REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE

SOILS OF TIGONI POTATO RESEARCH STATION.

KIAMBU DISTRICT

By

OTIENO OSWAGGO

NATIONAL AGRICULTURAL LABORATORIES.

NAIROBI - 1971.

SOILS OF TIGONI POTATO RESEARCH STATION

By Otieno Oswaggo.

C O N T E N T S

FOREWORD

This report is an expression of the general conditions of the Research Station. It outlines five soils phases based on colour, drainage, slope and presence of gravels; these being the only prominent morphological properties found to be variable over the station. Soils IA, IB and 2B which are dominant on the station are suitable for cultivation. Soil 2A is however only marginally suitable for cultivation since it lies in a depression and is liable to waterlogging unless drains are installed while soil 3 occupies too steep a slope for cultivation and even for grazing, may require protection from erosion.

A prominent feature of the Station at the time of the survey is the richness in available plant nutrients perhaps because the land was under grass pasture. The pHs of the soils which may be cultivated seem to be well within the accepted ideal range of acidity (pH 5.5 to 6.5) for potatoes.

It should be pointed out that basically the soils of the Station represent only one textural class of soils on which potatoes may be grown. The results of agronomic trials from this station although may be applicable to a large potato growing area of the Central Kenya may therefore not be extrapolated too far.

N. N. Nyandat
SOIL SURVEYOR

I N T R O D U C T I O N

Tigoni Potato Research Station is comprised of approximately 72 hectares of land. It is situated about eleven Kilometres south of Limuru town and falls within grids 414/737, 411/732, 431/726 and 428/721 in Survey of Kenya topographic map series Y 731 sheet 148/1.

At the time soils of the area were investigated, the area was under grazing. A few fields were however under maize and beans.

The survey was requested by the Potato Unit to prepare a soil suitability map with a view to planning of the station and future potato experiments. This report therefore aims to indicate soil types and to outline their suitability and methods for improvement.

Method of Investigation and Classification:

Vertical aerial photographs for the area were examined in detail and tentative soil boundaries drawn using variations in topography. Within each area tentatively delineated as a soil unit, at least two pits were dug to 150 cms. These pits were morphologically described in detail and sampled. Auger samples were also collected for purposes of precise location of the soil boundaries. The soils from the soil profile pits as well as auger borings were chemically and physically analysed and the results together with those of the profile description used to draw the final soil boundaries.

The soil classification employs factors of drainage, colour texture (top and subsoil), depth of soil and slope of land. These soil units are simply outlined on the soil map legend for the comprehension of the field users who may be unfamiliar with the classical terminology. Complete data are however available for each soil unit so that classifying to any system may be facilitated should the need arise in future. All colours are standard Munsell colours and relate to moist soils.

...../2

Abbreviations and Definitions:

The following abbreviations have been used in this report.

C	Organic Carbon
Ca	Calcium
C.E.C.	Cation Exchange Capacity
E.C.	Electrical Conductivity
E.S.P.	Exchangeable Sodium Percentage
Hp	Concentration of Permanent Charge hydrogen
Hv	Concentration of variable change hydrogen
K	Potassium
m.e. %	milli equivalent per cent.
m.e./l	milli equivalent per litre.
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
P	Phosphorus
ppm	parts per million
pH	The negative logarithm of the hydrogen ion activity in the soil.
R.S.C.	Residual Sodium Carbonate
S.A.R.	Sodium Adsorption Ration
Light Clay -	% clay less than 50
Medium Clay -	% clay 50 - 70
Heavy Clay -	%clay more than 70.

The writer acknowledges with thanks the Head man and the workers of the scheme for their co-operation and labour rendered during the investigation.

...../3

GENERAL CHARACTER OF THE AREA

Geology and Landscape

A detailed geological report for the area is still under preparation. It was therefore not possible to obtain detailed geological information for the survey area. However, from the available small scale geological maps of the area, it may be deduced that the area is underlain by Limuru trachytes and quartz trachytes of Pleistocene Age.

The northern portion of the survey area can be described as a region of strong slopes comprising broad ridges and depressions. The western and south western parts of the project area however have very steep slopes which end in Masindi stream running in a North west to South east direction.

Climatic Condition:

Temperature may be an important factor in potato production and the principal production areas are characterized by cool weather. Although the climatic data for the survey area are not available the Limuru area is generally known to enjoy a cool climate with a good rainfall. Besides, Limuru district is noted for the good quality potatoes which are already grown there.

Average mean temperature of 16° to 17°C may be prefered for potato, although prior to tuberization slightly higher temperatures may give the best growth. Tuberization is considered best at a soil temperature of 15.5°C and is decreased at 19°C, while inhibited at 25°C. A day length of 16 to 17 hours, cool temperatures and high relative humidity seem most desirable for the potato and seed developments

...../4

SOILS DESCRIPTION AND ANALYTICAL DATA.

SOIL 1A:

This soil is found mostly on slight slopes but also occur on interfluves. The soil occupies major portion of the survey area and is a deep well drained dark reddish brown medium clay overlying dark red heavy clay. The structure is blocky and is comprised of moderately developed fine peds. The consistence is hard when dry, firm when moist and sticky when in wet conditions. Fine manganese concretions are found from 52 cms. in pits 1 and 6.

The soil is sufficient in Mg, Mn, and Phosphorus. Potassium is rich in the top soil and sufficient in the subsoil. Calcium which is sufficient only in the top soil and deficient in the subsoil could be taken care of if Calcium ammonium nitrate and single superphosphate are employed. Pits 1 and 8 nevertheless, are rich in Calcium in the top soil, have sufficient amount in the second horizons but are deficient in this nutrient in the deep subsoil.

Pit No. 1. represents these soils and the analytical data appear in table 1.

PIT NO. 1	Profile Description
LOCATION	Tigoni
ASPECT	South West
SLOPE	$6\frac{1}{2}^{o}$
MICRO RELIEF	Even
MACRO RELIEF	High ridges and valleys
PARENT MATERIAL	Limuru Trachytes
DRAINAGE	Good
PROFILE DEPTH	More than 82 cms.
MAXIMUM ROOT DENSITY	30 cms.

...../5

ROOT DEPTH	More than 82 cms.
LAND USE	Grazing
VEGETATION COVER	Grass
0 - 15 Cms.	Dark reddish brown (5YR $^{3}/_{3}$) clay with granular blocky structure. The consistence is hard when dry, firm when moist and sticky when wet. Fine and medium roots are common and the lower boundary is smooth and diffuse.
15 - 52 Cms.	Dark reddish brown (5YR$^{3}/_{3}$) clay with blocky structure which consists of moderately developed fine peds. Fine and medium roots are common and the lower boundary is smooth and diffuse.
52 - 82 Cms.	Dark red (2.5YR$^{3}/_{4}$) clay which is slightly hard when dry, firm when moist and sticky when in wet conditions. The structure is blocky. Fine manganese concretions are rare and fine roots are few. The lower boundary is smooth and diffuse.
82 Cms +	Dark red (2.5YR$^{3}/_{6}$) clay with blocky structure. The consistence is firm when moist and sticky when wet. Fine manganese concretions are common. Roots are fine and rare.

...../6

TABLE 1

L O C A T I O N : Tigoni

LAB.NO.757-760/70

PIT NO.1

SOIL 1A

CMS DEPTH	% C	% Sand	% Silt	% Clay	m.e.% C.E.C.	EXCHANGEABLE BASES m.e. % Ca	Mg	K	Na	E.S.P.
0-15	5.90	17	30	53	36.0	17.4	3.6	3.0	0.3	0.82
15-52	-	7	26	69	32.0	11.6	2.9	1.1	0.2	0.62
52-82	-	7	20	73	28.6	5.6	2.7	0.6	0.2	0.69
82+	-	11	8	81	28.6	3.6	2.2	0.1	0.2	0.69

CMS DEPTH	pH 1:5 H_2O	pH 1:5 KCl	EC 1:5 m.mhos/cm	m.e.% Hp	m.e.% Hv	AVAILABLE NUTRIENTS m.e. % Mn	Na	K	Ca	Mg	P ppm	% N
0-15	6.1	5.1	0.14	-	-	0.90	0.18	2.90	10.0	2.9	59	0.71
15-52	5.9	5.3	0.10	-	-	0.92	0.14	0.84	2.8	2.2	59	-
52-82	5.9	4.9	0.05	0.5	-	0.92	0.04	0.41	0.4	2.3	60	-
82+	5.3	4.5	0.04	1.0	-	0.64	0.06	0.10	0.2	1.9	59	-

For % organic matter, multiply % C by 1.73

SOIL 1B:

This soil which occupies an interfluve is a dark reddish brown medium clay overlying dark red heavy clay with gravel. The structure which is composed of fine and medium peds is blocky. The consistence is slightly hard when dry, slightly soft when moist and sticky when wet.

Potassium, Magnesium, Manganese and Phosphorus are sufficient in this soil and the organic matter content is fairly high. Calcium is rich in the top soil but deficient in the subsoil. The soil is slightly acid with the pH in the region of 5.8 to 6.3. Calcium may be taken care of if nitrogen is applied as calcium ammonium nitrate and phosphorus applied as single superphosphate. This soil is suitable for cultivation.

Soil profile No. 4 is typical of these soils and table 2 gives the analytical data.

PIT NO. 4	Profile Description
LOCATION	Tigoni
SLOPE	Interfluve
MICRO RELIEF	Even
MACRO RELIEF	Ridges and Valleys
PARENT MATERIAL	Limuru Trachytes
DRAINAGE	Good
PROFILE DEPTH	More than 80 cms.
MAXIMUM ROOT DENSITY	34 cms.
ROOT DEPTH	More than 80 cms.
LAND USE	Grazing
VEGETATION COVER	Grass
0 - 27 Cms.	Dark reddish brown ($5YR^3/_4$) clay with blocky structure. The consistence is hard when dry, firm when moist and

...../8

sticky when wet. Fine and medium roots are many and the lower boundary is smooth and diffuse.

27 - 52 Cms. Dark reddish brown ($2.5YR^{3}/_{4}$) clay with blocky structure. The consistence is hard when dry, firm when moist and sticky when wet. Roots are fine and many and the lower boundary is smooth and diffuse.

52 - 60 Cms. Dark red ($2.5YR^{3}/_{6}$) clay whichis hard when dry, firm when moist and sticky when in wet conditions. The structure is blocky. Manganese concretions are rare. Roots are fine and rare.

...../9

TABLE 2

LOCATION : Tigoni

PIT NO. 4

LAB.NO.769-771/70

SOIL 1B

CMS DEPTH	% C	% Sand	% Silt	% Clay	m.e. % C.E.C.	EXCHANGEABLE BASES m.e.% Ca	Mg	K	Na	E.S.P.
0-27	5.90	17	24	59	38.0	17.2	3.9	2.0	0.3	0.78
27-52	-	5	14	81	25.8	9.2	3.3	1.1	0.2	0.77
52-60	-	9	10	82	24.2	6.8	3.2	0.9	0.2	0.82

CMS DEPTH	pH 1:5 H_2O	pH 1:5 KCl	EC 1:5 m.mhos/cm	AVAILABLE NUTRIENTS m.e. % Mn	Na	K	Ca	Mg	P ppm	% N
0-27	6.2	5.3	0.10	0.72	0.12	1.00	10.0	2.5	58	0.60
27-52	6.4	5.5	0.04	0.70	0.02	1.20	2.0	2.2	6.1	-
52-60	6.3	5.4	0.08	0.62	0.04	0.48	0.4	2.2	61	-

For % organic matter, multiply % C by 1.73

SOIL 2A:

Soil 2A is found in a depression. The soil is very dark brown medium clay underlain by dark brown clay. This soil is deep but has impeded drainage. The structure is prismatic. Cutans are distinct in the first and second horizons and yellowish brown mottles are abundant from third horizon. The consistence is hard when dry very firm when moist and very sticky when in wet condition. Very well expressed and fine manganese concretions are encountered from third horizon.

P, Mn, and Mg are sufficient and the organic matter content is quite high in this soil. Calcium and Potassium are rich in the top soil and are sufficient in the deep subsoil. The soil is slightly acid.

Since this soil is liable to seasonal water logging it is only marginally suitable for potato production. The soil has a limited suitability because it requires amendments. It needs drainage layout to improve permeability and guard against seasonal flooding.

Soil profile No. 2 is representative of these soils and the analytical data are provided in table 3.

PIT NO. 2	Profile Description
LOCATION	Tigoni
SLOPE	Depression
MICRO RELIEF	Depression
MACRO RELIEF	Ridges and Valleys
PARENT MATERIAL	Limuru Trachytes
DRAINAGE	Impeded
PROFILE DEPTH	More than 187 cms.
MAXIMUM ROOT DENSITY	50 cms.
ROOT DEPTH	More than 187 cms.
LAND USE	Grazing

...../11

VEGETATION COVER Grass

0 - 50 Cms. Very dark brown (10YR $^{2}/_{2}$) clay which is very hard when dry, very firm when moist and very sticky when wet. The structure which is composed of fine and medium peds is blocky. Cutans are distinct. Fine, medium and coarse roots are abundant. The lower boundary is smooth and gradual.

50 - 74 Cms. Dark brown (7.5YR $^{4}/_{2}$) clay with blocky structure. Cutans are distinct and the consistence is slightly hard when dry, very firm when moist and very sticky when wet. Fine and medium roots are many. The lower boundary is clear and abrupt.

74 - 90 Cms. Brown (7.5YR $^{5}/_{4}$) clay with common yellowish brown mottles (10YR $^{5}/_{4}$). The structure is blocky and the consistence is firm when moist and sticky when wet. Very fine manganese concretions are very well expressed. Roots are fine and rare. The lower boundary is smooth and abrupt.

90 - 120 Cms. Light brown (7.5YR $^{6}/_{4}$) clay with blocky structure. Yellowish brown (10YR $^{5}/_{4}$) mottles are abundant and the consistence is firm when moist and sticky when wet. Very fine and very well expressed manganese concretions are common. Roots are fine and rare and the lower boundary is smooth and gradual.

120 Cms + Light brown (7.5YR $^{6}/_{4}$) clay with blocky structure. Yellowish brown mottles are abundant. The consistence is firm when moist and sticky when wet. Very fine and well expressed manganese concretions are common. Roots are fine and rare.

...../12

LOCATION: Tigoni

TABLE 3

LAB. NO. 761-765/70

PIT NO.2

SOIL 2A

CMS DEPTH	% C	% Sand	% Silt	% Clay	m.e.% C.E.C.	EXCHANGEABLE BASES m.e.% Ca	Mg	K	Na	E.S.P.
0-50	4.09	7	36	57	38.0	18.8	3.2	2.2	0.3	0.78
50-74	-	11	26	63	22.6	12.8	1.7	1.5	0.3	1.31
74-90	-	11	28	61	27.8	13.0	2.1	1.1	0.2	0.77
90-120	-	15	20	65	24.2	10.8	2.4	1.2	0.3	1.23
120+	-	17	20	63	25.0	9.8	2.8	0.3	0.3	1.20

CMS DEPTH	pH 1:5 H_2O	KCl	EC 1:5 m.mhos/cm	m.e.% Hp	Hv	AVAILABLE NUTRIENTS m.e. % Mn	Na	K	Ca	Mg	P ppm	% N
0-50	6.4	5.5	0.09	-	-	0.66	0.15	1.73	12.6	2.3	63	0.51
50-74	6.7	5.6	0.04	-	-	0.34	0.04	1.04	2.6	1.2	60	-
74-90	6.7	5.7	0.06	-	-	0.74	0.14	0.76	2.2	1.6	60	-
90-120	6.7	5.7	0.05	-	-	0.80	0.06	0.34	1.2	1.8	61	-
120+	6.6	5.6	0.06	-	-	0.88	0.08	0.25	1.0	1.9	64	-

For % organic matter, multiply % C by 1.73

SOIL 2B

This is a deep dark reddish brown medium clay which is found mainly on gentle slopes. The structure which is composed of moderately developed peds is prismatic blocky. Consistence is hard when dry firm when moist and sticky when wet. Fine manganese concretions are encountered in pits 13 and 15 from 40 and 70 cms. respectively.

The soil is slightly acid to strongly acid with pH ranging from 5.5 to 6.7. Phosphorus, Potassium and Manganese are sufficient. Pit 16 however is rich in Potassium in the top soil but deficient in this element in the subsoil. Mg. is rich in the top soil and sufficient in the subsoil. Calcium on the other hand is rich in the top soil but deficient in the deep subsoil. The organic matter is fairly high. The soil is suitable for cultivation.

Soil Profile No. 12 is typical of these soils. The analytical data are given in table 4.

PIT NO. 12	Profile Description
LOCATION	Tigoni
ASPECT	North
SLOPE	2^{o}
MICRO RELIEF	Even
MACRO RELIEF	Ridges and Valleys
PARENT MATERIAL	Limuru Trachytes
DRAINAGE	Good
PROFILE DEPTH	More than 160 cms.
MAXIMUM ROOT DENSITY	60 cms.
ROOT DEPTH	More than 160 cms.
LAND USE	Grazing
VEGETATION COVER	Grass

...../14

0-40 Cms.	Dark reddish brown (5YR $^{3}/_{3}$) clay with blocky structure. The consistence is hard when dry, firm when moist and sticky when wet. Roots are fine and abundant and the lower boundary is smooth and diffuse.
40 - 70 Cms.	Dark reddish brown (5YR $^{3}/_{3}$) clay which is hard when dry, firm when moist and sticky under wet conditions. The structure is prismatic. Roots are fine and few and the lower boundary is smooth and diffuse.
70 - 160 Cms.	Dark red (2.5YR $^{3}/_{6}$) clay with prismatic structure. The consistence is firm when moist and sticky when wet. Roots are fine and few.

...../15

LOCATION : Tigoni

TABLE 4

LAB.NO. 976-977/71

PIT NO. 12

SOIL 2B

CMS DEPTH	% C	% Sand	% Silt	% Clay	m.e.% C.E.C.	EXCHANGEABLE BASES m.e. %				E.S.P.
						Ca	Mg	K	Na	
0-40	2.52	5	30	65	38.0	11.2	1.8	2.0	0.1	0.26
40-70	-	11	24	65	32.0	8.8	1.6	1.2	0.1	0.31
70-160	-	13	20	67	25.8	8.8	2.1	0.6	0.1	0.38

CMS DEPTH	pH 1:5		EC 1:5 m.mhos/cm	m.e.%		AVAILABLE NUTRIENTS m.e. %					P ppm	% N
	H_2O	KCl		Hp	Hv	Mn	Na	K	Ca	Mg		
0-40	6.2	5.3	0.06	-	-	1.10	0.04	1.52	5.6	2.4	56	0.36
40-70	6.5	5.2	0.05	-	-	1.30	Trace	0.92	1.8	1.7	58	-
70-160	6.5	5.2	0.09	-	-	1.26	0.02	0.44	1.2	2.4	57	-

For % organic matter, multiply % C by 1.73

SOIL 3

This soil is a deep dark reddish brown medium clay overlying dark red heavy clay with blocky structure. The soil is hard when dry, firm when moist and is sticky in the subsoil. This soil is found on very steep slopes and is subject to erosion. Protection from erosion and gullying along paths and tracks will have to be enforced if this soil is to be even grazed. The soil is nevertheless considered too steep for cultivation.

Potassium, Phosphorus and Manganese are sufficient and the organic matter content is quite high. In pit A Magnesium and Calcium are sufficient in the top soil but deficient in the subsoil. The soil is slightly acid to strongly acid with a pH range of 4.3 to 6.2.

Soil profile No. 14 is representative of this soil and table No. 5 provides the analytical data.

PIT NO. 4	Profile Description
LOCATION	Tigoni
ASPECT	South
SLOPE	14^{o}
MICRO RELIEF	Even
MACRO RELIEF	Ridges and Valleys
PARENT MATERIAL	Limuru Trachytes
DRAINAGE	Good
PROFILE DEPTH	More than 160 cms.
MAXIMUM ROOT DENSITY	40 cms.
ROOT DEPTH	More than 160 cms.
LAND USE	Grazing
VEGETATION COVER	Grass
0 - 40	Dark reddish brown (5YR $^{3}/_{3}$) clay with granular blocky structure. The consistence

...../17

boundary is smooth and gradual.

40 Cms. + Dark red (2.5YR $^{3}/_{6}$) clay with blocky structure. The consistence is hard when dry, firm when moist and sticky when in wet conditions. Fine and medium roots are common.

...../18

LOCATION: Tigoni

TABLE 5

LAB.NO. 4296-4297/70

PIT NO. 14

SOIL 3

CMS DEPTH	% C	% Sand	% Silt	% Clay	m.e.% C.E.C.	EXCHANGEABLE BASES m.e. % Ca	Mg	K	Na	E.S.P.
0-40	3.64	18	18	64	34.0	15.2	1.2	2.2	0.3	0.88
40+	-	8	18	74	23.2	10.4	1.3	2.4	0.2	0.86

CMS DEPTH	pH 1:5 H_2O	pH 1:5 KCl	EC 1:5 m.mhos/cm	m.e.% Hp	m.e.% Hv	AVAILABLE NUTRIENTS m.e. % Mn	Na	K	Ca	Mg	P ppm	% N
0-40	6.3	5.3	0.10	-	-	0.75	0.15	1.34	9.4	3.0	42	0.48
40+	6.5	5.9	0.12	-	-	0.85	0.02	1.42	2.2	3.0	43	-

For % organic matter, multiply % C by 1.73

General Information on Soil Suitability for Potato Production

The ideal soils for potatoes are fertile, well drained and of rather loose texture. Soils 1A, 1B, 2B and 3 of the station therefore appear ideal in this respect. In poorly drained soils such as soil 2A the tubers would frequently be deformed, and will not be attractive in appearance. Soil 2A may therefore be avoided. While potatoes may be grown on a wide range of soil types, the best yields may be expected on sandy loams and silt loam.

Soils with a high moisture holding capacity must be avoided even if the drainage is adequate. This type of soil remains moist too long after rain for irrigation. A situation of high moisture holding capacity may however not be expected in soils which are recommended for cultivation in the station.

...../20

PEDOLOGICAL FACTORS OF SIGNIFICANCE TO SOIL MANAGEMENT IN THE STATION

Soil Depth and Rooting:-

Potato is a fairly deep rooted plant so that if the best results are to be obtained the cultivation must also be deep and thorough. Generally speaking, potato land should be ploughed to a depth of about 40 to 50 cms. and the bottom soil stirred to facilitate root development. In comparatively shallow soil there is a risk of bringing subsoil to the surface in the process of land preparation.

The soils of the survey area are however quite deep and well suited to deep ploughing. Roots are also fairly well distributed in the soil horizons.

Slopes:-

The northern part of the area is a region of strong slopes comprising broad ridges and depression while the western and south western parts have very steep slopes. Although many large growers may obtain satisfactory yields by growing potatoes on the same land year after year, there is danger of soil erosion on sloping land, of loss of organic matter, and eventually of deterioration of the soil. Soil 3 which is on very steep slope is considered unsuitable for cultivation. Even for grazing, the soil may have to be protected from erosion.

Soil Fertility and Fertilizer Requirements:-

The soil test data suggest that the station generally seems adequate in the major plant nutrients. Calcium however is rather low in the subsoil. The use of single superphosphate and calcium ammonium nitrate may adequately supply the required calcium.

It should be noted that soil test data are not designed to provide precise recommendations as to the amounts of each fertilizer to be applied, but merely to give a broad indication of those

...../21

nutrients that are likely to be limiting production. Only properly conducted crop trial sited on the relevant soil type can provide more complete information. Fertilizer trials will therefore have a vital role to play in determining the most economic and effective fertilizer regime. Single superphosphate, triple superphosphate, diamonium phosphate, and even compound fertilizer could all be tried.

As no experimental data on potato are available for the station, no direct comparison can be made with results obtained elsewhere.

Experiments conducted elsewhere however, suggest that potatoes prefer a slightly acid soil (pH 5.5 to 6.5) and they are decidedly sensitive to alkaline soils with a pH value higher than 7.5 and also brackish soils. The application of Agricultural lime becomes necessary if pH value is below 5. Liming experiments are however not considered necessary for the soils which may be cultivated in the station. Only soil 3 which in any case is unsuitable for cultivation, indicates lime requirement.

...../22

REFERENCES

1. Experimental Husbandry Number 16, 1968.

2. Todd, T. M. 1969 A prospect for potato growing in Kenya.

3. William Bramley - 1965 Pick soils and parent Plants with care - Farmers Weekly.

Otieno Oswaggo.
SOIL SURVEY UNIT
N A I R O B I .

JULY 1971.

APPENDIX I

Analytical data for pit and Auger Soil samples

Field Designation	PIT	NO.1			PIT	NO.2			
Lab.No./70	757	758	759	760	761	762	763	764	765
Depth (cm)	0-15	15-52	52-82	82+	0-50	50-74	74-90	90-120	120+
AVAILABLE NUTRIENTS									
pH 1:1	6.1	6.0	5.3	4.8	6.0	6.7	6.7	6.6	6.5
Na m.e.%	0.18	0.14	0.04	0.06	0.15	0.04	0.14	0.06	0.08
K m.e.%	2.90	0.84	0.41	0.10	1.73	1.04	0.76	0.34	0.25
Ca m.e.%	10.0	2.8	0.4	0.2	12.6	2.6	2.2	1.2	1.0
Mg m.e.%	2.9	2.2	2.3	1.9	2.3	1.2	1.6	1.8	1.9
Mn m.e.%	0.90	0.92	0.92	0.64	0.66	0.34	0.74	0.80	0.88
P ppm	59	59	60	59	63	60	60	61	64
N %	0.71	-	-	-	0.51	-	-	-	-
C %	5.90	-	-	-	4.09	-	-	-	-
Hp m.e.%	-	-	3.5	1.0	-	-	-	-	-
TEXTURE AND EXCHANGEABLE BASES									
Sand %	17	5	7	11	7	11	11	15	17
Silt %	30	26	20	8	36	26	28	20	20
Clay %	53	69	73	81	57	63	61	55	63
Class	C	C	C	C	C	C	C	C	C
C.E.C. m.e.%	36.0	32.0	28.6	28.6	38.0	22.6	27.8	24.2	25.0
Ca m.e.%	17.4	11.6	5.6	3.6	18.8	12.8	13.0	10.8	9.8
Mg m.e.%	3.6	2.9	2.7	2.2	3.2	1.7	2.1	2.4	2.8
K m.e.%	3.0	1.1	0.6	0.1	2.2	1.5	1.1	1.2	0.3
Na m.e.%	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3

C for Class = Clay

Field Designation		PIT	NO. 3	PIT	NO.4		PIT	NO.7	
Lab.No./70	766	767	768	769	770	771	772	773	774
Depth (cm)	0-20	20-73	73+	0-27	27-52	52-60	0-20	20-67	67+

AVAILABLE NUTRIENTS

pH 1:1	5.7	6.4	5.8	5.8	6.1	6.3	5.3	4.7	4.9
Na m.e.%	0.12	0.02	0.04	0,14	0.04	0.02	0.15	0.06	0.04
K m.e.%	1.0	1.20	0.48	1.50	0.82	0.72	1.28	0.64	0.40
Ca m.e.%	10.0	2.0	0.4	12.2	1.8	0.6	2.8	Trace	Trace
Mg m.e.%	2.5	2.2	2.2	3.0	2.2	2.9	2.5	0.2	0.4
Mn m.e.%	0.72	0.70	0.62	0.89	0.74	0.74	0.86	0.72	0.58
P ppm	58	61	61	53	61	66	52	52	58
N %	0.60	-	-	0.69	-	-	0.66	-	-
C %	5.91	-	-	7.20	-	-	7.26	-	-
Hp m.e.%	-	-	-	-	-	-	0.1	1.1	0.2

TEXTURE AND EXCHANGEABLE BASES

Sand %	17	13	17	17	5	9	15	7	5
Silt %	22	26	6	24	14	10	24	12	12
Clay %	61	61	77	59	81	81	61	81	83
Class	C	C	C	C	C	C	C	C	C
C.E.C. m.e.%	27.0	39.0	27.0	38.0	25.8	24.2	36.0	27.0	23.2
Ca m.e.%	10.8	16.8	7.4	17.2	9.2	6.8	8.0	1.6	2.2
Mg m.e.%	3.1	3.0	2.5	3.9	3.3	3.2	3.1	1.6	1.4
K m.e.%	1.6	1.4	0.6	2.0	1.1	0.9	1.6	0.8	0.2
Na m.e.%	0.3	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3

C for Class = Clay

Field Designation	PIT NO. 8		
Lab.No./70	775	776	777
Depth (cm)	0-27	27-70	70+

AVAILABLE NUTRIENTS

pH 1:1	6.1	6.5	6.6
Na m.e.%	0.10	0.06	0.02
K m.e. %	2.30	1.86	0.96
Ca m.e.%	10.2	4.4	1.6
Mg m.e.%	3.6	1.9	2.0
Mn m.e.%	0.80	0.76	0.72
P ppm	60	61	63
N %	0.39	-	-
C %	4.98	-	-
Hp m.e.%	-	-	-

TEXTURE AND EXCHANGEABLE BASES

Sand %	15	7	17
Silt %	24	24	7
Clay %	61	69	76
Class	C	C	C
C.E.C. m.e.%	38.0	34.0	27.0
Ca m.e.%	17.6	14.8	12.4
Mg m.e.%	5.2	2.5	2.2
K m.e. %	3.0	2.5	1.4
Na m.e.%	0.3	0.2	0.3

C for Class = Clay

Field Designation	PIT NO. 10			PIT NO.12			PIT NO.16		
Lab.No./70	972	973	974	975	976	977	978	979	980
Depth (cm)	0-30	30-60	60-130	0-40	40-70	70-160	0-40	40-70	70-160

AVAILABLE NUTRIENTS

pH 1:1	6.0	6.2	5.8	6.1	6.2	6.5	6.3	6.7	6.1
Na m.e. %	0.34	0.10	0.08	0.04	Trace	0.02	0.04	Trace	0.02
K m.e.%	1.46	1.32	0.70	1.52	0.92	0.44	2.20	1.60	0.14
Ca m.e.%	8.0	2.2	0.6	5.6	1.8	1.2	10.4	1.8	0.2
Mg m.e.%	2.9	2.4	2.0	2.4	1.7	2.4	3.2	3.0	3.0
Mn m.e.%	1.04	0.94	0.64	1.10	1.31	1.26	1.10	0.86	0.79
P ppm	58	56	56	56	58	57	58	58	56
N %	0.53	-	-	0.36	-	-	0.54	-	-
C %	4.23	-	-	2.52	-	-	4.49	-	-
Hp m.e.%	-	-	-	-	-	-	-	-	-

TEXTURE AND EXCHANGEABLE BASES

Sand %	13	5	11	5	11	13	11	11	7
Silt %	20	20	2	30	24	20	22	16	6
Clay %	67	75	87	65	65	67	67	73	87
Class	C	C	C	C	C	C	C	C	C
C.E.C. m.e.%	38.0	30.0	27.0	38.0	32.0	25.8	38.0	36.0	25.8
Ca m.e.%	12.4	7.8	4.8	11.2	8.8	8.8	15.4	8.8	4.2
Mg m.e.%	2.7	2.1	2.1	1.8	1.6	2.1	2.9	2.8	2.5
K m.e. %	1.9	1.6	0.9	2.0	1.2	0.6	2.7	2.2	0.2
Na m.e. %	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1

C for Class = Clay

Field Designation	PIT A			PIT 14		AUGER 15		
Lab.No. /70	4293	4294	4295	4296	4297	4298	4299	4300
Depth (cm)	0-30	30-60	60+	0-40	40+	0-30	30-70	70+

AVAILABLE NUTRIENTS

pH 1:1	5.0	4.3	4.4	5.8	6.2	5.8	5.9	5.5
Na m.e.%	0.08	0.12	Trace	0.15	0.02	0.22	0.06	0.12
K m.e.%	1.75	0.74	0.78	1.34	1.42	1.46	0.90	1.12
Ca m.e.%	2.2	Trace	Trace	9.4	2.2	13.8	3.6	0.6
Mg m.e.%	2.8	0.3	0.4	3.0	3.0	5.5	2.6	2.0
Mn m.e.%	0.86	0.70	0.81	0.75	0.84	1.10	1.11	0.86
P ppm	25	24	31	42	43	46	44	46
N %	0.52	-	-	0.48	-	0.71	-	-
C %	4.56	-	-	3.64	-	5.77	-	-
Hp m.e.%	0.3	3.1	2.5	-	-	-	-	0.1

TEXTURE AND EXCHANGEABLE BASES

Sand %	10	8	12	18	8	22	12	14
Silt %	24	14	12	18	18	20	22	12
Clay %	66	72	76	64	74	58	66	74
Class	C	C	C	C	C	C	C	C
C.E.C. m.e.%	32.0	22.0	24.0	34.0	23.2	36.0	27.0	22.0
Ca m.e.%	7.4	2.4	2.4	15.2	10.4	17.6	11.2	6.8
Mg m.e.%	0.8	0.3	Trace	1.2	1.3	3.6	1.3	1.3
K m.e.%	2.7	1.2	1.4	2.2	2.4	2.4	1.5	1.7
Na m.e.%	0.3	0.2	0.2	0.3	0.2	0.2	0.1	0.2

C for Class = Clay

A P P E N D I X II

Nutrient deficiency standards at the National Agricultural Laboratories.

Deficiencies are suspected if the nutrient levels are below the following values.

Ca:	3.0	m.e.%
N :	44.8	Kg/ha
P :	20	ppm
Mg:	1.0	m.e.%
Mn:	0.1	m.e.%
K :	0.4	m.e.%

To convert % N to Kg/ha N multiply by 2,000.

To convert % C to % organic matter, multiply by 1.73.