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MINISTRY OF AGRICULTURE—NATIONAL AGRICULTURAL LABORATORIES

KENYA SOIL SURVEY

A PRELIMINARY EVALUATION OF THE SOILS OF NJUKINI IRRIGATION SCHEME

(TAVETA DIVISION)

by

J. K. Kanake

SITE EVALUATION REPORT NO. P58, JULY, 1981

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1. INTRODUCTION

The request to carry out a site evaluation of Njukini Irrigation Scheme was received from the Irrigation Engineer, Coast Province. The provincial irrigation unit is planning to open up a new area for an extension of the already existing scheme. To asses the suitability for irrigation a general examination (site evaluation) of the soils was carried out.

The field work was done in two days, between 8th and 11th June, 1981. This was done in collaboration with the Irrigation Engineer, Coast Province (Mr. Voestermans), and a topographical survey team, who assited in the selection and location of soil observation points both on the map and on the ground.

The effort made by all the people concerned, to make the fieldtrip a success is much appreciated.

2. ENVIRONMENTAL CONDITIONS

2.1 Location and Communications

The survey area is located about 30km north of Taveta town, along the road to Rombo and Loitokitok. It is roughly intersected by Longitude and Latitude $37^{o}45'E$ and $3^{o}11'S$ respectively, and lies at an elevation of 950m (approx.) above sea level.

The area can be reached by road either from Tavete or from Loitokitok. This is a dry-weather road which is only suited to four-wheel-drive vehicles and light trucks. During the rains some parts may be impassable to all kinds of vehicles.

2.2 Geology and Physiography

The soils of the area are primarily developed from undifferentiated volcanic rocks (predominantly pumice) of the Rombo series of Tertiary age (L.M. Bear, 1955).

Physiographically, the area forms a part of the general and extensive piedmont plain, which extends from the footslopes of Mt. Kilimanjaro, to the Pare mountains in the South East. The area is generally flat (slope 1-2%) but is studded with numerous small parasitic cones (hills) and plugs, which rise above the general level of the plain.

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2.3. Climate

The survey area belongs to the sub-tropical semi-arid climatic zone. The average annual temperature is 22.7°C, with the lowest in the months of July-August (20.4°C) and the highest in the month of March (24.9°C). The annual rainfall distribution (table 1), shows two pronounced rainy seasons, namely the long rains from March to May and the short rains from November to December. The mean annual rainfall is about 526mm. The highest mean monthly precipitation occurs in April (122.1mm) and the lowest in July (2.7mm).

On average, the evapotranspiration exceeds the rainfall during every month of the year. The calculated (Woodhead) annual potential evaporation (Eo) is 2164mm, and the r/Eo ratio (r=rainfall, and Eo=potential evaporation) is 24.3%.

From the above climatic data it is clear that rainfall is in deficit throughout the year and that for sustained crop production irrigation is imperative.

Table 1. Average monthly rainfall (in mm) for Ziwani Sisal Estate. Taveta (average of 27 years)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
37.4	28.5	86.3	122.1	65.3	9.1	2.7	4.0	7.7	23.1	74.0	65.4	525.6

2.4. Vegetation

The natural vegetation of the area is mainly wooded, bushed grassland with Acacia trees bushes and shrubs, and tall perennial grasses, of which Cynodon dactylon (stargrass) is dominating. In a few low-lying areas (depressions) Cyperus papyrus (swampgrass) grows abundantly.

2.5. Present Land use and Agricultural Practices

The tenants of the scheme grow a wide range of crops under furrow irrigation. Maize, beans and bananas are the major crops, and are grown both for home consuption and for sale on the local markets to get cash. Other crops include vegetables, pigeon peas, sorghum, sunflower green grams and sugarcane.

Elsewhere outside the scheme area rainfed crops are grown seasonally but their chances of failure are high due to the poor distribution and low amount of the rainfall.

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2.6 Hydrology and water resources

The main source of water available for irrigation is the Njukini river, which is an upper tributary of the Tsavo river. There is enough water available for irrigation for most of the year, although the river (Njukini) may dry up during some very dry periods of the year.

No laboratory chemical analysis was done to determine the water quality, but several samples drawn from the irrigation canals were tested in the field using portable electrical equipment for pH and Electrical conductivity (EC) measurements. An average pH and EC of 7.6 and 0.33 mmhos was recorded respectively. In general, waters with conductivity values below 0.75 mmhos/cm may be used satisfactorily for irrigation, in so far as salt content is concerned. According to the U.S. Salinity Laboratory, waters with a conductivity of 0.25 to 0.75 mmhos/cm (at 25°C) are classified as Medium Salinity Water. This can be used for irrigation if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without any special practices for salinity control (Richards et al, 1954). However, this rating may be considered rather severe by other standards (F.A.O., 1974).

The Njukini water may also be classified as moderately alkaline (pH 7.6), but without the availability of analytical data it can only be reasonably assumed that this is caused by the presence of significant amounts of Calcium carbonate ($CaCO_3$). The field observations indicate that most of the soils are calcareous.

Groundwater was not reached within 150cm throughout the survey area.

3. SURVEY METHODS

A topographical map of scale 1:2,500, produced by the Provincial Survey team, Coast Province, was used as a base map. Observation points were selected on the map and then located on the ground (with the assistance of the surveyors). Soil augerings were made to a depth of 1.5m, soil depth permitting. The soils were described in detail according to the Kenya Soil Survey standards and sampled at various depths for field determination of pH and EC.

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A total of 17 augerhole observations were made and described. These were plotted on the base map on which also the soil boundaries were drawn. The final field map was reduced to a scale of 1:5,000 and handed over to drawing room, which prepared the final map, also at scale 1:5,000.

4. SOILS

4.1. Systematics and nomenclature

Initially the survey area was subdivided into two main physiographic units, viz. hills and piedmont plains. Within these physiographic units various soil mapping units were distinguished, taking into account soil characteristics, such as soil depth, soil colour, drainage conditions, salinity, etc.

Each mapping unit of the soil map is identified by a code for which the following symbols are used:

Physiography

H = hills

Y = piedmont plain

Geology

P = undifferentiated pyroclastic rocks (predominantly pumice)

Soils

C = complex of soils of varying depth

The numericals 1, 2, etc., distinguish different soil units within the same physiography - geology grouping.

4.2. Description of the soil mapping units

Mapping unit HPC

Extent	-	9.0 ha
Relief	-	Hilly.
Vegetation	-	Wooded/bushed grassland and bare rock outcrops.
Land use	-	A little grazing of cattle and goats, but mostly unused due to rock outcrops.
Soils	-	Complex of well drained, shallow to deep, dark reddish brown (5YR 3/4) to dark brown (7.5YR 3/2), friable to firm, calcareous, clay loam to clay.

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Mapping unit YP1

Extent - 130 ha

Relief - Level to very gently undulating (slope 1%)

Vegetation - Wooded grassland - mainly Acacia trees and shrubs and tall stargrass (Cynodon dactylon). A few small, low-lying areas (depressions) have swampgrass (Cyperus papyrus).

Land use - both rainfed and irrigated maize, beans and green grams are grown.

Soils - Well drained to moderately well drained, extremely deep, reddish brown (5YR 4/4) to very dark greyish brown (10YR 3/2), friable to firm, calcareous, clay loam to clay.

Mapping unit YP2

Extent - 58 ha

Relief - Level to very gently undulating (slope 1%).

Vegetation - Wooded grassland, with Acacia trees and tall stargrass species (Cynodon dactylon).

Land Use - irrigated maize, beans, onions, bananas, and pigeon peas, some sugarcane and arrowroots are also grown along the banks of the irrigation canals.

Soils - well drained to moderately well drained, deep to very deep, reddish brown (5YR 3/4) to dark brown (7.5YR 3/2) very friable to firm calcareous, clay loam to clay over rock at 130-150cm depth.

Mapping unit YP3

Extent - 34 ha

Relief - Level to very gently undulating (slope 1%)

Vegetation - Wooded grassland, with mainly Acacia trees and shrubs and tall stargrass (Cynodon dactylon) species.

Land use - Both rainfed and irrigated maize, beans, sorghum and sunflower are grown.

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Soils - Moderately well drained very deep to extremely deep. dark brown (7.5YR 4/4) to very dark grey (10YR 3/1), friable to firm, clay loam to clay. These soils are saline from 100cm depth (see table 2 for salinity rating). Gypsum crystals commonly occur between 90 and 130cm depth.

Table 2. Key to soil salinity and sodicity rating

DESCRIPTION		EC_e^* (mmho/cm)	ESP(%)	pH
Free.....	no injury to crops	0-4	6	8.5
slightly affected	sensitive crops show injury	4-8	6-15	8.5
Mod. affected	no crop does well	8-15	15-30	8.5-9.0
Strongly affected	only few plants survive	15-30	30-50	9.0-9.5
Excessively affected	bare land, nothing grows	> 30	> 50	

* The electrical conductivity values are measured from a saturation extract. The EC of a soil: water suspension with a ratio of 1:2.5 (vol/vol) is about three times the equivalent of a saturation extract (ECe) at 25°C; (i.e. ECe = 3X EC 1:2.5).

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5. CONCLUSIONS AND RECOMMENDATIONS

1. The soils of the survey area, especially those of the piedmont plain, comprising of mapping units YP1, YP2 and YP3 are considered to be generally suitable for irrigation. However, mapping units YP1 and YP2 may be classified as highly suitable for irrigation while unit YP3 is classified as moderately suitable due to the presence of salinity in the deeper subsoil (from 100cm onwards).

2. The soils of the hills (mapping unit HPc) are considered unsuitable for irrigation due to their steep gradients, shallowness, and the presence of numerous rock outcrops. However, this is of minor consequence, as the hills constitute only a very small percentage of the total area.

3. Virtually all the irrigable soils (mapping units YP1, YP2 and YP3) are well drained to moderately well drained, deep to extremely deep, friable and easily workable. They are also quite fertile (personal observation - the crops in the fields were doing extremely well). Therefore a wide range of crops may be grown. These would include maize, beans, bananas, vegetables, sorghum, grams, sunflower, orchards and possibly cotton.

4. The general suitability of the soils for irrigation notwithstanding, proper drainage improvement measures should be considered in the development and longterm planning of the scheme. Especially so because of the "medium" salinity and/alkalinity irrigation water and the presence of bedrock at 130-150cm depth in unit YP2. Mapping unit YP3 should, of necessity, be given a high priority on drainage improvement measures.

5. Furrow irrigation should be prefered to basin irrigation because it is better suited to a large variety of crops. Proper water management and control should be installed.

6. It should be emphasised that in a preliminary evaluation of the soils such as this one, the soil boundaries are strongly generalised. Nevertheless they give a quick and useful picture of the soils, and their suitability for irrigation. In the case of Njukini, no major problems are foreseen so long as careful management of land and water is undertaken.

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6. REFERENCES

Bear, L.M., 1955	-Geology of the Tavota area
E.A.M.D.	-Summary of rainfall and Temperature records (vario years)
F.A.O., 1974	-Soil survey in irrigation investigations, F.A.O., Rome.
Irrigation and Drainage Branch, Min. of Agriculture 1980.	-Tavota Irrigation rehabilitation programme, Min. of Agriculture, Nairobi
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Appendix 1 to Site evaluation No. P58

PRELIMINARY SOIL MAP OF NJUKINI IRRIGATION SCHEME

(TAITA – TAVETA DISTRICT)

SCALE 1:5000

0 100 200 300 400 500 metres

LEGEND

H HILLS

HP Soils developed on undifferentiated volcanic rocks (predominantly pumice)

HPC — complex of well drained, shallow to deep, dark reddish brown to *dark brown, friable to firm, rocky to non-rocky, calcareous, clay loam to clay*

Y PIEDMONT PLAINS

Soils developed on undifferentiated volcanic rocks (predominantly pumice)

YP1 — well drained to moderately well drained, extremely deep, reddish brown to very dark greyish brown, friable to firm, calcareous, clay loam to clay

YP2p — well drained to moderately well drained, deep to very deep, reddish brown to dark brown, very friable to firm, calcareous, clay loam to clay, over rock

YP3 — well drained to moderately well drained, very deep to extremely deep, dark brown to very dark grey, friable to firm clay loam to clay; saline from 100cm

KEY TO SLOPE CLASSES

slope %	slope class symbol+	name of the macrorelief
0-2	A	flat to very gently undulating
2-5	B	gently undulating
5-8	C	undulating
8-16	D	rolling
16-30	E	hilly

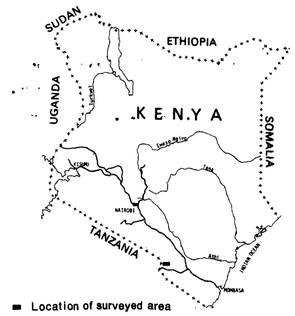
KEY TO DEPTH CLASSES

thickness soil in cm	symbol+ over rock	name
0-50		shallow
50-80		moderately deep
80-120	p	deep
more than 120		very deep

+ *if a complex of depth classes occurs within one unit, only the symbol of the shallowest depth class is indicated*

KEY

YP2p ..... soil mapping symbol
A ..... depth class symbol
slope class symbol
soil boundary
1cm² 0.25 ha
16 augerhole observation with number
motorable track
river
irrigation canal
contour lines
houses/huts
boundary of survey area
J topo survey traverse point



Location of surveyed area

Prepared and drawn by Kenya Soil Survey, Aug. 1981
Drawing No. 81029