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Land Resources Development Centre

Kenya

Profile of Agricultural Potential

SURVEYS: KENYA LRD

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KENYA
PROFILE OF AGRICULTURAL POTENTIAL

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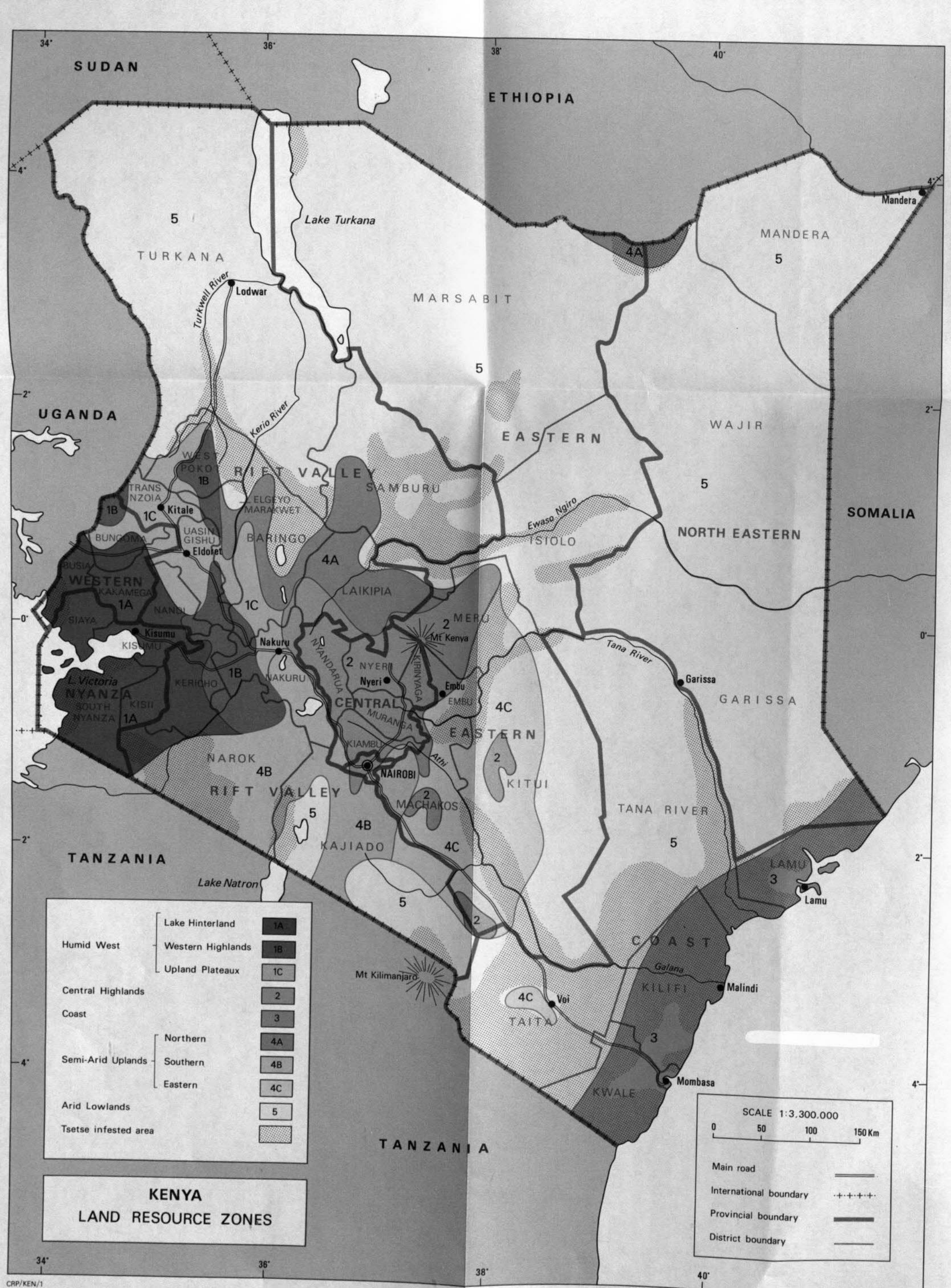


KENYA
LAND RESOURCE ZONES

CRP/KEN/1

INTRODUCTION

This Profile of the Agricultural Potential of Kenya was prepared by the Land Resources Development Centre at the request of ODA's Chief Natural Resources Adviser to provide a frame of reference for assessment of existing agricultural technologies. The Profile is the product of a rapid desk study which involved the use of satellite imagery, and existing reports and maps. Acknowledgement is due to a variety of organisations and individuals including multilateral organisations, commercial consultants and ODA staff.

Kenya sub-divides into five Land Resource Zones, two of which are sub-divided as shown on the folded map. The characteristics of each Zone are reported under 4 sub-heads: Physical Environment, Population, Land Use and Potential. Development potential, defined as possible increases in production over existing levels, is assessed for 3 different levels of technology. No attempt is made, however, to estimate the social and economic costs and benefits associated with particular developments.

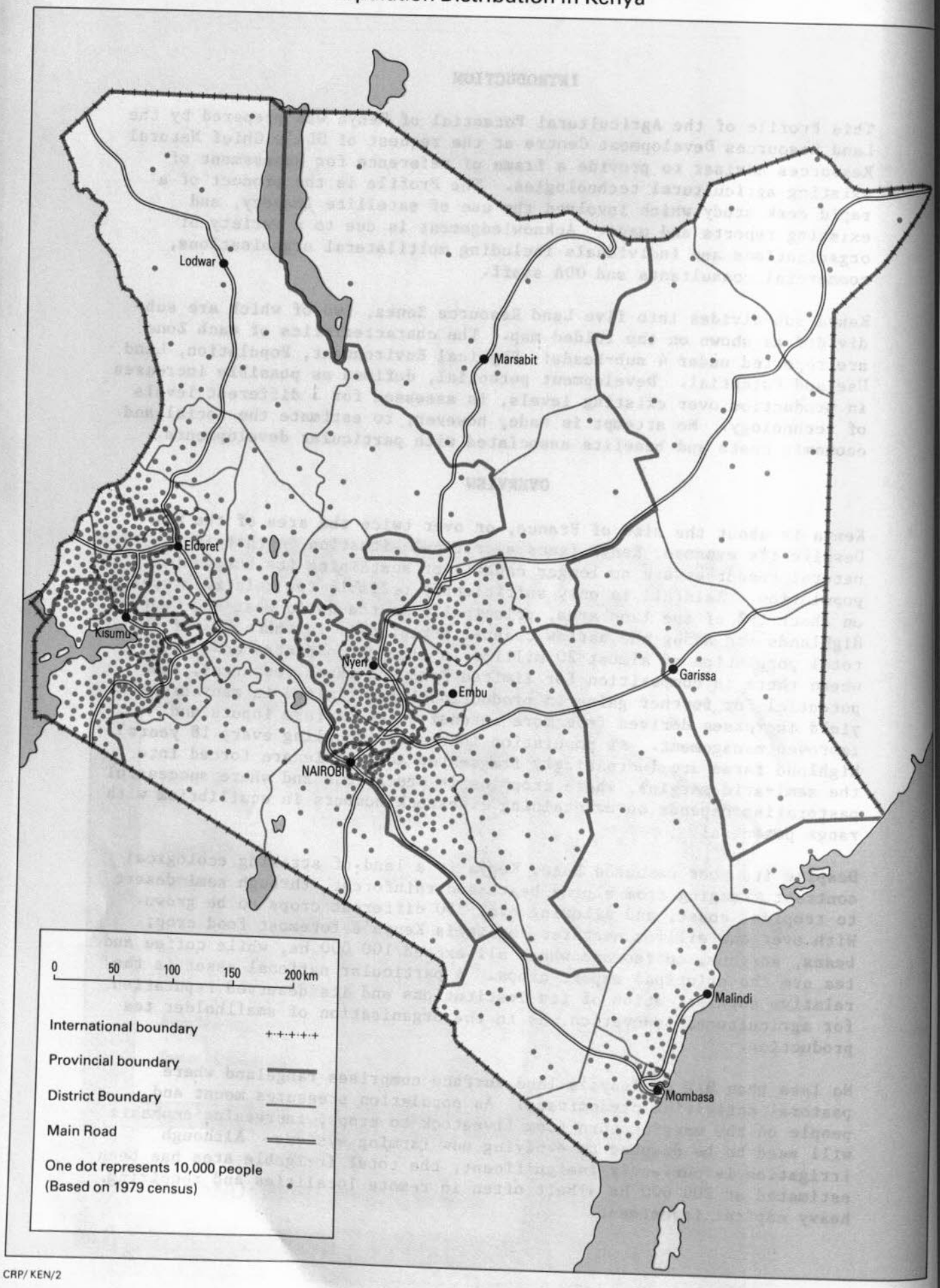
OVERVIEW

Kenya is about the size of France, or over twice the area of the UK. Despite its expanse, Kenya faces a critical situation in that its natural resources are no longer capable of sustaining its burgeoning population. Rainfall is only sufficiently reliable for rainfed cropping on about 19% of the land area, principally in the Humid West and Central Highlands and along the narrow coastal strip; this is where 85% of the total population of almost 20 million is already concentrated. Everywhere there is competition for limited land and water resources, the potential for further gains in production being limited in many areas to yield increases derived from more intensive use of farm inputs and improved management. As population increases (doubling every 18 years), highland farms are increasingly fragmented and people are forced into the semi-arid margins, where cropping is precarious and where successful pastoralism depends on maintaining livestock numbers in equilibrium with range potential.

Despite its poor resource base, Kenya is a land of striking ecological contrast, ranging from alpine heath and rainforest, through semi-desert to tropical coast, and allowing over 250 different crops to be grown. With over one million hectares, maize is Kenya's foremost food crop; beans, sorghum, coffee and wheat all exceed 100 000 ha, while coffee and tea are the principal export crops. A particular national asset is the relative sophistication of its institutions and its deserved reputation for agricultural innovation, as in the organisation of smallholder tea production.

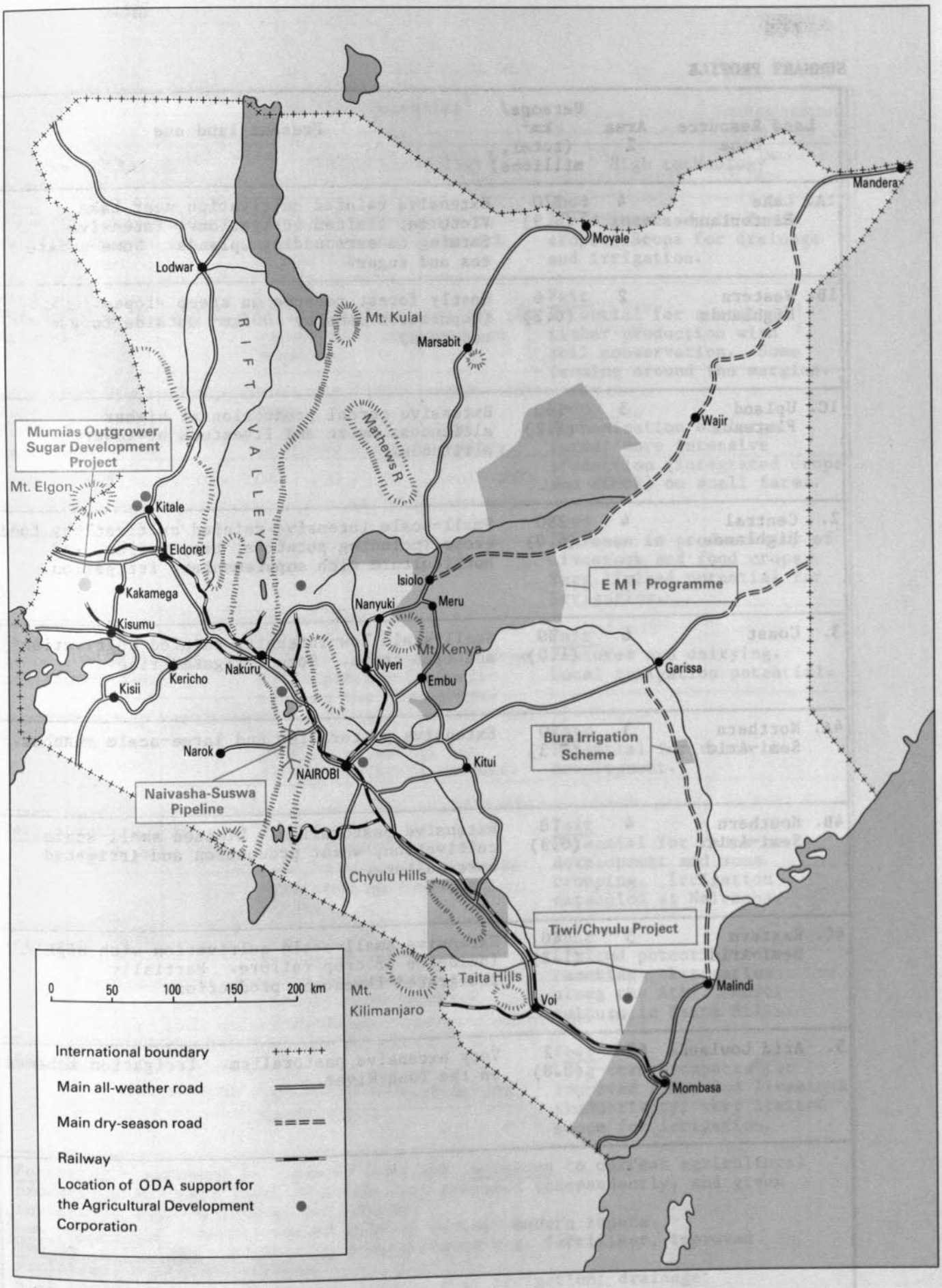
No less than 87% of Kenya's land surface comprises rangeland where pastoral activities predominate. As population pressures mount and people on the margins turn from livestock to crops, increasing emphasis will need to be devoted to evolving new farming systems. Although irrigation is currently insignificant, the total irrigable area has been estimated at 200 000 ha albeit often in remote localities and requiring heavy capital investment.

Population Distribution in Kenya



CRP/ KEN/2

Communications and Locations of Major ODA Natural Resource Projects in Kenya



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SUMMARY PROFILE

Land Resource Zone	Area %	Persons/ km^2 (total, millions)	Present land use
1A. Lake Hinterland	4	270 (4.9)	Extensive rainfed cultivation near Lake Victoria; limited irrigation. Intensive farming on surrounding uplands. Some estate tea and sugar.
1B. Western Highlands	2	6 (0.2)	Mostly forest reserve on steep slopes. (Population density 100/km^2 outside forest reserves)
1C. Upland Plateaux	3	160 (2.2)	Extensive cereal production at higher altitudes; maize and livestock at lower altitudes.
2. Central Highlands	4	280 (5.0)	Small-scale intensive rainfed cultivation; food crops including potatoes; tea, coffee, and horticulture with supplementary irrigation.
3. Coast	6	30 (1.0)	Small-scale low-intensity rainfed cultivation and tree crops. Some irrigated rice.
4A. Northern Semi-Arid	3	20 (0.3)	Extensive pastoralism and large-scale ranches.
4B. Southern Semi-Arid	4	10 (0.3)	Extensive pastoralism. Limited small-scale cultivation, wheat production and irrigated horticulture.
4C. Eastern Semi-Arid	5	40 (1.2)	Extensive small-scale cultivation with high incidence of crop failure. Partially integrated livestock production.
5. Arid Lowlands	69	2 (0.8)	Very extensive pastoralism. Irrigation schemes on the Tana River.

Potential[1]		
Low technology[2]	Medium technology[3]	High technology[4]
Poor Scope for expanding cultivated area.	Fair Limited improvements in food crops and livestock production.	Good Yield increases in food crops. Scope for drainage and irrigation.
Very poor Retention as Forest Reserve.	Poor Recommend some planting and urgent soil conservation measures.	Fair Potential for sustained timber production with soil conservation. Some farming around the margins.
Poor Scope for expanding cultivated area.	Good Higher cereal yields; improved stock husbandry.	Good Mechanisation on large farms; more intensive production (integrated crops and stock) on small farms.
Very poor	Fair Limited improvements in food crops.	Good Increase in productivity of livestock and food crops. Very limited potential for irrigation.
Fair Scope for expanding cultivated area.	Fair Climatic limitation. Scope for expansion in horticulture and tree crops.	Fair Pastures and dairying. Local irrigation potential.
Very poor	Poor Limited potential for drought-tolerant cereals.	Fair Potential for ranch development.
Very poor	Poor to fair Limited potential for drought-tolerant cereals; expansion of wheat in Narok.	Fair Potential for ranch development and some cropping. Irrigation expansion at Naivasha.
Very poor	Poor Potential for drought-tolerant cereals, agroforestry and improved livestock.	Fair Limited potential for ranching. Irrigation along the Athi. Horticulture in Taita Hills.
Very poor	Poor Scope for improving livestock production and marketing.	Poor Long-term prospects for improved range and livestock productivity; very limited scope for irrigation.

[1] Potential - assessed in terms of possible increases to current agricultural production for each level of technology assessed independently, and given favourable socio-political conditions.
[2] Low technology - mainly manual labour, minimal modern inputs.
[3] Medium technology - increasing modern inputs e.g. fertiliser, improved varieties, extension service.
[4] High technology - heavy capital inputs, e.g. irrigation; drainage; mechanisation; water supplies; processing capacity.

AGROCLIMATIC DATA

Zone	Altitude range: metres	Mean* annual temperature °C	Rainfall		Growing season: more than (>) or less than (<) 100 days
			Annual total, mm	Type of distribution**	
1A Lake Hinterland	1100 - 2200	23 - 16	800 - 2000	Prolonged Single≠	>
1B Western Highlands	2000 - 4000+	17 - 5	1300 - 2500	Prolonged Single	>
1C Upland Plateaux	1800 - 2300	18 - 15	900 - 1200	Double or Triple	>
2 Central Highlands	1500 - 3000+	20 - 10	600 - 2500	Double	>
3 Coast	0 - 400	27 - 25	500 - 1400	Single with tail	30 to 150 days
4A Northern Semi-Arid	1000 - 2000	24 - 15	400 - 800	Double or Triple	<
4B Southern Semi-Arid	1000 - 2000	24 - 15	400 - 1000	Single	<
4C Eastern Semi-Arid	600 - 1500	28 - 20	500 - 800	Double	<
5 Arid Lowlands	50 - 1500	30 - 20	150 - 500	Double or Indeterminate	<

* Localised frost above 2000 m altitude and/or cold night winds can pose severe limitations.

**Double = split wet season. Single = continuous unimodal wet season.
Single with tail = long drawn out post-wet season.

≠ In drier areas, as near Lake Victoria, there is a distinct double peak.

1. HUMID WEST

Although accounting for only 9% of the surface area of Kenya, this Zone supports over 7.3 million people, almost half the rural population, at an average density of 200 persons/km^2. It can sustain these numbers (density exceeding 750/km^2 locally) because it enjoys a long rainy season associated with a temperate equatorial climate; this enables a range of subsistence and cash crops to be grown with a high degree of reliability.

Within this relatively small area, there are immense contrasts in elevation and geology which in turn give rise to a wide range of climate, soils and land use. It is convenient therefore to divide the Humid West into three sub-zones:

1A Lake Hinterland, comprising the plains, catchments and hills surrounding the Lake Victoria Basin;

1B Western Highlands, comprising the mountain ranges that divide the Lake Victoria Basin from the Rift Valley; and

1C Upland Plateaux, being the distinctive intermediate elevation undulating plains of the interior.

All three sub-zones are characterised by the length of rainy season and by relatively high humidity generated through proximity to Lake Victoria.

1A. LAKE HINTERLAND

Physical Environment

This sub-zone comprises not only the land adjoining Lake Victoria but also the scarps and uplands surrounding the lake basin; to the north these include the Nandi Hills, to the south the Kisii Highlands (see folded map). These are areas that are under the daily influence of lake winds. Consequently, except in immediate proximity to the lake, the rainy season - extending from March to November - is both continuous and reliable. Indeed, the hilly areas of the hinterland comprise some of the wettest parts of Kenya. A total annual rainfall of around 800 mm close to the lake increases rapidly inland to approach and sometimes exceed 2 000 mm.

Although the geology and hence the soils are highly complex, the latter are generally not fertile. In the north, moreover, rooting depth tends to be impeded by the presence of hard ironstone or laterite. Much variation occurs over only short distances, the soils ranging from deep fertile red clays to shallow infertile sandy loams. Near the lake there are alkaline clay plains and discrete swamps. Soil quality differences, though important locally, do not characterise the sub-zone as a whole; nevertheless, detailed knowledge of the soils is essential before embarking on development.

Population

Throughout this area, population pressures are becoming increasingly serious, the average density of 270 persons/km^2 belying a marked variation between locations. Kisii District is under severest pressure, with 400 persons/km^2 overall (less than 0.1 ha per person in one location); population pressures are leading to fragmentation of holdings, landlessness and a decline in labour productivity.

Land Use

Great contrasts in cropping pattern reflect altitude, rainfall reliability and soil differences. Close to the lake, holdings range up to 20 ha and are not intensively farmed. Significant land is used for rough grazing by the high density of cattle. The main crops are maize, sorghum, cassava and cotton intercropped. Yields are low and modern inputs rarely used; malnutrition occurs widely. In contrast, the surrounding uplands are farmed intensively on holdings of 1-5 ha, with maize and beans the principal food crops: tea, coffee, dairying and, more locally, pyrethrum and passion fruit, the main sources of income. In addition to 20 000 ha of tea and 11 000 ha of coffee grown by smallholders, there are 20 000 ha of estate tea. Sugar is locally important with three factories east of Kisumu and a major centre to the north at Mumias, where 32 000 ha of cane are cultivated by 30 000 outgrowers for the 210 000 tonne capacity factory.

Potential

Other than close to the lake, there is little scope for increasing the area under cultivation, but considerable potential for raising yields by use of manure, fertilisers, plant protection and weed control. More emphasis is needed therefore on efforts to intensify research and extension as these relate to smallholdings in the contrasting ecological conditions. Early maturing crops of beans and vegetables need to be promoted near the lake where low rainfall coincides with excessive cassava and poor diet. The lake basin is generally too dry for sugar cane, the intermediate elevations have too uniform rainfall for quality coffee. Cotton may be more appropriate in the former areas, tea with dairying in the latter; and sugar concentrated north of the lake in the wet lower valleys of the Yala and Nzoia.

Fewer than 2 000 ha of irrigation (mostly rice) have been developed in the lake basin. A pre-feasibility study has however indicated an irrigation potential of some 25 000 ha, complete realisation of which would require drainage of the Yala Swamps. Despite the high capital requirements, irrigation development will become more attractive as population pressures increase.

Close to the lake, tsetse fly (sleeping sickness in cattle and man) is currently advancing from its stronghold in South Nyanza. Livestock production could nevertheless be raised through improved husbandry, specifically aimed at disease control and more intensive feeding.

1B. WESTERN HIGHLANDS

Physical Environment

These comprise the range of mostly volcanic mountains which, rising to over 3 000 m, form the western wall of the Rift Valley: the Cherangani Hills in the north, Tinderet Forest along the equator, and the Mau Escarpment to the south. For completeness, the sub-zone includes the volcanic massif of Mount Elgon which rises to over 4 000 m on the Uganda border north of the lake. This mountain country is high, wet and cold, often with steep slopes and scarps, and a tendency to night frost. Rains occur over some nine months of the year and even the dry season is marked by low levels of evaporation. The soils are of widely varying depth but with generally humic topsoil. On the Mau and lower slopes of Elgon, there are deep reddish-brown clays. Soils with impeded drainage occur on some plateaux and in valley bottoms.

Population

Much of the land comprises Forest Reserve and has little or no population; Outside the forest reserves, population density varies widely from 20 persons/km^2 in Narok to about 200/km^2 on the footslopes of Mt Elgon.

Land Use

Some of the higher hills have valuable stands of timber; about 100 000 ha of coniferous plantations supply sawmills and a pulpmill. Along the western borders of these Reserves, there is some tea cultivation and pressure to open up more of the forest. In other areas where it is too dry, or cold, for tea, cultivation generally comprises potatoes, pyrethrum and cabbage, with maize only at the lowest altitudes. Above about 2 700 m, wool sheep thrive where there is grassland; below this, dairying is undertaken.

Potential

Ideally, much of this sub-zone should be retained in, or planted to, forest. Where there are large farms and not too high a rainfall, wheat and sheep comprise the best combination of enterprises. On small farms, intensive vegetable production could prove rewarding though frost-pockets need to be avoided. Where slopes have been cleared and cultivated, soil conservation is crucial. In the wetter areas on gentle slopes, pyrethrum can be strip-cultivated on the contour, alternating with potatoes which are becoming increasingly important in this Zone.

1C UPLAND PLATEAUX

Physical Environment

This high country comprises the Uasin Gishu and Trans-Nzoia Plateaux, together with the highest part of the Rift Valley west of Nakuru. The influence of Lake Victoria is less than in 1A and 1B, resulting in two separate rainy seasons, March/May and July/ September, a less humid atmosphere and a distinct 3-month dry season. Elevation ranges between 1 800 and 2 300 m, while average annual rainfall varies from 160 to 1 200 mm.

Much of the terrain is underlain by rather infertile red clays often with gravel sheets; in the bottomlands, soils are imperfectly drained and also of low fertility. In the Rift Valley however, deep highly fertile brown loams and clay loams occur on volcanic materials.

Population

Traditionally an area of large farms - the 'White Highlands' - a number of these are still maintained. Though increasing rapidly the population density is still relatively low, at about 160 persons/km^2.

Land Use

Cereal cropping predominates; the actual crop chosen is determined rather precisely by altitude. Because of low temperatures the highest altitudes are used for wheat and pyrethrum. At somewhat lower elevations (down to 1 900 m), it tends to be too dry for pyrethrum; this is the principal area in Kenya for wheat and malting barley, sometimes associated with dairying. Where it is warmer, especially in the Rift Valley below 2 100 m, beef ranching represents the main economic activity accompanied by large-scale maize production. On the plateaux below 1 950 m and especially in Trans-Nzoia, the climate is ideal for late-maturing hybrids of maize and sunflower.

Potential

Continuing sub-division of the remaining large farms is expected to lead to more pyrethrum, maize and livestock, less wheat and barley. Unless increased production can be achieved, the current saleable cereal surplus will be endangered. Good husbandry, crop protection and the selection of disease-free varieties remain at the forefront of efforts to raise yields. In this, the local research services should focus on maize and wheat improvement in relation to environmental adaptability and disease resistance, while the Agricultural Development Corporation has a key role in maintaining grade cattle and in bulking quality seed. Careful crop selection is important both in relation to environment and size of farm. Support will continue to be required by the various agricultural machinery services based on Nakuru.

2. CENTRAL HIGHLANDS

Physical Environment

The distinguishing features of this Zone are its elevation (above 1 500 m) and bimodal rainfall. Depending on altitude and aspect, mean annual rainfall varies between 600 and 2 500 mm; being split into two rains (March-May and October-December), each is unreliable and separated from the next by a dry season which can extend for 3-4 months. On the southern and eastern slopes of the mountains, however, rains tend to be prolonged, more reliable in occurrence and rendered more effective by persistent low cloud.

The principal volcanic ranges east of the Rift comprise Nyandarua (the Aberdares) and Mt. Kenya, both of which rise to over 4 000 m, while the granitic hills of Machakos and Kitui to the east ascend to 2 100 m. Surrounding these mountains are plains at elevations between 1 250 and 2 500 m. The most important soils are the deep, dark red, friable clays known as 'Kikuyu red loam' on the southern and eastern footslopes of Mt. Kenya and Nyandarua. These permit arable cropping even on steep slopes due to their stable structure and high porosity. In contrast, soils on the granites are shallower and, though coarse-textured, are less porous, intensified cultivation or overgrazing tending to promote erosion. The soils of the plains are variable, often comprising impermeable black clay; the broad high-altitude plain south of Nyandarua is distinguished by poorly drained soils with clay pan.

Population

Apart from Nairobi with 1.2 million population, five million people live in this Zone. Although, overall, the population density averages 210/km^2 (280/km^2 excluding Forest Reserves and National Parks), the corridor from Kiambu to the Nyambeni Hills is more densely populated. In Kiambu District, an average density of 355 persons/km^2 disguises locations with serious population pressure; e.g. Kinoo with 0.3 ha per household, equivalent to only 0.06 ha per person, with farm units too small to support a family. Some supplement their farm incomes by seeking outside employment.

Land Use

South and east of the mountains, the small-farming pattern comprises intensive mixed cropping of maize, beans, potatoes and vegetables with climatically adapted cash crops, particularly tea and coffee. Intensive dairying is important, with 80% of the cattle comprising improved breeds mostly zero-grazed, such is the land pressure.

Murang'a District provides an example of cropping descending the eastern slopes of Nyandarua. Above 2 200 m, the land is so wet, cold and steep that it is best left in forest. Below this is the principal area for tea production, vegetables and dairying which, in turn, is separated

from the main coffee belt by mixed coffee and tea. Lower down, the soils are suitable for coffee but the rainfall is marginal; here coffee is produced with supplementary overhead irrigation. This merges into a maize-sunflower zone also producing sisal and pineapple. Smallholder coffee and tea cover, respectively, 63 000 ha and 29 000 ha, whereas estate coffee now only totals 22 000 ha.

North and west of the mountains, where the climate is drier and cooler, small farmers combine dairy production with wheat, maize, vegetables and pyrethrum. Where frosts and waterlogging are major problems, pyrethrum becomes the principal cash crop. Estate production of wheat is important in the Timau area on the northern slopes of Mt. Kenya.

The upper slopes of Mt. Kenya and Nyandarua are designated National Park and Forest Reserve. Here there have been widespread agricultural incursions, partially formalised by a recent Decree designating the lower 1 000 m smallholder tea land. Elsewhere forest plantations comprise some 60 000 ha of exotic conifers.

Potential

Despite the intensive farming, food crop yields are well below potential; there is scope for wider use of intensified inputs and improved farming techniques (including soil conservation). Although coffee expansion is constrained by the coffee quota, there is continuing scope for raising the area of tea, installing tea roads and constructing additional factories. Proximity to centres of population and Nairobi Airport provides major opportunities for intensive vegetable, flower and strawberry production. Another intensive enterprise available to smallholdings is seed production. At the higher elevations, potatoes yield better than maize and mature more quickly.

Standards of livestock husbandry have fallen markedly because of recent failings in the artificial insemination and field veterinary services, though pastures are still intensively used. It follows therefore that there is now considerable scope for raising stock productivity through rehabilitation of necessary supporting services.

Opportunities exist for small-scale pump irrigation close to streams, though there is already competition for dry season flow from urban users.

3. COAST

Physical Environment

The Coast combines high temperatures with high humidity. Though subject to the coastal monsoon, seasonal rainfall can vary greatly. Extending inland some 30 km, there is a single extended rainy season, from April to August. Along the Coast, rainfall generally declines from south to north, from 1 400 mm/year at Gazi to under 600 mm near the Somali border. Inland, rainfall decreases rapidly and the Arid Zone is reached within 75 km.

Apart from the Shimba Hills, much of the Coast lies below 250 m. The soils are complex but share in common a lack of fertility; they range from beach sands to poorly drained clays. The floodplains of the Tana and Galana (Athi) are fertile however, but subject to flooding and localised salinity. East of the Tana the clay soils are prone to waterlogging.

Population

The rural population of the Coast is about one million. Overall population density is around 30 people/km^2, with up to 300/km^2 in some locations. There are few signs of serious population pressure. Mombasa, Kenya's main sea port, has a population of about 400 000.

Land Use

Farms on the Coast average 6-8 ha, with low-intensity cropping dominated by maize. Cassava and sweet potatoes are important food crops. Nearly 50% of the arable land is under tree crops - mostly cashew and coconuts with some grapefruit and mangoes. A higher proportion of the coconut hectarage occurs on the south coast where the rainfall is heavier, whereas the drier Kilifi coast (north of Mombasa) is better suited to cashew. High night temperatures constrain maize yields, detract from pineapple quality and inhibit citrus ripening.

Despite unsuitable soils, a sugar factory on the south coast receives cane from an estate of 4 500 ha and 800 ha of outgrowers. Otherwise the main arable cash crop is cotton, important in Kilifi, Tana River and Lamu Districts, though yields and quality are poor. In Kwale District, where the rainfall is high, the dye crop anatto is important. Rice is produced locally wherever surface water levels can be controlled. Largely owing to trypanosomiasis, few livestock are kept, numbers averaging one stock unit*/13 ha; grazing is extensive mainly on communal land.

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* One stock unit is equivalent to a mature zebu cow with calf, averaging about 300 kg liveweight; this is also roughly equivalent to 5 calves, 7 sheep and goats, or one adult camel.

Remnants of coastal forest occur in localised pockets where protection has been effected, e.g. on the upper Shimba Hills south of Kwale and in Boni National Reserve adjoining the Somali border. Of an estimated 45 000 ha of mangrove, about one third is merchantable timber.

Potential

Although the Coast is not densely settled, potential for expansion is limited by soil fertility and rainfall variability. There is some scope for increasing the area under cultivation but the main opportunities for increasing production lie with intensified management and inputs. In this latter respect, there is need for more cropping and farm systems research (to include intercropping and mixed cropping) to give the extension service more effective messages.

Unquestionably there is potential for tree and root crops, as well as for tropical forages under tree crops in support of dairying. Milk production is feasible given high standards of husbandry, but EEC surplus dried milk is reconstituted locally and this would provide severe competition for the liquid product. The buoyant tourist industry provides a ready market for fruits and vegetables, as well as for beef, pork and poultry. Sorghum might prove a more successful cereal than maize if the people were prepared to grow it; there may nevertheless be scope for producing sorghum concentrates for stall feeding pigs and poultry. On the sandier soils there are opportunities for expanding cashew and, on well drained but more fertile soils some 15-20 km inland, quality pineapple can be produced. On the floodplains of the lower Tana and Galana, small-scale irrigation of rice, sorghum and sesame could be expanded, though constrained by problems related to high watertables, salinity and poor access. Of the total irrigation potential at the Coast of some 25 000 ha, only a small proportion has yet been exploited.

4. SEMI-ARID UPLANDS

These comprise the country around the northern, southern and eastern margins of the Central Highlands, at elevations exceeding 750 m but featuring erratic rainfall often interspersed with severe dry seasons. Although subsistence cropping is risky with total crop failure anticipated at least one year in five and partial failure every second year, because of overpopulation in the higher potential zones these are lands that are rapidly becoming settled. Despite the low overall population density (15 persons/km^2), given the poor resource base and the prevailing technology the environment is already under pressure with localised soil erosion becoming more prevalent. High priority is given therefore to devising new technologies appropriate to these marginal areas; these will only emerge as a result of sustained long-term research.

Models are being developed to predict human carrying capacity in these critical environments. Though subject to considerable simplification, they do give some indications as to maximum population density. Based on a long-term carrying capacity defined by the lowest annual rainfall received over an average 10-year period and assuming that only half the land is actually cultivable, it appears that for areas with average rainfall of 750 mm the maximum human population may be some 35 persons/km^2. Below 380 mm, the population is forced to depend totally on livestock production which is less sensitive to rainfall but permits only a low human population of about 2 persons/km^2, a level which is already generally exceeded.

4A. NORTHERN SEMI-ARID

Physical Environment

This comprises the high-altitude (1 600-2 000 m) Laikipia Plains north-west of Mt Kenya, together with the northern Rift Valley falling away to 1 000 m north of Nakuru. The soils are derived from volcanic rocks and ash. On the plains they are mainly fertile clays; on the Rift walls they are shallow and stony, and on the Rift Valley floor clay sediments are variably affected by salinity. The climate on the Laikipia Plains is cool and dry, with rainfall of 400-800 mm in indeterminate seasons, each inadequate for cropping. The Rift is hotter with a similar total rainfall in one season, or two short seasons, between April and September.

Population

The country is sparsely populated with about 20 persons/km^2.

Land Use

Agriculture is based on beef ranching and pastoralism. Local pressure of human population is carrying subsistence cropping well into the Zone. Despite some expanses of open grassland, bushland and woodland predominate. The ranches of Laikipia are well developed with water and internal fencing, running improved zebu or cross-bred beef animals supplemented by immature stock bought in from northern Kenya. Elsewhere, extensive pastoralism is the main activity. In Laikipia there is a density of 1 stock unit/4 ha; in the Rift Valley 1 per 8 ha. The land is hilly and the soils fragile with consequent risk of progressive sheet and gully erosion, both of which can be severe. Bush encroachment is prominent on slopes. Near Lake Baringo, a 415 ha irrigation scheme produces onions, while some 500 ha of traditional irrigation are centred on perennial streams and springs.

Potential

There is little potential for arable agriculture other than early maturing millets and sorghum. Some potential exists for irrigation from the Ewaso Ngiro River, although the areas of suitable soils and topography are limited. Because each of the rains is often inadequate for crops though, in aggregate, more than adequate for cereal production, there is considerable scope for water harvesting and moisture conservation. Under these dry, high elevation conditions the best cereals are barley and tef; in the event of drought either could be fed off to stock. Otherwise, the main potential lies in large-scale beef ranching, involving bush control.

4B. SOUTHERN SEMI-ARID

Physical Environment

This comprises high-altitude plains east and west of the Rift Valley, at 1 600-2 000 m, together with the dry floor of the Rift from 1 900 m at Naivasha to 1 000 m on the Tanzanian border. The soils of the plains are mostly clays, poorly drained with a characteristic open grassland. The Rift walls are steep with shallow, stony soils; below the soils range from loose, erodible sandy ash around extinct volcanoes to alkaline loams and clays in the valley bottoms.

The climate is cool and dry on the plains. Annual rainfall is 500-700 mm, rising to 1 000 mm to the west of the Loita Plains and in the Loita Hills, though the benefit of this higher rainfall is offset by low night temperatures. The Rift Valley floor is warmer and dry, rainfall decreasing southwards from 600 mm around Naivasha to 400 mm on the Tanzanian border.

Population

There is a population of some 250 000 at a low density of about 10 persons/km^2.

Land Use

This is the homeland of the pastoral Maasai; owing to the serious soil and climatic constraints, the greater part has to be regarded as essentially cattle country. Overall livestock density is estimated at one unit/3.5 ha. The Maasai are not entirely nomadic, many having settled down to cultivate: maize and vegetables near Kajiado and, more remarkably, extensive wheat near Narok based on machinery cooperatives. Other cultivators have also moved into western Narok, and into the Rift Valley south of Naivasha where they grow maize.

Kaputiei (in Kajiado District), where Maasai territorial rights are based on social groupings, was selected for introduction of ranching cooperatives with land title, known as 'Group Ranches'. At Kaputiei, each Group averaged about 15 000 ha and 50 families; the largest Group Ranch covers 135 000 ha.

The Loita Hills are protected as Forest Reserve; here the soils are shallow and unsuitable for cultivation. Parts of the plains are set aside as National Parks, principally the Maasai Mara (1 600 km^2). Small areas of overhead irrigation on commercial farms around Lake Naivasha produce horticultural crops and, farther south below the Nguruman Escarpment, traditional food crops are grown on surface irrigation.

Potential

Other than for ranching, potential is seriously constrained by variable and often low rainfall, poor soils, widespread gully erosion and low night temperatures. There are moreover large areas with inadequate surface water supplies, while groundwater is either non-existent or seriously saline. The Naivasha-Suswa pipeline (extending 75 km south from Lake Naivasha) constructed at considerable expense to relieve water shortages in the Rift Valley was ironically washed out by torrential floods. On the better more stable soils in upper Narok, there is scope for early-maturing wheat, and for cold-tolerant sorghum at somewhat lower elevations. In general, there is rather better potential for cropping in Narok than in Kajiado District.

4C. EASTERN SEMI-ARID

Physical Environment

This comprises dissected plains and hills east of Mt Kenya, the Nyambeni Range and the Machakos Highlands, varying in altitude from 600 to 1 500 m, and traversed by the two main rivers of eastern Kenya - the Athi and the Tana. The soils are medium and sandy textured, generally deep but of low fertility and locally shallow as on the Kitui and Taita Hills. Annual rainfall is 500-900 mm, falling erratically in two equal seasons, March-May and November-December. Storms can be intense causing severe erosion. The rains are separated by long dry seasons.

Population

The population is estimated at 1.2 million. Population density varies according to soils, water availability and historical patterns of settlement, from about 20 persons/km^2 in Kitui District, 34/km^2 in lower Meru, 44/km^2 in lower Embu, to 70/km^2 in the Taita Hills.

Land Use

In the past quarter century these lands have experienced a major influx of population, such that extensive areas of bushland have been transformed into cultivation. In lower Embu/Meru between 1948 and 1982, land in the cultivation cycle increased from 12% of the area to 41%, i.e. by 3½ times (Appendix 1). Patterns of shifting cultivation with long resting periods are rapidly breaking down under pressure both from increasing population and from land adjudication. Average holding sizes vary from 2-4 ha in Embu/Meru to 3-10 ha in Machakos. Maize is the dominant cereal despite a high risk of failure; other common (and more appropriate) food crops include sorghum, millet, pigeon peas and green gram. About half the maize hectarage is intercropped with legumes. Cotton and tobacco are locally important cash crops. In lower Machakos (near Kibwezi) there is a 3 200 ha sisal estate.

In the Kitui Hills, maize and beans are planted extensively usually intercropped with pigeon pea, the maize often failing; sorghum, millet and cotton are also grown. In contrast, on the Taita Hills, farms are small and intensive. Dominant food crops are maize and beans, with vegetables sold to coast markets. There are about 450 ha of coffee, but the area is marginal and yields are low.

The livestock population is about 1 unit/10 ha, the numbers of sheep and goats being about the same as the cattle. Although there are few improved stock, many farmers own draught animals. Cattle are mostly grazed on communal land; overgrazing is severe locally. When, as all too often, crops fail, the population subsist by selling their small-stock, principally goats. Charcoal making and honey production are other significant sources of income. Despite the use locally of trash lines and stone bunds, land degradation is well advanced, with general incidence of gullying and surface compaction; this leads to high runoff which, combined with low rainfall, implies little available moisture for vegetation.

The Sub-Zone includes the largest and most successful irrigation scheme in Kenya - that at Mwea-Tebere where much of the country's rice is produced on black clays (5 800 ha). There are several small-scale private pump irrigation developments along tributaries of the Athi, mostly for the commercial production of vegetables.

Potential

Because of the shortage of soil moisture, there are few suitable crops and these limited to quick-maturing varieties, e.g. of sorghum, millet and grams. On black clays, chick peas and coriander usually succeed; as a perennial crop on better drained soils, jojoba looks promising.

The Embu-Meru-Isiolo (EMI) Programme is pioneering new technology for these semi-arid areas. Early results indicate opportunities for moisture conservation using terraces and stone bunds; appropriate tree species for agroforestry; and varieties of early maturing food crops. There is also potential for small-scale irrigation in Meru where perennial streams flow off Mt Kenya. In general, priority needs to be given to technical support for smallholders, with emphasis on soil water conservation, animal draught, storage of food crops, and improved husbandry. Smallstock, especially goats, play a key role and here the emphasis needs to be on nutrition and disease control.

The potential of the Taita Hills lies in raising existing yields along lines set out for Zone 2 (above). Here there is scope for providing supplementary irrigation by constructing small dams across ravines. Although there are opportunities for only localised irrigation from the upper Tana, feasibility studies completed on the Athi indicate potential for river regulation with a view to irrigating up to 13 000 ha below Kibwezi.

5. ARID LOWLANDS

Physical Environment

The Arid Lowlands cover the whole of northern and eastern Kenya other than the Coast and, in the south, extend as far west as the Rift Valley. Annual rainfall is under 500 mm, falling to below 200 mm around Lake Turkana, generally bimodal with peaks in November and April; rainfall seldom if ever exceeds evaporation. Hot desiccating winds are a feature of the climate. Roughly 30% of the Zone can be classified as semi-desert with average annual rainfall below 300 mm and evaporation regularly exceeding 3 000 mm. The Zone is characterised by cyclic variations in rainfall. The effect of these cycles on grassland composition and productivity can be very significant; periods of better rainfall give one effective growing season every nine months whereas drier cycles provide a growing season only once every 20 months, with serious consequences for the survival of perennial grasses.

Soils are mostly sandy, often sandy loams. Also clay plains occur and quite extensive areas have been overlaid by volcanic deposits. Plain landscapes predominate, but in western areas the relief is undulating or hilly and soils are often shallow. In the semi-desert areas, extensive lava fields occur with well developed lava stone mantles. It is a characteristic of this Zone, with its sparse ground cover, that most sites are either water-shedding or water-receiving; the vegetation production potentials of the two are vastly different.

Five significant rivers enter the Zone: the Athi, Tana and Ewaso Ngiro in the east, and the Kerio and Turkwell flowing occasionally into Lake Turkana. The floodplains of the Tana, Ewaso Ngiro and Turkwell though nowhere very wide have some irrigable soils. Alkaline deposits flanking the floodplains present serious problems for irrigation. Groundwater resources are generally localised and often intensely saline; local tribesmen obtain water supplies in the long dry seasons by digging in the beds of sand rivers.

Population

The total population in this Zone is uncertain and, in any case, fluctuates as nomads move freely across the Uganda, Ethiopian and Somali borders. It is probably around 0.8 million, with an average density of about 2 persons/km^2.

Land Use

The Zone has special importance for livestock production by pastoral tribes. Population and grazing pressures vary but, compared with the semi-arid zones, only small areas are unoccupied. However, significant land has been taken for wildlife, e.g. Tsavo National Park (20 000 km^2). In the less arid areas, the characteristic vegetation is dry thorn-bushland with some woodland and grassland. In the semi-desert

APPENDIX 1

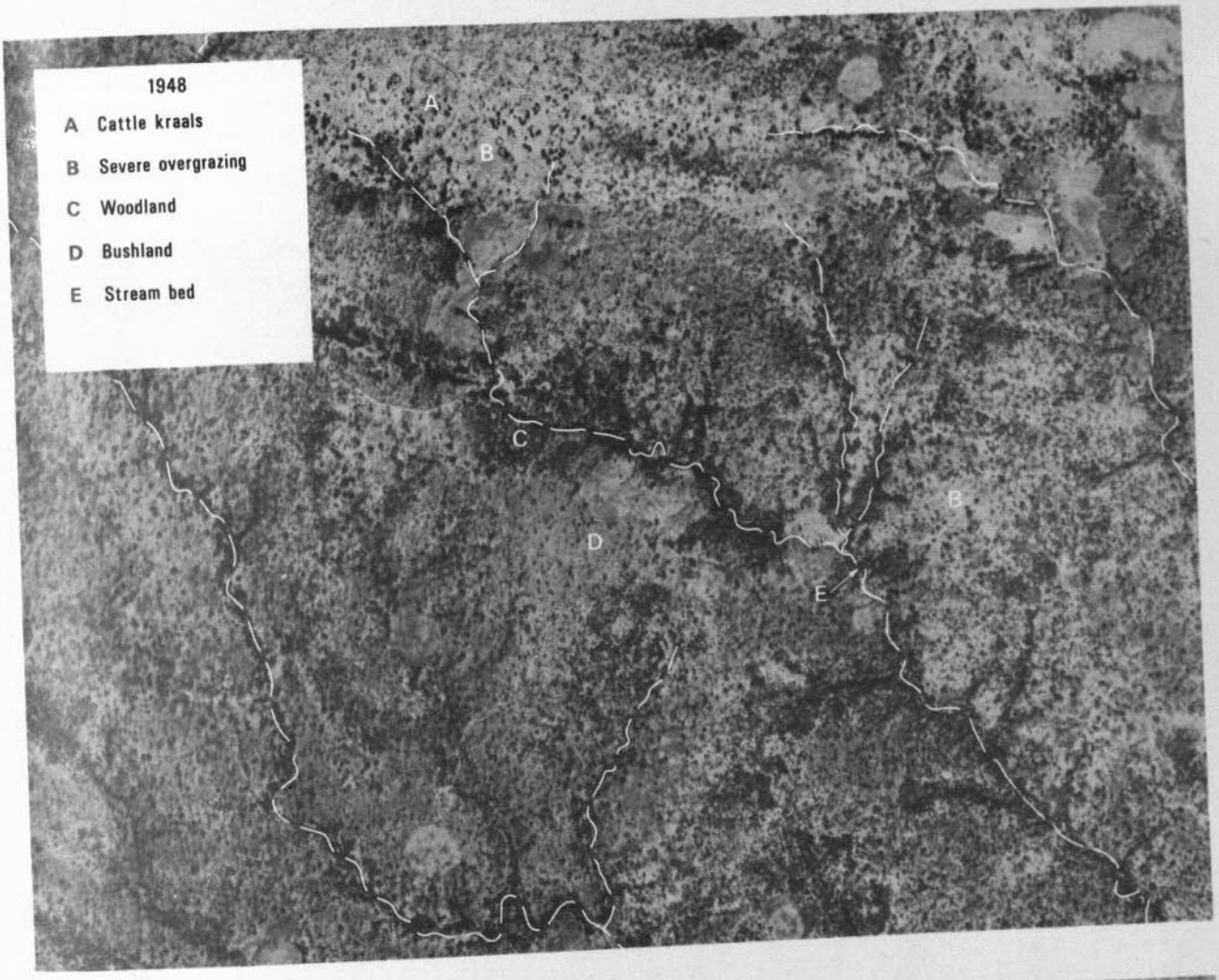
COMMENTARY

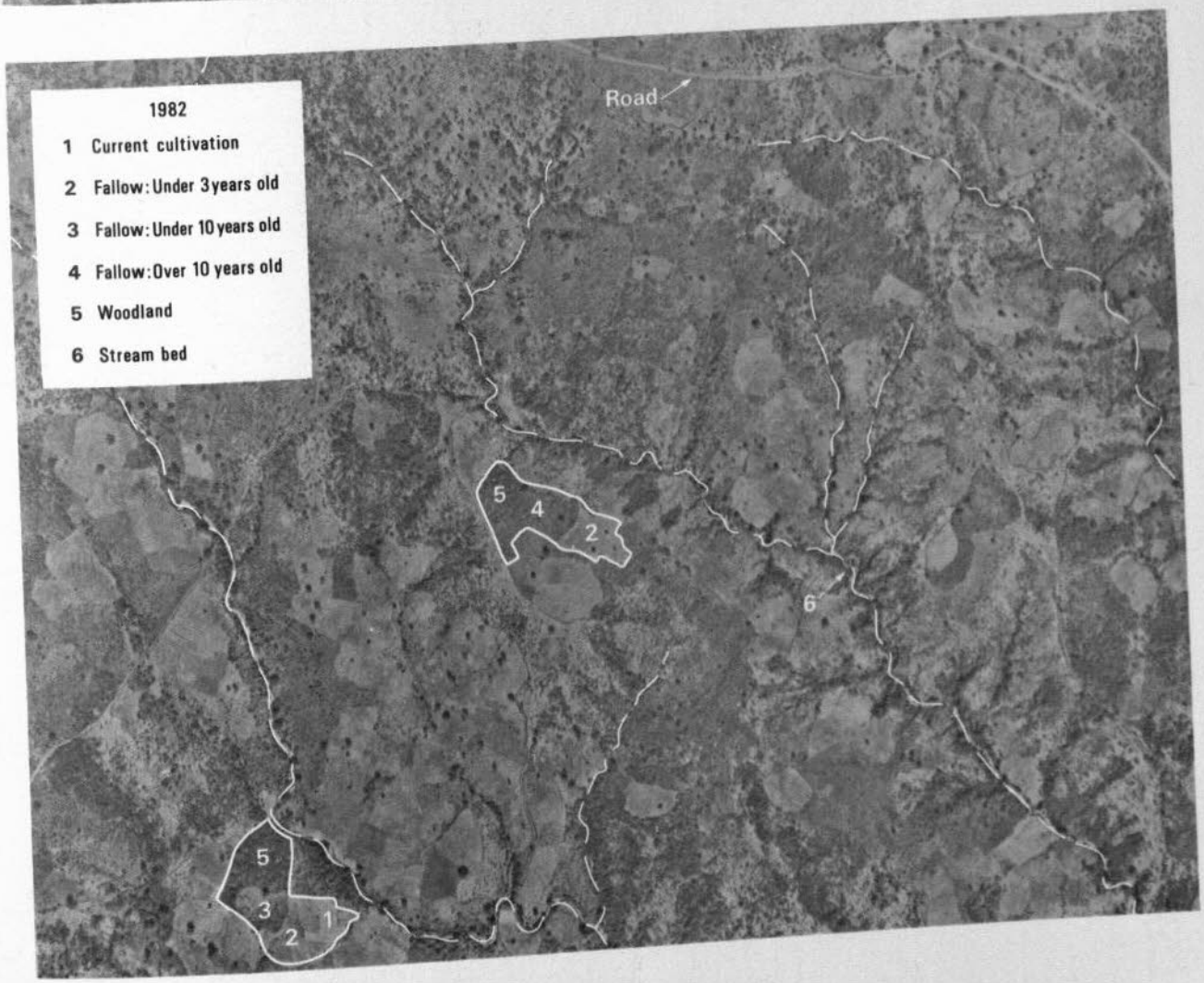
These two aerial photographs show the same area of lower Meru District (Zone 4C). The top one was taken in 1948; and the bottom one a third of a century later - in 1982. During this time, the area has been opened up by a road, seen on the top right hand side of the 1982 photo, and by provision of domestic water supplies.

Typical vegetation and cultivation patterns are highlighted on the photos. These illustrate a dramatic shift from an essentially pastoral society to one dependent on rainfed cropping. Land within the cultivation cycle has increased by six times in the 34 years. Though atypical of the District as a whole, the changes illustrated in these photos accurately reflect recent trends throughout the marginal semi-arid areas of Kenya.

SUMMARY

	% coverage	
	1948	1982
Land in the cultivation cycle		
Currently cultivated	0	5
Fallow: cultivated in the past 3 years	0	12
Fallow: less than 10 years old	3	37
Fallow: over 10 years old	9	20
Total in the cultivation cycle	12	74
Land uncultivable (steep, rocky)	7	7
Woodland/bushland	69	11
Overgrazed land	12	8


1948
A Cattle kraals
B Severe overgrazing
C Woodland
D Bushland
E Stream bed
A
B
C
D
E
B


1982
1 Current cultivation
2 Fallow: Under 3 years old
3 Fallow: Under 10 years old
4 Fallow: Over 10 years old
5 Woodland
6 Stream bed
Road
5
4
2
6
5
3
2
1