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MINISTRY OF AGRICULTURE — NATIONAL AGRICULTURAL LABORATORIES

KENYA SOIL SURVEY

SOIL CONDITIONS IN THE MUTHANGENE LOCATION

(Meru District)

B y

W. Siderius and E.N. Njeru

SITE EVALUATION REPORT

No. 26, March 1976

Kenya Soil Survey
S347/CW/WS/EN - 19/3/76

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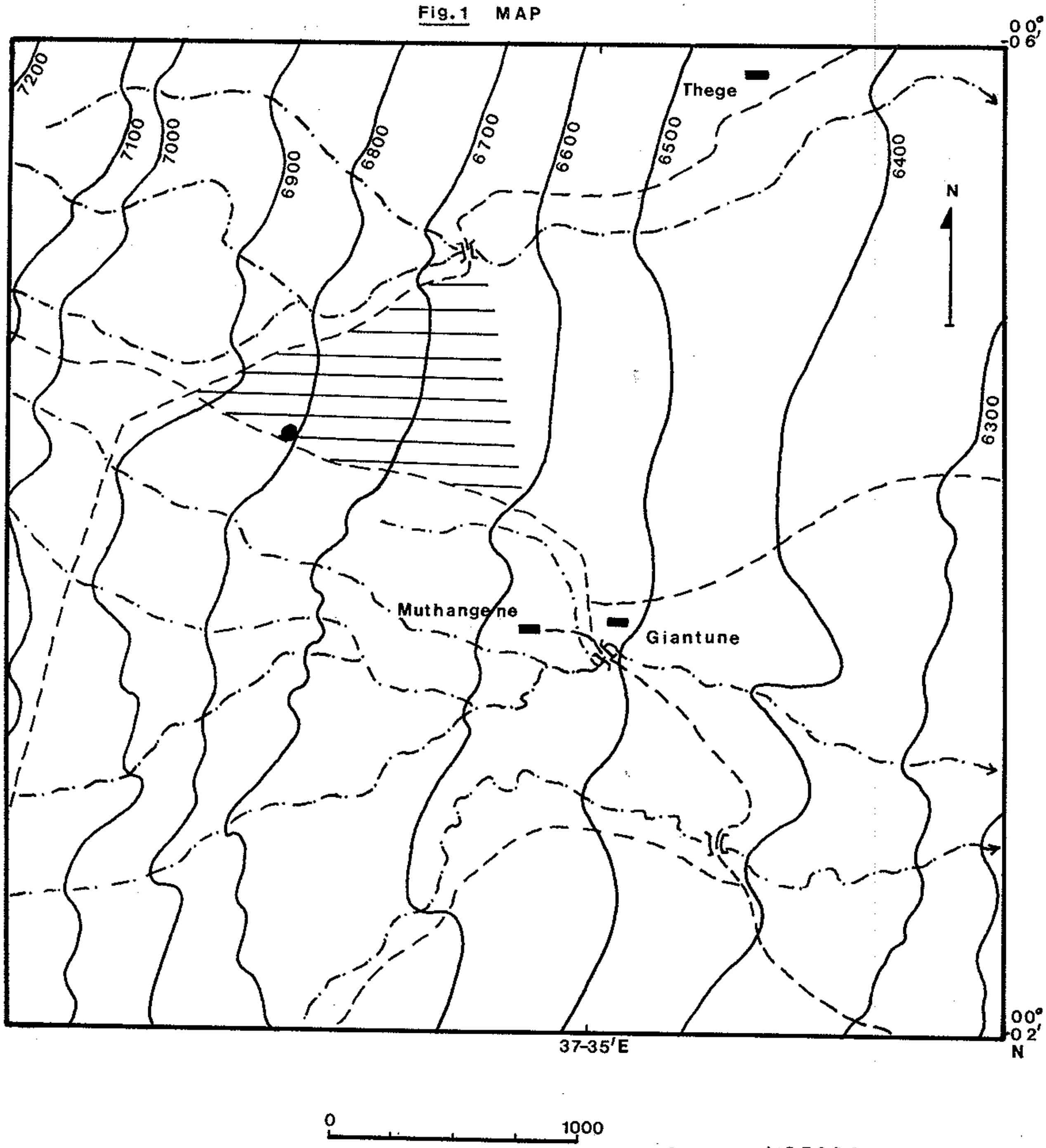
Fig. 1 MAP



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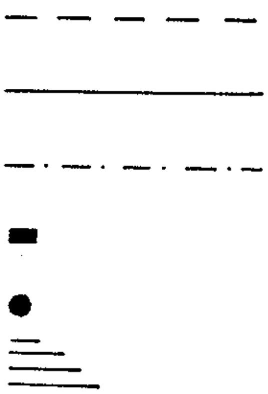

dry weather road

form lines in feet

watercourse

village

soil observation

Muthangene triangle

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1. Introduction

This evaluation of a site near Muthangene Market (Meru District) was carried out on request of the Muthangene Water Association, through Mr. Gitobu. The purpose was to look into the possibilities for irrigation in an area of about 150 acres (Muthangene triangle). A field inspection was therefore carried out during 17 - 18 December, 1975. The results can be extrapolated to the surrounding area, covering 1600 ha (3840 acres).

2. Physiography of the Area

2.1. Location and Access

The area is located about 10 km west of Meru town and some 2 km NW of Muthangene market. It is accessible by a good murram road. Geographic coordinates of the central point of the triangle are 0^o 05'N and 37^o 35'E (fig. 1).

2.2. Geology and Parent Material

The area under consideration is underlain by volcanic rocks from Mt. Kenya; dominant rock is kenyte (= phonolite from Mt. Kenya), sometimes interbedded with volcanic tuffs and olivine basalts.
The phenocrysts are waxy nepheline and anorthoclase. Micro phenocrysts of olivine may occur. The parent material of the soils is considered a mixture of the weathering products of the phonolite with an admixture of tuff. On the whole, the silica content is low (<54% SiO_2), while a high content of ferromagnesian minerals is encountered. The Calcium percentage is also relatively low.
Table 1 given the composition of a Mt. Kenya phonolite in weight percentages as reported by Baker (1967).

Table 1: Composition of a Kenyte (weight percentages)

SiO_2	52.10	$H_2O\pm$	1.75
Al_2O_3	22.29		
Fe_2O_3	1.73	TiO_2	0.30
FeO	4.10	P_2O_5	0.46
MgO	1.17	MnO	0.23
CaO	2.42	-	-
Na_2O	8.60	-	-
K_2O	4.66	TOTAL	99.81

In the weathering products of the kenyte the amount of potassium is expected to be satisfactory, but the phosphorus and calcium content may be low.
In depressions with distinct dry seasons the possible accumulation of sodium in harmful amounts can not be excluded.

2.3. Topography

The relief parallel to the interfluves may be described as undulating, but perpendicular to the drainage ways the slopes are much steeper and the topography may be classified as rolling to hilly ("volcanic ridge landscape"). The overall altitute of the triangular shaped area varies from 6900 to 6600 ft. over a distance of 750m (slope about 10%). Extrapolated over a larger area there is a drop in altitude of 7200 to 6200 (=1000ft) over 4 km (see also Fig. 1). High relief differences are caused by the fact that the area is located on the NE slopes of Mt. Kenya. The tops of the interfluves are flat to slightly convex; down to the valley bottom, slopes are straight to slightly concave; streams are deeply incised and valleys are generally V-shaped.
The local drainage pattern is parallel in the area and forms part of the overall radial pattern induced by Mt. Kenya.
The danger of erosion is counteracted by the excellent structure stability and permeability of the soils, which gives rise to rapid infiltration and little surface run-off.
The area is drained towards the ESE and is part of the Tana River catchment area.

2.4. Climate

As no meteorological data are available from the Muthangene location, information of Marienne Coffee Research Sub-station (No. 90.37/124), somewhat north of the area, was taken as being representative. Rainfall (P), temperature (T) and potential evaporation (Eo) data is given in table 2 (EAMD 1975); see also fig. 2.

Table 2: Climatic data for the study area

	J	F	M	A	M	J	J	A	S	O	N	D	yearly average
P	64	84	165	394	188	23	13	22	29	375	459	155	1971
T mean	17.5	18.1	18.4	17.3	17.0	15.9	15.3	15.7	17.2	18.3	17.5	17.1	17.2
Eo	140	144	141	130	139	116	114	129	162	183	132	132	1662
T max.	24.1	25.1	25.1	23.7	22.8	21.7	20.7	21.4	23.9	24.3	22.5	22.9	23.2
T min.	11.0	11.1	11.7	11.9	11.1	10.0	9.9	10.0	10.3	12.2	12.5	11.3	11.1

Mean monthly rainfall (P) in mm, period 1961 - 1970

Mean monthly temperature (T) in C^{o}; period 1961 - 1970

Potential Evaporation (Eo) in mm; period 1966 - 1970

Altitude: 5300 ft (1620m).

The rainfall pattern is clearly bimodal with maxima during March - April May and during October - November. The total amount of rainfall exceeds the evaporation, but during July, August and September dryness is experienced. The total rainfall and its distribution will allow for two seasonal crops per year. In terms of actual amounts the evaporation exceeds the mean monthly rainfall during J, F, J, J, A, S and may cause a short moisture deficit during August and September.

The variation in mean monthly temperature is from 15.3 - 18.4^{o}C. The lowest temperatures are recorded during June, July and August and the highest during (October and) January, February and March. The former coincide with limited soil moisture. Restricted plant growth is expected during this period.

On the bais of the above, the soil moisture regime is classified as "Udic", while the temperature regime is calssified as "Iso-thermic" (USDA, 1975). The area as a whole falls into Ecological Zone II. (Atlas of Keny:

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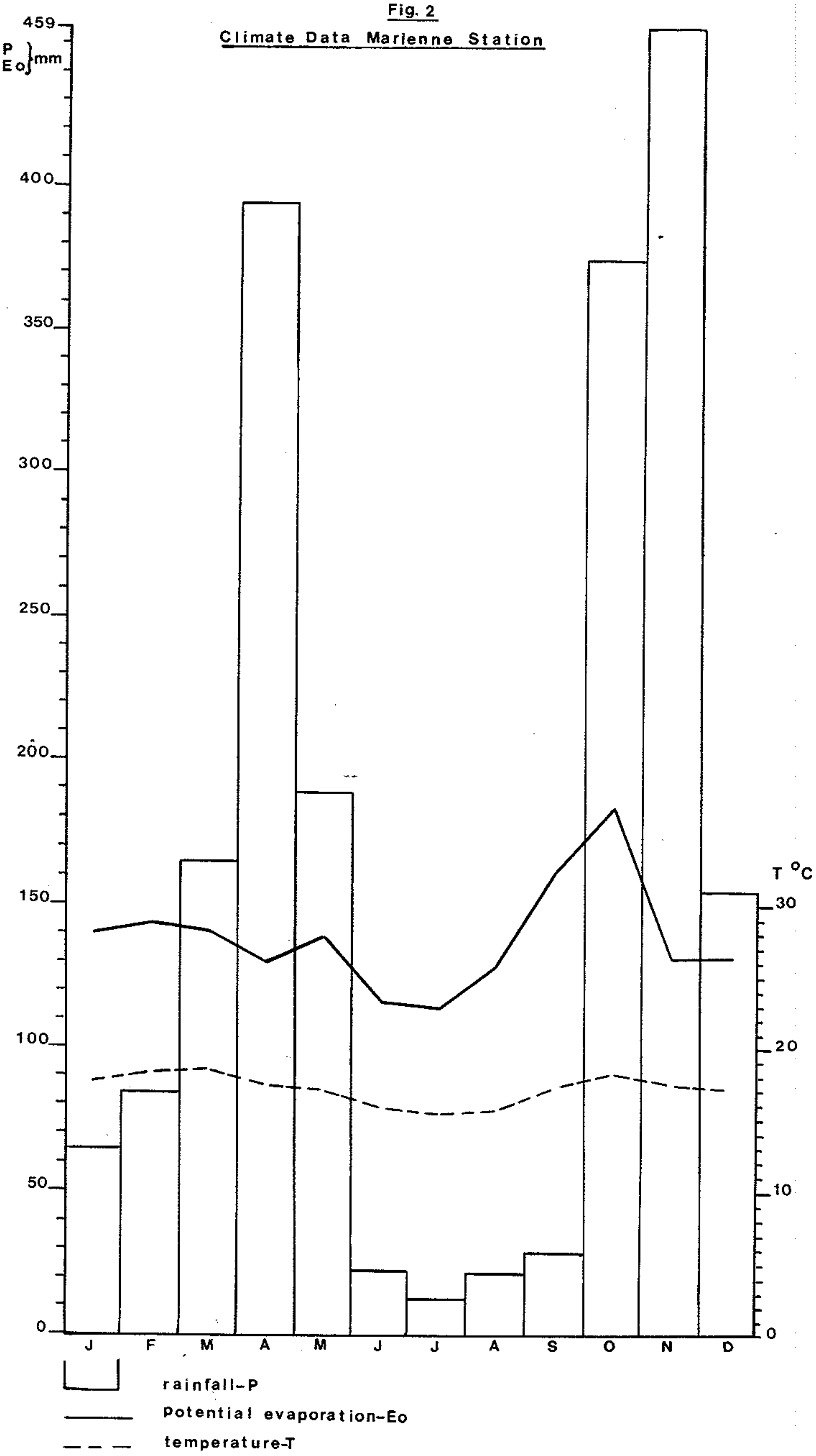
Fig. 2

Climate Data Marienne Station



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2.5. Vegetation and Land use

The original vegetation of moist forest with Podocarpus milanjianus and Acacia abyssinica has been cleared to make way for cultivation. Because of favourable environmental conditions there is an intensive land use pattern that embraces food as well as cash crops.
In the Muthangene triangle, tea, pyrethrum, potatoes and maize are the main crops cultivated. A similar land use is reported for the larger area surrounding the triangle. If any irrigation is being considered, this should be sprinkler in view of the soils physical properties and the topography.

3. Soils

3.1 Soil Description

The major soil in the Muthangene triangle as well as the adjoining larger area is a deep, well drained, dark reddish brown silt loam to slilty clay loam; an "andic Nitosol" (FAO, 1974) - Table 3.
The soils have a A - B - C profile morphology, gradual horizonation and a decreasing structural development with depth.
They are friable when moist and often smeary when wet.
Water holding capacity is thought to be good, while no drainage problems are encountered.
Root penetration is deep, in addition there are no physical factors that would hamper the soil management, apart from the topography at the steeper areas. The soil nutrient level is relatively low as is illustrated in Table 4.

Table 3	Soil Profile Description
Profile:	181/1-1, Date: 17 December 1975
Soil Classification:	"Andic" Nitosol (FAO, 1974)
Ecological zone:	II
Observation-Location:	Muthangene, 10 km West of Meru
Geological Formation:	Mt. Kenya Phonolite (Kenyte)
Local Petrography:	weathering products of Kenyte and tuffs.
Physiography:	dissected lower slopes on the NE side of Mt. Kenya; altitude 6800 ft.
Relief-macro:	undulating to rolling in parts; occasionally hilly
" micro:	plough ridges
Vegetation/Land use:	the original vegetation of montane forest has been cleared for the rainfed cultivation of pyrethrum, potatoes, maize and bananas
Internal drainage:	well drained, class 4.

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Profile Description

Horizon	Depth in cm.	Description
A1	0-20	Dusky red (2.5YR 3/2) moist, clay loam; moderate fine subangular blocky to crumbly; hard dry; friable moist, sticky and plastic wet; common fine pores; some coarse sand; many fine, medium and coarse roots; smooth gradual boundary; (sample 108/1-a)
B1	20 - 50	dark reddish brown (2.5YR 3/3) moist, clay loam with an appreciable amount of dily; weak fine subangular blocky; slightly hard dry, friable moist; smeary, sticky and plastic wet; some fine broken cutans; roots and pores as A1; smooth gradual boundary; (sample 108/1-b),
B_{21}	50-100	dark reddish brown (2.5YR 3/3) moist, silty clay loam; weak fine subangular blocky; soft dry; friable moist; smeary, sticky and plastic wet; some fine broken cutans; common fine and medium roots; common fine pores; smooth diffuse boundary: (sample 108/1-c).
B_{22}	100 - 130	dark reddish brown (2.5YR 3/3) moist, silt loam; porous massive; few fine cutans; common fine pores; soft dry; friable moist; smeary, sticky and plastic wet; common fine and medium roots; smooth diffuse boundary; (sample 108/1-d),
B_{23}	130+	dark reddish brown (2.5YR 3/4) moist, silty clay (loam); porous massive; common fine cutans; consistence as above; common fine pore; (sample 108/1-e).

The soils of the area are indicated on the Soil Map of the World (sheet VI - 3, East and South Africa) as "medium textured Eutric Nitosols in steeply dissected mountainous topography".

The soil in question is of a finer texture; in addition, thixotropic soil materials are present (smeary consistence).

To separate the Nitosol of the present area from the Eutric, Dystric and Humic proper, the term "Andic" is tentatively proposed, possibly as prefix to Humic Nitosol.

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Table 4: Fertility tests results of soil 181/1

m.e.%

Horizon	Depth in cm.	pH	Na	K	Ca	Mg	Mn	P ppm	N %	C %
A1	0-20	6.9	0.10	1.78	10.0	7.0	0.76	10	0.45	3.91
B1	20-50	6.7	0.10	1.84	1.2	3.3	0.88	9	-	-
B21	50-100	5.5	0.04	0.96	tr.	2.2	0.88	6		
B22	100-130	5.0	0.10	0.72	tr	1.5	1.06	8		
B23	130+	4.9	0.10	0.54	tr	1.4	1.60	7		

Note: the above data represent Mehlich analysis results; comprehensive data are still awaited; Lab. no's 7149-7153.

3.2 Interpretation of the Survey and Laboratory Data

The survey data indicated good physical properties of the soil, coupled with sufficient depth and absence of coarse fragments.

It is evident from the data presented in Table 4 that a better soil fertility is found in the topsoil (A1 - horizon), where also the highest amount of organic matter is encountered.

Of the three major nutrients needed for plant growth (N, P and K), potassium (K) is in fairly good supply throughout the soil. Nitrogen (N) is sufficient in the A1, while also a reasonable amount is expected in the B1, however, the amount decreases sharply with depth. The phosphorus (P) content is low, although under good management the mineralization of P from organic matter may keep pace with the crop requirements.

The amount of calcium is very low in the subsoil and liming may be a necessity if Ca deficiency occurs.

The pH is regularly decreasing with depth from 6.9 in the A1 to 4.9 in the deep soil indicating respectively neutral to very strong acid conditions.

Results of analysis on rather comparable soils "East of Meru" (Nyandat, 1973) indicate CEC values of 16 - 24 m.e.%, with calcium and magnesium as dominant cations on the exchange complex.

The soils are considered suitable for rainfed crop production and/or sprinkler irrigation practices (class 1).

Steeply sloping areas (slope 8% - 12) may hamper management and increase costs of cultivation (class 2) - (USDA, 1953).

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4. Conclusions and Recommendations

The land is considered highly suitable for the growth of climatically adapted crops. The natural environment favours particularly the cultivation of citrus, potatoes and maize, pyrethrum in the highest areas.
For sustained high yield, application of N and P is necessary while liming may have to be considered in places.
The area is considered too cold for extensive banana cultivation. The uneven distribution of rainfall does not favour the cultivation of tea; in this case supplementary sprinkler irrigation may prove beneficial during the dry months. The introduction of irrigation is a costly operation as sprinklers or even the more costly drip-system will have to be installed. The return of input through increased crop production would be a liability since irrigation would only be supplementing the low rainfall in August and September when a possible soil moisture deficit may occur. Crops worth consideration for irrigation in the area are tea on the higher slopes and coffee on the lower slopes. A fairly large area is however necessary to warrant the installation of a sprinkler irrigation system, while the water supply for irrigation should be reliable and the water of good quality. In addition, the irrigation will require the re-organisation of the already well established fields in the Muthangene triangle, a move that may not be appreciated by its inhabitants.

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LABORATORY DATA PROFILE NO. 181/1 AREA Muthangene

lab. no.	depth in cm	horizon	weight % 2 mm	particle size distribution (mu) weight % sand 2000-1000	1000-500	500-250	250-100	100-50	silt 50-20	20-2	clay 2
7149/75	0-20	A1	-	32					18		50
7150/75	20-50	B1	-	16					14		70
7151/75	50-100	B21	-	12					10		78
7152/75	100-130	B22	-	10					10		80
7153/75	130+	B23	-	4					10		86

pH 8.2
pH 7.0
↓
etc.

depth in cm	pH H_2O 1:1	pH KCl	C %	N %	C/N C%	exchangeable cations me/100 g soil Ca	Mg	K	Na	sum	CEC	Base sat. %	P_2O_5 ppm	N%
0-20	6.1	5.7	3.91	0.45	3.55	13.4	4.64	2.10	0.15	20.29	31.3	65	10	0.50
						11.0	3.2	3.1	0.15	17.5	24.21			[illegible]
20-50	5.8	5.4			1.40	6.0	3.20	2.35	0.10	11.65	19.8	59	9	0.23
						4.0	3.2	1.9	0.10	9.3	15.69			
50-100	5.0	5.0			0.87	3.2	2.04	1.35	0.10	6.69	19.0	35	6	0.15
						2.0	3.5	2.0	0.07	7.6	15.11			
100-130	4.5	4.5			0.84	1.6	2.08	0.92	0.05	4.65	16.6	28	8	0.13
						1.0	2.0	1.1	0.05	4.2	13.83			
130+	4.5	4.5			0.81	1.6	6.52	0.75	0.05	8.92	17.4	51	7	0.13
						1.0	2.0	0.9	0.05	4.0	13.10			

depth in cm	EC mmhos/cm	ESP	$CaCO_3$ %	available nutrients m.e.% Na (Mehlich)	K	Ca	Mg	Mn	Hp	CEC_c pH8.2	CEC_c pH7.0
0-20	0.35	-	-	0.10	1.78	10.0	7.0	0.76		35.2	
20-50	0.20	-	-	0.10	1.84	1.2	3.3	0.88		25.7	
50-100	0.13	-	-	0.04	0.96	tr	2.2	0.88		22.1	
100-130	0.07	-	-	0.10	0.72	tr	1.5	1.06		18.5	
130+	0.07	-	-	0.10	0.54	tr	1.4	1.60		18.1	

Remarks. Remarks by Sombroek

Kenya Soil Survey, S112/2/OW/EN-9/75

"andic" humic Nitosol

LABORATORY DATA

PROFILE NO. 181/1 AREA Muthangene

lab. no.	depth in cm	horizon	weight % 2 mm	particle size distribution (mu) weight % sand 2000-1000 / 1000-500 / 500-250 / 250-100 / 100-50	silt 50-20 / 20-2	clay
7149	0-20	A1	–	32	18	50
7150	20-50	B1	–	16	14	70
7151	50-100	B21	–	12	10	78
7152	100-130	B22	–	10	10	80
7153	130+	B23	–	4	10	86

silt/clay	depth in cm	pH H_2O 1:1	pH KCl	C %	N %	C/N	Ca	Mg	K	Na	sum	CEC	Base sat. %	P_2O_5 ppm
							meq/100 g soil						pH 8.2 / 7.0	
36	0-20	6.1	5.3	3.90	0.50	7.1	13.4	4.64	2.10	0.15	20.29	31.3	65	10
							16.0	2.2	3.18	0.15	17.50	24.21	72	
20	20-50	5.8	5.4	1.70	0.23	7.9	6.0	3.20	2.35	0.10	11.65	19.8	59	9
							4.0	3.2	1.9	0.10	9.3	15.69	59	
13	50-100	5.0	5.0	0.87	0.15	5.8	3.2	2.04	1.35	0.10	6.69	19.0	35	6
							2.0	3.5	2.0	0.07	7.6	15.11	50	
12.5	100-130	4.5	4.5	0.84	0.13	6.5	1.6	2.08	0.92	0.05	4.65	16.6	28	8
							1.0	2.0	1.1	0.05	4.20	13.83	30	
11.5	130+	4.5	4.5	0.81	0.13	6.2	1.6	6.52	0.75	0.05	8.92	17.4	51	7
							1.0	2.0	0.9	0.05	4.0	13.10	31	

depth in cm	EC mmhos/cm	ESP	$CaCO_3$ %	Na (Mehlich)	K (Mehlich)	Ca	Mg	Mn	Hp	CEC_c pH 8.2	CEC_c pH 7.0
				available nutrients m.e.%							
0-20	0.35	–	–	0.10	1.78	10.0	7.0	0.76		32.8	22.6
										[illegible]	
20-50	0.20	–	–	0.10	1.84	1.2	3.3	0.88		27.0	12.9
										21.3 (?)	15.4
50-100	0.13	–	–	0.04	0.96	tr	2.2	0.88		18.3	12.4
										20.5	15.5
100-130	0.07	–	–	0.10	0.72	tr	1.5	1.06		18.7	13.8
										18.8 (?)	13.6
130+	0.07	–	–	0.10	0.54	tr	1.4	1.60		15.5	12.0
										17.0	11.9
										15.5	10.8

Remarks:
Remarks by Sombroek

first figure
active 1% C 9.5
second: " 5.0