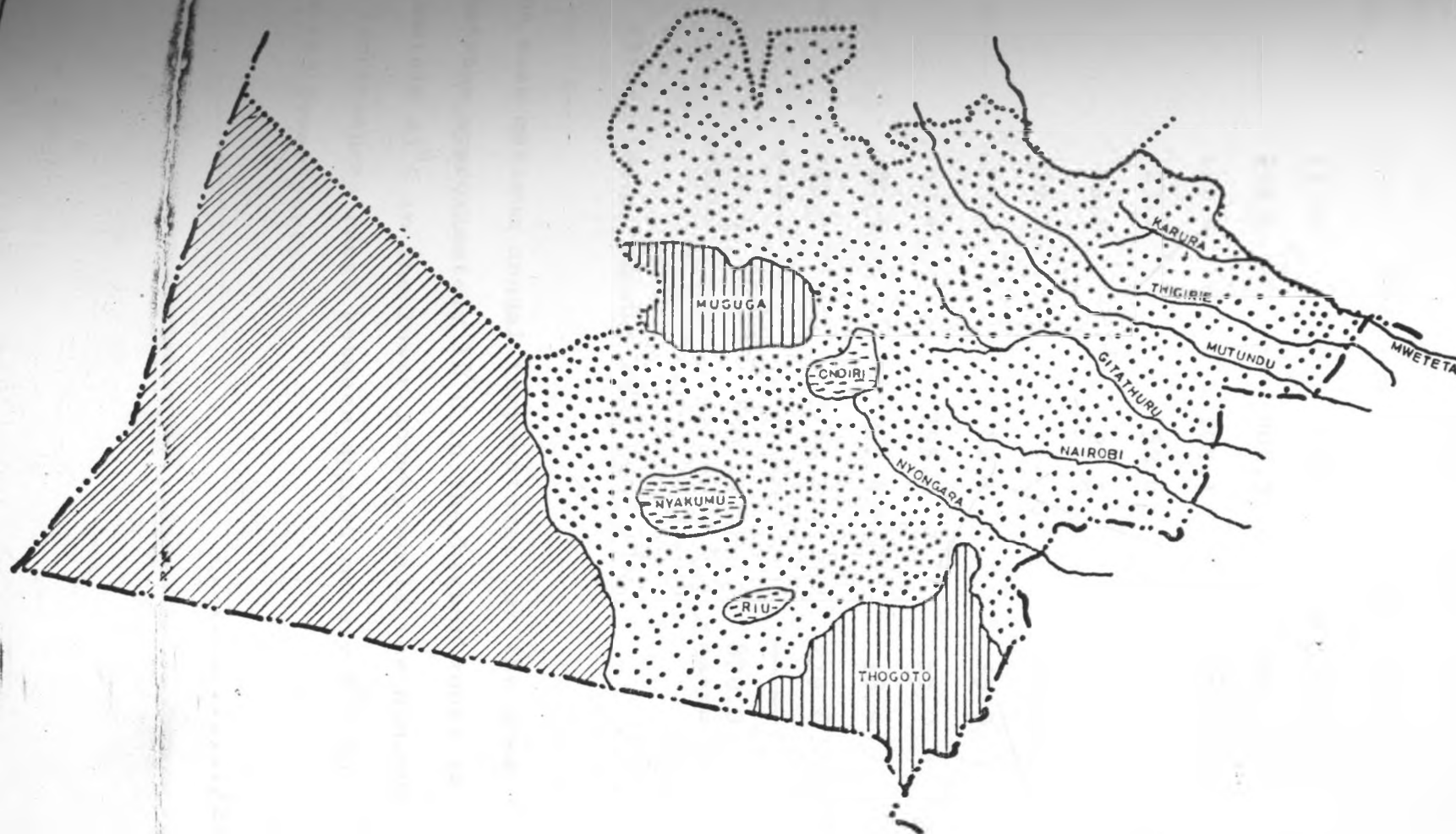


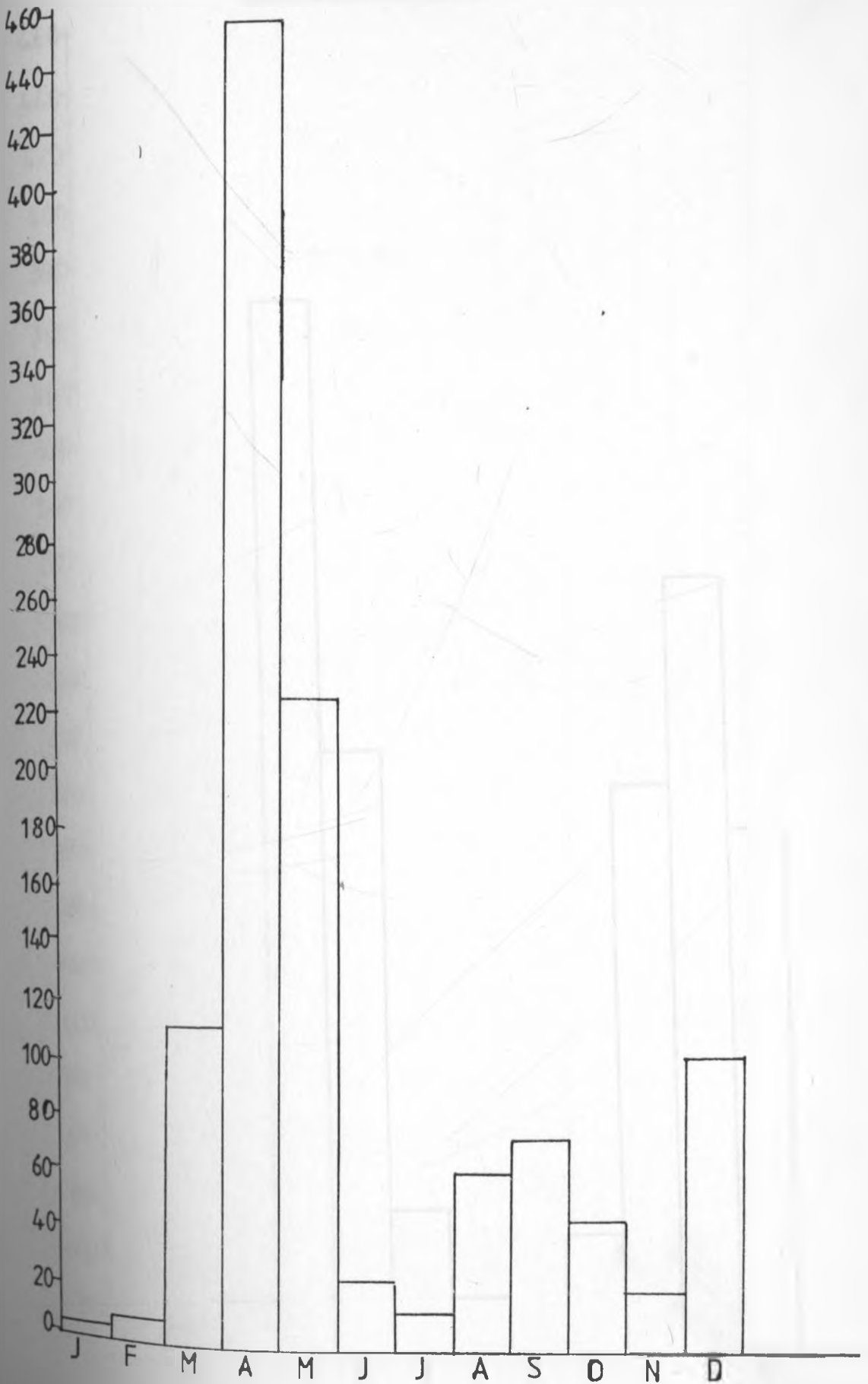
TABLE I
MONTHLY RAINFALL COMPARISON FOR THREE YEARS

January	5.3	-	-
February	7.2	14.2	15.6
March	115.4	21.5	34.0
April	454.1	304.5	309.1
May	222.8	209.1	64.5
June	23.1	52.6	43.8
July	12.8	21.5	12.0
August	59.2	-	12.3
September	72.0	42.1	25.0
October	43.6	195.2	55.0
November	20.4	265.4	18.9
December	100.5	181.2	279.8
Totals	<u>1136.4</u> =====	<u>1307.3</u> =====	<u>870.0</u> =====

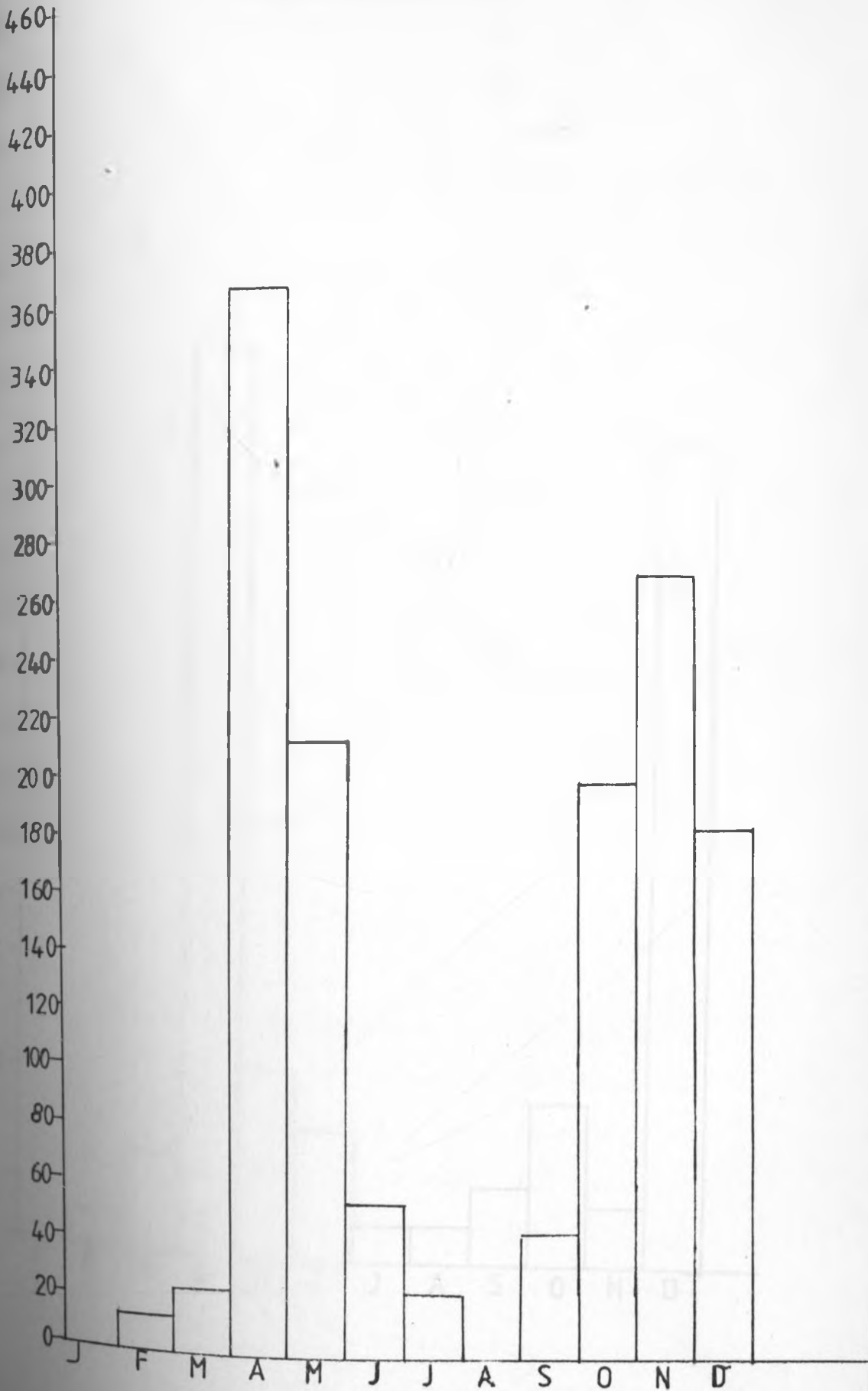
SOURCE: KIKUYU ANNUAL REPORT FILE 1985

The mean maximum annual temperatures for the area range between approximately 18°C in the higher zones to approximately 23°C in the lower zones, while the minimum annual temperatures range between approximately 8°C to 12°C in the lower parts.

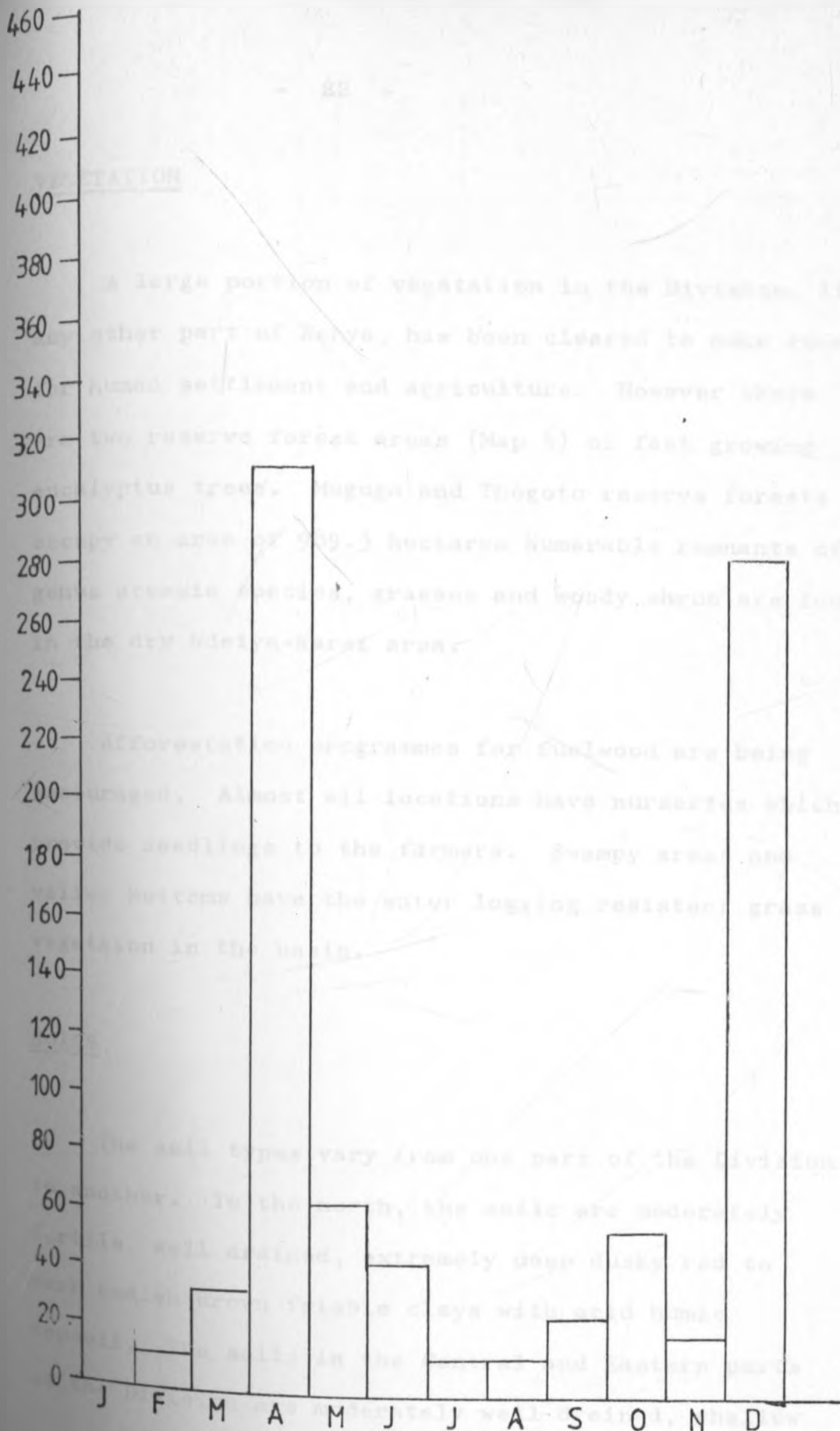
RAINFALL FOR 1981



RAINFALL FOR 1982



RAINFALL FOR 1983



2:5 VEGETATION

A large portion of vegetation in the Division, like any other part of Kenya, has been cleared to make room for human settlement and agriculture. However there are two reserve forest areas (Map 4) of fast growing eucalyptus trees. Muguga and Thogoto reserve forests occupy an area of 989.3 hectares. Numerous remnants of genus acacia species, grasses and woody shrub are found in the dry Ndeiya-Karai area.

Afforestation programmes for fuelwood are being encouraged. Almost all locations have nurseries which provide seedlings to the farmers. Swampy areas and valley bottoms have the water logging resistant grass vegetation in the basin.

2:6 SOILS

The soil types vary from one part of the Division to another. To the north, the soils are moderately fertile, well drained, extremely deep dusky red to dark redish brown friable clays with acid humic topsoil. The soils in the Central and Eastern parts of the Division are moderately well drained, shallow

yellowish red to dark yellowish brown, friable gravelly clay and black cotton soils while in the western part of the Division the soils are brown calcareous loams associated with lava boulders formed of volcanic ash and lava.

Valley soils are a complex of shallow to moderately deep dark reddish brown to very dark greyish brown; firm slightly to moderately rocky, stony or gravelly clay. There are strips of shallow soils and waterlogged places which have only grazing potential.

2:7 SOCIAL ECONOMIC PROFILE

Kikuyu Division is the second most densely populated Division of Kiambu District. This can be attributed to three factors:-

- (a) High birth rate and low mortality rate
- (b) Its nearness to Nairobi hence offering residential facilities to people working in Nairobi.
- (c) The rapid industrialization which is taking place in the Division making it an immigration zone.

The last two factors are favoured by its nearness to Nairobi, available cheap housing and excellent infrastructure (MAP 4). The 1979 census estimated the population of the Division to be 109,146 people (table 2) with average density of 639 people per square kilometer. At present (1985) the population is estimated to be 142,789 people with the average density being 836 people per sq. km (table 2). By the end of this plan period (1984-1988) the population will have increased to 161,016 which represents an increase of 48% over the 1979 population.

TABLE 2:

KIKUYU POPULATION FROM 1979 TO 1988

YEAR	POPULATION	DENSITY
1979	109 146	639
1983	131 820	772
1985	142 789	836
1988	161 016	945

SOURCE: Central Bureau of Statistics
Kiambu Development Plan (1984 - 1988)

The above analysis is very crucial as far as energy supply is concerned. As the population pressure increases, the land shortage will become very acute as the sizes become smaller and smaller. Land is the

main rural energy supplier as will be seen later and as it decreases in size due to increasing population, a further stress will be put resources in general and energy in particular. The energy crisis in the Division is examined against this background. But this alone does not give a true perspective of the problem. A true picture of the crisis is brought out by the examination of the economic situation of the Division.

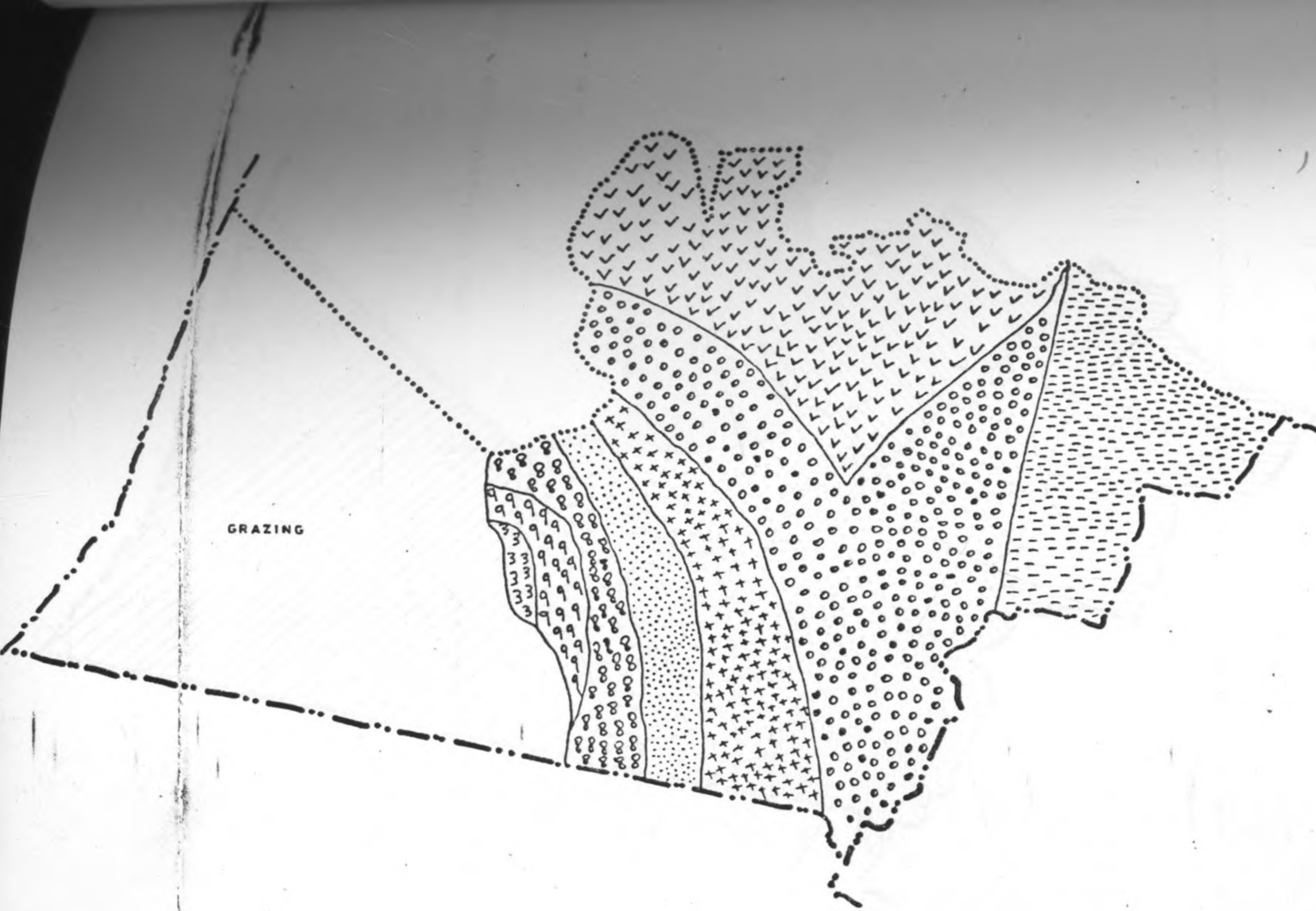
The community's level of income is hard to quantify. Much of the development in the Division has been influenced by its nearness to Nairobi. The community's income sources are small hold farms; small retail business and limited income from formal employment for the few who are able to secure employment in Nairobi. However no records of the employment are available which makes it difficult to gauge the income level of most people in the Division.

Family members in a number of cases are under-employed mainly because of the seasonal nature of agriculture. It can be assumed that half of the people engaged in agriculture are either under-employed or earn only a subsistence income from their farm holdings. The unemployment rate is very high among the youth especially the school dropouts and school leavers.

The agricultural sector remains the main source of employment and income for the majority of the people. The arable land is cropped intensively (Map 5). The people derive their income from poultry keeping, pig keeping, dairy farming, growing of horticultural crops and subsistence farming. The cash crops include coffee, which occupies only 90 hectares and its production is below national average production level. A negligible amount of pyrethrum is grown which occupied about 200 hectares before the drought, but after the drought the area had been reduced to 50 hectares. Dairy farming especially in drier areas is also significant (map 6).

The average land holding in the Division is 0.6 hectares per family of six.⁽³⁾ But in Kinoo Location the average land holding size is 0.3 hectares per household of six.

Income from farming is generally very low. The consequences of too many people living and working on too small land areas is a high degree of unemployment and underemployment. Full employment in the agricultural sector is only possible during the harvesting season. Such employment is mainly manual employment in the few adjacent large coffee and tea farms. The income from such employment is quite low.



GRAZING

LEGEND:

	UPPER HIGHLAND 3 (Coffee, maize and beans)
	LOWER HIGHLAND 3 (Wheat, maize)
	LOWER HIGHLAND 2 (Maize, wheat, pyrethrum)
	LOWER HIGHLAND 4 (Cattle, sheep, barley)
	LOWER HIGHLAND 5 (Cattle, sheep, barley)
	UPPER MIDLAND 5 (Cattle, sorghum)
	UPPER MIDLAND 6 (Poor pasture)
	LOWER MIDLAND 6 (Cattle, sheep, millet)
	LOW GRASSLAND (Grazing)

SCALE 1:100,000

0 1 2 3 4 5 KILOMETRE

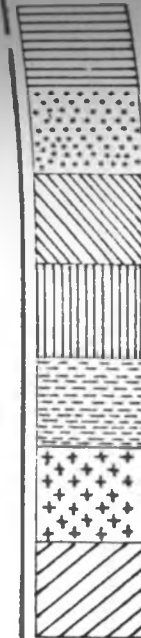
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Map No.
5



LEGEND

MAIN CROPS



COFFEE, MAIZE, BEANS

MAIZE, BEANS, VEGETA

PYRETHRUM WHEAT, VEGE

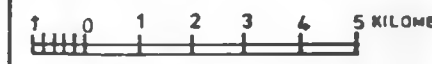
F O R E S T S

S W A M P S

MILLET, SORGHUM, MAIZE, B

G R A Z I N G

SCALE 1:100,000



Map
6

Farm produce from the farmers who have less than 2.5 hectares is mainly for consumption.

Horticultural farming plays quite a significant role. It is very often found scattered all over the Division but mainly in Muguga and Kabete Locations. Nearly all kinds of vegetables can be cultivated here. This farming type is quite profitable because the Division is situated within reasonable distance from Nairobi which offers a ready market.

In conclusion, this chapter has laid a strong basis to the root causes of the energy shortage in the Division. It has revealed factors or problems which have contributed to the energy shortage in the Division. The factors can be summarised as follows:-

- (a) Historical events which have led to shortage of land overtime.
- (b) Land encroachment by agriculture which has led to clearance of large tracks of land of its natural forests.
- (c) Rapid population growth which has led to high population density.

- (d) Cultural factors of land inheritance which has led to continuous land subdivisions and thus leading to diminishing land sizes.

- (e) Low income level.

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C H A P T E R T H R E E

KIKUYU DIVISION HOUSEHOLD ENERGY SUPPLY SYSTEM

3:0 INTRODUCTION

Rural Energy Supply System refers to those forms of energy, all renewable, whose production is hardly recorded and whose consumption is treated quite separately from that of other forms of energy. It includes wood, crop residue, animal wastes, the wastes of processing certain commodities such as saw dust and coffee husks.

The survey carried out in Kikuyu Division indicated that, practically all the household energy for cooking, water heating and space warming comes from the renewable sources of energy whereas paraffin is the principal source of lighting. Up till recently, household energy was not a problem in the area. It was a "free commodity" and those who did not have woodlots in their shambas would comfortably collect it from a friend's or a neighbour's shamba with no trouble. However destruction of trees and forests have been so rapid and ruthless that people are now forced to depend on sawdust, agricultural residue, coffee husks and even cowdung for domestic energy. Areas which were once covered by thick indigenous forests now stand bare and bleak hopelessly exposed to soil erosion elements.

The selling of fuelwood has developed into a booming business in the Division, where trees have been quickly hewn down to give way to cultivation and human settlement. As the same time, the people themselves are desperately searching for alternative sources of household energy. The charcoal made from wastes (briquettes), coffee husks and sawdust are rapidly replacing the traditional fuelwood in the area.

3:1 FORESTS

Forests provide the most important source of domestic energy in the Division. Fuelwood occupies a special place in rural energy system because it is produced within the system itself and for the fact that it does not require complex, expensive equipment to use or procure it. Availability of forests therefore contributes to the availability of fuelwood. But forest availability is determined by population pressure on land and climate. In the Division the rapid population growth, land adjudication and inheritance, closeness to the main urban area, intensive land use and human settlement all lead to heavy forest depletion, bringing not only scarcity of energy, but also promoting adverse environmental effects which threaten agricultural potential over wide

In many rural communities, the energy systems reflect an intergrated structure of relationships between resources and activities and the role of fuelwood must be seen as a complex function with many connections with the land tenure and land use systems, agricultural practices, the machinery for allocating resources, social structure etc. The use of fuelwood in rural areas for domestic purposes still forms part of the traditional subsistence economy systems.

The Division's forest area are almost non-existent. (Map 4) As has been indicated earlier, most of the land has been cleared of all its forests. There are hardly any forest areas that can be seen of substantial size except the gazetted forests. Due to land shortage, most people have completely cut down all the trees from their farms and turned the land into agricultural lands. Those who have larger land sizes have standing tree stock. But these trees are negliigible in terms of satisfying the population's present fuelwood demand.

There are however two Government forest reserves Dagoretti (764.0 Ha.) and Muguga (365.2 Ha). These two forest reserves provide energy source to the people living nearby. Permission to collect fuelwood in the

reserves is granted on payment of four shillings per month. Daily permit is obtained after clearance of unwanted vegetation as allocated by the forest rangers. Fuelwood procurement is allowed for fallen branches, twigs and dead stumps. There is explicit prohibition against cutting live trees.

With limited fuelwood sources, the people (mostly women) spend more time and money from their limited resources for collection or purchase of fuelwood. The selling of fuelwood has developed into a booming business in the area. Most of the wood sold is brought into the area from aberdares forests or from the two forest reserves by the wood dealers. The price of fuelwood varies from area to area and is determined by the type of fuelwood. The hardwood species such as *Acacia mearnsis* and *croton megatocarpus* cost more than the soft wood species such as eucalyptus. A piece of wood on the average costs fifty cents. A backload of firewood weighing about 33 kg costs about 10 shillings. (See Plate I). A stack of wood $1m^3$ costs between one hundred and ten shillings depending on the type of wood and the area. Fuelwood is more expensive in Kinoo and some parts of Muguga and Kabete locations than the rest of the Division.



PLATE I. A LOAD OF FUELWOOD



PLATE II A BAG OF SAWDUST

In short, the closer you are to the forest reserve, the cheaper the fuelwood.

In so thickly a populated area, where almost every square inch of the land is under foodcrops and settlement, the scarcity of trees and hence charcoal is an acute problem. Charcoal burning within the Division is very negligible. Only those land owners (about 1%) who have some standing trees sometimes burn charcoal for sale. This charcoal is more expensive than the charcoal brought into the region by the charcoal dealers. The charcoal burnt by the individuals costs fifty shillings(50/=) and forty five (45/=) shillings per bag. Most of the respondents confirmed that due to high costs of the charcoal, they used it very rarely.

2 AGRICULTURAL RESIDUE

Where fuelwood becomes scarce or costly, the most common substitute is agricultural residue. Agricultural residue includes stalks from all types of crops; maize cobs, roots of all types of crops, grass, fruit tree prunnings, fencing shrubs and leaves. Scarcity of fuelwood in some locations for example Kabete, Muguga and Kinoo is so acute that crop residue is being used as energy. The agricultural residue is collected by

both women and children from their small shambas. When any crop has been harvested, the waste is usually left on the shambas to refertilise it. It is this waste which is turned fuel for cooking.

When agricultural residue is returned into the soil, it improves the nutrient level, structure and capacity to retain moisture. When residue is turned into energy the soil becomes impoverished. Unless heavily compensated by chemical fertilisers, the use of residue leads to lower yield per hectare which is likely to create more pressure to bring more land under agricultural crops. (The dilemma is that there is not enough land given the already existing pressure on land). This has resulted in every available land in Kikuyu Division being turned to cultivation and exhaustion of soil due to continuous use without replenishment.

3:3 ANIMAL WASTES

3. Animal wastes have also been used as a substitute for firewood in areas of extreme scarcity. Unless compensated by the application of fertilisers the diversion of animal dung from agricultural use to fuel use will lead to lower yield per hectare. This problem can be overcome if it is used to produce commercial energy by anaerobic digestion, since this yields methane (biogas) as a fuel while the plant nutrient

value of the residue remains. Animal wastes are however not very commonly used in the Division. The respondents indicated having used animal wastes when there was no other energy source at all at sight. This is however a very rare occurrence.

3:4 ALTERNATIVE SOURCES

It is often said that man thinks best when faced with a crisis and looks for ways and means of evading the crisis. As a result of fuelwood scarcity, the Kikuyu people have turned to processing wastes and briquettes as alternative sources of energy. Availability of sawdust, coffee husks and briquettes is a most welcome solution to the scarcity of fuelwood.

Sawdust is obtained from the sawmill in Kikuyu township, at the cost of one shilling per bag (Plate II). The respondents felt that the sawdust is very economical compared to charcoal. They have a special jiko for the burning of sawdust which is made locally. One jiko according to them would burn for about four hours. A bag of sawdust (Plate II) would last them two months while the same bag of charcoal takes only two weeks. The respondents also preferred using saw dust jiko

because of its safety. Unlike the charcoal jiko, sawdust jiko does not heat at the sides and hence cannot burn the children even if they happened to touch it, as it happens so often.

The respondents were also in favour of using saw dust because it is cheap to buy. However those who are far from Kikuyu township complained of the distance and the transportation costs. Sawdust is becoming a famous fuelwood substitute to those areas already hard hit by fuelwood scarcity. Those who are near the forest reserves did not use it at all. Those found using sawdust complained of the unpleasant smell of the sawdust smoke.

Coffee husks are also an alternative source of energy in the Division (Plate III). Already it is being used in Uthiru, Kanyariri, Gitaru, Muguga and Kahuho sublocations. Unlike sawdust which is available in the Division, coffee husks are brought to Kikuyu from outside the Division. A thriving coffee husks trader said that he bought the husks from a coffee factory near Kiambu town. Coffee husks cost three shillings a tin (Plate IV), and fifteen (15/=) shillings per bag.

The respondents who indicated using coffee husks said

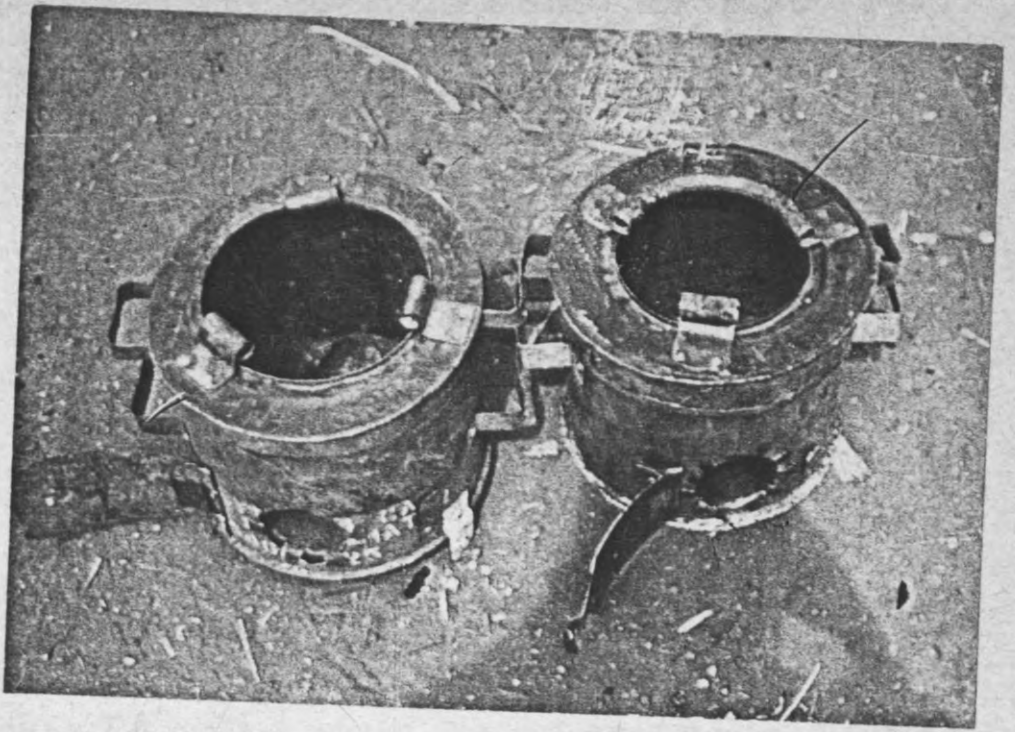


PLATE III A SAWDUST JIKO



PLATE IV COFFEE HUSKS

that they preferred it to sawdust because it emits hotter fire, takes longer to burn and has no strong unpleasant smell. A bag of coffee husks takes about three months. The coffee husks burn on the same jiko as the sawdust.

Briquettes are another alternative source of energy in the area. Made from charcoal dust, soil and water the briquettes which are referred to as "Ichanga" in the area are also used to a limited extent. Two parts of soil are thoroughly mixed with one part of charcoal dust and sufficient water to make moulds of briquettes. The moulded briquettes are left under the sun to dry. Once dry, the briquettes are used as charcoal mostly in the traditional charcoal jiko.

The skill of briquettes making was brought into Kikuyu Division by some Zambian women who live in Kiambaa centre. Some informants in Muguga and Mwimuto sublocations indicated having learnt the skill and admitted that they liked the briquettes because their fire is very hot and they take a very long time to burn a whole day non-stop, according to the informants.

Gas and electricity is used by few people in the area. The informants indicated that only a few high income people use gas and electricity. None of the informants used gas or electricity because it is too expensive and the price of the cooking appliances is prohibitive. However they indicated that electricity is not difficult to get if one had the money to enable one to pay the necessary fees to tap it. Gas is bought at Nairobi. As the informants said, there was no gas depot to store the gas. Thus it is not easily available in the area.

In conclusion, the foregoing analysis describes the energy supply systems of the Division. From the analysis it is clear that woodfuel is very scarce as most of the land is used for agriculture. Owing to scarcity of woodfuel, people have generally turned to other sources of fuel such as agricultural residue and animal wastes. Substitution of fuelwood with agricultural residue and animal wastes deprives the soil of its valuable nutrients which results in low crop production. At the same time, scarcity of woodfuel has made the people of the Division have a chance to diversify their energy sources by turning to sawdust, coffee husks and briquettes. This is a welcome solution to woodfuel scarcity.

CHAPTER FOUR

THE PRESENT WOODFUEL SITUATION

4:0 INTRODUCTION

"If you find cooking as easy as turning the buttons of that present day kitchen gadgetry, and choosing room temperature as simple as pressing a wall switch, then you should be forgiven for doubting that, elsewhere many more people still trudge across the country for fuel, in an act very much similar to that of chasing the horizon". Standard Newspaper, Tuesday, October 1t, 1984.

Should that sound a bit like an incredible folkrole, then make the rounds of Kikuyu Division to see for yourself the scarcity of trees which are the main source of woodfuel. In the Division, where all households continue to depend on the woodfuel, the woodfuel plays a very important role in energy supply. As wood resource declines, agricultural, animal and processing wastes are used as a supplement or substitute. Wood is the fuel customarily preferred by the people both because, its decentralised method of production is suited to the scattered nature of rural habitation and usually make it possible to obtain the fuel without the added cost, and because production can be maintained on the basis of sustained yield.

In the past, fuelwood has been gathered principally from woodlots near households. As population increases due to high population growth rate, better health delivery system and improved agriculture, these woodlots have been cleared to make room for agriculture and settlement. Increased human population leads to increased demand for energy and the gap between the needs and supplies grows. This gap will continue to widen as population grows at 4% per annum while energy resources decline. A table indicating the "National wood resource supply/demand relationship in Kenya will help demonstrate the situation.

TABLE 3

NATIONAL WOOD RESOURCE SUPPLY/DEMAND RELATIONSHIP IN KENYA

	1980	1985	1990	1995	2000
DEMAND	20.41	26.42	32.37	49.74	49.74
SUPPLIED FROM YIELDS	11.07	9.41	8.06	6.29	4.97
SUPPLIED FROM STOCK	9.26	10.94	13.51	21.62	12.16
SHORTFALL	-08	6.07	10.80	13.13	32.61
STANDING STOCK	934.82	885.41	829.36	744.40	674.40

SOURCE:

In the Division, there is an acute shortage of fuelwood. Gauging of scarcity was done subjectively by asking the informants whether they found fuelwood abundant, scarce or very scarce. The response was that fuelwood was very scarce. This was so in every sublocation even those near the gazetted forests. The author's observation proved this beyond doubt. This was because there was no sublocation where fuelwood was obtained freely as used to be in the past. Those near the gazetted forests had to get a permit from the forestry department allowing them to enter the forest. Without the permit, nobody would dare enter the forest. Those who did were in danger of having their equipments and fuelwood consificated if the forest rangers happened to catch them.

The acute shortage of fuelwood in the Division can be attributed to a number of factors. Its geographical location near Nairobi can be said to be one of them. The informants narrated how in the past charcoal burning on commercial basis was a thriving business. The Charcoal so produced would be taken to Nairobi where there was a ready market. Many trees have been felled to provide charcoal to Nairobi market and this in time has contributed to deforestation and thus shortage of woodfuel. The scarcity is further exacerbated by the rising urban

demand which forces charcoal dealers to direct their charcoal to the city where the prices are higher depriving the rural people their source of energy.

Land adjudication and land tenure create considerable accessibility problems. Land adjudication gave individual title to the land and consequently restricted access to firewood. Forests are government controlled and thus not accessible except at a price in order to obtain the permit. The subdivision of land among the sons and the population pressure is creating a landless class of people who find the access to fuelwood resource extremely difficult.

In the Division the average land holding is 0.6 hectares per household. Competition for land use is thus very intense. Continued population increase exacerbates land competition making it impossible to leave any part for woodlot.

The presidential directive banning the felling of trees has greatly contributed to the fuelwood shortage. Formally there were fuelwood dealers who had licences to cut trees in the gazetted forests and sell the wood

so obtained to the people. With the Presidential directive these fuelwood dealers had their licences withdrawn.

The physical availability of fuelwood supplies is the most important factor in determining who consumes fuelwood as well as how much they consume. By far the most significant use of fuelwood is to fuel the cooking fires. Cooking activities are carried out on open fires, which are wasteful as energy conversion devices. The archaic method of three stone cookstove has a conversion efficiency of only eight per cent. Though open fire has many other functions it is considered to be very wasteful in wood consumption. A lot of fuelwood is required when using this device and it has led to clearing of forests in search of fuelwood.

4:1 FACTORS AFFECTING PRODUCTION: DISTRIBUTION AND CONSUMPTION OF WOODFUEL

4:1:1 PRODUCTION

In the Division, fuelwood production is part and parcel of the subsistence economy. It is obtained from the reserve forests within the Division; individual farm woodlots or brought into the Division from Aberdares forest.

From the gazetted forests, the wood collectors are allowed to gather dead wood, branches and twigs. From the individual woodlots the owners may decide to trim branches or fell a whole tree to provide the fuel. Those who have to buy fuelwood prefer to buy a whole tree and fell it for themselves. A whole tree costs between fifty and one hundred and fifty shillings, depending on the size and species of the tree. The preferred species such as acacia mearnsis and corolia africana are much more expensive than others.

A discussion with a fuelwood dealer at Wangige Centre revealed the fact that the wood he traded in was brought from Aberdares Mountains. Formally he had been licensed to fell trees in either Muguga or Thogoto forests but with the Presidential directive banning the cutting of trees his license was withdrawn. He then got a permit to obtain his supply from Aberdares forest where trees are plentiful. Thus he obtains his supplies from outside the Division.

The fuelwood buyers obtain their supplies from the dealers at two split pieces per shilling. This is very expensive, as one informant indicated that fuelwood of five shillings would only be enough to prepare tea.

The informants preferred buying standing trees from their neighbours than buying pieces from the dealers. The reason being a whole tree is more economical than either stacked wood or split pieces from the fuelwood dealers. Once a tree is bought the whole labour of the household is deployed to felling it. The tree has to be dried before the fuel is used. The reduction of moisture content reduces the weight, raises calorific value, reduces the smoke produced in burning and lowers transport and handling costs. Wood for fuel is cut as roundwood, split logs, branches and twigs. Roundwood is usually the preferred domestic fuel, the most convenient in use and the easiest to prepare.

Charcoal production is very rare in the Division. Charcoal production is controlled by wood availability and as has been shown, wood is very scarce in the Division. Charcoal found in the Division is brought into the Division by charcoal dealers who obtain it from charcoal burners of Rift Valley Province.

Charcoal is carbonised wood and is the simplest method of upgrading wood to a fuel of higher calorific value. It depends for its production on earth pit kiln within which the heat is applied internally and part of the wood is burnt. Charcoal production is generally a very wasteful process. Large pieces of wood are preferred

as they tend to produce better charcoal with rather less labour costs. The wood is dried to lower the moisture content. In earth kiln, the quality of the product is difficult to control and small branches and twigs are generally unsatisfactory.

Charcoal can be soft and crumbly or hard and brittle depending on the carbonization conditions and original wood density. Charcoal has a moisture content of less than five per cent and is relatively easy to ignite. It burns evenly. Providing a concentrated and steady heat with little smoke or flame and is easy to store. Hardwood is generally the source of charcoal. The charcoal of different species vary very much in quality and therefore in ease of firing heat production and other qualities of importance to users.

1:2 LABOUR

Fuelwood collection is a very tiring and demanding exercise and time consuming. Fuelwood is usually gathered by women and children for the households own needs. Gathering the families energy supply is an essential chore which may occupy a considerable part of the working

day. For example, in Karai sublocation, the respondents indicated that they spent a whole day collecting fuelwood that would take the household three days. Thus on the average, two days per week are used in provision of household energy. In Kibichiku sublocation when a tree is bought from a neighbour, the whole household labour is deployed to fell, split and transport the fuelwood home. If the tree is a big one, labour has to be hired to help in the cutting and splitting of fuelwood. In such a case, men fell and split the logs while women carry the split logs to the home compound where drying to reduce moisture content takes place.

The growing difficulty of obtaining sufficient fuelwood has serious repercussions. First it results in people who do not have access to any other source of energy having to devote an increasing proportion of their limited time and money in obtaining the supply they need. Fuelwood gathering has become a significant strain upon the economic systems especially when labour is needed for other activities notably agriculture.

11:3 FUELWOOD SPECIES

Clear local preferences for specific fuelwood species and parts of the tree exists. For example,

Acasia Mearnsis (Muthanduku), Croton Megalocarpus (Mukinduri), Corolia Africana (Muringa) and Cypress (Muthithinda) are the most preferred species. These preferences are based on the burning qualities, availability and traditional practice relating to the indigenous species found in particular region. In general, the most desirable wood species are those which are hard, dry rapidly, burn strongly but without getting out of control, provide "hot" fire, emit little smoke and give no unpleasant taste to the food (or give a traditional desirable flavouring to the food).

But scarcity affects availability and now most people have a great restricted choice. As preferred species disappear, they often have to use trees or parts of trees that they know to be inferior as fuelwood. The preferred species are much more expensive than the less desired trees. For example a stack of eucalptus costs two hundred and thirty shillings while the same stack of ocasia mearnsis or croton megalocarpus will cost three hundred shillings in Kanyariri sublocation.

41:4 LOADS

Average load weight carried by the wood collectors is almost impossible to determine. The load weight will vary depending on the distance carried, moisture content

and species of the wood. Dry wood is lighter than wet wood and hence the load is bigger in size. Some tree species are lighter and as a result more will be carried. In Muguga sublocation fuelwood is sold in form of loads. A load costs ten shillings (Plate V). In such a case you can carry as much as you can possibly manage. The size of the load will be determined by the carrying capacity of the individual and her health condition. The fleurets case study of Kwemzitu Village in Tanzania estimates that the average weight per load is about thirty three kilogrammes.

1:5 TECHNOLOGY

Most fuelwood collection is done with some combination of axe, pangas and ropes for tying up the load for carrying. Axes are only useful when there is a tree to be felled, a stump to uproot or logs to be split. Large branches are also cut using axes. On most occasions the equipments used are pangas and ropes for tying the collected wood. Those who obtain permits to collect wood from the gazetted areas equip themselves with pangas and ropes only. This is because the felling of trees is strictly prohibited.

1:6 DISTRIBUTION

Transport costs are often the heaviest costs in



PLATE V COFFEE HUSKS



PLATE VI A LOAD OF FUELWOOD

production and distribution of fuelwood transport element is crucial to fuelwood procurement and perhaps future prices of fuelwood will be controlled by transport changes and implicitly by oil prices. High transport charges mean scarcity of fuelwood.

The commonest transportation means in the Division is human backs (Plate IV). Whatever the source of fuelwood, it is transported to the homestead by women on their backs. However due to its scarcity and the fact that the point of production is getting farther and farther from the homesteads, men have come into assist in fuelwood transportation. But instead of carrying the wood on their backs, men transport it by bicycles (Plate VII) and wheelburrows (Plate VIII) or mikokotenis. Small boys also assist in the transportation using their hand made wooden carts (Tiri).

In Karai sublocation, donkeys pulling carts are used as means of transport. But in the sublocation the women walk long distances, about ten kilometers and over, in search of fuelwood. In such cases they use the ropes and transport the collected fuel on their backs.

Matatus are also used to transport fuelwood obtained

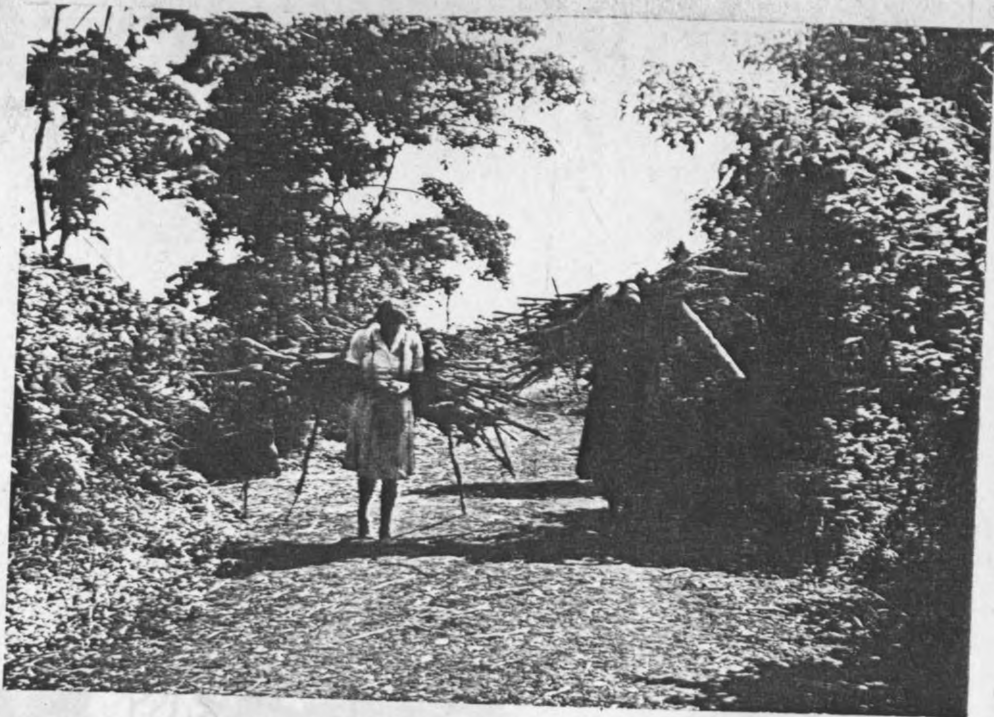


PLATE VII TRANSPORTATION OF FUELWOOD BY BACK



PLATE VIII TRANSPORTATION OF FUELWOOD BY BICYCLE

From the sawmill at Kikuyu township (Plate V) women come from all over the Division to buy the wasted pieces of wood from the sawmill (Plate V) and generally use oxen to transport the fuelwood.

The demand for fuelwood has led to wood dealers



PLATE IX TRANSPORTATION OF FUELWOOD BY A WHEELBURROW

Due to the scarcity of fuelwood, fuelwood distribution is also affected by weather conditions. During dry season, it is not difficult to obtain fuelwood from forested areas and the distribution is usually uninterrupted. But during the wet season, fuelwood is unavailable due to bad roads. transport is difficult and the roads are impassable and road becomes

from the sawmill at Kikuyu township (Plate V). Women come from all over the Division to buy the wasted pieces of wood from the sawmill. (Plate V) and generally use matatus to transport the fuelwood.

The demand for fuelwood has lead to wood dealers establishing themselves in small centres from where they sell their woodfuel. They sell split logs and maintain their own distinct system of direct supply and they hire their own gangs and transportation means to supply their centres. Although fuelwood is bulky, they find it easy to handle and store and it has a ready market.

Fuelwood is a bulky item and expensive to move in relation to its value. These transportation costs are shifted to the consumers making fuelwood very expensive. The high transport costs limits the distance from which fuelwood can be obtained economically. Thus contributing highly to the scarcity of fuelwood.

Fuelwood distribution is also affected by weather conditions. During dry season, it is not difficult to obtain fuelwood from forested areas and the distribution system is usually uninterrupted. But during the wet season fuelwood is unavailable due to bad forest transport network, the roads are impassable and wood becomes

extremely expensive. This condition has made people to have a tendency of buying wood during the dry season and storing it for the wet season periods.

147 CONSUMPTION

The survey has tried to show that fuelwood demand far exceeds the production and that supplies are continually exploited from existing stock. To make matters worse, the efficiencies of many of the devices which use non-commercial energy are extremely low and this results in serious wastage.

Fuelwood consists mainly of carbon and oxygen with variable proportions of moisture. Most species will burn, but vary their qualities such as calorific value, tendency to spark, tendency to smoke and effectiveness depending on whether the wood is dry or wet, soft or hard and its diameter or thickness. Species also vary in the ease with which they may be cut and handled and in the efficiency with which they may be converted into energy.

The physical availability of fuelwood supplies is the most important factor in determining who consumes firewood as well as how much they consume. Due to its shortage and expense, it is not available for the extremely poor and the aged of the society. These have turned to

agricultural residue, animal waste and sawdust to fuel their cooking fires.

By far, the most significant use of fuelwood is to fuel the cooking fires. Cooking activities are carried out on open fire which has very low conversion efficiency. The three stone open fire has energy conversion efficiency of between five and eight percent. This means that out of one hundred percent of fuelwood input, the three stone cookstove, only five to eight percent is effectively used in cooking. The rest of the energy is lost.

On the other hand, the metal charcoal jiko has an energy conversion efficiency of fourteen percent. Already we have seen that the process of turning wood to charcoal is very wasteful. According to Keith Openshaw, nine tonnes of wood is needed to produce one ton of charcoal. Further wastage takes place in conversion of this charcoal to energy. This means that a lot of wastage takes place before effective consumption can be realized.

We should be careful when considering fuelwood shortage because not all the wastage considered above is real wastage. If the three stone cookstove is analysed it should be kept in mind what other functions rather than cooking that it performs. During the day when the air

is hot and no space heating is necessary energy wastage definitely takes place. And this should be brought to a minimum. But during the night, when the air is cool, open fires are very essential in space heating. At the same time, the fire place acts as a focal point where all the members of the family meet to exchange their day's experiences while warming themselves. The fireplace thus acts as a very important social meeting place and provides life giving warmth. The fire is kept on long after the cooking which means that rather than cooking, fuelwood has a very essential social role.

1:2 IMPACT OF THE SHORTAGE

It is a stated fact that removal of tree cover has resulted in a treeless landscape which seriously affects the ecology of the region. The destruction of the forest and natural vegetation has resulted in all sorts of erosion. Erosion leads to soil degradation and hence low crop production. This erosion process is especially observable during the rainy season when the soil is carried into the rivers making the river appearance be brown. My informants agreed that there is a lot of soil erosion in the area.

The author could observe wind erosion which carried away a lot of soil. All these erosion results from the removal of vegetation cover as it has already been indicated.

The analysis of the energy supply system in the area has noted that the fuelwood shortage has led people to turn to other sources for fuel such as agricultural residue and animal wastes. The loss of crop residue and animal dung means less soil nutrients and low harvests. This automatically leads to underfeeding therefore leading to lower agricultural input and hence even lower agricultural output. At the same time, less time will be available for labour in agriculture and domestic duties as more and more time is spent in fuelwood procurement. Less fuel will mean that many families will either eat less desirable foods that require less cooking time.

As wood scarcity increases so does the difficulties of collection and so do old customs become modified. For example collection of fuelwood used to be assigned to women, but this is gradually changing. As has been noted, men are presently participating in procurement and transportation of fuelwood. Rigid practices are disappearing and flexibility of roles is taking place. The impact of scarcity is such that it forces change in social systems that have existed for centuries.

The reduction in the quantity of available fuelwood and cooking fuels in general alters traditional consumption pattern. It affects the kind of food grown and consumed and reduces the number of hot meals eaten as well as the way they are prepared. Reduced firewood supplies encourage dietary changes as well food requiring less cooking time come to be preferred because of fewer fires being made in general and the smaller fires used when they are lit.

The limitations imposed by lack of accessibility to fuelwood is especially serious for old women as the informants indicated. They are unable to walk long distances to get fuelwood thus are forced to depend on the animal wastes, twigs, shrubs and crop residue which they collect along the roadsides and pathways. Their very existence is thus threatened by lack of energy.

As scarcity of wood sets in, people spend longer periods, go farther a field, yet, return with less wood of inferior quality and crop residues. The scarcity of fuelwood and the increasing labour requirement for its collection affects many areas of life as indicated earlier.

Agricultural production is reduced, types of food cooked changes, leisure time available, ceremonial activities and in general the community's way of life and environmental change takes place.

Faced with the scarcity, the community has tried to explore other ways and means of overcoming the problem. They have turned to sawdust, coffee husks and making of briquettes; and have responded positively to energy saving technology. A few of the informants indicated having acquired the ceramic jiko which are more energy efficient than the metal jikos.

At the same time, people have become aware of the importance of trees and those who have bigger land plots have started planting trees, mainly the quick growing eucalyptus. The role of tree planting is no longer limited to men as used to be in the past. Women have also taken up tree planting as most of them confirmed.

In summary, this chapter analysis the important role played by woodfuel in provision of energy in particular and rural development in general. It has shown that energy issues hinge other issues of development and production and its solution requires an intergrated and comprehensive

planning. The main issues raised are:-

- (a) Limited wood sources
- (b) Wasteful methods of charcoal production
- (c) Low energy conversion efficiency of the cookstoves
- (d) Wasteful cooking methods

The above issues have exacerbated the wood shortage problem and have contributed to:-

- (a) Soil erosion
- (b) Modification of traditional roles
- (c) Time wastage in fuelwood procurement
- (d) Replacement of traditionally slow cooking foods with fast cooking meals which are often less nutritious.

Against the analysis that has been undertaken the author will proceed to analyse findings and recommend strategies to minimise the rural energy crisis.

CHAPTER FIVE

FINDINGS AND RECOMMENDATIONS

5:0 INTRODUCTION

The study set out to identify and describe the supply and consumption of rural household energy in Kikuyu Division with an aim of highlighting appropriate measures to the energy crisis. The findings of the analysis have established beyond doubt the scarcity of woodfuel in the Division. A number of factors have been identified which have contributed to the shortage. These factors can broadly be classified as;

- (a) Physical factors
- (b) Economic factors
- (c) Social Factors
- (d) Energy related factors.

These factors will be examined individually and recommendations made on the basis of their significance in relation to woodfuel crisis.

3:1 PHYSICAL FACTORS

The physical factors identified by the study include;

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deforestation, limited reforestation and afforestation programmes and inadequate forest department personnel. The study has revealed that deforestation has played a very significant role in creating woodfuel shortage. The demand for wood for various uses, and competing land uses have seen substantial clearance of the forests and woodlots to make room for agriculture and settlement.

This clearance has not always been followed by reforestation and afforestation programmes mainly because of the small land sizes and lack of community appreciation of the afforestation programmes. At the same time the forestry department lacks the staff and training necessary to provide technical assistance and extension services for a successful afforestation programme.

In recognizing the importance of forests and the dangers of soil erosion resulting from indiscriminate use, the government of Kenya has embarked on an extensive forest conservation programme that has a three way approach;

- (a) Preservation of indigenous forests
- (b) Forest plantation programme
- (c) Rural afforestation programme

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- (a) Preservation of indigenous forests
- (b) Forest plantation programme
- (c) Rural afforestation programme

The government is already very active in tree planting in the whole republic. The setting aside of National Tree Planting Day and the formation of Presidential Commission for Soil Conservation and Afforestation are already steps ahead.

By planting trees, Kenyans could ensure the cheapest supply of energy, create employment, protect the water catchment areas, stabilise the soil, enhance the quality of life for the people and enhance economic growth of the nation.

Although the Kikuyu people are aware of the importance of trees as the interview proved, they are not keen in embarking on tree planting. The major constraints expressed by the respondents is the land sizes. They are too small for any meaningful afforestation programme.

With the ever increasing pressure on the arable land, the adoption of agroforestry system is clearly seen as the most suitable form of land use. (Map 7) To meet the high fuel demand, foodcrops should be interplanted with fast growing multipurpose trees including indigenous trees

of which there are several that could be promoted; for example, Leucaena Sesbania, Calliandra and Mimosa species which can be harvested every three years or less and can be intercropped with foodcrops.

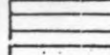

Tree growing needs community appreciation that it will meet a felt need and should be in consistent with their understanding of their own needs, aspirations and priorities. If afforestation programmes are to succeed, there must be a commitment on the part of the Government. This commitment must be expressed in the following ways

- (a) Giving priority to afforestation
- (b) Budgetary support
- (c) Provision of adequate staff

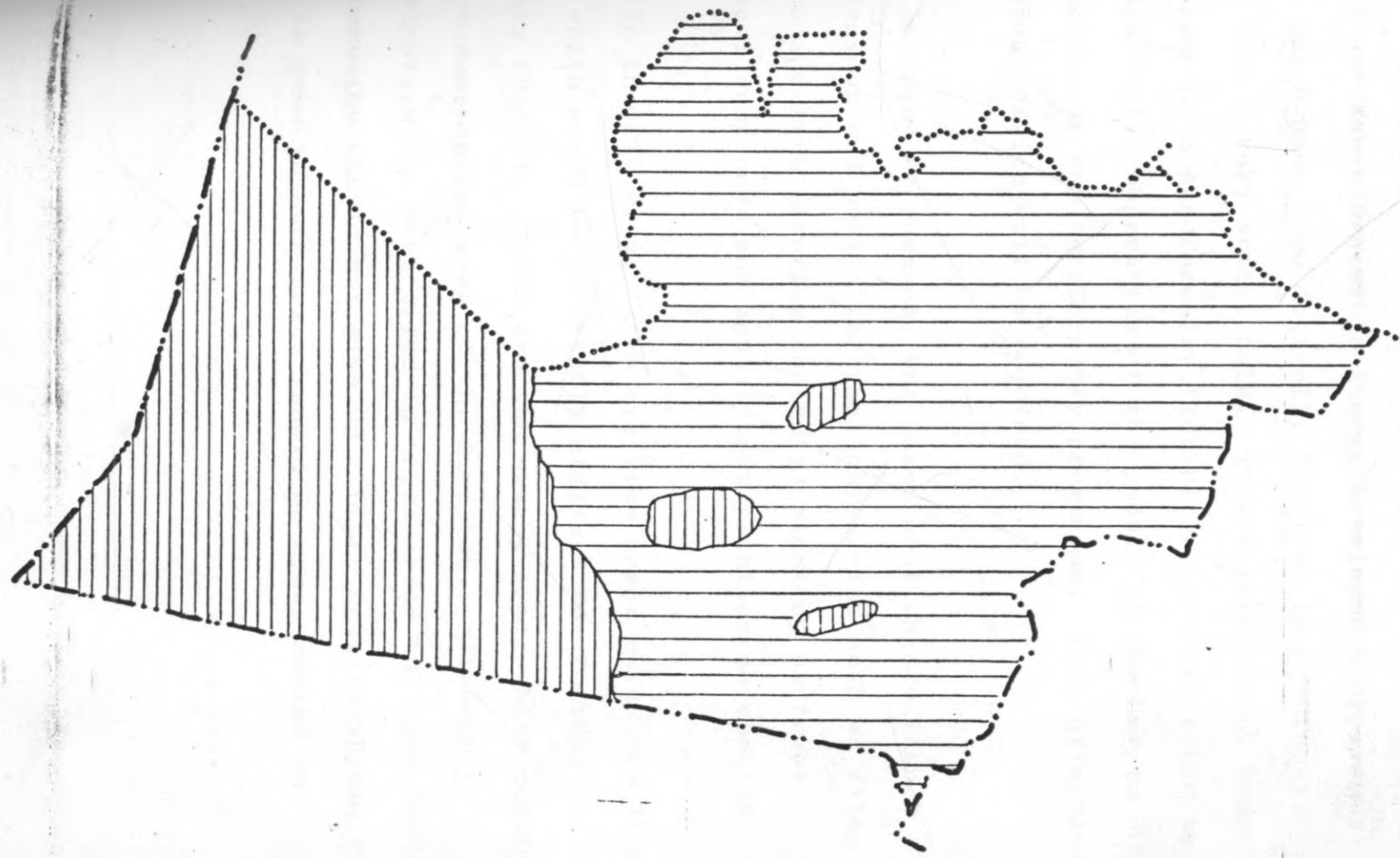
In the light of the above, it is recommended that the government be fully involved in the area to convince the people to practice agroforestry. Emphasis should be given to multipurpose tree species particularly those with positive relation and interaction with foodcrops.

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LEGEND:

-  AGROFORESTRY
-  AREAS FOR AFFORESTATION PROGRAMME

SCALE 1:100,000



Map No.
7

In this area, the Ministry of Energy, through such organizations as Kenya Non-Governmental Organization (KENGO) and Kenya Renewable Energy Development Programme (REDP) which have been actively involved in agroforestry, should take a very active role. The International Council for Research in Agroforestry (ICRAF) if involved could be realized that, cooperation of the people is the key to the success of any agroforestry programme. Thus effective extension service will be required.

In order to succeed, the Government should launch an extension and public information service such as films, posters and tree planting contests, planting of trees in school compounds and annual tree planting ceremonies.

In the Division, there are some areas which are lying waste which could be profitably utilized for community woodlots (Map 7). These are the swampy areas which occupy quite a substantial area of the Division. Although afforestation has been tried in these areas and have failed, the community should not give up. Other species which are known to grow in such areas should be experimented on.

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Another area very minimally used is the Nachu grazing area. (Map 7) This is a large stretch of land to the South-West of the Division in open grassland and could be afforested by planting drought resistant tree species. If successful, this could be a very useful community woodlot. However the success of such a woodlot would require full involvement of the community in planting caring and harvesting trees. The Karai Locational Chief, under whose administration this area falls, should prepare seedlings and then fix a day when the trees could be planted on harambee basis. The community should then organise themselves into groups and each group should have a day when to take care of the planted seedlings. The whole community should then be allowed to air their views on how they want harvest of woodlot to be. Such an involvement will make the community feel proud of the project and will protect the seedlings from livestock and unauthorised cutting which is the greatest enemy of any afforestation programme.

It is recommended that the government should embark on programmes aimed at educating the masses on the energy crisis and what it entails. Such education will enhance peoples appreciation of tree planting exercises.

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5:2 ECONOMIC FACTORS

The economic factors noted in the analysis include:-

- (a) Encroachment of land by agriculture and settlement
- (b) Timewastage in fuelwood procurement which leads to, low labour input in agriculture, which in turn leads to low income returns and famines due to reduced food production
- (c) Burning of agricultural residue deprives the soil of its nutrients
- (d) Commercialization of woodfuel

Land shortage and competing land uses have led to the scarcity of woodfuel as most of the forests have been cleared to make room for agriculture and settlement as has already been noted. The study has revealed that most of the households have an average size of 0.3 ha. which is used to grow subsistent crops and for settlement.

The study has also revealed that there is a lot of time wastage in fuelwood procurement as people have to travel farther and farther to collect fuelwood. This has led to low labour input in agriculture and this in turn has led to reduced agricultural output. As most of the households rely on agricultural production for their subsistence, reduced production will automatically mean low income levels and possibly famines.

It has also been noted that the scarcity of woodfuel has led the people to rely on agricultural residue as a fuel substitute. The turning of agricultural residue to fuel deprives the soil of its valuable nutrients contributing further to reduced agricultural production.

The study has also shown that commercialization of woodfuel has also contributed to many households who have no money being put into a situation where they can not buy fuelwood because it is too expensive.

To offset the economic factors already analysed the study recommends Government intervention in reorganization of the marketing system of woodfuel. This will make it cheaper than it is at present making people formally unable to buy it, afford the prices. The availability of cheap fuelwood would make the labour, formally deployed to procure fuelwood be available for agricultural production.

The Ministry of Agriculture should also step in to help the farmers maximise production on their farms by either intensifying farming or turning the cultivable areas to horticultural agricultural production. The products of horticultural farming have a ready market in Nairobi. The money so obtained will be used to purchase fuelwood. The above will help to alleviate the energy crisis to a certain extent.

5:3 THE SOCIAL FACTORS

The social factors contributing to fuelwood shortage noted in the study are:-

- (a) Rapid population increase leading to high population density.
- (b) Land tenure and land adjudication giving individual titles to the land.

Growing population pressure has been recognized as the most important single factor contributing to the fuelwood crisis in the Division. Rapid population increase has led to high population density which at

present is 836 people per sq. kilometre. This led to continued fragmentation of land holding through inheritance, as a result of land tenure system, leaving holdings too small to allow any tree growth. This in turn has greatly enhanced the fuelwood crisis. Wood supply is a function of population growth and increasing human population leads to increased demand for energy. The gap between needs and supply will thus continue to widen unless population control is achieved.

Already the Government is carrying out intensive campaigns aimed at lowering the population growth but so far, little has been achieved especially in the rural areas. This should not discourage the family planning officers. Traditions take long to change. Every possible available communication means, for example, posters, radios, newspapers, and local papers, Televisions films and local theatres should all be used to convey the message. This in the long - run will definitely achieve the target and will result in lower growth rate. Reduced population growth will mean reduced pressure on land and reduced energy demand and hence energy conservation.

4 POLICY IMPLICATIONS

The energy issues that have been analysed in the study as contributing to woodfuel scarcity include:-

- (a) Limited alternative sources leading to overdependence on wood.
- (b) Wasteful methods of charcoal production
- (c) Low energy conversion efficiency of cookstoves
- (d) Wasteful cooking devices

As has been revealed in the study, the main energy supply system in the forest. For a long time, the people of the Division have relied heavily on fuelwood because it is the most preferred energy source. However, inaccessibility or scarcity of woodfuel has made people to turn to other sources as a substitute. These alternative sources as has already been noted include agricultural residue, animal wastes, and processing wastes. These substitution and especially with agricultural residue and animal wastes has in turn contributed to reduced soil nutrients.

Energy diversification is therefore essential for it will reduce over reliance on woodfuel. This diversification can be achieved by;-

- (i) Introduction of biogas plants
- (ii) Rural electrification
- (iii) Expanding alternative sources

Biogas production involves production of Methane (Chemical equivalent of natural gas) from waste organic matter by actions of anaerobic (in absence of oxygen). Animal dung and human wastes and other organic materials are used.

There is already a biogas plant at Muguga Research Station used for demonstration. But biogas plants have not taken off in Kenya for although they need minimal equipment input, these would have to be imported and at present time, their prices are not competitive with the other alternative sources.

According to 1984 - 1988 Development Plan, "Rural Electrification Programme will be stepped up so as to

provide greater sources of lighting energy for the rural population".⁽¹⁾ The Division is very close to Nairobi, and should take the advantage of its closeness in rural electrification programme. This programme will further reduce reliance on woodfuel on a few upper income group of people who can afford the electrical appliances.

Sawdust and coffee husks use should be intensified. As already noted, there is widespread use of sawdust in the area and especially in the regions hard hit by fuelwood shortage. The people near gazetted forests, as the respondents confirmed, did not use sawdust.

The present constraint on its use is its non availability and the transport costs. It is however a good and economic source of energy and will ease pressure on forests if wood dealers are encouraged to collect sawdust from the saw mills in the Aberdares forests where it is lying wasted and sell it to the people in their wood selling centres.

Coffee husks is brought into the area from outside the Division. As has been indicated, it is a very economical source of cooking fuel. More dealers should be encouraged

to add coffee husks on their woodfuel stock and make it available, to the people. The respondents also indicated their preference of coffee husks to sawdust. Thus if coffee husks were made available, it would provide alternative cooking fuel and hence ease pressure on wood.

Charcoal briquetting which was noted to be practised on very small scale has also very high prospects in the Division. Encouragement and Research should be intensified to explore the possibilities of briquetting charcoal at a large scale. The Ministry of Energy and Regional Development should provide financial support to any interested persons and this could be a very welcome solution to cooking fuel shortage in the Division. Briquetting of charcoal should not be a very expensive project because the main component i.e. soil and charcoal dust are ubiquitous resources in the area. Hence any briquetting plant would require very low capital input. At the same time such a plant is a labour intensive plant which means that it could offer job opportunities to the unemployed and thus raise income level of a few people in the area.

As has been clearly indicated in the study, charcoal production is a very wasteful process as far as wood is concerned. It has also contributed greatly to wood scarcity

as charcoal production led to forest being cleared at a very fast rate.

Ideally, charcoal burning should be discouraged especially in an area whose forests have almost been consumed. However, if it has to be burned, efficient methods of production should be used. The efficiency of production depends on the type of kiln used. In Kenya, the most familiar metal kiln is the mark v charcoal kiln currently being made by Burns and Blane Kenya Ltd. The advantage of metal kiln is that it is mobile and therefore good for scattered wood.

The brick kiln used in Kenya is the American "Missouri model". It is exclusively used by the East African Tanning Extract in Eldoret. According to ADEC, ⁽²⁾ "The kilns are reported to be producing charcoal in high quality and quantity. Recovery from each kiln depends on the size of wood and ofcourse the moisture content of the wood. It is however reported that, recovery on the basis of over dry wood is 25-32%".

Brick kilns are definitely more superior to earth kiln. The constraint to wide use of the brick kilns is the initial cost which is fairly high. But as far as charcoal production is concerned, the Government should be very firm in executing the Presidential Directive banning the burning of charcoal.

The analysis has also attributed the woodfuel shortage in the Division to inefficiency of the cookstoves used. It was noted that the cookstoves used had a conversion efficiency of between 5-8%. In response to woodfuel shortage and widespread deforestation, there are now ongoing efforts in Kenya to introduce new and improved charcoal/wood cookstoves to reduce the cost and quantities of cooking fuels used. The introduction of more efficient cookstoves will help greatly in the reduction of overall consumption of fuelwood for cooking. Wood consumption could be reduced by up to 50% through the use of better designed stoves developed and tested for cooking.

There are several models of cheap and more efficient charcoal and woodstoves in use in different parts of the world, some being experimented within Kenya. According to Monica Opole,⁽³⁾ "Some of the cookstoves are achieving an efficiency saving of up to 50% of charcoal." Some improvements no doubt would lead to a large scale conservation of woodfuel.

In the Division there are already improved stoves made of mud with a chimney being tried. These are the Ruthigiti and Karai models. Mr. Micuta, the designer of Ruthigiti model has a lot of praise for the model. He

reckons that the stove has 40% thermal efficiency.⁽⁴⁾

But dealers who tried to make business of building Ruthigiti stoves quite the business due to lack of market.

The Karai stove model designed by UNICEF in association with Women Groups is also being experimented on. One informant who had the Karai Stove installed in her house agreed that the Karai Stove is definitely more efficient than the three stone cookstove. She testified that she used far less fuelwood for cooking her meals than using the previous threestone cookstove. But the stove though made in the Division is not very popular. The informants reckoned that the cookstove was unsuitable for quick cooking especially of light foods and does not play the warming role. For this reason it was unpopular.

In stove design, some important facts should be considered, these include:-

- (i) Design which suits existing needs
- (ii) Stove which fits into existing building structure

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- (iii) Suitable for use with local utensils.
- (iv) Produceable cheaply, quickly and from local materials
- (v) Should be locally acceptable

One potential danger in introduction of improved cookstove is that they may not actually safe fuel if they are not used properly. The three stone cookstove may thus be more efficient than improperly used stoves.

Some of the reported problems of cookstoves being tried in Kenya are;-

- (a) Lack of smoke to kill insects
- (b) There is no enough light emitted
- (c) They may take up too much kitchen space
- (d) Loss of space heating in the room

Improved jikos should be simple to operate, not too expensive, be fast or faster for cooking if they are

to be accepted. Their ability to radiate room temperature will also be important in cooler places.

According to Kinyanjui⁽⁵⁾ "In comparison with the widely used all metal Kenya charcoal jiko, the ceramic lined model showed a potential for cutting down fuel consumption per meal by up to 50% depending on the skill of the operator. The preliminary field tests results indicated that this saving is closely replicated under actual cooking conditions. The ceramic jiko has been tested in 451 Kenyan households. Field tests results indicated that 25-50% fuel saving is being obtained by test households. The stove is generally socially acceptable and majority of users find it suitable for cooking their routine meals."

The Ministry of Energy and Regional Development should encourage all the organizations involved in making the improved jikos to look for all the designs and come up with the most efficient model. The ceramic jiko, which is at present preferred by the users should be made available at the shops at affordable prices and the information of its efficiency should be promoted through all available means of communication.

Cooking methods were also noted to be very wasteful and have contributed to woodfuel shortage. Improving cooking methods will drastically reduce fuelwood consumption. Conservation through better cooking methods can be achieved through the following practices:-

- (a) Covering pots with well fitting lids to contain the heat and water otherwise lost through evaporation
- (b) Using right amount of water when cooking
- (c) Pre-soaking maize and beans overnight has been proved to reduce cooking time by half which means reducing fuelwood consumed by half
- (d) Using appropriate cooking devices; for maize and beans, clay pots are the most appropriate while sufurias are appropriate for fast cooking meals
- (e) Use dry wood as much as possible
- (f) Cut the wood into small pieces, this will increase the surface area and thus appropriate for preparing light meals

- (g) For simmering foods, slow the rate of burning by putting ashes on top of the fire
- (i) Extinguish fire when cooking is finished; learn to use remains of fuelwood and charcoal.
- (h) Do not extinguish fire with water because wood takes up water, so the firewood becomes too wet to burn and will need drying out again.
- (j) Cooking should be done inside in an area protected from winds.
- (k) Exact fitting of the cooking pot to the stove is also important.

The above practices can be achieved through intensive education programmes. The Ministry of Social Services, through the Adult Education classes could be used by the Ministry of Energy and Regional Development to include and emphasize on improved cooking methods. Effective extension services is thus very essential for the implementation of the mentioned practices.

The above analysis has tried to suggest ways and means of alleviating the woodfuel crisis in the Division. All in all, the analysis has come out with three broad solutions to the scarcity of woodfuel. These strategies can be classified into three:-

- (a) Energy conservation
- (b) Energy diversification
- (c) Increasing energy supply by growing more trees

The study will now proceed to identify the priority strategies based on short term and long term achievements.

5:5 POLICY PRIORITIES

5:5:1 SHORT-TERM PROPOSALS

It has been revealed in the study that Energy Conservation is the fastest, cheapest and the least disruptive means of alleviating the woodfuel shortage. At the same time conservation will have major social and economic benefits for the majority of the people and this will be realized almost immediately. The short-term priority programmes, should therefore include:-

- (1) Promoting efficiency use of woodfuel by:-
 - (a) Improving the cooking methods
 - (b) Improving cookstoves and making them available at affordable prices
 - (c) Improving the charcoal production methods

- (2) Reorganizing the woodfuel marketing system so that it is easily available at affordable prices

- (3) Diversification of Energy sources. This will be achieved through expanding sale of coffee husks and sawdust and introduction of large scale charcoal briquetting plants.

5:2 LONG-TERM PROPOSALS

The study has also noted that woodfuel will continue to be the main source of cooking fuel in Kikuyu Division. A long-term woodfuel strategy is therefore needed to ensure that adequate supplies of woodfuel at a sustainable yield is available. This strategy will be achieved through increasing energy supply by practising Agroforestry which is the compromise of tree growing and crop cultivation.

At the same time intensification of Rural afforestation and reforestation especially in public lands and unutilized areas such as the Nachu grazing area should be promoted. Proper forest management through training of adequate extension workers and forest technicians should be promoted. Population control which will result in reduced energy consumption should be a longterm target.

At the same time diversification of energy sources by introducing Rural Electrification and promoting appropriate technologies to exploit local sources for example biogas plants at affordable means should be aimed at.

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CHAPTER SIX
SUMMARY AND CONCLUSIONS

Energy plays a very important role in the day to day life of any society. Kenya, along with many other developing countries is facing a double edged crisis which seriously affects both the modern industrial sector and rural sector. Less developed countries need energy for survival. But increasingly they find that the energy crisis, fueled by a shrinking resource base, cripples efforts to meet development goals and fails to ensure a reliable rural energy supplies.

In many places, forest resources have been heavily depleted bringing not only a serious shortage of energy for rural people but also diverse environmental effects which threaten the agricultural potential over wide areas. The search for cultivable lands has sent subsistence farmers into forests and slopy areas resulting in deforestation, soil erosion and disrupted hydrological cycle. The shortage of fuelwood has become an alarming problem forcing people to spend more time in fuelwood procurement and less time in improving their agricultural output hence declining production and lowering the quality of rural life.

The rural energy crisis can be described as the women crisis. Women are closely connected with energy

generation and land-use in rural areas. They do much agricultural work, repair houses, draw water, cook and bear the burden of managing the family. They have to travel farther and farther to collect fuelwood. Many cook one meal a day because energy is too expensive. They boil water less often and in the worsening crisis they are forced to have more children who can help them with this crushing burden.

Fuelwood is being used in excess of its rate of natural replenishment. Projecting the present trends forward shows the position rapidly worsening and reaching the dimensions of a true and widespread rural energy crisis.

While noting the significant role played by woodfuel energy in development, a number of factors have been identified in this study which have contributed to the scarcity of woodfuel. These factors have been classified into four broad categories and each of them analysed accordingly. These classifications are:-

- (a) Physical factors
- (b) Economic factors
- (c) Social factors
- (d) Policy implications

The physical factors that have contributed to the scarcity of woodfuel and which have been analysed in the study are:-

- (i) Deforestation
- (ii) Limited afforestation programmes
- (iii) Inadequate forest departmental personnel

In the light of the above, afforestation and training more extension workers have been highlighted and recommended as the strategy to alleviate the problem.

The study further analysed the economic factors proved to play a part in contributing to woodfuel scarcity. These factors include:-

- (a) Encroachment of land by agriculture and settlement
- (b) Time wastage in fuelwood procurement
- (c) Burning of agricultural residue which results in loss of soil nutrients

(d) Commercialization of woodfuel

Energy diversification, increased agricultural production and agroforestry were highlighted as the solutions to the above problem.

The social factors noted included;-

- (i) Rapid population increase, leading to high population density
- (ii) Land tenure and land adjudication

While there is very little that can be done about land tenure and land adjudication, population control was recommended as a measure of conserving energy.

The study further revealed the policy implications and in this respect discussed the energy related issues which included:-

- (a) Limited alternative sources
- (b) Wasteful methods of charcoal production
- (c) Low energy conversion efficiency of cookstoves

(d) Wasteful cooking methods

As a result of the shortage, the study has revealed impacts which are observable in the study area and which were confirmed by the respondents. The impact arising from the shortage were:-

(i) Soil erosion

(ii) Low agricultural output

(iii) A replacement of traditionally slow cooking foods with fast cooking meals which may not be as nutritious

(iv) Modification of social roles leading to men lending a helping hand in fuelwood production

(v) More time spent on collection of less desirable fuelwood species.

Positive impacts noted by the study revealed that people have become more flexible in their use of fuel and can use any wood available irrespective of the species.

They have also become more receptive and inventive and have ventured to get alternatives or substitute to the fuelwood. It was also noted that the people have become more aware of the importance of trees and are ready to engage in afforestation. The only constraint to this afforestation is the shortage of land which is a major handicap in the area.

In view of the problems identified the study has recommended a short term priority strategy which should involve:-

- (1) Promoting efficient use of woodfuel by:-
 - (i) Improving the cooking methods
 - (ii) Improving cookstoves and making them available at affordable prices
 - (iii) Improving charcoal production methods
- (2) Reorganizing the woodfuel marketing system so that woodfuel is easily available at controlled prices
- (3) Diversification of energy sources by expanding sale of coffee husks, sawdust and briquetting.

As a long term strategy, the study has recommended the following:-

- (a) Agroforestry
- (b) Rural afforestation
- (c) Provision of adequate extension workers
- (d) Rural electrification
- (e) Biogas development
- (f) Population control

The study hopes that if the above strategies are implemented, the shortage of woodfuel in the Division will be alleviated.

In view of the shortcomings experienced during the data collection, this study has not exhausted the full scope of this subject. Further studies should be undertaken directing their attention to such areas as rural energy supply and demand; the extent to which the turning of

agricultural residue to fuel affects agriculture and analysis of how time spent in woodfuel procurement affects the rural development in general. Such studies should be undertaken in more localized areas such as a location in order to bring out a true picture of woodfuel situation to the policy makers.

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