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PRE-DIAGNOSTIC INFORMATION

KAKUYUNI WATERSHED

1. THE SEMIARID LANDS OF KENYA

Rapid population growth in Kenya (approx. 3.8-4.0 percent per annum), limited arable land and a shortage of employment opportunities in the industrial and service sectors have led to a substantial growth in the number of small-holders farming and ranching on Kenya's marginal lands. This trend is expected to continue into the twenty-first century. While increased settlement and exploitation of these lands provide a basis for the livelihood of small-scale farmers, the results are mixed. The soils, especially those on the steeper slopes, are subject to serious erosion. Much of the range land has been overgrazed and the ground cover in some areas is badly degraded. Also, rainfall in the semi-arid zone is low (600 to 800 mm on average) and subject to considerable variability These factors, combined with traditional methods of farming and ranching, have led to a low standard of living for many of the rural populace in these areas. During times of rainfall deficiency the Government of Kenya has had to divert scarce Treasury funds to famine relief for those most seriously affected. Moreover, the resulting depletion of the natural resources (forestry included) does not augur well for future generations who are expected to live on these marginal lands.

A pre-investment inventory study of the marginal/semi-arid lands in Kenya was conducted during 1977 and 1978 by the Consortium of International Development, the U.S. Soil Conservation Service (U.S.D.A.) and staff of the Ministries of Agriculture, Water Development and Natural Resources. The principal theme running throughout this study is that major investments in soil conservation works, farm production technology and infrastructure are needed to reverse the rapid decline in the quality of life and the condition of the physical environment in the semiarid lands.

Several institutions are now geared to fulfil this goal. The Katumani Research Station in collaboration with a team of F.A.O. experts and KARI in collaboration with U.S.A.I.D. experts are presently engaged in researching appropriate agricultural systems for the semi-arid areas while the European Development Fund sponsors an integrated development programme in Machakos District (M.I.D.P.). So far, most research is focused on purely agricultural and/or livestock systems, although the potential role of trees, expecially in solving the imminent energy shortage, has been clearly recognised by each of these institutions.

It is in this context that the formulation of an agroforestry research project is an important and appropriate contribution to the overall development of the semi-arid lands. The research plan discussed in this case study report proposes the refinement of results of on station species and provenance studies so far accumulated at Kibwezi, Hola, Ramogi and elsewhere through application to the farming situation, at Kakuyuni, Machakos District, Kenya.

2. METHODOLOGY

The identification of appropriate agroforestry systems and research needs for the target area was based on an application of ICRAF's diagnosis and design methodology (D&D), which is described in greater detail in Lundgren and Raintree (1983) and ICRAF (1983a, 1983b). A summary of the methedological steps taken in the preparation of this case study is presented below.

The first step was to select a specific study area, followed by an analysis of existing baseline data and a 'windshield' reconnaissance survey of the area coupled with preliminary interviews with qualified informants (articulate farmers, local officials, researchers, etc.) in the area. The output of this step was a basic structural-functional understanding/description of the area and its predominant land use systems.

The next step was to conduct a brief farm classification survey to identify one or two farming system types on which subsequent research would focus and to choose a sample of representative farms.

Subsequent to the selection of the focal system(s), a diagnostic survey of representative farms was conducted, followed by a diagnostic analysis of problems, constraints and potentials for agroforestry interventions to improve the performance of the selected farming system(s).

This led to the formulation of design proposals for agroforestry systems and technologies and, subsequently, to the identification of research needed to generate and test the candidate technologies and systems.

3. BIOPHYSICAL AND SOCIOECONOMIC CHARACTERISTICS OF THE TARGET AREA

3.1 Location of the target area

The Kakuyuni catchment area is located in Machakos District on the Yatta Plateau. It falls within agroclimatic zone 5 (Sombroek *et al.*, 1982), which comprises about one million hectares (i.e. 69% of the district's land area), and supports 465,000 persons (1979 census), i.e. 43% of the district's population. Kakuyuni is considered to be representative of the more densely populated areas of zone 5, where farmers are more dependent on agriculture than grazing (see Figure 1).

3.2 Terrain and Soils

The catchment area is about 1,200 meters above sea level and the terrain is gently to moderately sloping.

Soils in the catchment area are described as well drained, shallow to deep dark red, friable clay in many places rocky (nito rhodic ferralsols and nito chromic cambisols, including lithic and bouldery phases). In some depressions a poorly drained, very dark greyish-brown to black, very firm, slightly calcereous, cracking clay can be found, in many places with a saline and sodic deeper subsoil (pellic vertisols, partly saline - sodic phase, with eutric or vertic gleysols) (Sombroek *et al.*, 1982).

The ferralsol-cambisol soil association, including lithic phases, suffers from low inherent fertility once the organic matter content is lowered, as it quickly is by arable cropping, and also has a low capacity to retain added nutrients (although this is still worth doing). Maintaining or raising the organic matter content is particularly important.

The dark vertisols found in poorly drained depressions are very difficult to cultivate because clays are heavy, sticky and stiff when wet and hard when dry. The poor drainage also causes problems for most crops other than rice.

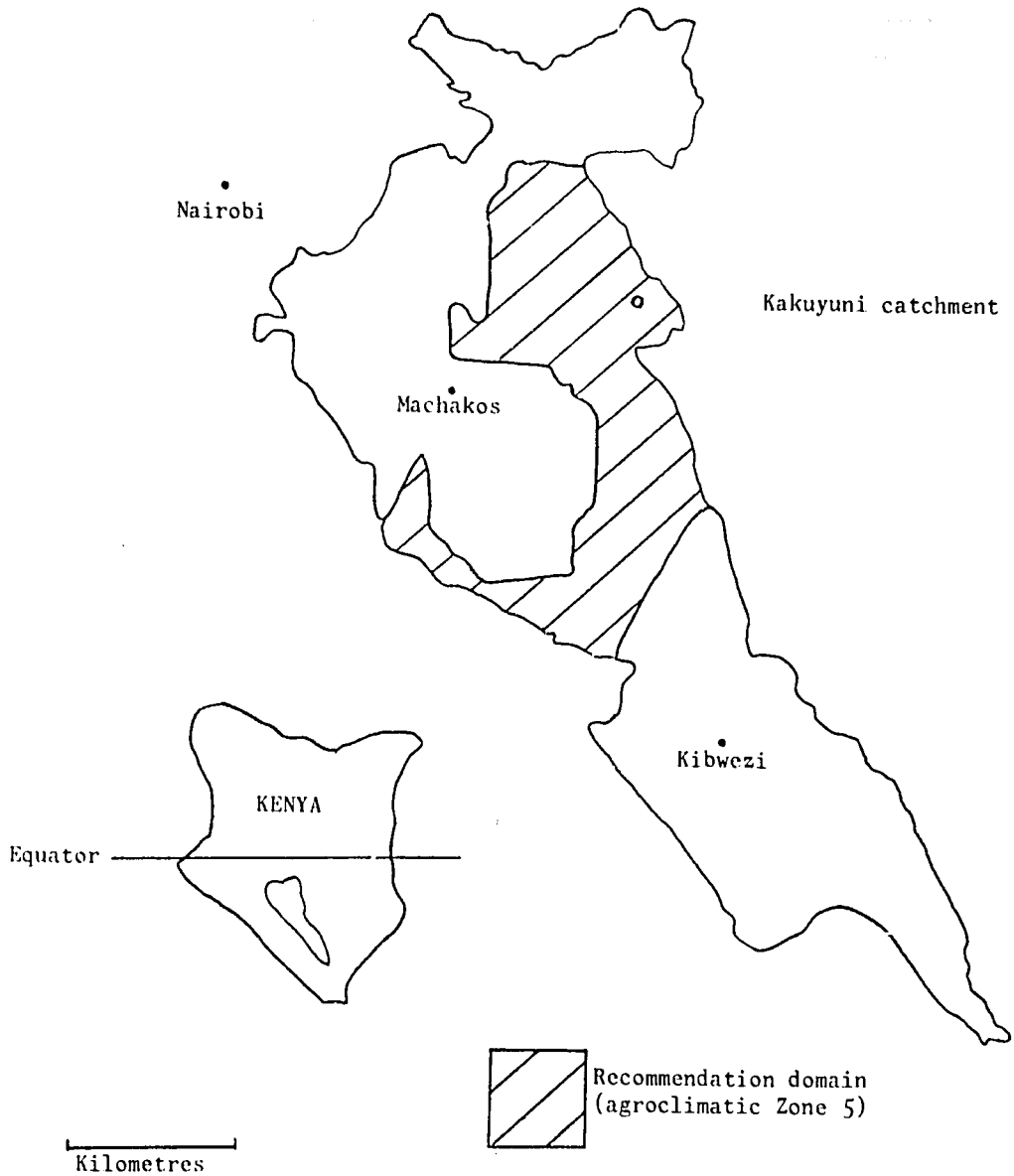

Figure 1. Location of the research site and recommendation domain in Machakos District, Kenya

3.3 Climate

The main climatic parameters for the target area, derived from climate maps and formulas published by Woodhead (1968) and the Kenya Meteorological Department, are presented in a climate diagram (Fig. 2).

It can be seen that optimal water requirements (E_T), on average, are only met in November, while the lower limit of normal plant water needs (0.4 Eo) is exceeded by precipitation in April, November and December only.

These already unfavourable climatic conditions are further aggravated by the variation in rainfall from one season and one year to the next (see Table 1).

Table 1. Seasonal rainfall probability for the project site (Jätzold, 1979).

	Percent probability of receiving more than:				
	100 mm	150 mm	200 mm	250 mm	300 mm
March-May (Mean 195 mm)	75%	54%	38%	23%	15%
October-November (Mean 305 mm)	96%	90%	74%	58%	39%

The projected onset and cessation of the rains in the project area are as follows:

	Onset	Cessation	Duration
"Long rains"	12-16 March	1-5 May	50 days
"Short rains"	18-22 October	22-26 December	60 days

This shows that the names "long rains" and "short rains" are somewhat misleading in the survey area, as the rainy period October-December is longer than the season March-May. Furthermore the rainfall quantity is higher and the probability of receiving a certain amount tends to be greater; therefore one can conclude that the rainy season October-December poses less risk to cropping activities.

3.4 Woody vegetation

The dominant tree/shrub vegetation in the area is comprised mainly of *Combretum molle*, *Acacia abyssinica*, *Balanites aegyptiaca* and *Terminalia brownii*. While these species are mainly found on the red clay soils, *Acacia drepanolobium* is common on the black clay soils.

3.5 Service infrastructure

Marketing of agricultural produce, mainly maize and beans, takes place through middlemen (shopkeepers), who in turn sell to the National Cereal and Produce Board as well to private traders from elsewhere. There is one market day each week in nearby Kitangi market. Although there is some form of price control, the farm gate price received by the farmer is often lower. The Kenya Farmers' Association sells agricultural inputs, such as seeds, chemicals, artificial fertilizers and livestock feed in its store in Machakos town (40 km). Very little is available locally, although the Machakos Integrated Development Programme is making an effort to improve this situation.

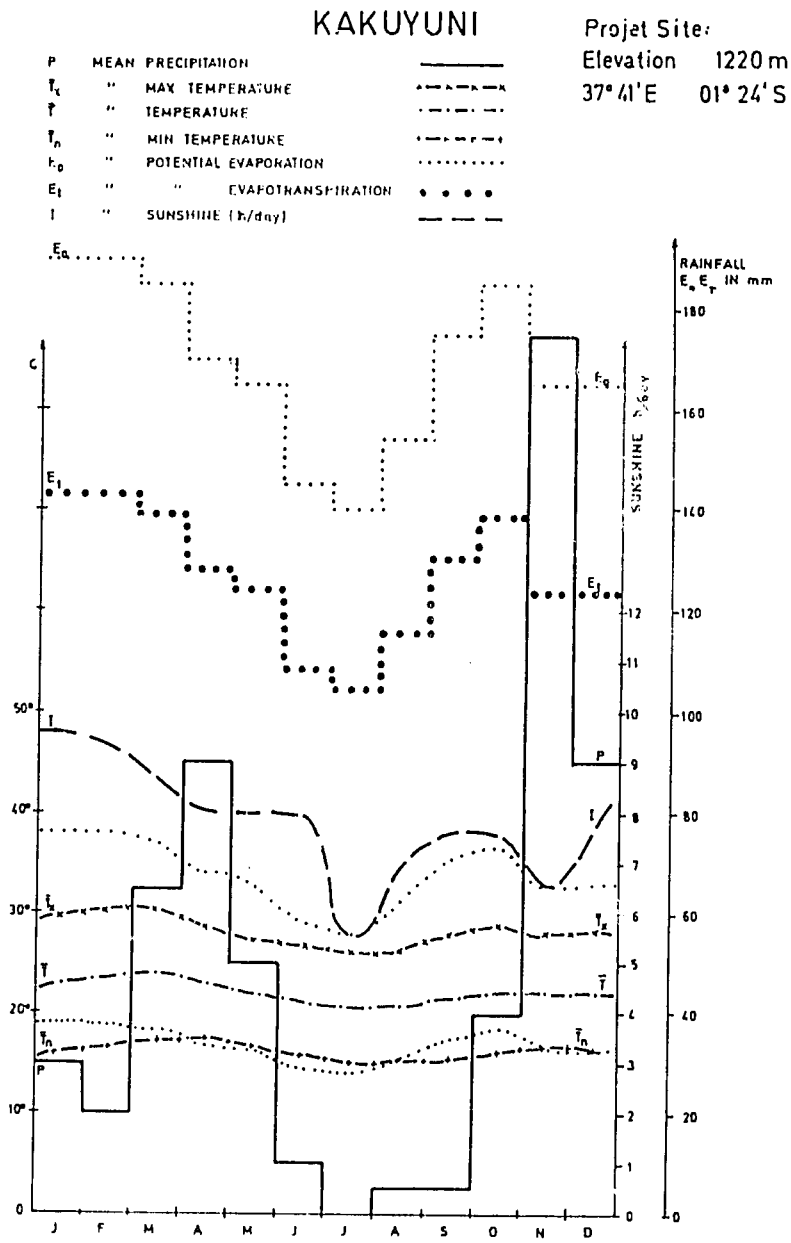

Figure 2. Climate diagram for the Kakuyuni area.

The government provides agriculture and livestock extension service, mostly at the location level, where a farmer may go to seek advice. Credit for small subsistence farmers is hardly available.

3.6 Population and land use

The majority of the population in Machakos District are Akamba people who have gradually shifted their emphasis from cattle grazing to arable cropping over the past fifty years.

Because of the rather unfavourable climatic conditions in zone 5, people moved into these areas only fairly recently mainly because of a population increase in the higher potential zones. The Kakuyuni catchment area is no exception to this pattern since farmers started settling in only as late as the 1950's. Until now no land has been officially adjudicated to invididual farmers in the area, although adjudication has been completed in some other parts of Machakos District.

Population density in Kinyatta Location, of which the Kakuyuni catchment area is a part, is 65 persons/km^2 (1979 census). This confirms the fact that the catchment is representative of the more densily populated areas of agroclimatic zone 5, where the overall population density is 47/km^2.

According to a recent aerial survey (Ecosystems Ltd., 1981), land use in Kinyatta location is as follows: 9,975 hectares are classified as cropland, 905 hectares as fallow, 5,065 hectares as infrastructural overhead, while the remaining 29,604 hectares can be used for grazing. Most of the area which is suitable for grazing is unimproved bushland in which the farmers invest very little labour. The fact that so much of the area is still in this condition does suggest that, given the present method of agriculture, labour is a constraining factor.

The livestock population, according to the same source, was estimated at 12,326 heads of cattle and 8,207 shoats. Based on herd composition data from the area, a stocking rate of about 0.4 A.U. $hectare^{-1}$ of grazing land was computed. This appears to be well above the stocking rates recommended by Rossiter and Ndegwa (1974), i.e. 0.16 A.U.

The main crops grown by the farmers are maize, cowpeas, beans and pigeon peas. The most common trees/shrubs and their uses are shown in Table 2.

Table 2. Most common indigenous trees and shrubs and their uses as observed in the Kakuyuni catchment area.

Name			Uses						
Botanical	Family	Location	Fuelwood	Building Material	Craft Wood	Fodder	Food	Fencing	Medicinal and other purposes
Acacia abyssinica	Mimosaceae	G	X	X	X	X		X	
Acacia drepanolobium	Mimosaceae	B	X					X	
Acacia tortilis	Mimosaceae	G	X	X		X			
Balanites aegyptiaca	Balanitaceae	G, A&B	X	X	X	X	Fruits	X	
Cassia singueana	Caesalpiniaceas	G & A	X						Stomach-ache, leaves also used for banana ripening
Combretum molle	Combretaceae	G	X	X	X	X			
Commiphora africana	Buraeraceae	G & A						X	Prevention of infection on open wounds
Croton megalocarpus	Euphorbiaceae	G & A	X	X					
Grewia tembensis	Tiliaceae	G	X	X		X	X		
Harrisonia abyssinica	Simanoubaceae	G	X			X			Stomach-ache and diarrhorea
Hymenodictyon parvifolium	Rubiaceae	G	X						
Ipomea spathulata	Convolulaceae	G							
Kigelia aethiopica	Blognoniaceae	G & A					Brew		
Lannea schweinfurthii	Anacardiaceae	G	X	X					
Maytenus putterlickodes	Celastraceae	G	X			X		X	Rheumatism
Ormocarpum kirkii	Papilionaceae	G & A	X			X			Wounds
Pappea capensis	Sapindaceae	G	X	X		X			Treatment of bruises
Rhus tenvinervis	Anacardiaceae	G & A	X	X		X	X	X	Stomach-ache & diarrh. measles.
Securinega vinosa	Euphorbiaceae	G	X			X			Tonsillitis
Terminalia brownii	Combretaceae	G & A	X	X	X	X			
Thespesia danis	Malvaceae	G	X	X			X		

G Grazing area
A Arable land
B Black Cotton soil

3.7 Distribution of farm resources

The distribution of the farm size in the Kakuyuni catchment area varied from 3 to 17 hectares, as shown in the following histogram.

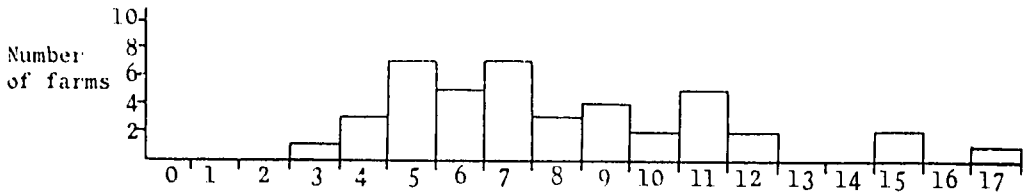

Figure 3. Farm size distribution in Kakuyuni catchment (hectares)

All farms were of a mixed enterprise composition, i.e. crops as well as livestock (cattle and shoats). The distribution of the livestock population over the farms is presented in the following histogram.

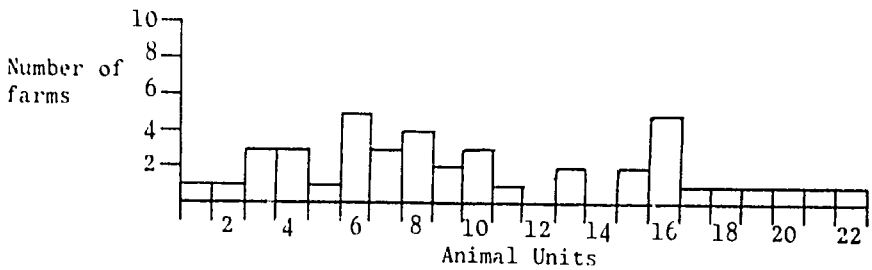

Figure 4. Livestock distribution on farms in Kakuyuni catchment.

A regression analysis of the farm size data indicate that the crop acreage increases with farm size. According to a survey in nearby Mwala Location, Machakos District, this is caused by the fact that most farmers want to reserve part of their land for grazing (Rukandema, 1981).

$y = 0.15 + 53x$ ($r = 0.91$, $n = 43$) in which y = acreage of cropland (in hectares x = farm size (in hectares), r = correlation coefficient, n = number of observations.

It is doubtful, however, that this straight line would continue once the crop acreage has reached a certain size, since it is exptected that labour and/or draught animal power would become constraining factors.

Although on average the larger farms were found to keep slightly more livestock units than the smaller farms, no clear relation could be found between farm grazing area and number of livestock units. This may be explained by the fact that most smaller farms rent additional grazing land during the latter part of the main dry season (August-October).

The grazing area of the farm is not only a source of food for the animals, but it is also the farmer's main source of fuelwood, poles and timber.

Most farmers rely entirely on family labour to produce their crops and to tend their livestock. The average farm family consists of two adults and a varying number of children who assist on a part-time basis.

The farm's capital resources are limited to land, livestock, buildings and ox-plough(s).