

TABLES

Table 2.1 Summary of Meteorological Condition at Ahero

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean/Total
Rainfall (mm)	71	91	133	187	131	75	74	81	77	79	124	85	1208
Air Temperature (°C)	22.3	22.7	23.1	22.6	22.1	22.4	21.2	21.4	21.7	22.4	22.2	22.1	22.1
Relative Humidity (%)	65	65	67	73	74	75	75	73	66	63	66	67	69
Sunshine Hours (hrs)	8.5	8.5	7.9	7.3	7.3	7.2	6.8	6.8	7.0	7.4	7.1	8.1	7.5
Solar Radiation (cal/cm ² /day)	606	627	614	586	574	547	533	549	572	593	572	600	582
Wind Velocity (km/hr)	5.4	5.6	5.3	4.8	4.1	4.1	4.0	4.4	4.7	4.7	4.6	4.9	4.7
Pan Evaporation (mm/day)	6.9	7.3	7.3	6.1	5.5	5.1	5.0	5.4	5.8	6.3	6.0	6.3	6.1

Table 3.1 Laboratory Test Methods
of Soil Analyses

Test Item	Principle or Method
Sample preparation	; Breaking up of aggregates by careful pounding; seaving through a 2mm sieve. This sieved fraction (<2mm) is used for further analyses.
Particle size analysis	; Hydrometer method - shaking overnight with sodium hexametaphosphate/sodium carbonate in an end-over-end shaken at 40 r.p.m.; measuring silt+clay (0-50 micron) and clay (0-2 micron) with a hydrometer after 40 seconds and 2 hours respectively. Sand fraction (50-2000 micron) is obtained by subtracting the sum of silt and clay from 100% (Day, 1956)
pH-H ₂ O and EC	; pH and EC are routinely measured in suspension with a soil:water ratio of 1:2.5. Suspensions are prepared by placing 10g of fine earth and adding it to 25cc of distilled water. pH-KCl is also measured.
Carbon	; Walkley and Black method (Black, 1965).
Nitrogen	; Kjeldal digestion method
Available phosphorus	; Olsen-P method
Cation exchange capacity	; CEC is determined by successive leachings of the soil with IN ammonium acetate of pH 7.0. Determing NH ₄ in the leachate.
Exchangeable cations	; Leaching of the soil with IN NH ₄ OAc of pH 7.0. Determing Na, K and Ca by flame photometer. Mg is determined by atomic absorption spectrophotometer.

Table 4.1 (1/3) General Information of Test Pit Sites

No.	Location	Physiography	Parent Material	Topography		Slope (K)	Drainage		Land use/ Vegetation	Remarks
				meso	micro		internal	external		
1.	Katito	fan base (F12)	colluvium/lac. clay	flat	smooth	0	mod. well	poorly	maize/sorghum	inundated (Apr-Jun)
2.	Awatch	lacustrine plain (K21)	lac. clay	flat	smooth	0	m. well-well	poorly	grass land	inundated (Apr-Jun)
3.	Katito	lacustrine plain (K21)	lac. clay	flat	smooth	0	m. well-well	poorly	maize/cotton	
4.	Magunga	fan base (F12)	colluvium/lac. clay	flat	smooth	0	well	well	grass land	
5.	Magunga	fan base (F12)	colluvium/lac. clay	flat	smooth	0	well	well	grass/sisal	
6.	Kanyamlori	fan base (F22)	colluvium/lac. clay	flat	irregular	0	well	well	open bush	severely eroded
7.	Kanyamlori	fan base (F12)	colluvium/lac. clay	flat	smooth	0	mod. well	mod. well	grass/maize	
8.	Ndori	fan base (F12)	colluvium/lac. clay	slight undulating	irregular	0	well	well	maize	wide U-shaped valley
9.	Maraba	fan base (F12)	colluvium/lac. clay	flat	smooth	0	well	well	maize/sorghum	rills & gullies
10.	Cherwa	old stream bed (F21)	fluvial deposits	flat	smooth	0	well	well	maize	partly rill erosion
11.	Onyongo	fan apex (F11)	colluvium	s. undulating	irregular	4	well	well	cotton/maize	
12.	Onyongo	foot of scarp (H21)	phonolite	gently sloping	irregular	6-10	impeded	excessiv. well	bush	frequent rock outcrops
13.	Onyongo	foot of scarp (H21)	tuffic sandstone	rolling	irregular	6-10	impeded	excessiv. well	bush	quarry site
14.	Onyongo	piedmont (P2)	colluv. /granite	rolling	smooth	2-6	well	well	maize/sisal	gullies
15.	Paponditri	piedmont (P31)	colluv./granodiorite	undulating	irregular	0-2	well	well	vegetable/maize	
16.	Paponditri	piedmont (P31)	colluv./granodiorite	s. undulating	irregular	0	well	mod. well	grass/sisal	gullies
17.	Urudi	micro-ridge (U2/F4)	colluv./granodiorite	flat	irregular	0	mod. well	poorly	house garden	
18.	Lisana	micro-ridge (F4)	phonolite	s. undulating	irregular	1	well	well	grass	sheet erosion
19.	Urudi	lac. plain (K21)	lac. clay	flat	smooth	1	mod. well	mod. well	maize	well-cultivated
20.	Urudi	river bank (K3/K21)	fluvium of Asawa	flat	irregular	0	well	well	sorghum	well-cultivated
21.	Wasare	lac. plain (K21)	lac. clay	flat	smooth	0	mod. well	poorly	maize/sorghum	inundated (Jun-Jul)
22.	Wasare	swamp (S2)	lac. clay	flat	smooth	0	very poorly	poorly	paddy	inundated (Jun-Jul)
23.	Wasare	lac. plain (K22)	fluvium of Nyando	gent. sloping	smooth	2-4	poorly	poorly	grass	inundated (Jun-Jul)
24.	Gem	lac. plain (K21)	lac. clay	flat	irregular	0	poorly	poorly	grass	inundated (Feb-May)
25.	Urudi	lac. plain (K22)	lac. clay	gent. sloping	irregular	2-4	poorly	well	grass	severe sheet erosion
26.	Katito	river bank (F12)	lac. clay	flat	irregular	0	poor-m. well	poorly	open bush	gullies
27.	Paponditri	piedmont (P32)	colluv./granodiorite	flat	irregular	0	well	well	grass/maize	gullies & rills
28.	Paponditri	piedmont (P31)	colluv./granodiorite	flat	irregular	0	well	well	grass/maize	gullies
29.	Nyarunya	piedmont (P31)	colluv./granodiorite	flat	irregular	0	mod. well	well	grass	gullies & rills
30.	Bungumeri	foot of scarp (H22)	colluv./granodiorite	rolling	irregular	5-10	impeded	excessiv. well	bush	gullies

Table 4.1 (2/3) General Information of Test Pit Sites

No.	Location	Physiography	Parent Material	Topography		Slope (%)	Drainage		Land use/ Vegetation	Remarks
				meso	micro		internal	external		
31.	Kandaria	piedmont plain (P11)	colluv./granodiorite	rolling	irregular	5-8	excessiv. well	well	bush	severely eroded
32.	Kandaria	piedmont plain (P31)	colluv./granodiorite	undulating	irregular	2-5	excessiv. well	well	grass/maize	severely eroded
33.	Kandaria	piedmont plain (P31)	colluv./lac. clay	flat	irregular	2	mod. well	well	maize	gullies
34.	Gimo	piedmont plain (P31)	colluv./lac. clay	flat	smooth	1	mod. well	well	grass	rill
35.	Onyinge	piedmont plain (P31)	colluv./lac. clay	flat	smooth	0	mod. well	poorly	grass	
36.	Onyinge	piedmont plain (P31)	colluv./lac. clay	flat	irregular	0	mod. well	poorly	bush	gullies
37.	Bodi	plateau (H1)	phonolite	s. undulating	irregular	0	impeded	well	maize	gullies
38.	Bonde	swamp (P3)	colluv./lac. clay	s. undulating	irregular	0-2	poorly	well	grass	gullies
39.	Bonde	piedmont plain (P31)	granodiorite	flat	irregular	0-2	mod. well	well	maize	gullies
40.	Bugo	piedmont plain (P31)	granodiorite	s. undulating	irregular	0-2	well	well	grass/maize	
41.	Bugo	swamp (S1)	alluvium	flat	smooth	0	poorly	poorly	grass	
42.	Mbugra	gully bank (P32)	colluv.	undulating	irregular	0-6	well	excessiv. well	maize	
43.	Mbugra	gully bank (P32)	colluv.	s. undulating	irregular	2-4	well	excessiv. well	maize/sorghum	
44.	Mbugra	gully bank (P32)	colluv.	flat	irregular	2-4	well	well	maize	surface erosion
45.	Mbugra	piedmont (P2)	fluvium from Mbugra	flat	smooth	0	well	well	maize	surface erosion
46.	Obange	sand ridge (D2)	alluvium	flat	irregular	0	excessiv. well	well	vegetable	rill/surface erosion
47.	Obange	cuscate delta (D12)	fluvium from Sondu	flat	smooth	0	poorly	poorly	grass	
48.	Obange	sand ridge (D2)	alluvium	flat	smooth	0	excessiv. well	well	grass	
49.	Bala	cuscate delta (D11)	fluvium from Sondu	flat	smooth	0	poorly	poorly	grass	partly eroded by gullies
50.	Nyagonge	cuscate delta (D11)	fluvium from Sondu	flat	smooth	0	poorly	poorly	grass	
51.	Sangoro	piedmont plain (P31)	colluv./lac. clay	flat	smooth	0	well	well	grass	
52.	Sangoro	piedmont plain (P32)	colluv./lac. clay	flat	smooth	0	well	well	grass	
53.	Nyakwere	piedmont plain (P31)	colluv./lac. clay	flat	smooth	0-1	well	well	grass	
54.	Sangoro	cuscate delta (D11)	colluv./lac. clay	flat	smooth	0-1	poorly	poorly	maize	
55.	Osodo	sand ridge (D2)	alluvium	flat	smooth	0-1	excessiv. well	well	groundnuts	
56.	Osodo	cuscate delta (D12)	fluvium from Sondu	flat	smooth	0	poorly	poorly	grass	
57.	Osodo	cuscate delta (D11)	fluvium from Sondu	flat	irregular	0	poorly	poorly	maize	
58.	Kogweno	fan apex (H22)	granodiorite	rolling	irregular	6-10	well	excessiv. well	grass	debris
59.	Kogweno	escarpment (H22)	granodiorite	undulating	irregular	3	impeded	excessiv. well	bush	gullies, debris
60.	Kogweno	piedmont plain (P11)	colluv.	undulating	smooth	2	well	excessiv. well	cotton	gullies

Table 4.1 (3/3) General Information of Test Pit Sites

No.	Location	Physiography	Parent Material	Topography			Slope (%)		Drainage		Land use/ Vegetation	Remarks
				meso	micro	micro	internal	external	internal	external		
61.	Karabondi	piedmont plain (P31)	colluv./lac. clay	flat	smooth	0	well	well	grass			
62.	Karabondi	piedmont plain (P31)	colluv./lac. clay	flat	smooth	0	well	well	grass			
63.	Karabondi	piedmont plain (P31)	colluv./lac. clay	gent. sloping	smooth	2	well	well	cotton			
64.	Kamser	piedmont plain (P31)	colluv./lac. clay	undulating	irregular	4-6	well	excessiv. well	guarfy			
65.	Kamser	piedmont plain (P31)	colluv.	gent. sloping	irregular	2	well	m. well	grass			
66.	Ahero	lacstrine plain	lac. clay	flat	smooth	0	poorly	poorly	irrigated paddy	Ahero Pilot Scheme (NIS)		
67.	Miwani	piedmont	colluv.	gent. sloping	smooth	2	well	m. well	sugarcane			
68.	Miwani	piedmont	colluv.	gent. sloping	smooth	2	well	m. well	sugarcane			
69.	Miwani	piedmont	colluv.	gent. sloping	smooth	4	well	well	sugarcane	well maintained		
70.	Kibos	piedmont	colluv.	gent. sloping	smooth	4	well	well	sugarcane	sugarcane estate		
71.	Kibos	piedmont	colluv.	gent. sloping	smooth	3	well	m. well	sugarcane			

Table 4.2 (1/6) Generalized Description of Soil Profile

Key of Description

Boundary of horizon: a (abrupt, less than 2.5 cm), c (clear, 2.6 - 6.3 cm), g (gradual, 6.4 - 12.5 cm), d (diffuse, more than 12.6 cm)

Form of boundary: s (smooth), w (wavy), i (irregular), b (broken)

Mottling:

abundance

f (few, 2%)
c (common, 2 - 20%)
m (many, 20%)

size

f (fine, 5 mm)
m (medium, 5 - 15 mm)
c (coarse, 15 mm)

contrast

f (faint)
d (distinct)
p (prominent)

Structure :

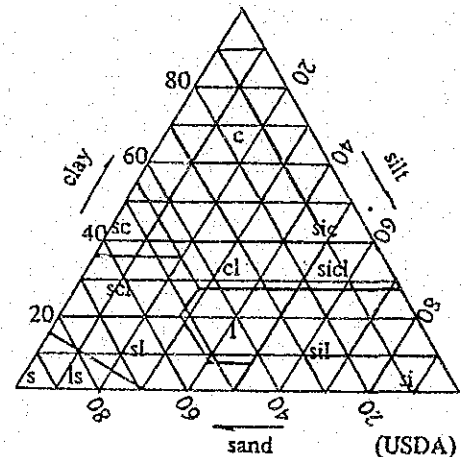
grade

l (structureless)
w (weak)
m (moderate)
s (strong)

type or form

pr (prismatic)
co (columnar)
bk (blocky)
abk (angular blocky)
sbk (subangular blocky)
pl (platy)
gr (granular)
cr (crumb)
sg (single grain)
m (massive)

Texture:



Size:

(unit:mm)

size/type	prismatic	blocky	granular
vf (very fine)	1	10	5
f (fine)	1 - 2	10 - 20	5 - 10
m (medium)	2 - 5	20 - 50	10 - 20
c (coarse)	5 - 10	50 - 100	20 - 50
vc (very coarse)	10	100	50

Consistence

wet soil

ns (non-sticky)
ss (slightly sticky)
s (sticky)
vs (very sticky)
np (non-plasticity)
sp (slightly plasticity)
p (plasticity)
vp (very plasticity)

moist soil

lo (loose)
vfr (very friable)
fr (friable)
fi (firm)
vfi (very firm)
efi (extremely firm)

dry soil

lo (loose)
s (soft)
sh (slightly hard)
h (hard)
vh (very hard)
eh (extremely hard)

Table 4.2 (2/6) Generalized Description of Soil Profile

No.	Horizon Symbol	Depth of Horizon	Boundary of Horizon	Form of Boundary	Colour		Textural class	Structure		Consistence		Remarks		
					Wet	dry		Grade	Type	Size	Wet		Moist	dry
1.	Al C	0 - 13 13 - 90	s	s	10YR3/1 7.5YR3/2	10YR3/1 7.5YR4/2	CL C	m s	sbk sbk	f m	ss,sp s, p	fi fi	h h	weakly developed slickenside crack to 60cm at depth.
2.	Al C	0 - 18 18 - 110	s	s	10YR3/2 10YR2/3	10YR4/2 10YR2/2	C C	s s	sbk sbk	f m	s, p vs, vp	vfi vfi	vh vh	no crack, weakly developed slickenside
3.	Ap C	0 - 13 13 - 50	s	s	10YR3/1 2.5Y2/1	10YR4/2 2.5Y2/1	C C	l s	- sbk	- m	ss,sp s, p	- -	lo vh	
4.	Al C	0 - 13 13 - 100	s	s	7.5YR3/4 2.5Y2/1	7.5YR3/4 2.5Y2/1	grav. SC SC	l m	- sbk	- m	ss,np s, p	- -	lo sh	gravel - ϕ 0.5 - 2cm, 40% few crack to 10cm at depth
5.	Al C	0 - 22 22 - 70	s	s	10YR2/2 10YR2/2	10YR3/2 10YR3/2	SCL SC	l w	- sbk	- f	ss,sp s, sp	- -	lo sh	partly red rounded cobbles no crack
6.	Al Cl C2	0 - 22 22 - 65 65 - 100	s	s	7.5YR2/2 10YR2/1 10YR3/3	7.5YR3/2 10YR3/1 10YR3/3	grav. C C C	m m l	sbk sbk -	f f -	ns,np ss,sp ss,sp	- fr -	sh vh vh	gravel - ϕ 0.5 - 1.0cm, 5% slickenside 1cm x 15cm
7.	Al Cl C2	0 - 4 4 - 54 54 - 150	s	s	10YR2/2 10YR2/1 10YR3/2	10YR3/3 10YR2/1 10YR5/3	grav. C C C	w s w	sbk sbk sbk	f f f	ss,np s, p ss,sp	- - -	sh eh vh	crack 0.5 - 1.0cm x 50cm tuffaceous gravel ϕ 0.5-0.8cm 5%
8.	Ap C	0 - 20 20 - 60	s	s	10YR3/2 10YR2/2	10YR3/3 10YR2/2	grav. C C	w l	sbk -	f -	ss,np s, p	- -	h h	red rounded gravel ϕ 0.2cm
9.	Ap C	0 - 18 18 - 100	s	s	10YR3/2 10YR2/2	10YR3/3 10YR2/2	CL SC	l w	- sbk	- f	ss, np s, sp	- -	sh sh	rounded cobbles ϕ 3-5cm 5% ^{20%} _{30%} ^{20%} _{30%}
10.	Al Cl C2	0 - 5 5 - 33 33 - 90	s	s	10YR2/2 10YR2/2 10YR2/2	10YR3/2 10YR3/2 10YR3/1	grav. CL grav. CL grav. CL	- - -	- - -	- - -	ns,np ss,np ss,np	- - -	sh sh sh	red rounded gravel ϕ 0.3-0.5cm 20% " " ϕ 0.5-1.0cm 10%
11.	Ap B1 B2	0 - 12 12 - 40 40 - 80	s	s	7.5YR3/3 7.5YR3/2 7.5YR4/4	7.5YR4/3 - -	grav. SCL grav. C grav. C/CL	l w w	- sbk sbk	- f f	ss,np ss,np s, p	- - -	s h vh	rounded gravel ϕ 0.1-1.0cm 10% " " ϕ 0.2-0.4cm 20% " " ϕ 0.2-0.4cm 10%
12.	Al	0 - 20	-	-	7.5YR4/6		grav. SL	l	-	-	ns,np	-	s	ϕ 10 - 50cm angular stones
13.	Al	0 - 5	-	-	7.5YR4/6		grav. SL	l	-	-	ns,pp	-	lo	tuffaceous sandstones
14.	Al C	0 - 15 15 - 80	s	s	10YR3/3 10YR3/1	10YR3/3 10YR3/1	CL CL	w w	sbk sbk	f m	ss,np ss,sp	- -	s s	overlying the weathered granite
15.	Ap C	0 - 22 22 - 100	s	s	10YR2/2 2.5Y3/1	10YR3/2 2.5Y4/1	C C	w w	sbk sbk	f f	s,sp vs, vp	fr -	s vh	

Table 4.2 (3/6) Generalized Description of Soil Profile

No.	Horizon Symbol	Depth of Horizon	Boundary of Horizon	Form of Boundary	Colour		Textural class	Structure			Consistence			Remarks
					Wet	dry		Grade	Type	Size	Wet	Moist	dry	
16.	Al1	0 - 5	a	s	-	10YR3/3	LS	1	-	-	ns,np	-	lo	root mat
	Al2	5 - 30	g	i	-	10YR3/3	LS	w	sbk	m	ss,sp	-	sh	
	Cl	30 - 80	g	i	-	10YR4/1	SCL	v	sbk	m	ss,sp	-	sh	
	C2	80 - 100				10YR3/3 10YR5/3	CL	v	sbk	m	s, sp	-	sh	
17.	Al	0 - 23	c	w		10YR2/3	CL	v	sbk	m	s, sp	-		gravel 10 - 20% rounded cobble and stone 70%
	C	23 - 80				7.5YR3/3					ns,np	-		
18.	Al	0 - 5	a	s		10YR3/2	S1CL	w	sbk	f-m	-	-	-	
	Cl	5 - 52	a	s		7.5YR3/4, 4/6	SC	w	sbk	m	-	-	-	
	C2	52 - 86	a	s		7.5YR3/4	SC	l	-	-	-	-	-	
19.	Ap	0 - 28	a	w		10YR2/1	C	w	sbk	f	s, p	-	-	
	Cl	28 - 56	a	w		7.5YR3/2	SCL	l	sbk	m	ss,sp	-	-	
	C2	56 - 80				2.5Y2/1	C	m	sbk	m	vs,vp	-	-	cobble ϕ 0.5 - 3.0cm, 30%
20	Ap	0 - 36	c	s		10YR3/3	CL	w	sbk	f	s,sp	fr	s	
	C	36 - 80				10YR3/1	C	-	-	-	vs, p	fr	sh	ϕ 0.2-0.8cm, 10%, mottles of kn and Fe
21.	Ap	0 - 29	a	s		10YR2/1	C	w	sbk	f	s, p	-	-	
	C	29 - 80+				7.5YR4/4	S	l	-	-	ns,np	-	-	
23.	Al	0 - 10	c	s		10YR2/2	CL	l	-	-	ss,sp	fi	h	f.m.d mottles (7.5YR4/6)
	Cl	10 - 29	a	s		2.5Y2/1	CL	l	-	-	s, p	fr	-	vf.m.f mottles (7.5YR4/6)
	C2	29 - 60	a	s		10YR6/3	L	w	sbk	m	s, p	vfr	-	
	C3	60 - 130+				2.5Y3/2	L	l	-	-	vs, p	-	-	
25.	Al	0 - 6	a	s		10YR2/2	S1C	w	sbk	f	ss,sp	-	-	
	Cl	6 - 40	c	s		10YR2/2	C	w	sbk	f	s, p	-	-	gravel (quartz) ϕ 0.2-0.4, 5% m.m.d mottles (10YR5/8)
	C2	40 - 50+				10YR6/2	C	s	abk	m	-	-	-	
26.	Al	0 - 11	c	s		10YR2/1	C	w	sbk	f	s, p	-	-	
	C	11 - 50+				10YR3/2	C	m	abk	m	vs, p	-	-	weekly develop. slickenside 0.3 x 10cm cracks
27.	A	0 - 36	a	s		7.5YR3/2	SL	l	abk	c	ns,np	fr	s-sh	crack 1 x 30cm, slickenside
	C	36 - 100+				10YR4/4	CL	e	-	-	s, p	fi	eh	
29.	Al	0 - 14	c	s		7.5YR3/3	S1L	w	sbk	vf	ss, np	-	vh	ϕ 0.2 - 0.4cm, 5%
	C	14 - 70+				7.5YR2/1	S1GL	m	abk	f	s, sp	-	vh	ϕ 0.3 - 0.5cm, 10%
30.	Al	0 - 10	a	w		10YR3/2	grav. L	l	-	-	ns,np	-	-	ϕ 1.0 - 2.5cm, 80% weathered granite
	C	10 - 70+				10YR5/2	grav. L	l	-	-	-	-	-	ϕ 0.5 - 1.0 cm, 80% weathered granite
31.	Al	0 - 18	a	w		7.5YR2/3	grav. L	l	-	-	-	-	-	
	C	18 - 100+				7.5YR4/3	grav. L	l	-	-	-	-	-	

Table 4.2 (4/6) Generalized Description of Soil Profile

No.	Horizon Symbol	Depth of Horizon	Boundary of Horizon	Form of Boundary	Colour		Textural class		Structure			Consistence		Remarks	
					Wet	dry	class	class	Grade	Type	Size	Wet	Moist		dry
32.	A11	0 - 3	d	s	7.5YR3/4	7.5YR4/3	grav. L	l	sbk	f	ns,np	-	sh	ø0.5 - 2.0cm, 5%	
	A12	3 - 13	c	s	7.5YR3/4	7.5YR4/3	grav. L	w	sbk	f	ns,np	-	h	ø0.3 - 0.5cm, 10%	
	C1	13 - 56	c	w	7.5YR2/3	7.5YR4/3	grav. SL	l	abk	f	ns,np	-	vh	ø0.3 - 0.5cm, 20%	
	C2	56 - 100+	c	s	10YR2/2	10YR3/2	SC	m	abk	f	ns,np	-	vh	ø0.3 - 0.5cm, 20%	
33.	A1	0 - 6	a	s	10YR2/2	10YR3/2	C	m	abk	f	s, p	-	vh	crack 1 x 40cm weekly slickenside	
	C	6 - 100	a	s	10YR1.7/1	10YR1.7/1	C	m	abk	m	s, p	-	eh		
34.	A1	0 - 10	a	s	10YR2/2	10YR2/2	SCL/CL	w	sbk	f	ss,sp	fr	sh	crack common 1 x 50cm	
	C1	10 - 27	c	s	10YR3/1	10YR3/1	C/CL	s	pr	m	s, p	fr	sh		
	C2	27 - 65	c	s	10YR2/1	10YR2/1	C	s	abk	m	s, p	fi	h		
	C3	65 - 100	c	s	10YR2/1	10YR2/1	C	s	abk	m	s, p	fir	h		
35.	A1	0 - 9	c	s	10YR3/3	10YR4/4	S1L	l	sbk	m	ss,np	-	h		
	C	9 - 80+	c	s	10YR2/1	10YR2/1	C	m	sbk	m	s, p	-	h		
37.	Ap	0 - 23	c	s	2.5YR3/4		grav. S1L	l			ss,np	fr		ø0.3 - 0.8cm, 20%	
	B11	23 - 37	c	w	2.5YR3/4		CL	l			ns,np	-		ø0.5 - 1.0cm, 70%(7.5YR5/8) iron	
	B12	37 - 90+	c	s	2.5YR4/6		CL	l			ns,np	-		ø0.5 - 1.0cm, 80%	
38.	A1	0 - 13	a	s	10YR3/2	10YR5/3	S1L	w	sbk	f	ns,np	vfr	sh	root mat 3cm thick	
	C1	13 - 43	c	w	10YR2/2		S1CL	w	abk	f-m	ss,sp	fr	eh		
	C2	43 - 70+	c	s	10YR3/3		SCL	w	abk	f	ss,np	fr	eh		
39.	A1	0 - 10	a	s	7.5YR3/3		SL	w	sbk	f	ns,np	fi	sh	ø0.5 - 1.0cm, 20%	
	B11	10 - 25	c	s	10YR2/3	10YR3/3	SC	s	abk	m	ss,sp	-	eh		
	B12	25 - 37	c	s	10YR2/3	10YR3/3	grav. SC	l	abk	m	ss,sp	-	eh		
	C		37 - 60+	c	s	10YR3/2	10YR5/3	grav. SL	m	abk	m	s,sp	-		eh
				c	s	7.5YR3/3	7.5YR5/3	LS	l			ss,np	vfr		s
40.	C1	21 - 45	c	w	7.5YR4/4	7.5YR5/3	LS	l			ns,np	vfr	s	fine roots, stratified mixed matrix, colour mottling vf.f.d (7.5YR5/8)	
	C2	45 - 69	c	s	7.5YR4/4	7.5YR5/4	LS	l			ns,np	vfr	s		
	C3		69 - 80+	a	s	10YR3/2	10YR4/2	CL	m	abk	f	s, sp	fi		vh
				a	s	7.5YR4/4	7.5YR6/6	grav. LS	l			ns, np	lo		lo
41.	C1	21 - 53	a	s	10YR2/2+	10YR4/3+	C/CL	w	sbk	f	ns,np	fr	sh	vf.f.d (7.5YR5/8)	
	C2	53 - 65+	a	s	10YR2/2	6/4	grav. SL	l			ns,np	fi	h		
42.	Ap	0 - 16	c	s	10YR3/4	10YR5/3	grav. S1L	l			ns,np	-	lo	ø0.5 - 7.0cm, 30%	
	B11	16 - 28	c	f	10YR2/3		grav. SL	l			ns,np	-	lo	ø0.5 - 3.0cm, 10%	
	B12	28 - 35+	c	s	10YR4/3	10YR6/3	grav. L	m	abk	f	ns,np	-	eh		
43.	Ap	0 - 12	a	s	10YR3/3	10YR6/2	grav. S1L	l			ns,np	fr	s	ø0.3 - 0.5cm, 5%	
	B11	12 - 38	c	s	10YR2/2	10YR4/2	grav. C	w	abk	f	ss,sp	fi	h	ø0.5 - 0.8cm, 20%	
	B12	38 - 60+	c	s	10YR3/3	10YR3/3	grav. SC	l			ns,np	fi	sh		

Table 4.2 (5/6) Generalized Description of Soil Profile

No.	Horizon Symbol	Depth of Horizon	Boundary of Horizon	Form of Boundary	Colour		Textural class	Structure		Consistence			Remarks	
					Wet	dry		Grade	Type	Size	Wet	Moist		dry
44.	Al C	0 - 18 18 - 70+	c	s		10YR2/2 10YR1.7/1	CL C	w s	sbk sbk	f f	ss,sp vs,vp	vfi fr	h eh	fine-medium roots cracks common
45.	Al Cl	0 - 28 28 - 80+	a	w		7.5YR4/4 7.5YR4/6	S S+S1	l l			ns,np ns,np	lo -	s -	φ0.5 - 1.0cm, 5%
46.	Al B11 B12	0 - 4 4 - 21 21 - 50+	c a	s s		7.5YR3/4 7.5YR3/3 7.5YR4/3 7.5YR4/4	SC CL L	w s m	sbk sbk sbk	f f f	ss,sp s,sp s,sp	- - -	sh h vh	clay cutan colour mottling - do - C.g.d 7.5YR5/8 f.f.f 7.5YR5/8
47.	Al Cl C2 C3	0 - 5 5 - 13 13 - 31 31 - 50+	a a c	s s		10YR2/3 10YR7/1 10YR2/2 10YR3/3	CL SL C C	w l w w	sbk sbk sbk sbk	vf f f vf	ss,np ns,np s,p ss,sp	vfr vfr fr fr	s s h sh	root mat shining ped surface
48.	Al B1	0 - 26 26 - 60+	g	s		10YR4/3 10YR3/4	Sl - S S1CL	l w	ebk	f	ns,np ss,sp	fr fr	lo s	colour mottling f.m.f 10YR5/8
49.	Al B11 B12	0 - 12 12 - 51 51 - 85	g c	s s		10YR4/1.5 10YR3/2 10YR4/2 10YR3/4	SCL L L	m m m	sbk sbk sbk	f f f	ss,sp s,sp s,p	fr fr fr	h-vh h h	φ0.3 - 0.5cm few purmis
50.	Al1 B11 B12	0 - 9 9 - 32 32 - 60+	c c	s s		10YR4/1 10YR3/2 10YR4/1 10YR3/3	S1L S1C S1CL	l w w	sbk sbk sbk	f f f	ns,np s,p s,sp	fr fr fr	sh sh h	
51.	Al Cl	0 - 14 14 - 70+	g	s		10YR3/1 10YR2/1	CL C	w s	sbk sbk	f m	ss,np s,p	vfr fr	s vh	fine roots 0.5cm x 20cm cracks
52.	Al C	0 - 7 7 - 60+	a	s		10YR3/3 10YR3/1	S1CL S1C	w m	sbk sbk	vf f	ss,np s,sp	fr fi	sh h	
55.	Ap Cl C2	0 - 18 18 - 32 32 - 60+	a a	s s		7.5YR3/4 7.5YR4/3 7.5YR3/3	S S S	l l l	- - -	- - -	ns,np ns,np ns,np	lo lo lo	lo lo lo	φ0.3 - 0.5cm, 30% φ0.3 - 0.5cm, 50% φ0.3 - 0.5cm, 70%
56.	Al B11ca B12ca Cca	0 - 11 11 - 21 21 - 40 40 - 60+	c c a	s s s		10YR4/1 10YR3/2 10YR4/2 10YR3/3 10YR2/2	CL C C C	w m m s	sbk sbk sbk sbk	vf f f f	ns,np ss,sp ss,sp s,p	fi fr fr vfi	h sh sh h	
57.	Ap Cl	0 - 18 18 - 60+	a	s		10YR3/2 10YR3/3	grav. S1L S1C	w m	sbk abk	f f	ss,np s,sp	vfr vfi	s h	
58.	Al	0 - 8				7.5YR4/6	grav. S1L	l	-	-	ns,np	lo	lo	φ0.3 - 1.0cm, 60%

Table 4.2 (6/6) Generalized Description of Soil Profile

No.	Horizon Symbol	Depth of Horizon	Boundary of Horizon	Form of Boundary	Colour		Textural class	Structure		Consistence		Remarks	
					Wet	dry		Grade	Type	Size	Wet		Moist
59.	Ap	0 - 5	a	s	7.5YR4/6	7.5YR5/4	SL	v w	sbk	vf	ns,np	lo	ø0.3 - 0.5cm, 5%
	B11	5 - 18	a	s	7.5YR4/6	7.5YR5/4	grav. CL	m	sbk	f	ss,sp	eh	ø0.3 - 0.5cm, 20%
	B12	18 - 60+					grav. C	s	sbk	f	s, np	eh	ø0.3 - 0.5cm, 40%
60.	Ap	0 - 6	c	s	10YR2/3	10YR4/3	grav. SL	wv	sbk	vf	ns,np	lo	ø0.3 - 0.5cm, 10%
	B11	6 - 34	e	s	10YR2/2	10YR4/2	grav. SL	m	abk	f	ns,np	h	ø0.3 - 0.5cm, 30 - 50%
	B12	34 - 60+			7.5YR3/3		grav. S	l	-	-	ns,np	vh	ø0.3 - 1.0cm, 70 - 80%
63.	A11	0 - 30	a	s	7.5YR4/3	7.5YR6/3	grav. SL	l	-	-	ns,np	h	
	A12	30 - 50	e	s	7.5YR4/3	7.5YR6/2	SL	l	-	-	ns,np	h	
	Cl	50 - 120+			10YR3/1	10YR4/1	SL	m	abk	f	ss,sp	vh	
64.	A11	0 - 26	a	w	10YR3/3	10YR4/3	grav. SL	l	-	-	ns,np	vh	ø0.2 - 0.4cm, 10%
	A12	26 - 43	a	w	10YR3/3	10YR4/3	grav. SL	l	-	-	ns,np	lo	ø1 - 8cm, 60%
65.	A1	0 - 49	a	s	10YR2/2	10YR4/3	grav. SL	w	sbk	f	ns,np	vh	ø1 - 5cm, 5%
	Cl	49 - 80+			10YR2/2	10YR3/3	grav. SCL	m	abk	m	s, sp	eh	
66.	Ap	0 - 16	a	s	10YR2/1	-	HC	w	sbk	f	vs,yp	vh	colour mottling c.f.d 7.5YR5/8
	Cl	16 - 51	c	s	10YR2/1	-	HC	s	bk	c	vs,yp	-	
	C2	51 - 70+			10YR2/1	-	HC				vs,yp	-	
67.	Ap	0 - 30	a	s	10YR2/2	10YR3/2	SL	w	sbk	vf	ns,np	-	ø0.3 - 0.5cm, few
	B11	30 - 90	c	s	10YR2/1	-	SL	l	-	-	ns,np	fr	
	B12	90 - 120+			7.5YR2/2	-	grav. SL	l	-	-	ns,np	fr	ø0.3 - 0.5cm, 10%
70.	Ap	0 - 15	a	s	10YR2/3	10YR5/2	SCL	w	sbk	-	ss,sp	lo	colour mottling f.f.f 2.5YR4/8
	B11	15 - 51	c	s	10YR2/1	-	SCL	l	-	-	ss,sp	h	- do - c.m.f 7.5YR5/8
	B12	51 - 70+			10YR4/2	-	SCL	l	-	-	ss,np	vh	- do - c.m.d 7.5YR5/8

Table 4.3 Physical and Chemical Properties of Soils (1/3)

Phys. Sample Unit	Depth	Sand	Silt	Clay	Texture Class	pH	EC (1:2.5)	C	N	Olsen-P	CEC	Exchangeable Cations				Base Saturation	ESP	CaCO3	
												Ca	Mg	Na	K				Total
		mmho/cm		%		%		%		me/100g soil		%							
		%		%		%		%		%		%							
P11	0-12	50	16	34	SCL	7.3	6.1	0.06	0.58	0.11	3	26.10	14.80	2.94	0.72	1.84	20.30	78	+
	12-40	40	18	42	C	7.3	5.9	0.08	0.64	0.11	3	29.30	18.00	4.69	0.78	1.80	25.27	86	+
	40-80	40	20	40	C/CL	8.4	5.3	0.11	2.16	0.22	4	31.50	22.60	5.90	2.20	1.68	32.38	103	+++
P31	0-22	20	18	62	C	6.2	5.3	0.22	2.16	0.22	13	32.50	22.80	6.76	1.17	2.04	32.77	101	+
	22-100	24	20	56	C	7.4	6	0.25	0.61	0.06	4	24.50	18.00	5.92	1.10	1.42	26.44	108	+
P31	0-6	20	26	46	C	6.9	5.5	0.12	1.23	0.11	11	19.50	9.60	3.54	1.10	1.42	15.66	80	+
	6-100	24	18	58	C	7.2	6.2	0.30	1.23	0.09	3	24.50	16.00	5.14	2.90	1.44	25.48	104	+
P31	0-10	48	20	32	SCL/CL	6.8	5.5	0.12	2.40	0.27	13	22.70	11.40	4.64	0.78	1.80	18.62	82	-
	10-27	42	18	40	C/CL	6.4	5.1	0.17	1.00	0.12	5	23.50	9.60	3.94	0.86	1.26	15.66	67	5
	27-65	44	14	42	C	6.5	5.1	0.10	0.97	0.10	4	26.10	12.60	5.62	0.88	0.96	20.06	77	4
P31	65-100	42	16	42	C	7.1	5.3	0.14	1.00	0.12	6	24.50	12.60	3.86	1.68	0.74	18.88	77	9
	0-21	88	4	8	LS	6.8	5.8	0.04	0.17	0.05	2	3.90	1.60	0.14	0.48	0.24	2.46	63	20
P31	21-43	88	4	8	LS	6.8	5.8	0.06	0.26	0.05	2	4.30	2.40	0.18	0.60	0.28	3.46	80	17
	45-69	82	14	4	LS	7.2	5.8	0.02	0.17	0.03	2	1.30	0.90	0.10	0.48	0.12	1.60	123	30
	69-80	36	32	32	CL	7	5.3	0.04	0.74	0.09	2	17.70	8.40	1.62	0.84	0.16	11.02	62	8
P31	0-14	20	40	40	CL	6.1	4.6	0.12	2.53	0.27	8	23.30	8.00	1.35	0.74	0.89	10.98	47	7
	14-70	20	32	48	C	6.4	6.1	0.05	2.62	0.25	14	27.60	9.40	2.66	0.65	0.98	13.69	50	5
P31	0-30	58	18	18	SL	7.2	6	0.09	0.26	0.06	3	11.10	6.00	0.78	0.64	0.39	7.81	70	8
	30-56	76	18	12	SL	7.2	6	0.13	0.10	0.07	4	8.90	7.00	0.50	0.52	0.51	8.51	96	+
	56-120	46	14	40	SC	8.3	6.3	0.13	0.60	0.07	3	26.30	17.00	2.18	3.74	0.75	23.67	90	++
P32	0-36	76	8	16	SL	7.2	5.8	0.04	0.50	0.04	3	8.50	5.60	0.62	0.56	0.24	7.00	82	8
	36-100	42	20	38	CL	7.8	5.8	0.10	0.41	0.05	2	28.10	12.80	2.34	1.98	1.08	18.20	70	11
P33	0-13	78	12	10	SL	7.6	6	0.06	1.20	0.19	4	6.70	3.00	0.46	1.25	0.84	6.52	68	27
	13-43	32	20	28	SCL	10	8.2	2.23	0.40	0.09	3	13.90	9.90	0.30	3.63	2.01	18.06	130	32
	43-70	54	20	26	SCL	10.4	8.9	2.25	1.26	0.03	6	16.10	12.00	0.18	6.00	1.84	19.82	123	30
D11	0-12	50	26	24	SCL	10.1	8.2	0.65	0.29	0.05	4	19.50	9.80	0.36	7.43	3.64	21.23	109	35
	12-51	32	42	20	L	10	8.2	0.65	0.29	0.05	4	17.50	6.60	0.25	9.45	3.42	19.72	113	48
	51-85	46	30	24	L	9.8	7.8	0.55	0.13	0.06	4	22.50	16.70	0.20	9.45	3.60	23.95	106	39
D11	0-18	66	20	14	SL	8.3	6.8	1.10	0.70	0.09	6	9.30	10.00	0.11	1.98	2.84	14.93	161	13
	18-60	30	42	28	SL	8.3	7.6	0.50	0.17	0.05	4	21.50	11.60	0.18	5.34	6.39	23.51	109	23
D12	0-5	30	34	36	CL	6.4	4.8	0.24	5.59	0.56	5	32.50	4.60	0.56	1.24	2.84	9.24	28	13
	5-13	24	60	16	SL	8.8	6.4	0.18	0.26	0.09	2	14.50	1.60	0.34	2.14	1.74	5.82	40	37
	13-31	22	38	40	C	9.6	7.9	1.25	0.32	0.07	2	22.50	6.00	0.52	7.45	6.35	20.32	90	37
D12	31-50	22	38	40	C	10.1	7.8	0.80	0.20	0.07	3	19.50	7.00	0.37	8.28	6.82	22.47	115	37

Table 4.3 Physical and Chemical Properties of Soils(2/3)

Phys. Sample Unit	Sample No.	Depth cm	Particle Size Texture Class		pH	EC (1:2.5)	C	N Olsen-P	CEC	Exchangeable Cations				Base Saturation						
			Sand	Silt Clay						Ca	Mg	Na	K	Total	ESP	CaCO3				
			mmho/cm		%		ppm		me/100g soil				%							
D12	56	0-11	32	32	36	CL	8.4	6.5	0.60	1.69	0.15	5 19.70	10.30	0.15	5.84	1.80	18.09	92	32	++
		11-21	30	26	44	C	9.6	8	1.10	0.26	0.08	4 24.50	14.90	0.20	7.43	5.64	28.17	115	26	+++
		21-40	26	20	54	C	9.7	8.1	1.50	0.15	0.03	5 26.50	11.90	0.18	10.55	6.04	28.67	108	37	+++
		40-60	32	24	44	C	9.5	6.3	0.16	0.05	0.01	2 20.20	9.50	0.22	11.85	4.64	26.21	130	45	+++
D2	46	0-4	16	44	42	SC	4.8	3.8	0.15	2.74	0.28	6 32.50	3.20	0.76	0.59	0.84	5.39	17	11	+
		4-21	24	40	36	CL	5.1	3.4	0.06	1.08	1.18	5 23.30	4.00	0.90	0.64	0.28	5.82	25	11	+
		21-50	38	38	24	L	6.8	4.6	0.05	1.22	0.07	3 18.20	5.20	0.76	0.56	0.04	6.56	36	9	+
D2	55	0-18	92	4	4	S	6.7	5.4	0.04	0.52	0.09	7 1.80	0.60	0.10	0.25	0.28	1.23	68	20	-
		18-32	90	4	6	S	6.5	4.9	0.02	0.35	0.08	6 2.90	1.00	0.12	0.18	0.20	1.50	52	12	-
		32-60	90	4	6	S	6.5	4.8	0.02	0.37	0.06	4 2.90	1.00	0.11	0.24	0.04	1.39	48	17	-
F12	1	0-13	26	32	42	CL	7.2	5.3	0.18	0.50	0.11	10 23.30	12.00	2.02	1.88	1.85	17.75	76	11	-
		13-90	18	28	54	C	8	6.5	0.27	0.73	0.06	6 24.50	18.00	3.14	4.42	1.60	27.16	111	16	+
F12	7	0-4	38	16	46	C	6.8	5.6	0.12	0.79	0.09	7 21.50	16.50	5.84	1.36	1.64	25.34	118	5	-
		4-54	22	16	62	C	7.8	6.2	0.16	1.22	0.10	2 25.50	20.00	6.94	3.66	1.44	32.04	126	11	++
		54-150	24	16	60	C	8.3	6.8	0.30	0.41	0.03	5 29.30	18.00	3.90	3.60	1.45	26.95	92	13	+++
F22	6	0-22	32	16	52	C	7.3	5.8	0.27	1.40	0.13	5 21.50	15.00	4.14	1.88	1.80	22.82	106	8	-
		22-65	22	14	64	C	8.1	6.2	0.35	1.40	0.12	4 22.50	17.00	4.54	3.52	1.64	26.70	119	13	+
		65-100	20	16	64	C	6.7	6.8	0.23	0.43	0.06	3 24.50	22.10	5.82	4.02	1.80	33.74	138	12	++
K21	19	0-28	18	36	46	C	6.8	5.2	0.10	1.25	0.10	12 24.50	15.00	4.98	0.86	1.60	22.44	92	4	+
		28-56	68	8	24	SCL	7.4	5.7	0.10	0.50	0.05	4 9.90	6.00	1.56	0.78	0.44	8.78	89	9	+
		56-80	18	22	60	C	7.8	5.7	0.09	0.93	0.08	5 25.50	17.60	2.75	1.14	1.25	22.74	89	5	+
K3/K21	20	0-36	40	24	36	CL	8.1	6.5	0.09	0.58	0.06	5 22.10	16.80	2.22	1.64	1.42	22.08	100	7	+
		36-80	44	16	40	C	6.7	6.1	0.12	0.38	0.05	4 25.00	18.30	3.14	1.10	1.04	23.58	94	5	+
K21	21	0-29	44	18	38	CL	8	6.5	0.17	0.85	0.09	5 26.10	16.50	1.74	2.66	1.20	22.10	85	12	++
		29-80	74	6	20SCL/SL	8.2	6.8	0.15	0.26	0.05	4 11.50	10.40	1.02	2.04	0.80	14.26	124	14	++	
K21	26	0-11	18	32	50	C	6.2	5	0.16	1.41	0.15	3 19.50	9.20	3.62	1.04	1.85	15.71	81	7	-
		11-50	20	28	52	C	7.1	5.2	0.09	1.08	0.14	2 21.50	11.80	5.02	1.36	1.60	19.78	92	7	-
K22	2	0-18	14	24	62	C	6.4	4.1	0.05	0.58	0.07	7 19.50	10.00	2.02	1.28	1.84	15.14	78	8	-
		18-110	14	40	46	C	6.9	5.2	0.10	0.96	0.13	7 26.70	11.60	2.90	1.16	1.32	16.98	64	7	+
K22	3	0-13	28	16	56	C	7	5.6	0.20	0.70	0.06	3 25.50	20.00	5.92	2.12	1.84	29.88	117	7	+
		13-50	24	12	64	C	7.5	5.9	0.35	0.82	0.08	2 24.50	18.00	5.62	3.52	1.60	28.74	117	12	-
K22	23	0-10	32	36	32	CL	6.6	5.3	0.10	0.96	0.11	14 24.50	10.80	2.94	0.73	1.84	16.31	67	4	+
		10-29	30	36	34	CL	7.3	5.6	0.10	0.32	0.07	7 24.50	11.00	3.02	1.04	1.26	16.32	67	6	+
		29-60	34	42	24	L	8.2	6.3	0.12	0.19	0.04	4 15.50	9.40	1.74	1.20	1.12	13.46	87	9	++
S1	41	0-21	82	14	4	LS	8.3	5.9	0.05	0.04	0.03	3 1.70	0.70	0.38	0.64	0.20	1.92	113	33	-
		21-53	36	38	26	C/CL	7.2	5.6	0.07	0.43	0.07	4 14.10	8.00	1.92	0.94	0.98	11.84	84	8	-
		53-65	76	8	16	SL	7	5.5	0.05	0.43	0.06	4 6.90	3.60	0.50	0.60	0.16	4.86	70	12	-

Table 4.3 Physical and Chemical Properties of Soils (3/3)

Phys. Sample Unit No.	Depth cm	Particle Size		Texture Class	pH	EC (1:2.5)	C	N Olsen-P	CEC	Exchangeable Cations			Base Saturation	ESP	CaCO ₃					
		Sand	Silt							Clay	Ca	Mg				Na	K	Total		
		%		mmho/cm		%		ppm		me/100g soil			%							
ARPS 66	0-16	12	16	72	C	6.6	5	0.16	1.43	0.18	22	28.50	13.00	7.70	0.95	1.85	23.50	82	4	+
	16-51	14	10	76	C	6.4	5.2	0.23	1.00	0.12	22	29.50	14.60	7.71	2.15	1.64	26.10	88	8	+
	51-70	16	14	70	C	6.4	5	0.21	0.73	0.08	26	24.50	12.80	12.80	1.35	7.52	34.47	141	4	+
SB 67	0-30	60	22	18	SL	6.6	5.1	0.06	1.31	0.12	10	9.10	3.40	1.38	0.47	0.92	6.17	68	8	-
	30-90	76	12	12	SL	6.4	5.1	0.03	1.31	0.06	10	6.90	2.60	0.82	0.48	0.24	4.14	60	12	-
	90-120	68	20	12	SL	6.7	5.2	0.04	0.44	0.05	8	5.50	1.60	0.53	0.48	0.20	2.81	51	17	+
SB 68	0-30	54	14	32	SCL	6.1	4.7	0.04	0.61	0.10	5	11.10	2.40	0.80	0.78	0.76	4.74	43	16	-
SB 69	0-30	50	12	38	SC	5.6	4.7	0.04	0.70	0.10	4	10.30	3.20	0.76	0.49	0.54	4.99	48	10	+
SB 70	0-15	54	22	24	SCL	5.4	4.9	0.40	1.92	0.20	18	16.50	5.00	2.30	0.62	1.60	9.52	58	7	-
	15-51	56	14	30	SCL	5.5	4.6	0.12	1.02	0.10	11	13.90	4.40	1.38	0.43	0.74	6.95	50	6	+
	51-70	64	16	20	SCL	6.4	5	0.04	0.61	0.07	4	9.50	3.00	0.10	0.37	0.14	3.61	38	10	+

Remarks: ARPS-Ahero Rice Pilot Scheme
SB-Sugarcane Belt

Table 4.4 Profile Description of Eutric Fluvisols

1. Profile No. ; No. 20
2. Observation Date ; July 10, 1985
3. Location ; Urudi, river drift of Asawo
4. Soil Name ; Eutric Fluvisols
5. Mapping Unit ; active stream banks formed on lacustrine plain (K3/K21)
6. Parent Material ; recent fluvial deposits
7. Topography meso ; flat (0%)
micro ; irregular
8. Vegetation Land Use ; sorghum, well-cultivated
9. Drainage Condition
internal ; well
external ; well
10. Flooding ; free
11. Profile Description ;

Ap 0-36 cm. Dark brown (10YR3/3, wet), dull yellowish brown (10YR4/3, dry); clay loam; weakly developed subangular blocky; sticky and slightly plastic wet, friable moist, soft dry; fine roots of sorghum common; clear smooth boundary.

C 36-80cm. Black (10YR3/1, wet and dry); clay; structureless massive; very sticky and plastic wet, friable moist, slightly hard dry; colour mottlings of Mn and Fe, few.

12. Physical and Chemical Properties

Horizon	Particle Size (%)			Texture Class	pH		EC2.5 (mmho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations (me/100g)					Base Saturation (%)	ESP (%)	CaCO ₃
	Sand	Silt	Clay		H ₂ O	KCl						Ca	Mg	Na	K	Total			
Ap	40	24	36	CL	8.1	6.5	0.09	0.58	0.06	5	22.10	16.80	2.22	1.64	1.42	22.08	100	7	+
C	44	16	40	C	6.7	6.1	0.12	0.38	0.05	4	25.00	18.30	3.14	1.10	1.04	23.58	94	5	+

Table 4.5 Profile Description of Calcaric Fluvisols

1. Profile No. ; No. 56
2. Observation Date ; July 30, 1985
3. Location ; Osodo
4. Soil Name ; Calcaric Fluvisols, sodic phase
5. Mapping Unit ; recent flood plain widely extending on cusplate delta formed in the river mouth of Sondu (D12)
6. Parent Material ; recent fluvial deposits derived from Sondu river
7. Topography meso ; flat (0%)
micro ; smooth
8. Vegetation Land Use ; grass land used for animal grazing
9. Drainage Condition
internal ; poorly
external ; poorly
10. Flooding ; suffering from frequent flooding in rainy seasons
11. Profile Description ;

A1 0-11 cm. Brownish grey (10YR4/1, wet), light grey (10YR 7/1, dry); clay loam; weakly developed subangular blocky; very fine; non sticky and non plastic wet, firm moist, hard dry; fine roots of grasses common; clear smooth boundary.

B11ca

11-21 cm. Brownish black (10YR3/2, wet), brownish grey (10YR4/2, dry); clay; moderately developed subangular blocky fine; slightly sticky and slightly plastic wet, friable moist, slightly hard dry; fine roots of grasses few; clear smooth boundary.

B12ca

21-40 cm. Dark brown (10YR3/3, wet); clay; moderately developed subangular blocky, fine, slightly sticky and slightly plastic wet, very firm moist, slightly hard dry; fine purmis few; abrupt smooth boundary.

Cca

40-60 cm. Brownish black (10YR2/2, wet); clay; strongly developed angular blocky fine; sticky and plastic wet, very firm moist, hard dry; shine ped surface.

12. Physical and Chemical Properties

Horizon	Particle Size (%)			Texture Class	pH		EC2.5 (mmho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations (me/100g)				Base Saturation (%)	ESP (%)	CaCO ₃	
	Sand	Silt	Clay		H ₂ O	KCl						Ca	Mg	Na	K				Total
A	32	32	36	Cl	8.4	6.5	0.60	1.69	0.15	5	19.70	10.30	0.15	5.84	1.80	18.09	92	32	++
B11ca	30	26	44	C	9.6	8.0	1.10	0.26	0.08	4	24.50	14.90	0.20	7.43	5.64	28.17	115	26	+++
B12ca	26	20	54	C	9.7	8.1	1.50	0.15	0.03	5	26.50	11.90	0.18	10.55	6.04	28.67	108	37	+++
Cca	32	24	44	C	9.5	6.3	0.16	0.05	0.01	2	20.20	9.50	0.22	11.85	4.64	26.61	130	45	+++

Table 4.6 Profile Description of Eutric Gleysols

1. Profile No. ; No. 23
2. Observation Date ; July 11, 1985
3. Location ; Wasare
4. Soil Name ; Eutric Gleysols
5. Mapping Unit ; lowlying terrain of Kano plain,
receiving drainage (K22)
6. Parent Material ; fluviium of Nyando
7. Topography meso ; gently slopping (2-4%)
micro ; smooth
8. Vegetation Land Use ; grass
9. Drainage Condition
internal ; poorly
external ; poorly
10. Flooding ; inundated during June - July
11. Profile Description

- A1 0-10 cm. Brownish black (10YR2/2, wet); clay loam; structureless massive; slightly sticky and slightly plastic wet, firm moist, hard dry; few, medium, distinct colour mottling, brown (7.5YR 4/6); fine roots many, clear, smooth boundary.
- C1 10-29 cm. Black (2.5Y2/1, wet); clay loam; structureless massive; sticky and plastic wet, friable moist; very few, medium fine colour mottling, brown (25YR4/6); abrupt smooth boundary.
- C2 29-60 cm. Dull yellowish brown (10YR4/3, wet); loam; weakly developed subangular blocky, medium; sticky and plastic wet, very friable moist; abrupt smooth boundary.
- C3 60-130 cm+. Brownish black (10YR4/3, wet); loam; structureless massive; very sticky and plastic wet.

12. Physical and Chemical Properties

Horizon	Particle Size(%)			Texture Class	pH		EC2.5 (mmho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations(me/100g)					Base Saturation (%)	ESP (%)	CaCO3 (%)
	Sand	Silt	Clay		H2O	KCl						Ca	Mg	Na	K	Total			
A1	32	36	32	CL	6.6	5.3	0.10	0.96	0.11	14	24.50	10.80	2.94	0.73	1.84	16.31	67	4	+
C1	30	36	34	CL	7.3	5.6	0.10	0.32	0.07	7	24.50	11.00	3.02	1.04	1.26	16.32	67	6	+
C2	34	42	34	L	8.2	6.3	0.12	0.19	0.04	4	15.50	9.40	1.74	1.20	1.12	13.46	87	9	++

Table 4.7 Profile Description of Eutric Regosols

1. Profile No. ; No. 32
2. Observation Date ; July 13, 1985
3. Location ; Kandaria
4. Soil Name ; Eutric Regosols
5. Mapping Unit ; almost flat to undulating terrain on alluvial toeslopes of piedmont plain (P31)
6. Parent Material ; colluvial deposits derived from granodiorite
7. Topography meso ; slightly undulating (2-5%)
micro ; irregular
8. Vegetation Land Use ; grassland and partly used for maize
9. Drainage Condition
internal ; excessively well
external ; well
10. Flooding ; free
11. Profile Description ;

- | | |
|-----|---|
| All | 0-3 cm. Dark brown (7.5YR3/4, wet), brown (7.5YR4/3, dry); gravelly loam; structureless single grain; non-sticky and non-plastic wet, loose moist, loose dry; ϕ 0.5 to 2.0 cm of cobble 5%; few roots; diffuse smooth boundary. |
| A12 | 3-13 cm. Dark brown (7.5YR3/4, wet), brown (7.5YR4/3, dry); gravelly loam; weakly developed subangular blocky, fine; non-sticky and non-plastic wet, loose moist, loose dry; ϕ 0.3 to 0.5 cm of cobble 10%; clear smooth boundary. |
| C1 | 13-56 cm. Very dark brown (7.5YR2/3, wet), brown (7.5YR4/3, dry); gravelly sandy loam; structureless single grain; non-sticky and non-plastic wet, loose moist, loose dry; ϕ 0.3 to 0.5 cm of cobble 20%; clear wavy boundary. |
| C2 | 56-100 cm+. Brownish black (10YR2/2, wet), brownish black (10YR3/2, dry); sandy clay; moderately developed angular blocky fine; slightly sticky and non-plastic wet, friable moist, slightly hard dry; much quartz. |

Table 4.8 Profile Description of Eutric Regosols

1. Profile No. ; No. 27
2. Observation Date ; July 13, 1985
3. Location ; Padonditi, Omondo river bank
4. Soil Name ; Eutric Regosols
5. Mapping Unit ; alluvial toeslopes of piedmont plain,
stream bank (P32)
6. Parent Material ; colluvium overlying old lacustrine deposits
7. Topography meso ; flat (0%)
micro ; irregular
8. Vegetation Land Use ; grass land, partly cultivated with maize
9. Drainage Condition
internal ; well
external ; well
10. Flooding ; free
11. Profile Description ;

A1 0-36 cm. Brownish black (7.5YR3/2, wet), brownish black (10YR3/1, dry); sandy loam; structureless massive; non-sticky and non-plastic wet, friable moist; soft to slightly hard; stratified with thin layers; abrupt smooth boundary.

C 36-100+cm. Brown (10YR4/4, wet), brownish grey (10YR5/1, dry); clay loam; strongly developed angular blocky, coarse; sticky and plastic wet, firm moist, extremely hard dry; vertical cracks 1 cm wide x 30 cm deep; slickensides

12. Physical and Chemical Properties

Horizon	Particle Size(%)			Texture Class	pH		EC2.5 (mmho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations(me/100g)					Base Saturation (%)	ESP (%)	CaCO ₃
	Sand	Silt	Clay		H ₂ O	KCl						Ca	Mg	Na	K	Total			
A1	76	8	16	SL	7.2	5.9	0.04	0.50	0.04	3	8.50	5.60	0.62	0.54	0.24	7.00	82	8	-
C	42	20	38	CL	7.8	5.8	0.10	0.41	0.05	2	26.10	12.80	2.34	1.98	1.08	18.20	70	11	-

Table 4.9 Profile Description of Lithosols

1. Profile No.	;	No. 30
2. Observation Date	;	July 13, 1985
3. Location	;	Bungmeri, Ndorimarket
4. Soil Name	;	Lithosols
5. Mapping Unit	;	foot of scarp (H22)
6. Parent Material	;	granodiorite
7. Topography	meso ;	rolling (5-10%)
	micro ;	irregular
8. Vegetation Land Use	;	bush
9. Drainage Condition		
	internal ;	impeded
	external ;	excessively well
10. Flooding	;	free
11. Profile Description	;	
	A1	0-10 cm. Brownish black (10YR3/2, wet), grayish yellow brown (10YR5/2, dry); gravelly loam; structureless single grain; non-sticky and non-plastic wet, loose moist, loose dry.

Table 4.10 Profile Description of Ferralic Arenosols

1. Profile No. ; No. 40
2. Observation Date ; July 17, 1985
3. Location ; Bugo Mbugra river bank
4. Soil Name ; Ferralic Arenosols
5. Mapping Unit ; Colluvial footslopes of piedmont plain
convex slopes (P11)
6. Parent Material ; colluvial and alluvial deposits derived from
granodiorite
7. Topography meso ; slightly undulating (0-2%)
micro ; smooth
8. Vegetation Land Use ; eroded land, partly cultivated with maize & sorghum
9. Drainage Condition
internal ; well
external ; well
10. Flooding ; free
11. Profile Description ;
 - A1 0-21 cm. Dark brown (7.5YR3/3, wet), dull brown (7.5YR5/3, dry);
Loamy sand, gravel ϕ 0.5-12 cm 5%; structureless single grain;
slightly sticky and non-plastic wet, very friable moist; soft
dry; clear smooth boundary.
 - C1 21-45 cm. Brown (7.5YR4/4, wet), dull brown (7.5YR5/3, dry);
Loamy sand; structureless single grain; non-sticky and non-
plastic wet, very friable moist, soft dry; clear wavy boundary.
 - C2 45-69 cm. Brown (7.5YR4/4, wet), dull brown (7.5YR5/4 dry);
Loamy sand; structureless single grain; non-sticky and non-
plastic wet, very friable moist, loose dry; abrupt smooth
boundary.
 - C3 69-85 cm. Brownish black (10YR3/2, wet), grayish yellow brown
(10YR4/2, dry); clay loam; moderately developed angular blocky;
sticky and slightly plastic wet, firm moist, very hard dry.

12. Physical and Chemical Properties

Horizon	Particle Size(%)			Texture Class	pH		EC2.5 (mmho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations(me/100g)					Base Satu- ration (%)	ESP (%)	CaCO ₃
	Sand	Silt	Clay		H ₂ O	KCl						Ca	Mg	Na	K	Total			
A1	88	4	8	LS	6.8	5.8	0.04	0.17	0.05	2	3.90	1.60	0.14	0.42	0.24	2.46	63	20	-
C1	88	4	8	LS	6.8	6.0	0.06	0.26	0.05	2	4.30	2.40	0.18	0.60	0.28	3.46	80	17	-
C2	82	14	4	LS	7.2	5.8	0.02	0.17	0.03	2	1.30	0.90	0.10	0.48	0.12	1.60	123	30	-
C3	36	32	32	CL	7.0	5.3	0.04	0.74	0.09	2	17.70	8.40	1.62	0.84	0.16	11.02	62	8	+

Table 4.11 Profile Description of Pellic Vertisols

1. Profile No. ; No. 7
2. Observation Date ; July 5, 1985
3. Location ; Kanyamlori
4. Soil Name ; Pellic Vertisols
5. Mapping Unit ; lower alluvial fan base (F12)
6. Parent Material ; colluvium sealing lacstrine deposits
7. Topography meso ; flat (0%)
micro ; smooth
8. Vegetation Land Use ; grass/maize
9. Drainage Condition
internal ; moderately well
external ; moderately well
10. Flooding ; free
11. Profile Description ;
 - A1 0-4 cm. Black (10YR2/1.5, wet), dark brown (10YR3/3, dry); gravelly clay; weakly developed subangular blocky slightly sticky and non-plastic wet, slightly hard dry; gradual, smooth boundary.
 - C1 4-54 cm. Black (10YR2/3, wet and dry); clay; strongly developed angular blocky fine; sticky and plastic wet, extremely hard dry; may vertical cracks of 0.5-1.0 cm wide x 50-60 cm deep; weak slickenside; gradual smooth boundary.
 - C2 54-150 cm. Brownish black (10YR3/2, wet); clay, tuff gravel ϕ 0.5-0.8 cm 5%; weakly developed angular blocky fine; slightly sticky and slightly plastic wet, very hard dry.

12. Physical and Chemical Properties

Horizon	Particle Size(%)			Texture Class	pH		EC2.5 (umho/cm)	C (%)	N (%)	P (ppm)	CEC (me/100g)	Exchangeable Cations(me/100g)					Base Saturation (%)	ESP (%)	CaCO ₃ (%)
	Sand	Silt	Clay		H ₂ O	KCl						Ca	Mg	Na	K	Total			
A1	38	16	46	C	6.8	5.6	0.12	0.79	0.09	7	21.50	16.50	5.84	1.36	1.64	25.34	118	5	-
C1	22	16	62	C	7.8	6.2	0.16	1.22	0.10	2	25.50	20.00	6.94	3.66	1.44	32.04	126	11	++
C2	24	16	60	C	8.3	6.8	0.30	0.41	0.03	5	29.30	18.00	3.90	3.60	1.45	26.95	92	13	+++

Table 4.12 Profile Description of Ironstone Soils

1. Profile No.	;	No. 37
2. Observation Date	;	July 16, 1985
3. Location	;	Bodi
4. Soil Name	;	Ironstone Soils
5. Mapping Unit	;	plateau (H11)
6. Parent Material	;	phonolite
7. Topography	meso ;	slightly underlating (0-2%)
	micro ;	irregular
8. Vegetation Land Use	;	maize fields
9. Drainage Condition		
	internal ;	impeded
	external ;	well
10. Flooding	;	free
11. Profile Description	;	
Ap		0-23 cm. Dark reddish brown (2.5YR3/4, wet); gravelly silty loam; large particles ϕ 0.3-0.8 cm 20%; structureless single grain; slightly sticky and non-plastic wet; friable moist; clear smooth boundary.
B11		23-37 cm. Dark reddish brown (2.5YR3/4, wet); clay loam; iron nodule ϕ 0.5-1.0 cm 70%; structureless single grain; non-sticky and non-plastic wet clear wavy boundary.
B12		37-90+cm. Reddish brown (2.5YR4/6, wet); clay loam; iron nodule ϕ 0.5-1.0 cm 80%; structureless single grain, non-sticky and non-plastic wet.

Table 5.1 Land Suitability Criteria for Rice
(mainly wetland rice production)

Land Class	S1	S2	S3	NS1 and NS2
Land characteristics				
Texture(s)	<p>Topsoil: Fine sandy loam to clay</p> <p>Subsoil: Clay but non-compacted</p>	<p>Topsoil: Fine sandy loam to clay loam</p> <p>Subsoil: Sandy clay to clay but non-compacted</p>	<p>Topsoil: Sandy loam to clay loam</p> <p>Subsoil: Clay to clay loam but non-compacted</p>	<p>NS1: Includes lands which require additional investigations to determine their irrigability.</p> <p>NS2: Includes lands which do not meet the minimum requirements for the other land classes.</p>
Depth(after land development) To clear sand or gravel. To pisoplinthite in permeable rock. To relatively impermeable zone (water)	<p>Over 80 cm</p> <p>less than 210 cm</p>	<p>Over 50 cm</p> <p>Over 50 cm</p>	<p>Over 30 cm</p> <p>Over 30 cm</p>	
Alkalinity (reaction)	pH-H ₂ O less than 7.5 for non-calcareous soils and less than 8.6 for calcareous soils	pH-H ₂ O less than 9.0 unless soil is calcareous and non-sodic	pH-H ₂ O less than 9.0 unless soil is calcareous and non-sodic	
Salinity(ECe)	Total salts not to exceed 0.2%, ECe less than 4mmhos/cm	Total salts not to exceed 0.5%, ECe less than 8mmhos/cm	Total salts not to exceed 0.5%, ECe less than 8mmhos/cm	
Slope (t)	less than 1%	less than 1%	less than 2%	
Surface (micro relief, t)	Smooth except for gilgai and minor undulations	Smooth except for gilgai and minor undulations (sink holes)	Somewhat irregular but no major gulleys, sink holes or dissection	
Vegetation(T)	Woody cover less than 20%. Clearing cost small.	Woody cover less than 40%. Clearing required but at moderate cost.	Woody cover less than 80%. Expensive clearing required.	
Drainage(d)	Well drained to imperfectly drained may have surface water but only for short period	Well drained to poorly drained, may have surface water for several months	Well drained to poorly drained, may have surface water or be waterlogged for major parts of the year	

Table 5.2 Land Suitability Criteria for Upland Crops
(maize, beans, sugarcane, peanuts and cotton)

Land Class	S1	S2	S3	NS1 and NS2
Land characteristics				
Texture(s)	Sandy loam to friable clay loam	Sandy loam to very permeable clay, non-compacted	Loamy sand to permeable clay	NS1: Includes lands which require additional investigations to determine their irrigability.
Depth(s) to sand, gravel	90cm plus and greater than 150cm to impermeable horizon	60cm plus and greater than 120cm to impermeable horizon	45cm plus and greater than 100cm to impermeable horizon	NS2: Includes lands which do not meet the minimum requirements for the other land classes and are not suitable for irrigation. These include lands with very shallow soils, impermeable soils, excessive concentrations of salts, pH above 9.0 and more than 15% ESP etc.
Alkalinity (reaction)	pH-H ₂ O less than 7.5 for non-calcareous soils and less than 8.6 for calcareous soils	pH-H ₂ O less than 9.0 unless soil is calcareous and non-sodic	pH-H ₂ O 9.0 or less unless soil is calcareous and non-sodic	
Salinity (ECe)	Total salts not to exceed 0.2%, ECe less than 4mmhos/cm	Total salts not to exceed 0.5%, ECe less than 8mmhos/cm	Total salts not to exceed 0.5%, ECe less than 8mmhos/cm	
Slopes (t)	Flat to very gently undulating (less than 2%)	Flat to very gently undulating (less than 5% in general)	Flat to undulating (less than 8% in general)	
Surface (micro-relief)	Even enough to require only small amounts to levelling and no heavy grading	Moderate grading required but in amounts found feasible at reasonable cost	Heavy and expensive grading required	
Vegetation (T)	Woody cover less than 20%. Clearing cost small.	Woody cover less than 40%. Clearing required but at a moderate cost.	Woody cover less than 80%. Expensive clearing costs.	
Drainage (d)	Well drained to moderately well drained. No flooding	Well drained to imperfectly drained. May have surface water for short periods.	Well drained to poorly drained, may have surface water for several months.	

Table 5.3 Extent of Land Suitability Class for Rice

Unit: ha

Land Suitability Class	Physio-graphic Unit	Sub-area			Total
		I	II	III	
S1	K21	0	360	2130	2490
S1	K22	0	90	540	630
Total(S1)		0	450	2670	3120
S3t	P31	1190	3580	0	4770
S3t	P32	0	650	0	650
S3t	F11	0	0	0	0
S3t	F12	0	0	670	670
S3t	F22	0	0	620	620
S3st	K13	0	0	0	0
S3td	S1	0	0	0	0
Total(S3)		1190	4230	1290	6710
Land Suitable		1190	4680	3960	9830
N2st	P11	0	120	0	120
N2st	P2	0	420	0	420
N2st	P33	0	180	0	180
N2st	P34	0	120	0	120
N2s	D11	50	520	0	570
N2s	D12	400	260	0	660
N2s	D13	0	180	0	180
N2s	D14	40	240	0	280
N2s	D2	110	320	0	430
N2std	U1	0	0	0	0
N2st	U2	0	0	30	30
N2st	F21	0	0	460	460
N2t	F3	0	0	240	240
N2t	F4	0	0	190	190
N2sd	K11	0	0	0	0
N2st	K3	0	150	70	220
N2t	K12	0	0	0	0
N2t	K4	0	0	0	0
N2st	K5	0	0	50	50
N2d	S2	0	0	0	0
Land Unsuitable		600	2510	1040	4150
Total		1790	7190	5000	13980

Table 5.4 Extent of Land Suitability Class for Maize, Sugarcane, Groundnut, Cotton and Other Common Crops

Unit: ha

Land Suitability Class	Physio-graphic Unit	Sub-area			Total
		I	II	III	
S2t	P31	1190	3580	0	4770
S2t	P32	0	650	0	650
S2sd	K21	0	360	2130	2490
Total(S2)		1190	4590	2130	7910
S3t	P2	0	420	0	420
S3s	D2	110	320	0	430
S3d	F11	0	0	0	0
S3d	F12	0	0	670	670
S3d	F22	0	0	620	620
S3d	F3	0	0	240	240
S3std	F4	0	0	190	190
S3sd	K12	0	0	0	0
S3sd	K13	0	0	0	0
S3d	K22	0	90	540	630
S3t	K4	0	0	0	0
Total(S3)		110	830	2260	3200
Land Suitable		1300	5420	22690	11110
N2t	P11	0	120	0	120
N2s	P33	0	180	0	180
N2s	P34	0	120	0	120
N2s	D11	50	520	0	570
N2s	D12	400	260	0	660
N2s	D13	0	180	0	180
N2s	D14	40	240	0	280
N2s	U1	0	0	0	0
N2s	U2	0	0	30	30
N2s	F21	0	0	460	460
N2s	K11	0	0	0	0
N2s	K3	0	150	70	220
N2s	K5	0	0	50	50
N2d	S1	0	0	0	0
N2d	S2	0	0	0	0
Land Unsuitable		490	1770	610	2870
Total		1790	7190	5000	13980

FIGURES

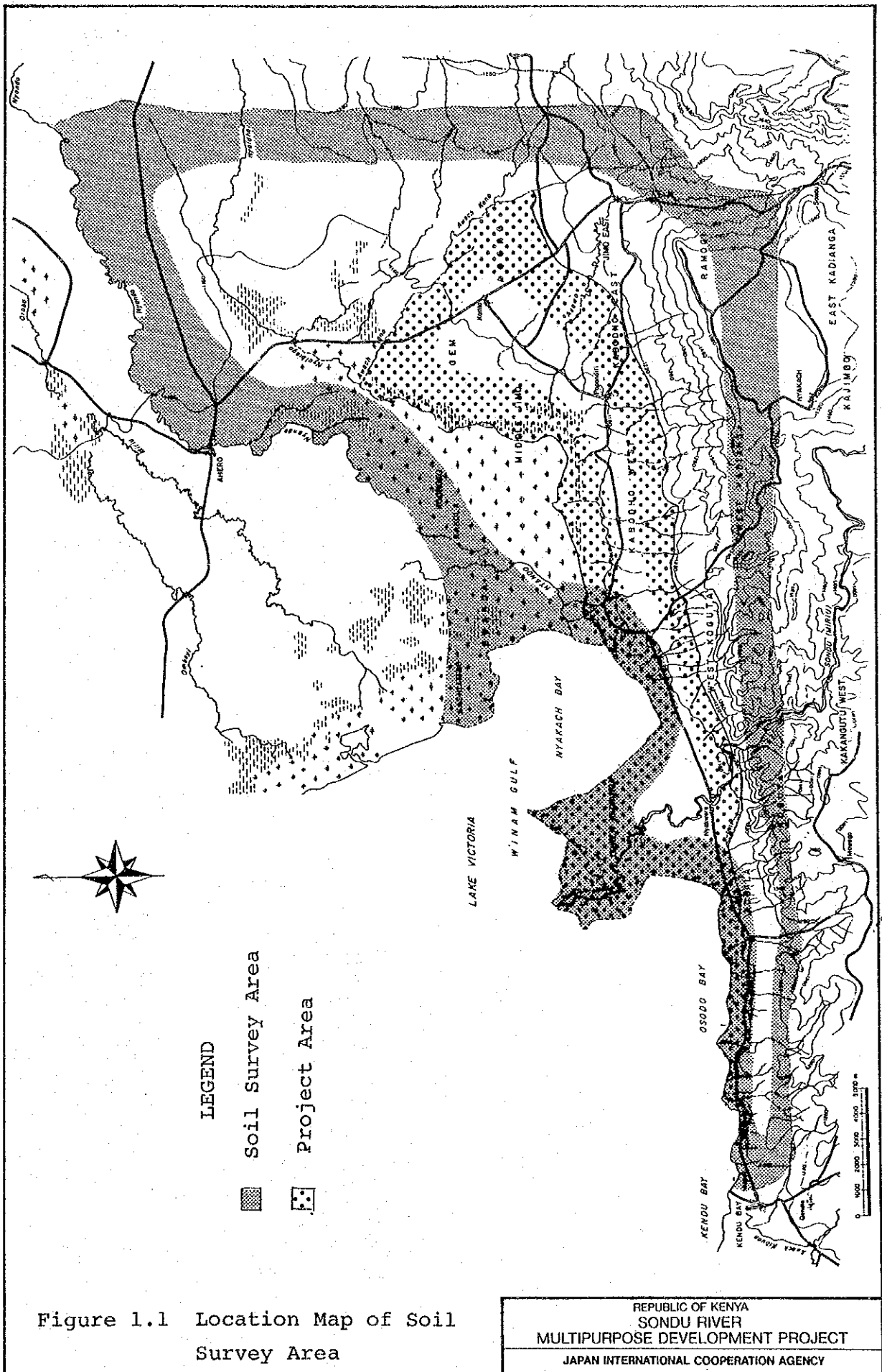
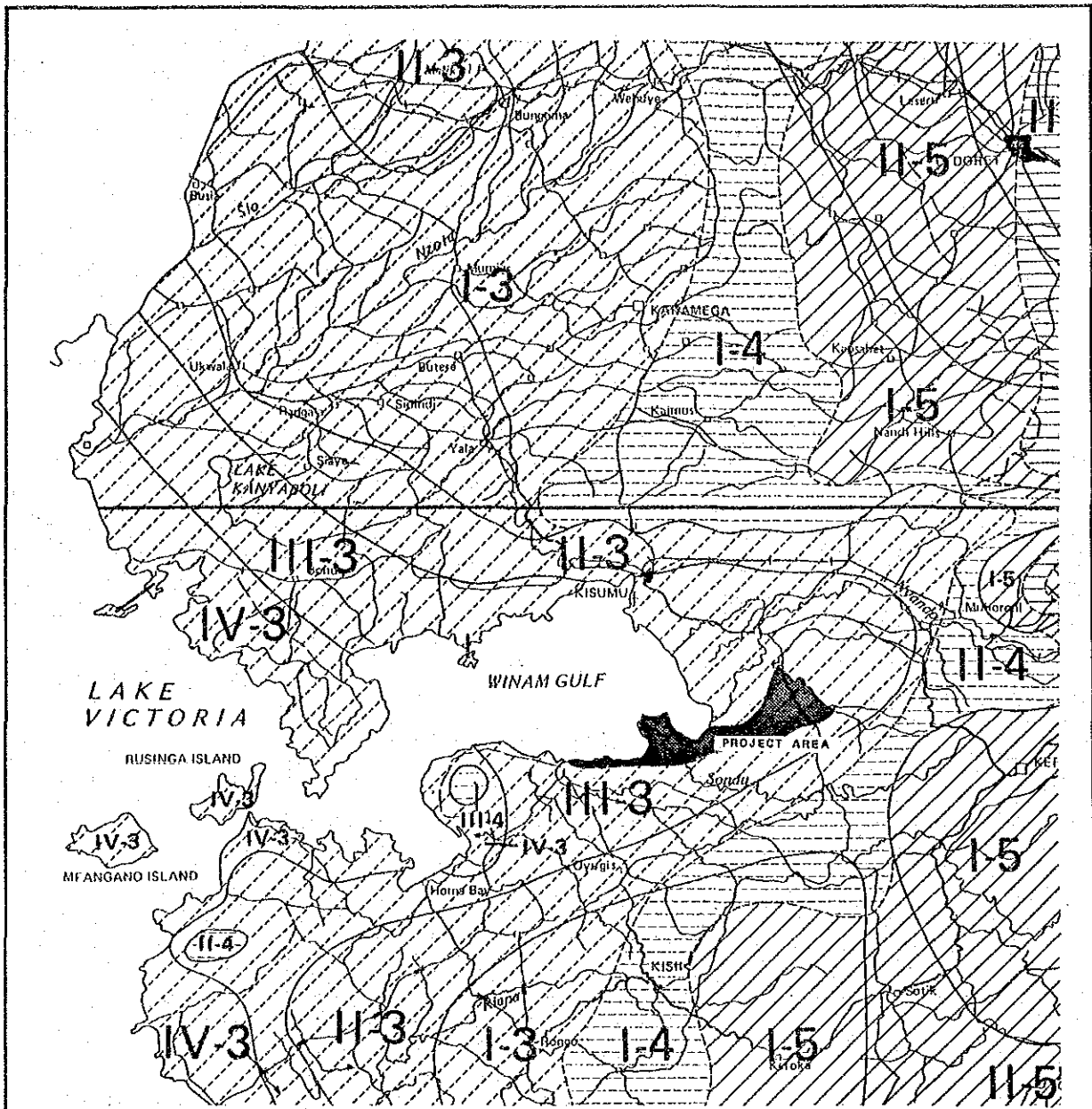


Figure 1.1 Location Map of Soil Survey Area



Boundary criteria for the moisture availability zones and their climatic designation

Zone	r/Eo ratio	r/Eo ratio in %	climatic designation
I	> 0.8	> 80	humid
II	0.65 - 0.80	65 - 80	sub-humid
III	0.50 - 0.65	50 - 65	semi-humid
IV	0.40 - 0.50	40 - 50	semi-humid to semi-arid
V	0.25 - 0.40	25 - 40	semi-arid
VI	0.15 - 0.25	15 - 25	arid
VII	< 0.15	< 15	very arid

r = average annual rainfall
 Eo = average annual potential evaporation

Boundary criteria for the temperature zones; their mean annual temperatures and their climatic designation

zone	altitudes (feet)	mean annual temperature (°C)	climatic designation
9	> 10,000	< 10	cold to very cold
8	9,000 - 10,000	10 - 12	very cool
7	8,000 - 9,000	12 - 14	cool
6	7,000 - 8,000	14 - 16	fairly cool
5	6,000 - 7,000	16 - 18	cool temperate
4	5,000 - 6,000	18 - 20	warm temperate
3	4,000 - 5,000	20 - 22	fairly warm
2	3,000 - 4,000	22 - 24	warm
1	0 - 3,000	24 - 30	fairly hot to very hot

Figure 2.1 Agro-climatic Zone Map

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zone	r/Eo ratio [%]	moisture range suitable for various crops	types of animal production	types of forestry species
I	> 80	rice tea sugar cane barana coco Yam Irish potatoes pyrethrum citrus tobacco coconut wattle pineapple coffee barley finger millet sweet potato simsim cashew cotton beans wheat sunflower cowpea groundnut mango pawpaw sisal grams cactior (perennial) sorghum cassava maize pigeon pea burrush millet	dairying	coniferous species
II	65 - 80			
III	50 - 65			various Eucalyptus species
IV	40 - 50		ranching	
V	25 - 40			various Acacia species Prosopis sp.
VI	15 - 25		nomadic pastoralism	
VII	< 15			

Figure 2.2 Moisture Range of Crops,
Types of Animal Production
and Types of Forestry Species

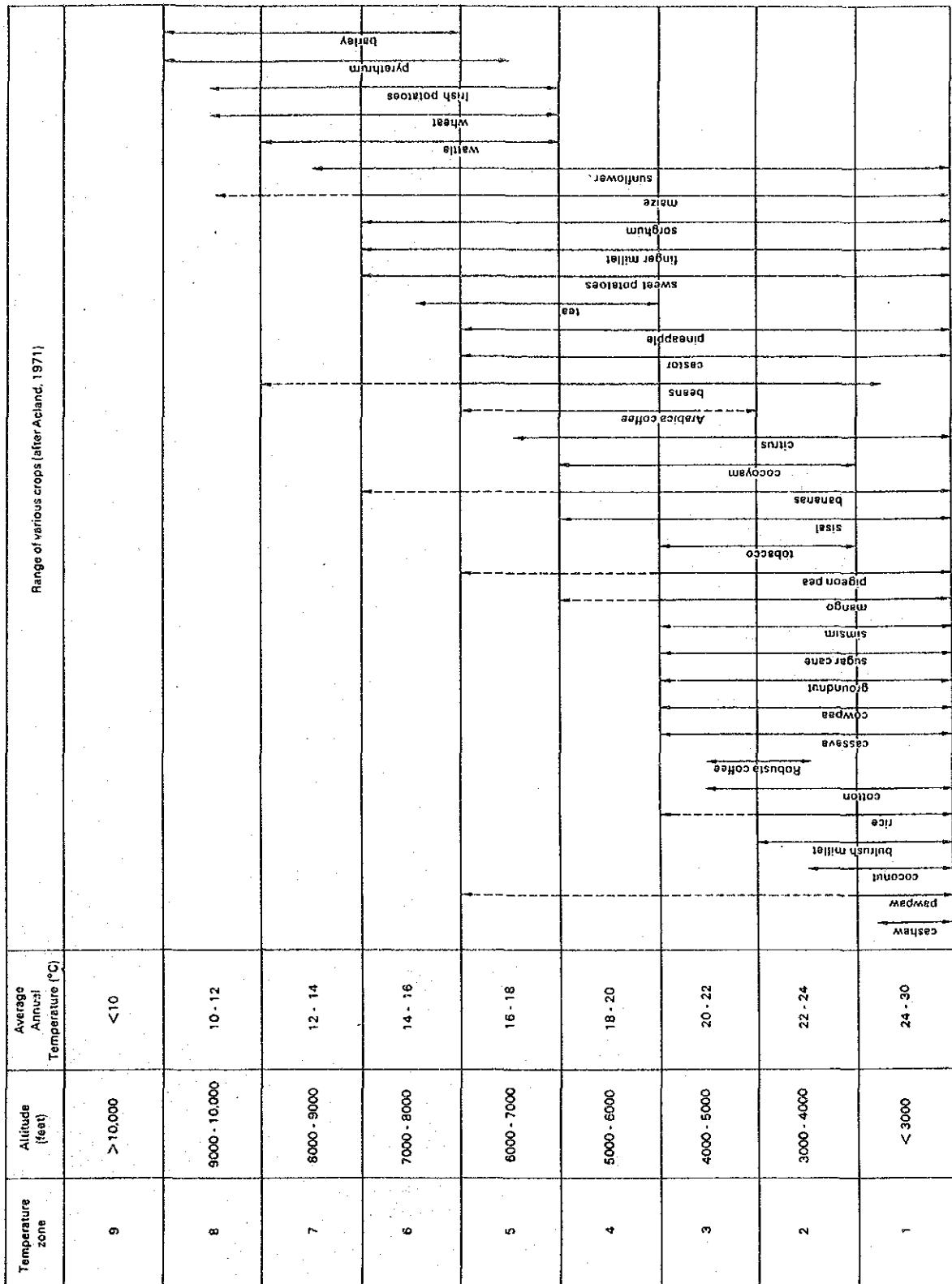
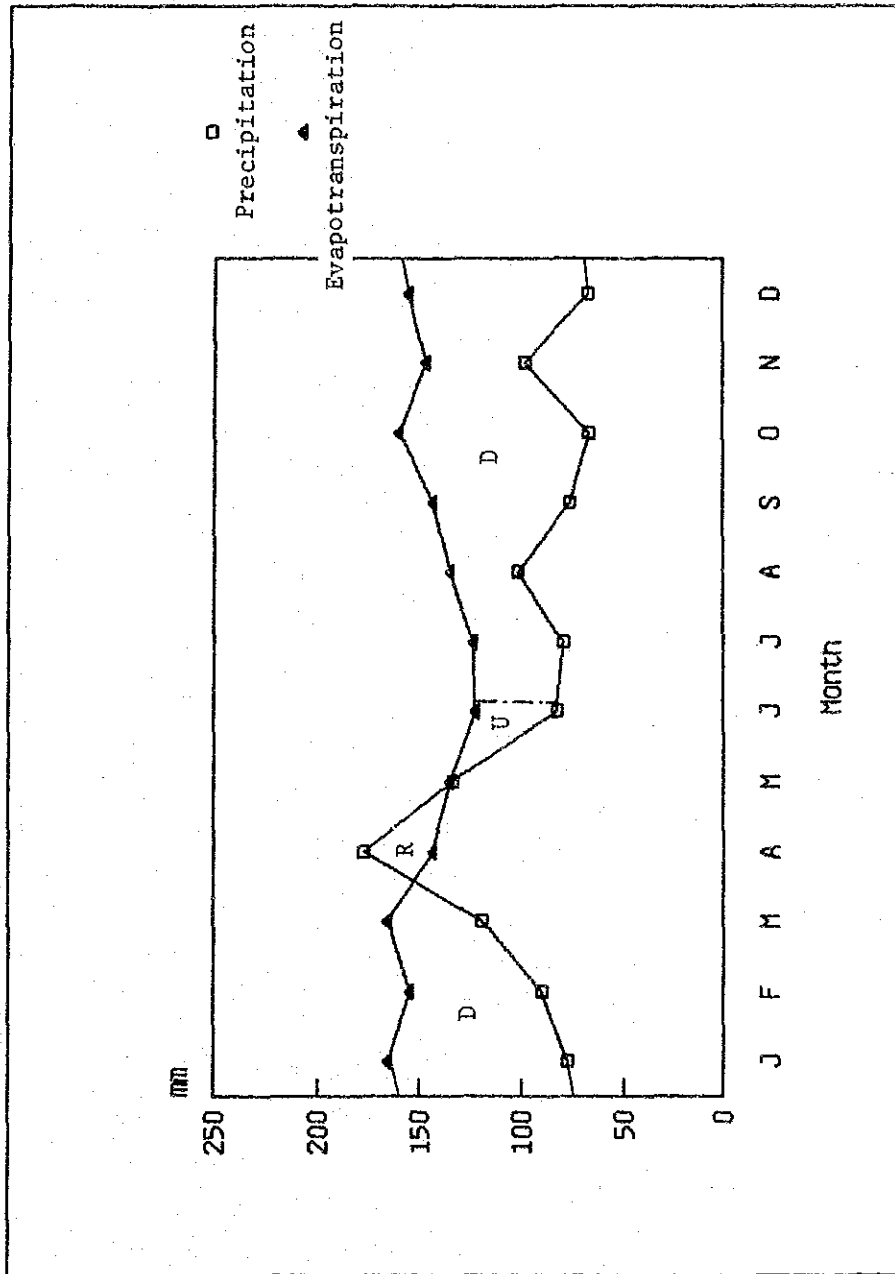


Figure 2.3 Altitude and Temperature Range of Various Crops





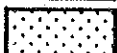
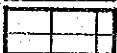


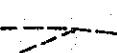


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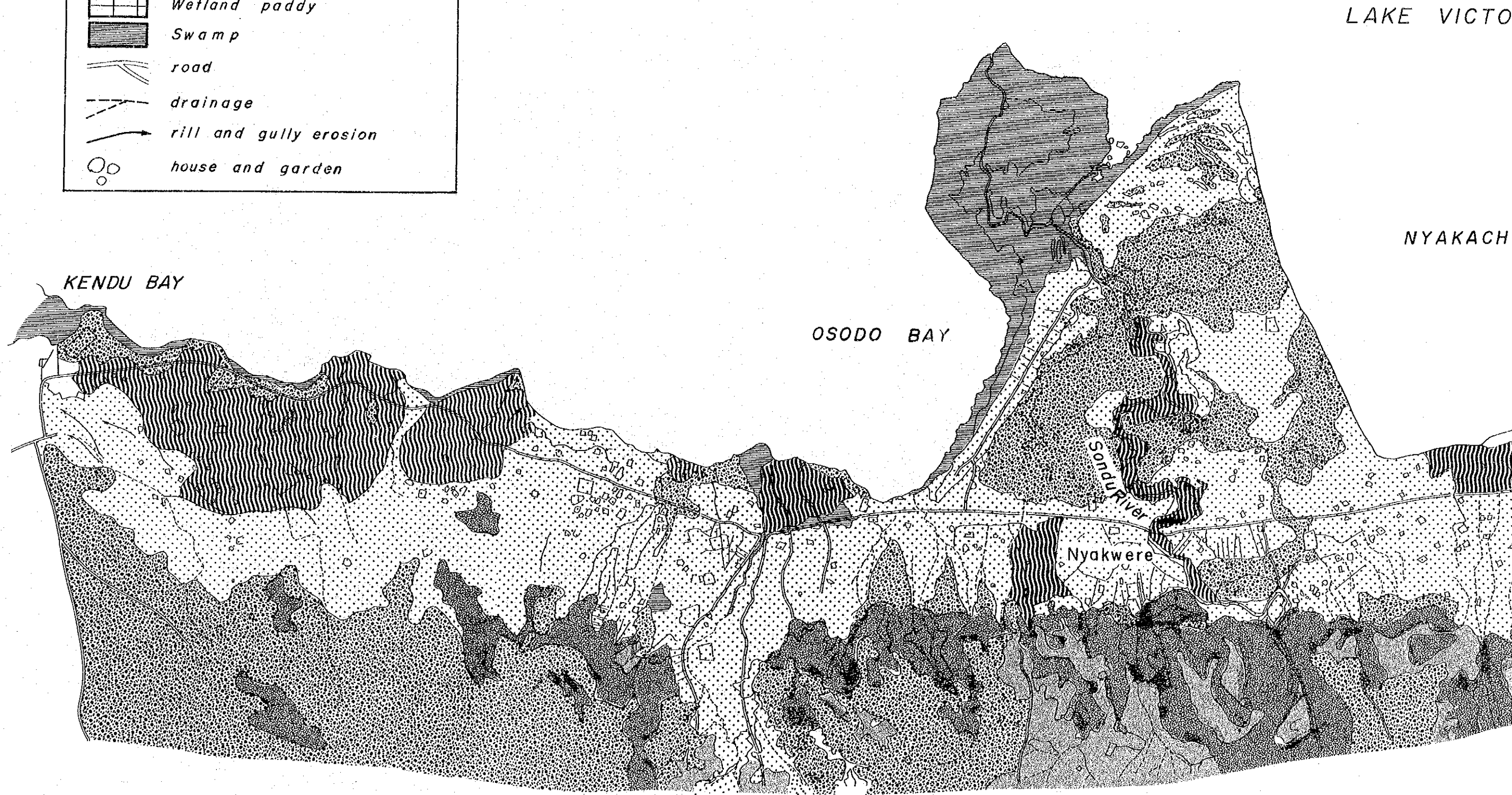


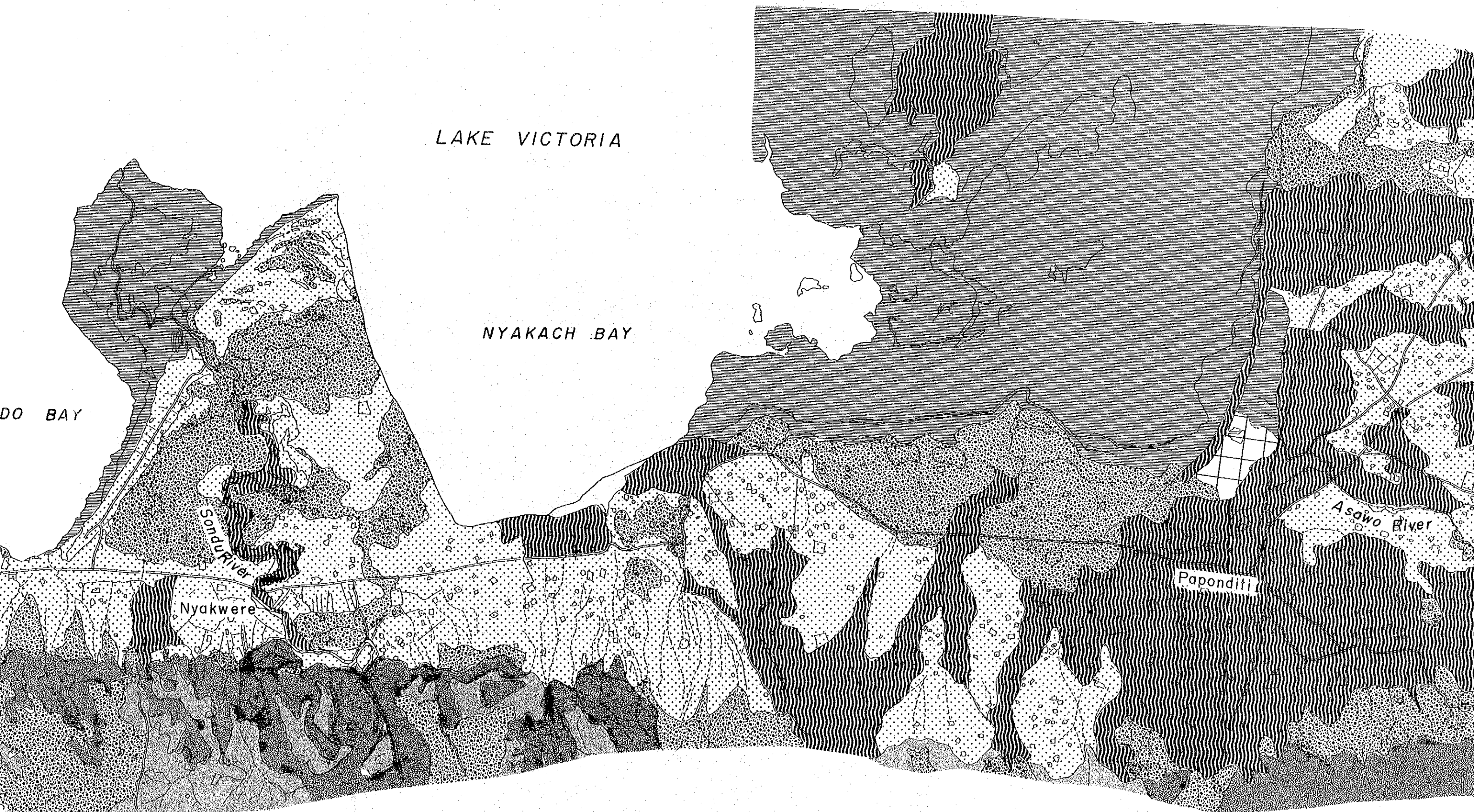
Remarks : D deficit
 R recharge
 U utilization

Figure 2.4 Water Balance Diagram

LEGEND

	Forest
	Scrub Woodland
	Grassland
	Upland Crops, densely planted
	Upland Crops, sparsely planted
	Wetland paddy
	Swamp
	road
	drainage
	rill and gully erosion
	house and garden





LAKE VICTORIA

NYAKACH BAY

DO BAY

Songdu River

Nyakwere

Paponditi

Asowo River

TORIA

CH BAY

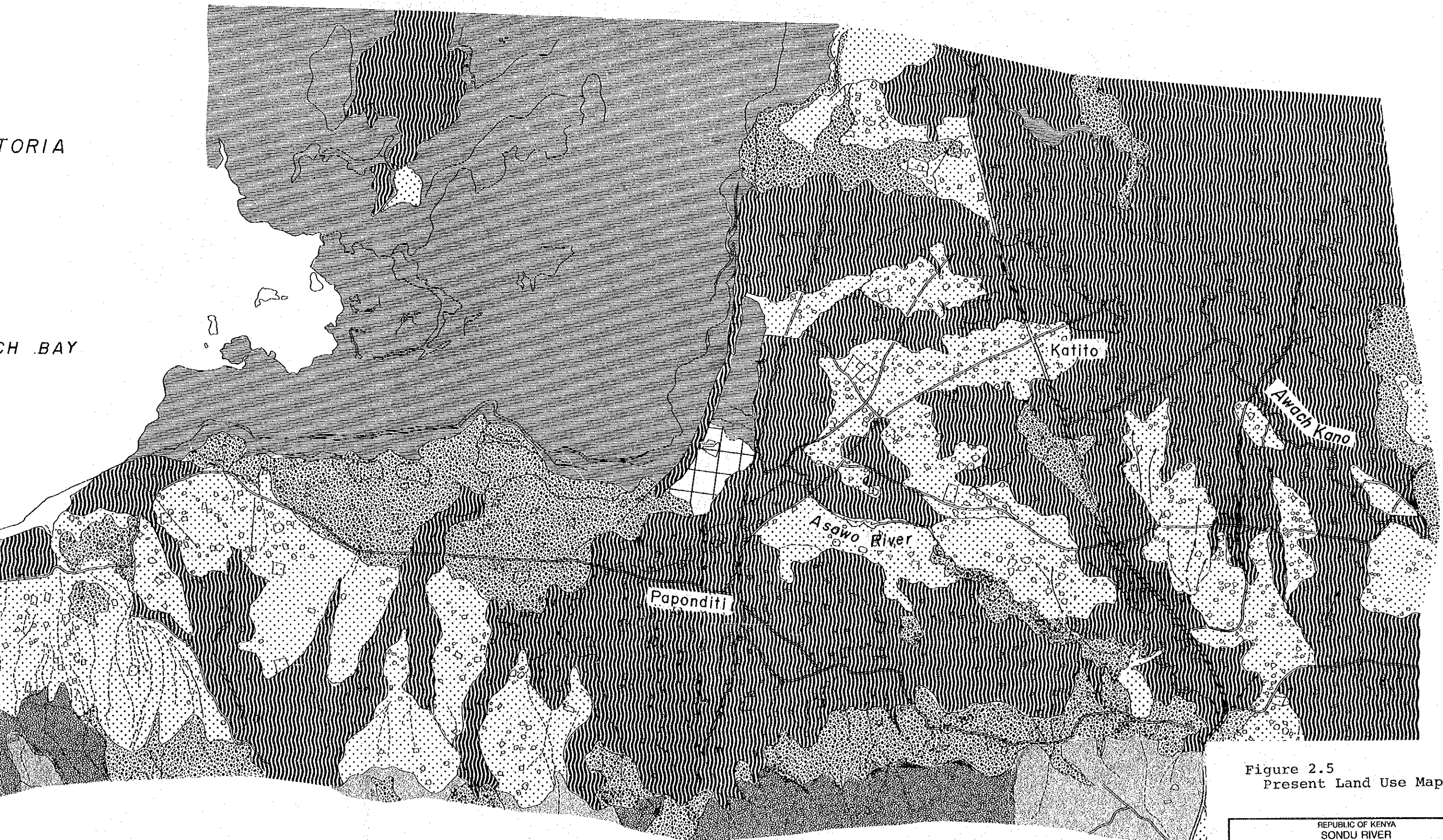


Figure 2.5
Present Land Use Map

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Note: LEGEND is shown in Figure 4.1 (2/2)

Conventional Symbols

- P32 --- Physiographic Unit
- O28 --- Test Pit Site

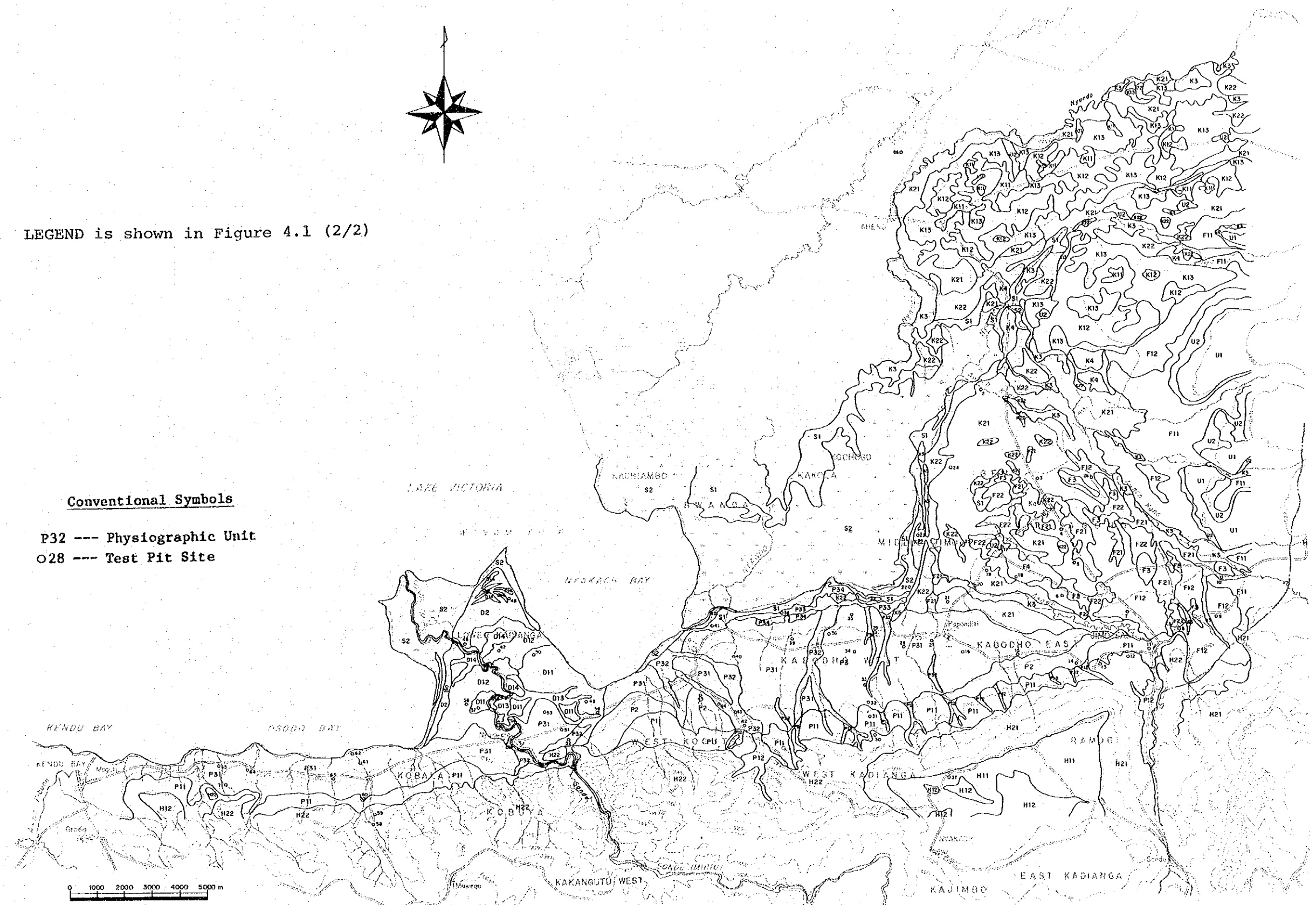


Figure 4.1 (1/2) Soil Map

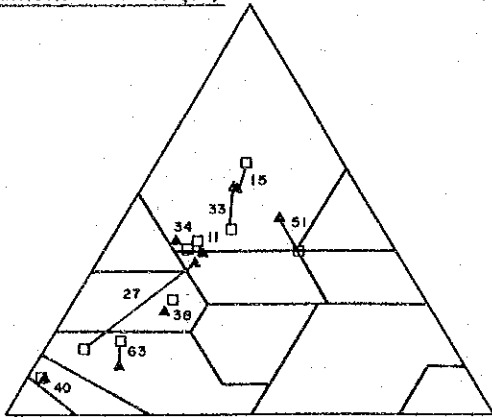
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LAND FORM	SUBDIVISION	MAPPING SYMBOL	MAPPING UNIT	SLOPE %	DRAINAGE CONDITION	COLOR	TEXTURE	DEPTH	SOIL UNIT	EXTENT (ha)	
HILLS Intermediate igneous rocks H	Plateau mainly phonolite H1	H11	higher parts with irregular microrelief	0-3	well	dark reddish brown to dark red	friable clay, ironstones	deep	Ironstone Soils Micro-rhodic Ferralsols	0	
			lower bottom lands	0-1	well	dark red	friable clay over petro-plinthite	mod. deep to deep	Chromic Cambisols Rhodic Ferralsols	0	
	Escarpment H2	H21	phonolite, highly resistant to erosion	25<	excessively well to well	dark red	friable sandy clay loam to clay, rocky	shallow	Lithosols Ironstone Soils	0	
			granodiorite, granite	25<	excessively well to well	dark red to brown	friable sandy clay loam to clay, rocky	shallow	Lithosols Ironstone Soils	0	
PIEDMONT PLAIN coalescing alluvial and colluvial fans P	Transitional colluvial footslopes P1	P11	convex slopes	1-4	excessively well to well	dark reddish brown to yellowish brown	gravelly loam	mod. deep to shallow	Ferralic Arenosols Ironstone Soils	120	
			valley bottoms	0-2	moderately well	dark red to brown	clay loam to loam	very deep to deep	Chromic Cambisols Ferralic Arenosols Ferralsol-chromic/orthic Luvisols	0	
	Mid-slopes P2	P2	transitional unit between P1 and P3	0-2	well	reddish brown to yellowish brown	clay loam	deep	Ferralic Arenosols Chromic Cambisols	420	
			almost flat terrain	0-1	moderately well to well	reddish brown (black to dark grey subsoil)	clay loam to clay	deep	Eutric Regosols Chromic Cambisols	4,770	
	Alluvial toeslopes overlying old lacustrine deposits P3	P31	streams (gullies) bank	0-1	moderately well	yellowish brown	clay loam	very deep	Eutric Regosols Chromic Cambisols	550	
			old stream courses	1-4	poorly	very dark brown grey to dark grey brown	sandy clay loam	deep	Eutric Regosols Chromic Cambisols	180	
	Deltaic deposits widely extending terrain formed in the river mouth of Sondu D	Sand ridges D2	D2	raised lake beach	0-2	well to poorly	very dark brown to grey	silty clay to sandy clay loam	mod. deep	Eutric Regosols	120
				terrace-like higher land	0	well	brown to dark grey	silty clay loam	deep	Calcic Fluvisols, sodic phase	570
	CUSPATE DELTA fluvium, partly lacustrine deposits D	widespread D1	D12	recent flood plain	0	poorly to mod. well	brownish grey to brownish black	silty loam	deep	Calcic Fluvisols, sodic phase Eutric Fluvisols	660
				former river courses and point bar complex	0	poorly to mod. well	brownish black	sandy clay to silty clay	deep to very deep	Eutric Fluvisols, sodic phase	180
depression seasonally submerged D14		D14	depression	0	poorly	dark grey to black	clay	deep	Eutric Fluvisols, sodic phase	280	
			seasonally submerged	0	poorly	dark grey to black	clay	deep	Eutric Fluvisols, sodic phase	280	
UPLANDS lower flow hill of kericho phonolite U	Platform U1	U1	higher lands (1-2m) on unit D1	0-1	well to excessively well	dark brown to yellowish brown	sandy clay to loamy sand	mod. deep to deep	Eutric Regosols Chromic Cambisols	430	
			footslopes of phonolite hills and plateau	2-6	excessively well	reddish brown to greyish	gravelly to stony clay	very shallow	Chromic Cambisols Ironstone Soils	0	
FAN BASE colluvial apron and fan base F	Slope U2	U2	edge and flank of U1	0-2	well to poorly	dark grey brown to reddish brown	gravelly clay to sandy clay	shallow	Ironstone Soils	30	
			extending fan base (phonolite) U	1-2	poorly	very dark grey	sandy clay to clay	deep	Chromic Vertisols Pellic Vertisols	0	
	Fan base F1	F11	lower alluvial fan base	0-4	poorly	black to very dark grey to brown	clay	deep	Chromic Vertisols Pellic Vertisols	670	
			hills granodiorite	1-4	poorly	very dark brown grey to dark grey brown	sandy clay loam	deep	Gleyic Luvisols, sodic phase	450	
	Old stream courses F2	F21	old stream courses, eroded sites	0-2	poorly	dark grey brown	clay	deep	Pellic Vertisols	620	
			old stream courses, below colluvial apron	0-2	poorly	dark grey brown	clay	deep	Pellic Vertisols	620	
	Higher sites of colluvial aprons F3	F3	old stream courses, eroded sites	1-4	moderately well to poorly	dark brown, dark greyish brown	sandy clay to sandy loam	deep	Eutric Regosols	240	
			old stream courses, eroded sites	1-4	moderately well to poorly	dark brown, dark greyish brown	sandy clay to sandy loam	deep	Eutric Regosols	240	
	Micro-ridges F4	F4	old stream courses, eroded sites	1-3	moderately well to impeded	dark brown, reddish brown	coarse clay loam to sandy loam, gravel	mod. deep	Eutric Fluvisols Eutric Regosols	190	
			old stream courses, eroded sites	1-3	moderately well to impeded	dark brown, reddish brown	coarse clay loam to sandy loam, gravel	mod. deep	Eutric Fluvisols Eutric Regosols	190	
LACUSTRINE PLAIN lacustrine deposit and mudstone material K	Slightly higher lands, mainly alkaline and calcareous mudstone K1	K11	flatish summit of minor ridge	0-2	impeded	dark brown to greyish brown	gravelly sandy clay to clay loam	very shallow	Vertic Cambisols	0	
			gently sloping land	1-3	poorly	very dark brown to grey	clay	shallow	Pellic Vertisols, paralthic	0	
	Low lying extensive terrain, lacustrine deposits K2	K21	depression	0-2	poorly	very dark grey to brown	clay	moderately deep	Pellic Vertisols	0	
			base level	0	poorly	very dark grey	clay	very deep	Pellic Vertisols Chromic Vertisols	2,490	
	Active stream banks K3	K3	receiving drainage	0	very poorly	very dark grey to black	clay	very deep	Pellic Vertisols Chromic Vertisols	630	
			receiving drainage	0	very poorly	very dark grey to black	clay	very deep	Pellic Vertisols Chromic Vertisols	630	
	Old levee K4	K4	irregular micro-relief	0-2	well to poorly	very dark brown to grey	clay to silty clay	moderately deep	Eutric Fluvisols	220	
			irregular micro-relief	0-2	well to poorly	very dark brown to grey	clay to silty clay	moderately deep	Eutric Fluvisols	220	
	Raised lake beach K5	K5	slopy mound, uneven	0	moderately well to poorly	very dark brown to dark greyish brown	sandy clay loam	deep to very deep	Dystric Regosols, saline phase	0	
			slopy mound, uneven	0	moderately well to poorly	very dark brown to dark greyish brown	sandy clay loam	deep to very deep	Dystric Regosols, saline phase	0	
Seasonal swamp S1	S1	raised lake beach	0-2	well to poorly	very dark brown to grey	silty clay to sandy clay loam	moderately deep	Eutric Regosols, saline-sodic phase	50		
		raised lake beach	0-2	well to poorly	very dark brown to grey	silty clay to sandy clay loam	moderately deep	Eutric Regosols, saline-sodic phase	50		
Swamp covered by papyrus and reeds S	S2	seasonal swamp	1-2	very poorly	very dark grey to black	clay	very deep	Pellic Vertisols	0		
		permanent swamp	0	very poorly	very dark grey to black	peaty	very deep	Eutric Greysoils	0		

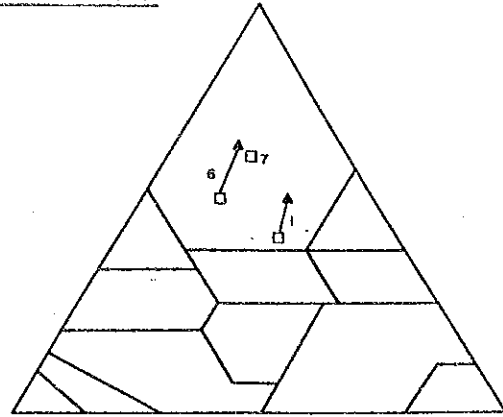
indicating area extent of each mapping with in the Project area with 13,980ha

Figure 4.1 (2/2) Soil Map

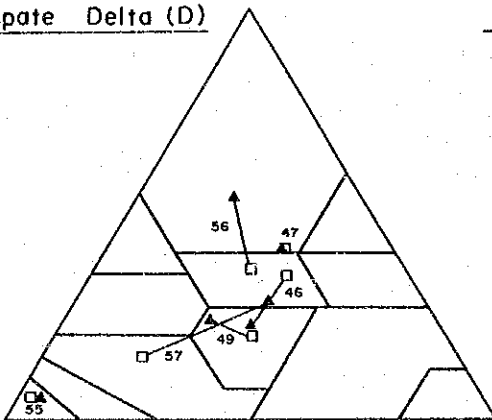
Piedmont Plain (P)



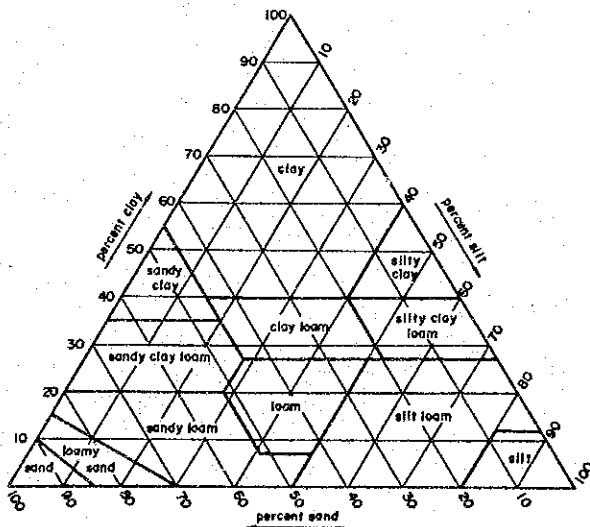
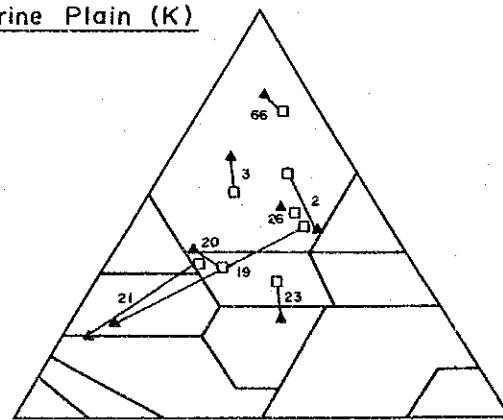
Fan Base (F)



Cuspate Delta (D)



Lucustrine Plain (K)



□ ----- Topsoil
 ▲ ----- Subsoil
 47 ----- Sample number

Chart showing the percentages of clay (below 0.002 mm.), silt (0.002 to 0.05 mm.), and sand (0.05 to 2.0 mm.) in the basic soil textural classes. (USDA 1962)

Figure 4.2 Textural Classes of soils by Physiographic Unit

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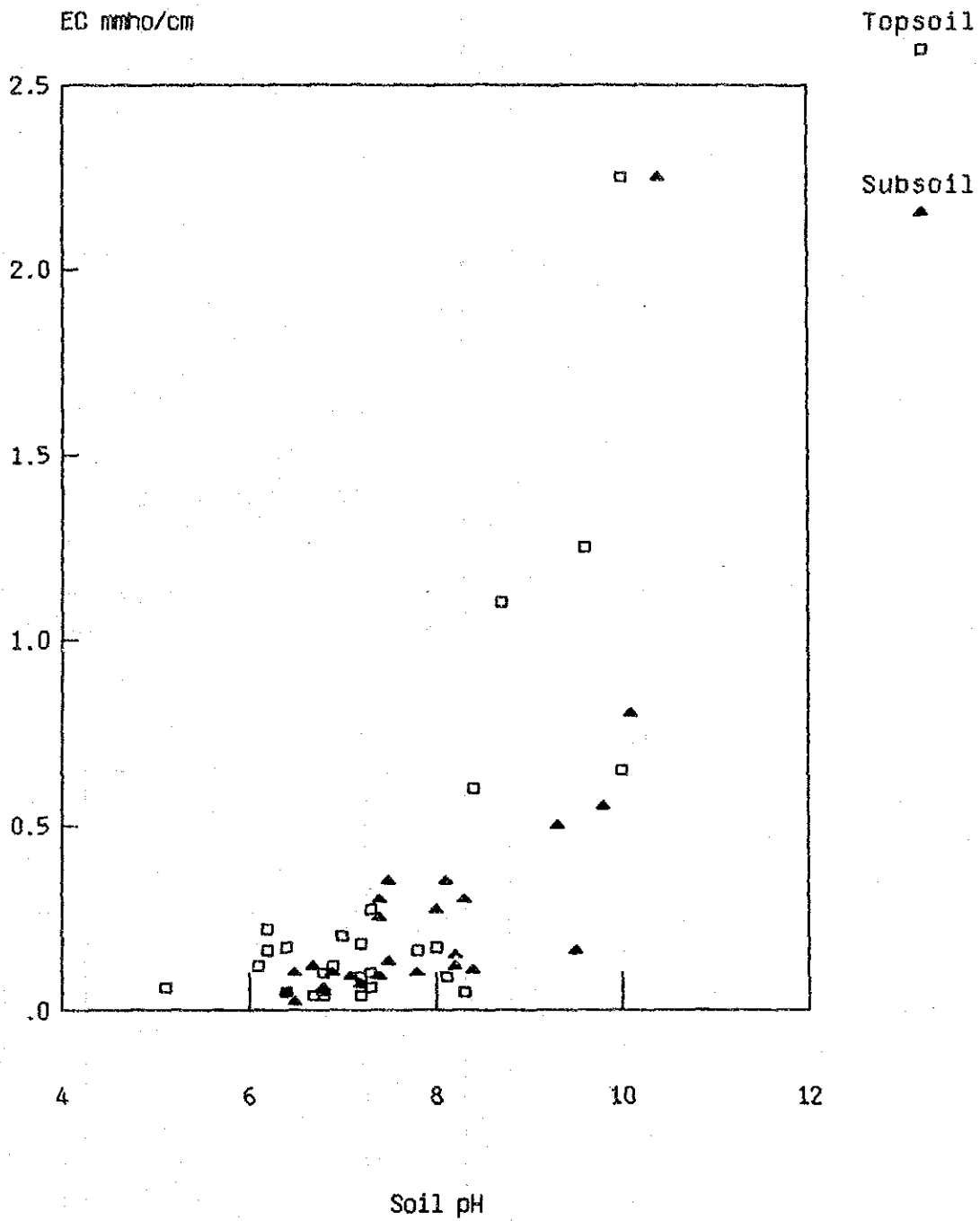


Figure 4.3 Relations Between Soil pH and Electrical Conductivity (EC)

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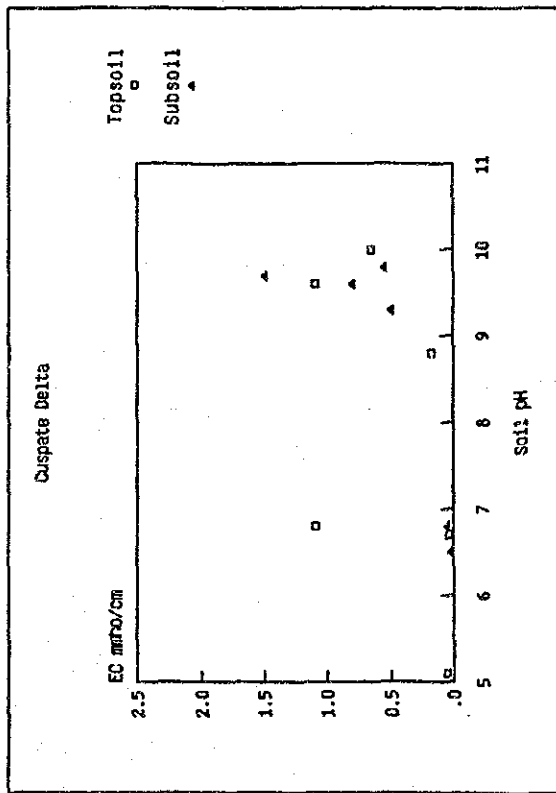
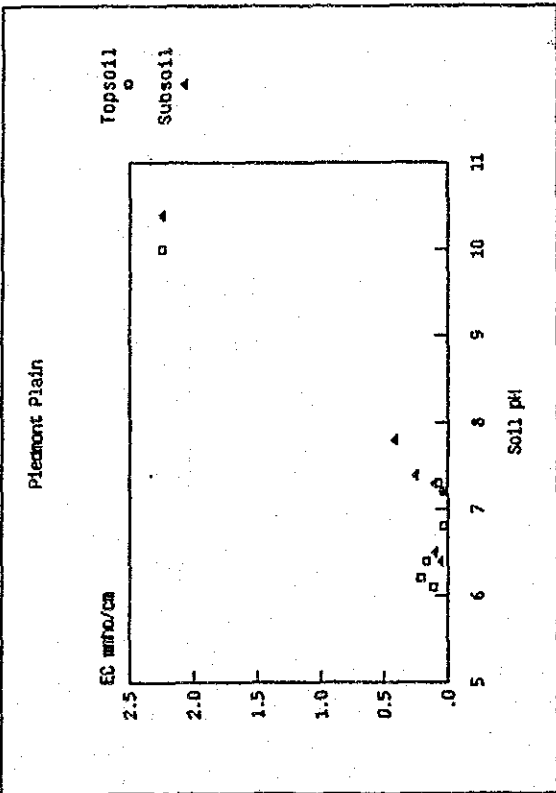
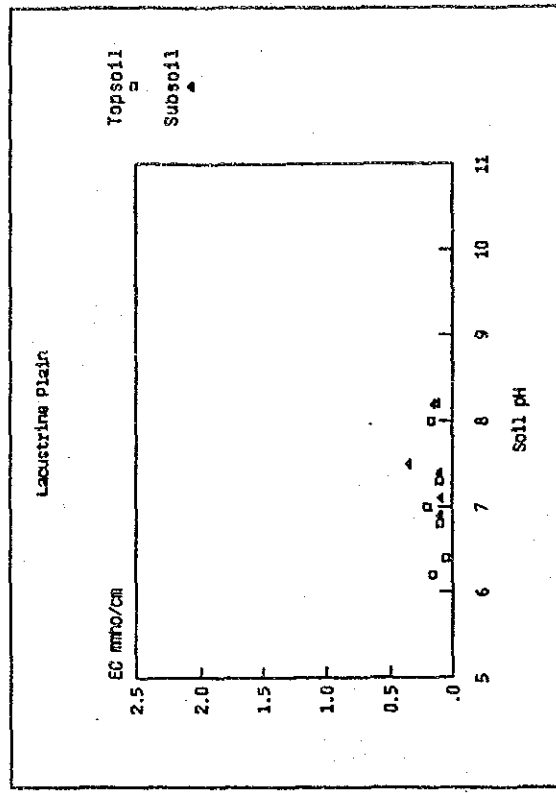
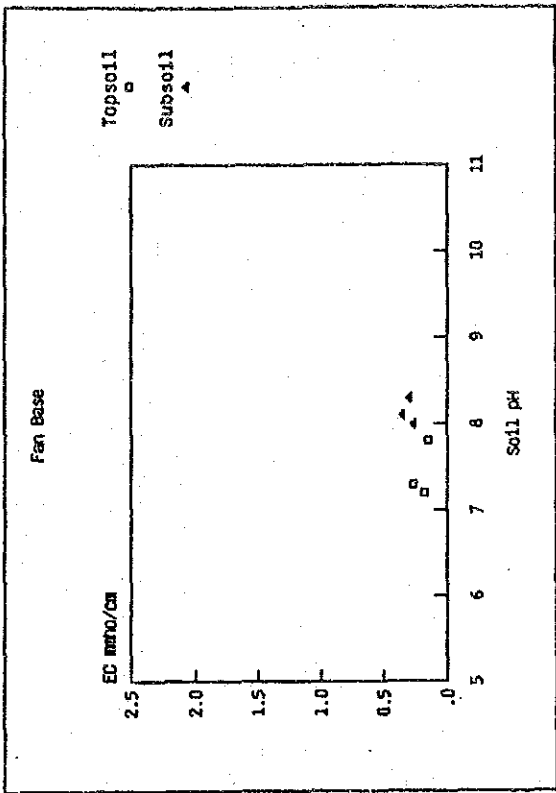


Figure 4.4 Soil pH and Electrical Conductivity by Physiographic Unit

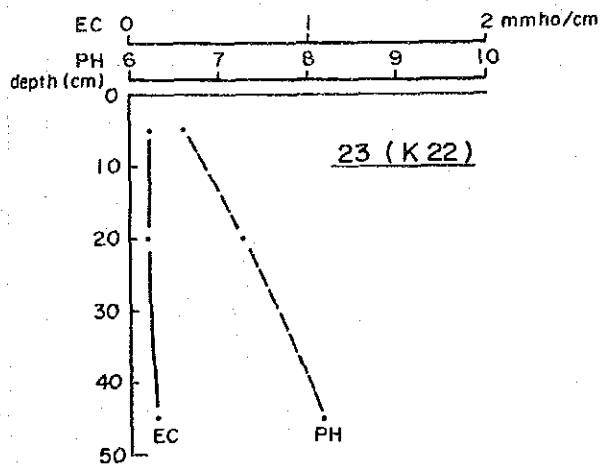
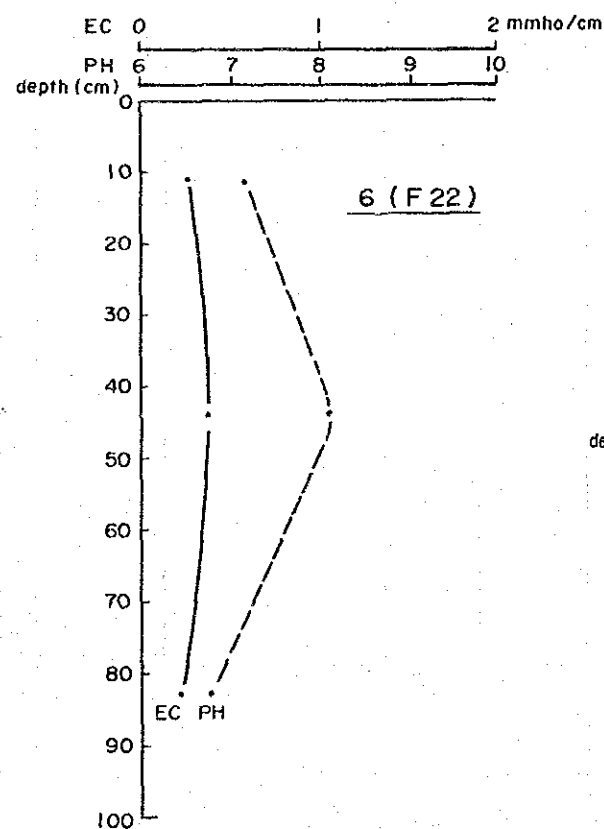
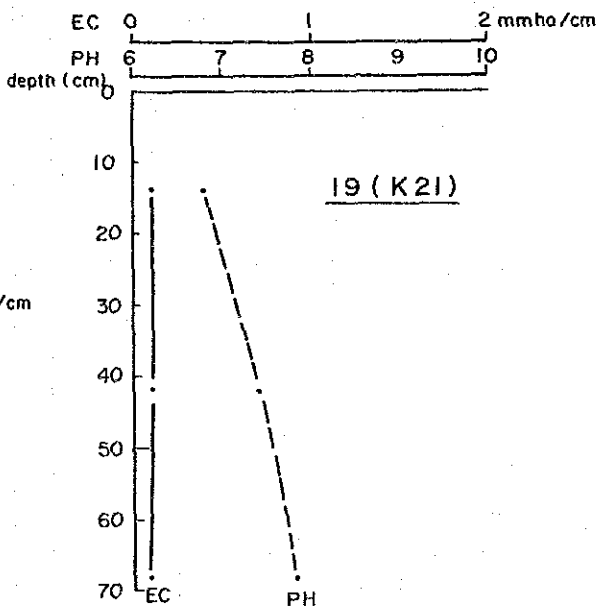
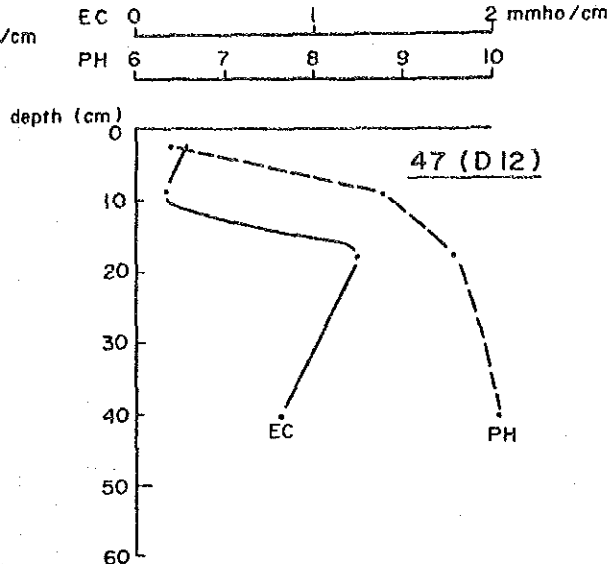
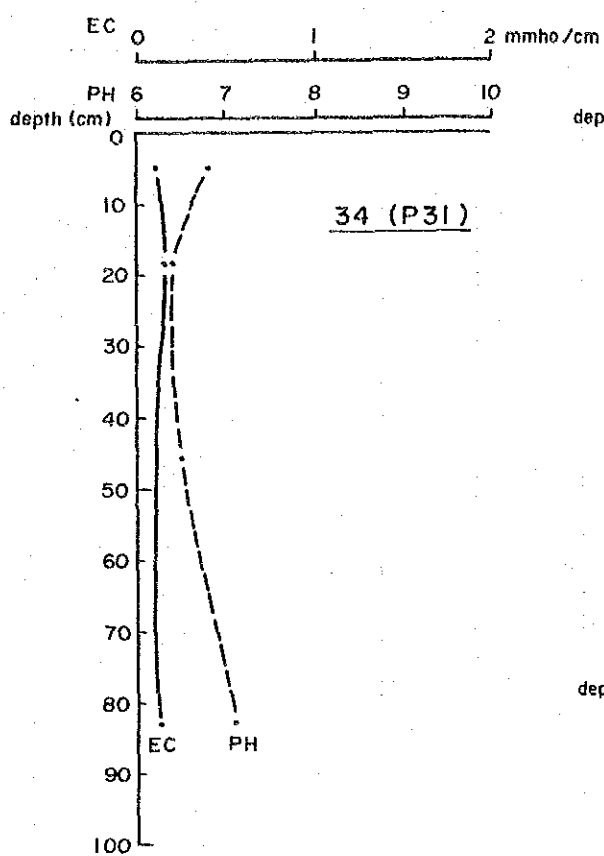


Figure 4.5 Soil pH and EC 2.5 of Plant-Root Zone in 5 Representative Soil Profiles

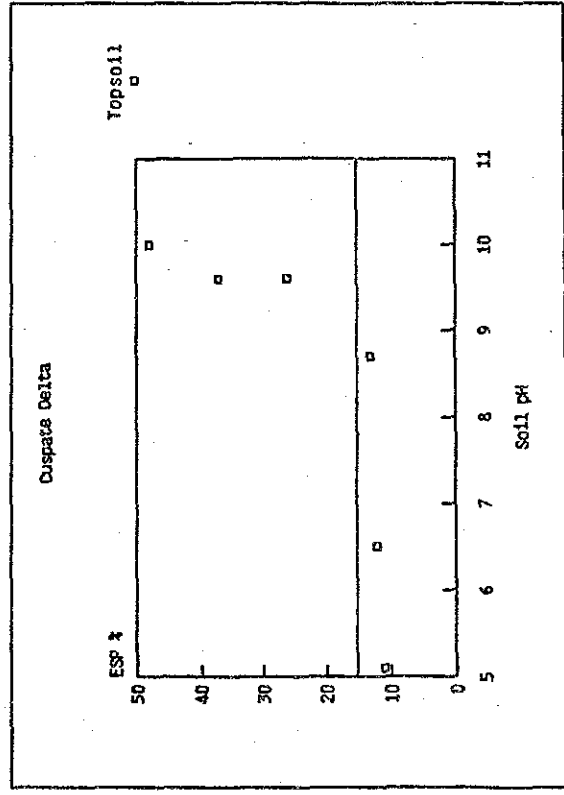
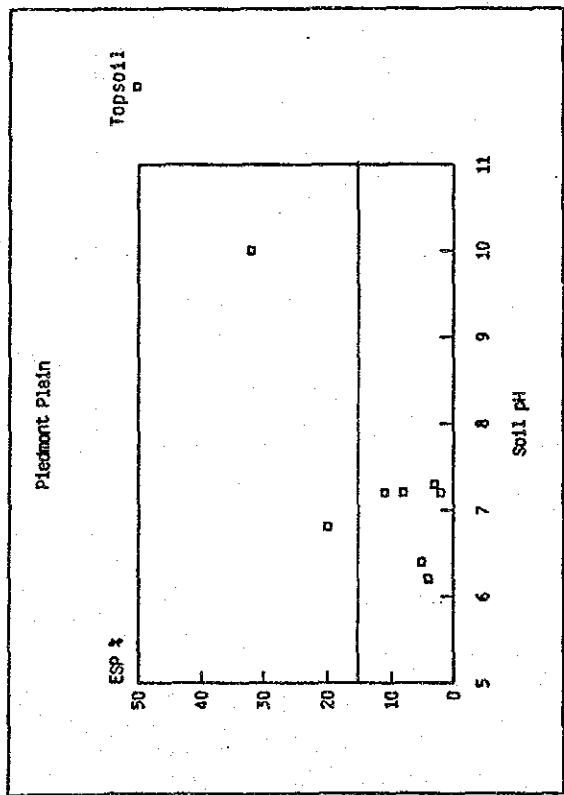
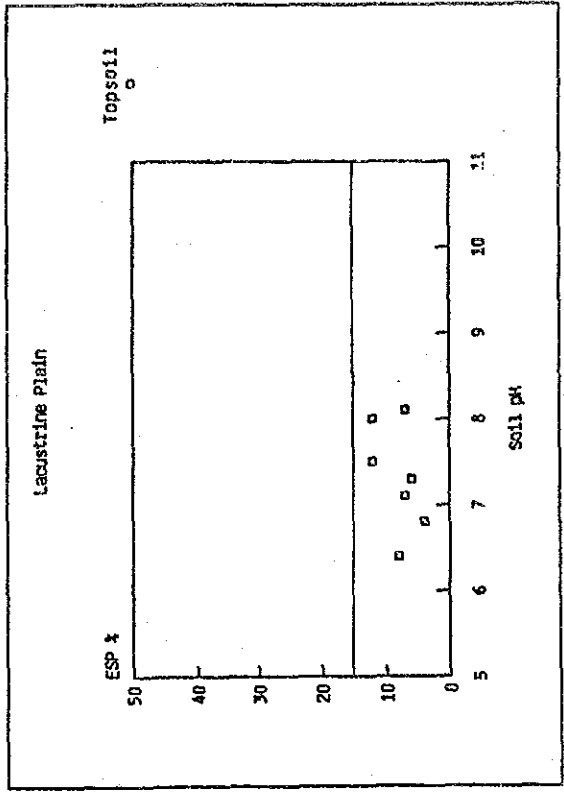
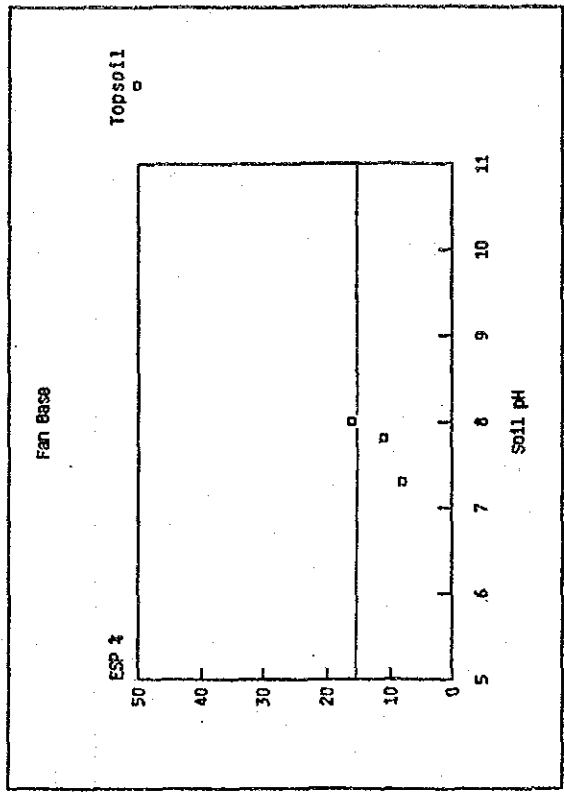


Figure 4.6 Relations Between Soil pH and ESP by Physiographic Unit

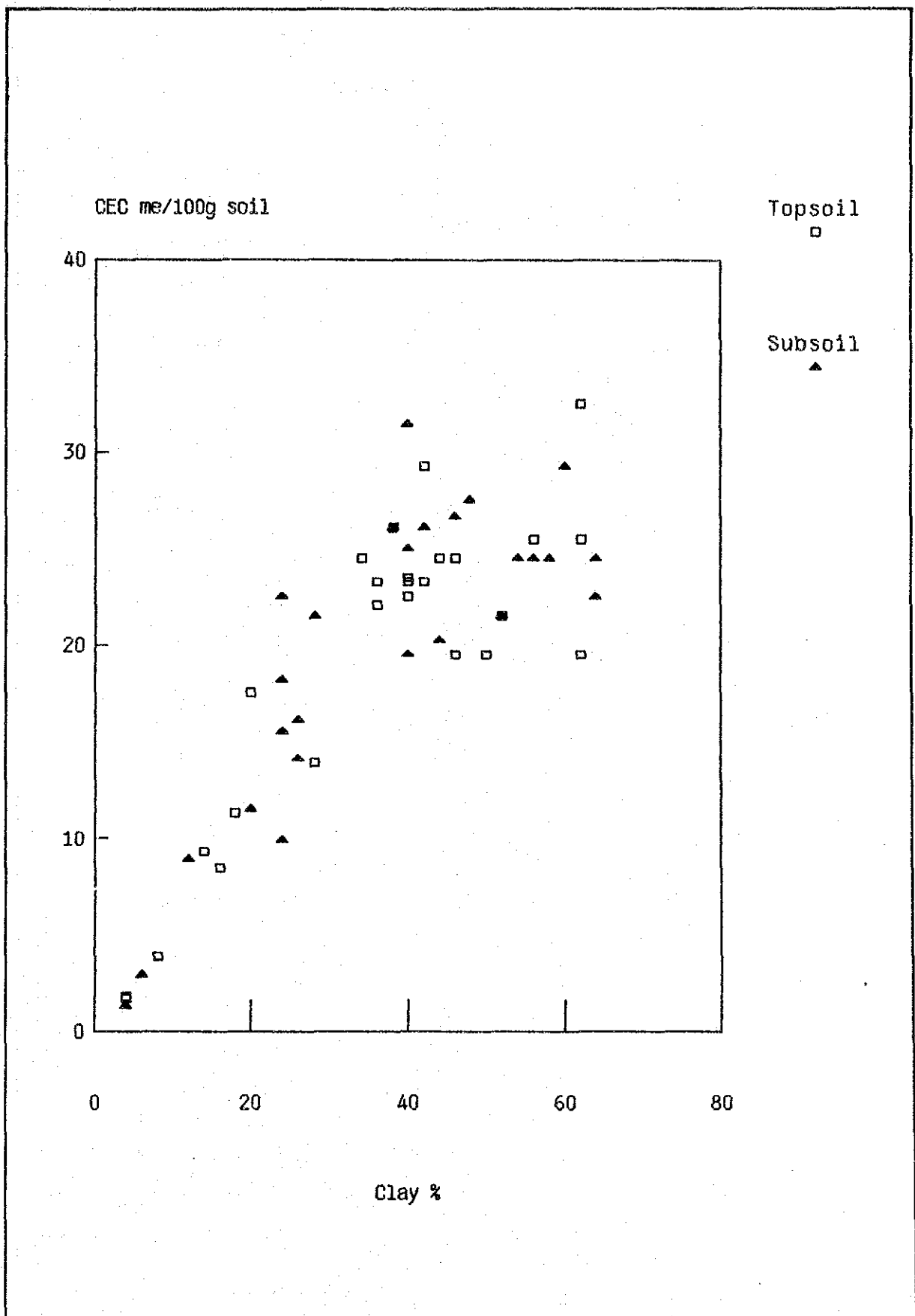


Figure 4.7 Relations Between CEC and Clay Content

LEGEND

Mapping Symbol	Suitability Class	Physiography	Cropping Pattern	Subarea (ha)			
				I	II	III	Total
	S2sd/S1	K21	A	0	290	1,700	1,990
	S3d/S1 N2d/S3td	K22 S1	B	0	70	430	500
	S2t/S3t S3t/N2st S3d/S3t S3sd/S3st S3d/N2t S3std/N2st S3sd/N2t	P31 P32 P2 F11 F12 F22 K13 F3 F4 K12	C	950	3,720	1,380	6,050
Total				950	4,080	3,510	8,540

- Note; 1. Land suitability classes are indicated by the following symbols;
S1 - highly suitable, S2 - moderately suitable, S3 - marginally suitable and N2 - unsuitable
2. Limitations are indicated by the following letter suffixes;
s - soil (effective depth, texture, alkalinity and salinity), t - topography (slope and microrelief) and d - drainage conditions. (see Tables 5.1 and 5.2)
3. Suitability classes for upland crops and for wetland rice are shown in the symbol " upland crops / rice ".
4. Proposed cropping patterns A, B and C are summarized below.
A - a single cropping of rice and upland crops (maize, beans and greengram).
B - a double cropping of rice and upland crops (maize, beans and greengram).
C - upland crops only (cotton, maize, beans and groundnuts).

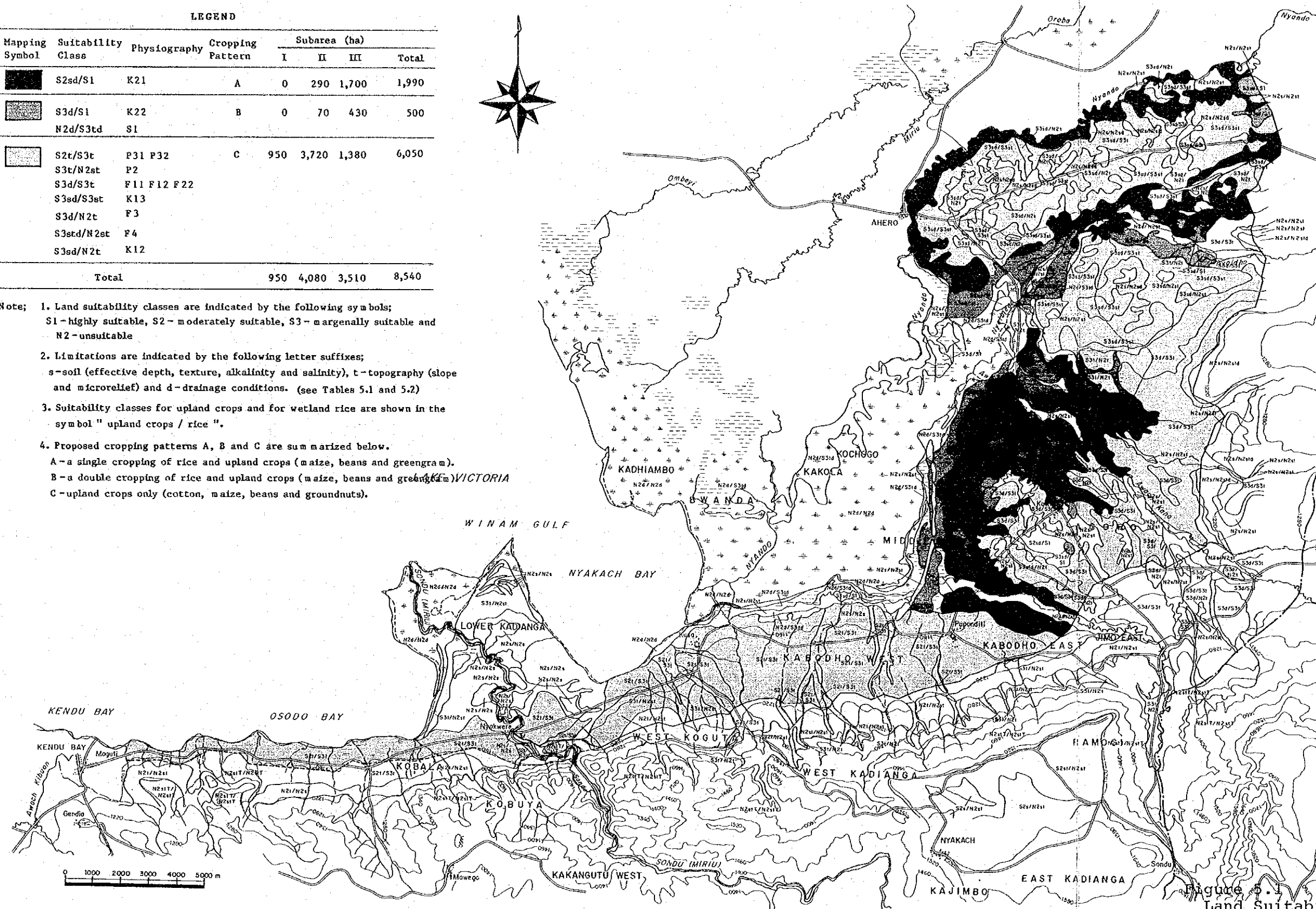


Figure 5.1
Land Suitability
Classification Map

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APPENDIX IV. AGRICULTURE AND AGRO-ECONOMIC STUDY

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Chapter 1. GENERAL

The studies on agriculture and agricultural economy were undertaken (i) to clarify present constraints for agricultural development in the project area, (ii) to assess the agricultural potential and (iii) to make the optimum agricultural development plan for the maximum exploitation of the potential.

For these, the following field investigation and data collection were made in and around the project area:

- (1) Data collection on socio-economic data including population, labour force, tenurial status, farm size, etc.,
- (2) Collection of data and information on present agricultural production including crops being grown, present cropping pattern, crop yield and production, farming practices, etc.,
- (3) Data collection on current marketing systems and prices of agricultural commodities,
- (4) Collection of data on existing agricultural support systems including agricultural extension, research, credit, farm inputs supplies and farmers' cooperatives, and
- (5) Present land use survey using topographic map of 1/50,000 and aerial photographs and making field reconnaissance.

The data and information were mainly obtained from the government authorities concerned such as Office of Provincial Director of Agriculture at Nyanza Province, District Agricultural Offices at Kisumu and South Nyanza, Divisional Agricultural Extension Offices at Nyakach, Nyando, Oyugis and Kendu, National Irrigation Research Stations at Ahero and Mwea, National Agricultural Research Stations at Kitale, Kakamega, Kibos and Kisii, Kenya Farmers Association, National Cereals and Produce

Board, Cotton Lint and Seed Marketing Board at Kisumu. The data and information collected and referred are listed in Table 2.1.

In addition, a field reconnaissance was made in and around the project area to supplement and confirm the collected data and information, being paid emphasis on farming practices and farmers' intention concerning to the irrigation development.

Chapter 2. PRESENT CONDITION OF AGRICULTURE

2.1 Location

The project area is 13,980 ha comprising three sub-areas. Administratively it belongs to Nyakach Division of Kisumu District and Kendu Division of South Nyanza District. About 90% of the area is located in Nyakach Division. The project area is defined by administrative jurisdiction as seen below:

(Unit : ha)

Project area	District	Division	Location	Area
Sub-area I	South Nyanza	Kendu	Wang Chieng	1,790
Sub-area II	Kisumu	Nyakach	West Nyakach	5,010
			North Nyakach	2,180
Sub-area III	Kisumu	Nyakach	North Nyakach	5,000
Total				13,980

2.2 Human Resources

The population and its distribution in and around the project area are shown in Table 2.2. The demographic features in the area are characterized by rather wide variation of population densities by Sub-location and high rate of female population. Generalizing and applying the population density at Location level, the population in the project area is estimated at 26,990 as of 1979. (see Figure 2.1)

According to Kenya Population Census, the population in Kenya is growing with a rapid pace at 3.4% per annum. More recent study by Nairobi University concluded annual population growth rate is at about 4%.

The age structure of the population in Kisumu District is shown in Table 2.3. The working population (15-59 years old) in Kisumu District occupies about 49% of the total population. Since average family comprises 5.1 persons per household, about 2.6 persons are expected as labour force for each household. The estimation of demographic condition in the project area is summarized below:

Description	Sub-area			Total/ Average
	I	II	III	
Project Area (ha)	1,790	7,190	5,000	13,980
Population Density (person/km ²)				
North Nyakach	-	186	186	
West Nyakach	-	195	-	193
Wang Chieng	216	-	-	
Population in the Project Area	3,870	13,820	9,300	26,990
No. of Household per km ²	36	41	41	40
No. of Household in the Project Area	660	2,950	2,050	5,660

2.3 Land Resources

The land suitability classification carried out in the project area concludes that 10,680 ha of arable lands suitable for the proposed irrigation farming.

The soils covering the project area are broadly classified into two groups according to their physiography and geological origins. On the foot slope and the piedmont plain, Sub-areas I and II, formed adjacent to the Nyabondo escarpment, Eutric Regosols and Chromic Cambisols are predominant. They are characterized by their reddish deep profiles. Due to unconsolidated medium to coarse texture and low groundwater

table, the internal drainage condition is well.

They are rather favourable for upland crops. Since they are very susceptible to erosion, the soil conservation measures are required and the current over-grazing should be minimized under the well-planned livestock development.

On the other hand, most part of Sub-area III extend to the Kano plain which is covered by the lowlying lacustrine deposit originating from Lake Victoria. The major soils are so-called "Black cotton soils", being classified into Pellic Vertisols. Their profile consists of black friable clay partly showing deep vertical cracks. Being richly endowed with inherent fertility, they are highly suitable for irrigated paddy. Because of poor drainage and frequent overflowing of small streams and creeks traversing the plain, the area often suffer from seasonal flooding.

2.4 Present Land Use

Primarily the economy of the people in the project area is dependent on agriculture and on animal husbandry at subsistence level. Almost of land in the area is developed rainfed agricultural land for upland crops, and the very limited area is developed for paddy field with small-scale irrigation under the management of Provincial Irrigation Unit. Maize and sorghum are cultivated as the main crops to supply staple food in the area. Cotton is the predominant cash crop. Beans, peas, sweet potato, cassava, ground nut, etc. are also cultivated. The land in the area is mainly used for those crop cultivation and grazing for cattle, sheep and goats.

Present land use in the command area is summarized below:

Land Use	(Unit : ha)			Total
	Sub-area			
	I	II	III	
A. Project Area	1,790	7,190	5,000	13,980
B. Unsuitable Area for Irrigation	600	2,090	610	3,300
C. Commanded Area (A - B)	1,190	5,100	4,390	10,680
1. Arable land:	540	1,340	1,150	3,030
Upland crops	240	550	450	1,240
Paddy field	0	0	130	130
Fallow	300	790	570	1,660
2. Natural vegetation:	420	3,000	2,610	6,030
Tree and bush	120	900	400	1,420
Grass (Grazing)	300	2,100	2,210	4,610
3. Others	230	760	630	1,620
Total	1,190	5,100	4,390	10,680

About 3,030 ha or 30% of the total land of the commanded area are arable land which are used for crop cultivation and grazing at present. Out of the total arable land, only 1,370 ha are cropped in a year on an average, mainly in the long rainy season (March to May), and the rest of the arable land is usually left as fallow. The natural vegetation of tree and bush, and grass land are sources of fuel wood and grazing pasturage.