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**NGWAZI ESTATE
MUFINDI, TANZANIA**

**REPORT ON SOILS AND WATER
RESOURCES, WITH SPECIAL
REFERENCE TO THE DEVELOPMENT
OF IRRIGATED TEA
PART 1: SOILS AND LAND SUITABILITY**

ANNEX 1, ANNEX 2 and ANNEX 3

NOVEMBER 1993

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ANNEX 1

**SUMMARY DATABASE
OF SOIL AUGER
DESCRIPTIONS**

ANNEX 1

Summary Database of Soil Auger Descriptions

Annex 1.2

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE & SHAPE	LAND USE	TOPSOIL (0 - 10 cm)		UPPER SUBSOIL (55 - 65 cm)		LOWER SUBSOIL (180 - 200 cm)		Fe NODULE DEPTH cm
							COLOUR	TEXTURE	pH	COLOUR	TEXTURE	COLOUR	
C3/34495635	R14	Nz	S1	>200	<1 str	Py	vdkgB	hSL	4.37	mSCL	rY	fSCL	
C3/34625650	R13	Nz	S1	>200	1 str	Py	dkgB	mSCL	4.74	mSCL	rY	fSCL	
C3/34685696	R134	Nz(m)	S1	>210	1 str	Py	vdkg	(h)mSL	5.46	fSCL	Y	fSCL	200
C3/34765665	R12	Nz	S1	>270	1 str	Py	dkgB	mSL	5.16	mSCL	rY	fSCL	
C3/34875680	R11	Nz(m)	S1	>245	1 str	Py	dkgB	mSL	4.88	mSCL	rY	fSCL	
C3/34905609	C13	Nz	S1	>200	1 str	Py	dkgB	mSCL	5.07	mSCL	rY	fSCL	
C4/34035708	R27	Nz	S1	>250	0	Py	dkG	(h)SL	5.57	mSCL	rY	CL	
C4/34065781	R139	-	S2m	>210	0	Py	dkG	LmS	5.03	LmS	bY	mSCL	
C4/34185719	R28	Nz	S1	>210	0	Py	dkgB	mSL	4.44	mSCL	lYB	mSL	
C4/34205780	R138	Nz(m)	S1	>190	<1	Py	vdkgB	mSCL	5.83	mSCL	bY	fSCL	
C4/34345730	R29	Nz(m)	S1	>150	2 str	Py	dkgB	mSCL	6.03	mSCL	rY	fSCL	
C4/34445783	R137	Nz	S1	>210	3 cx	Py	dkgB	mSCL	4.78	mSCL	-	-	
C4/34575721	R135	Ng	S2d	>210	1 str	Py	vdkg	mSL	5.34	mSL	rY	fSCL	
C4/34685793	R117	Nz	S1	>240	3 str	Py	dkgB	mSCL	5.21	CL	Wh	ZCL	
C4/34925750	R126	Ng	S2d	>180	2 cx	Py	vdkg	hmSCL	5.16	mSCL	rY	fSCL	
C5/34725850	C134	Nz	S2	>200	2 str	Py	dkgB	mSL	4.88	mSCL	-	-	
C5/34815801	R116	Mk(d)	S2m	>210	3 cx	Pm	vdkgB	mSL	5.18	mSCL	rY	fSCL	
C5/34875879	C108	No(s)	N2r	95	2 str	Pm	vdkgB	LmS	5.09	mSCL	rY	C	175
C5/34885887	C109	Lg(d)	S3r	165	2 str	Pm	dkB	LmS	4.82	mSL	-	-	85
C5/34965813	R115	Mk(d)	S2m	>200	0	Py	dkgB	mSCL	5.03	mSCL	stB	fSCL	25
C6/34915909	C110	Nz(m)	S1	>220	2 str	Pm	vdkgB	mSL	5.54	fSCL	rY	C	135
C6/34955968	C113	Lg(s)	S3r	90	4 str	Pm	dkgB	mSL	5.05	SCL	-	-	45
C6/34955993	C70	Nz	S1	>290	10 cx	Py	dkgB	mSL	5.08	mSCL	rY	mSC	
C6/34965933	C111	Bc	N1d	205	3 str	Pm	vdkgB	hLmS	5.01	mSL	G	LcS	
C6/34965947	C112	Ng	S2d	>240	3 str	Pm	vdkgB	mSL	4.92	mSC	Y	fSCL	
C7/34976014	C114	Nz	S1	>300	3 str	Py	vdkgB	mSCL	6.07	fSCL	stB	fSCL	
D2/35065526	C24	Nz	S1	>290	1 str	Py	dkB	mSL	4.68	mSCL	rY	CL	
D2/35245529	C25	Nz(m)	S1	>220	4 str	Py	dkgB	mSL	5.75	mSCL	rY	fSCL	
D2/35255565	R157	Nz	S1	>200	0	Py	vdkgB	mSL	5.10	mSCL	rY	fSCL	
D2/35425533	C26	Kg	S2d	>260	4 str	Py	vdkg	hmSL	5.12	mSCL	Y	fSCL	
D2/35615536	C27	Kg	S2d	>120	5 str	Py	dkB	mSL	4.94	mSCL	-	-	
D2/35775592	R156	Nz	S1	>210	1 str	Py	dkgB	mSCL	5.03	mSCL	rY	fSCL	
D3/35005694	R10	Nz(m)	S1	>205	1 str	Py	dkgB	mSCL	5.09	mSCL	Y	fSCL	
D3/35025633	C10	Nz	S1	>230	1 str	Py	dkgB	mSL	5.54	mSCL	bY	mSC	
D3/35155641	C11	Nz	S1	>300	1 str	G	dkB	mSL	4.97	mSCL	rY	fSCL	
D3/35225657	C12	Nz	S1	>200	1 str	Py	dkB	mSCL	4.58	mSCL	rY	CL	

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE ° & SHAPE	LAND USE	TOPSOIL (0 - 10 cm)		UPPER SUBSOIL (65 - 65 cm)		LOWER SUBSOIL (180 - 200 cm)		Fe NODULE DEPTH cm
							COLOUR	TEXTURE	COLOUR	TEXTURE	COLOUR	TEXTURE	
D3/35415668	C9	Nz	S1	>240	1 str	Py	dkB	mSCL	B	fSCL	rY	C	
D3/35535683	C8	Nz	S1	>300	2 str	Py	dkB	mSCL	yB	mSCL	yB	CL	
D3/35665614	R155	Nz	S1	>210	<1	Py	dkgB	mSCL	B	mSCL	rY	CL	
D3/35905684	C105	Nz	S1	>305	2 str	Py	dkgB	mSL	Yb	mSCL	rY	fSC	
D4/35045763	R125	Nz	S1	>250	1 str	Py	vdkg	mSCL	yB	mSCL	rY	fSCL	
D4/35165707	R9	Kg(d)	S2d	>250	<1 str	Py	dkG	mSL	B	mSCL	Y	fSCL	110
D4/35205782	R124	Nz	S1	>210	1 str	Py	dkgB	mSCL	yB	mSCL	rY	fSCL	
D4/35315721	R8	Kg(d)	S2d	>270	<1 str	Py	dkG	mSL	B	mSCL	pY	fSCL	100
D4/35395791	R122	Nz	S1	>300	1 str	Py	B	mSL	B	mSCL	stB	fSCL	
D4/35445735	R7	Kg(d)	S2d	220	0	Py	dkgB	(h)SCL	B	mSCL	Wh	fSCL	95
D4/35485773	R123	Nz(m)	S1	>250	1 str	Py	dkgB	mSCL	B	mSCL	Wh	fSCL	
D4/35545753	R6	Kg(d)	S2d	205	<1	Py	vdkgB	mSCL	dkgB	mSCL	lRb	fSCL	150
D4/35625702	C7	Nz(m)	S1	>300	1 str	Py	dkB	mSL	yB	mSCL	bY	mSC	
D4/356645740	C107	Nz(d)	N1r	140	0	Py	vdkgB	mSL	B	mSCL	-	-	110
D4/35765711	C6	Nz(m)	S1	>240	1 str	Py	dkB	cSL	yB	mSCL	bY	mSC	
D4/35825702	C106	Nz(m)	S1	>280	2 str	Py	vdkgB	LoS	yB	mSCL	rY	fSC	
D4/35925732	C5	Nz(m)	S1	>290	2 str	Py	dkgB	mSL	dkyB	mSCL	bY	mSC	
D4/35955772	R133	Kg	S2d	>180	0	Py	dkgB	mSL	B	mSCL	-	-	
D4/35985756	R4	Nv(m)	S1	>280	2 str	Py	dkgB	mSCL	yB	mSCL	bY	fSCL	
D5/35015860	R118	Nz(m)	S1	>220	2 str	Py	vdkgB	mSCL	dkgB	mSCL	bY	CL	
D5/35095828	R114	Mk(d)	S2m	>170	3 cx	Py	dkgB	mSCL	B	mSCL	-	-	140
D5/35125849	R119	Mk(d)	S2m	>200	2 str	Pm	vdkgB	mSL	yB	mSCL	rY	mSCL	132
D5/35225845	R113	No(s)	N2r	75	3 cx	Py	dkgB	mSCL	B	mSCL	-	-	60
D5/35235827	R120	Mk(d)	S2m	>210	0	Py	dkgB	mSL	yB	mSCL	-	-	145
D5/35315818	R121	Nz	S1	>210	1 str	Py	vdkgB	mSL	B	mSCL	rY	fSCL	
D5/35355857	R112	Nz	S1	>300	3 cx	Py	vdkg	mSCL	B	fSCL	rY	fSCL	
D5/35505869	R111	Kg(d)	S2d	>180	4 str	Py	dkgB	mSL	B	mSCL	rY	fSCL	
D5/35585840	R128	Nz	S1	>210	2 str	Py	dkgB	mSCL	B	mSCL	bY	mSL	115
D5/35655870	R110	Mk(d)	S2m	>260	4 str	Py	dkgB	mSL	stB	fSCL	stB	fSCL	190
D5/35705819	R129	Nz(m)	S1	>210	3 str	Py	dkgB	mSCL	dkgB	mSCL	yR	fSCL	
D5/35865870	C97	Nz	S1	>210	4 cx	Pm	dkB	mSL	B	mSCL	bY	mSCL	
D5/35905855	C98	Nz(m)	S1	>220	6 str	Pm	dkB	mSL	yR	fSC	rY	CL	
D5/35925828	R130	Nz(m)	S1	>250	3 str	Py	dkgB	mSL	B	mSL	bY	mSCL	
D5/35965885	C94	Lg(s)	S3r	210	2 cx	Py	dkB	cSL	rY	CL	rY	C	30
D5/35985898	C95	Lg(d)	S3r	>220	1 cx	Py	dkB	mSCL	B	fSCL	Y	cSCL	125
D6/35105984	C69	Nz	S1	>270	6 str	Py	dkB	mSL	stB	fSCL	rY	CL	230

ANNEX 1

Summary Database of Soil Auger Descriptions

Annex 1.4

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE & SHAPE	LAND USE	TOPSOIL (0 - 10 cm)		UPPER SUBSOIL (55 - 65 cm)		LOWER SUBSOIL (180 - 200 cm)		Fe NODULE DEPTH cm
							COLOUR	TEXTURE	COLOUR	TEXTURE	COLOUR	TEXTURE	
D6/35225973	C68	No(s)	N2r	70	5 str	Py	dkgB	mSL	B	fSCL	-	-	70
D6/35405952	C71	Lg(d)	S2r	180	5 cx	Pm	dkB	mSL	stB	fSCL	rY	fSCL	
D6/35435983	C67	Nz	S1	>305	3 str	Py	dkB	fSL	rB	fSCL	rY	CL	
D6/356335902	R127	Nz	S1	>310	2 str	Py	vdkgB	mSCL	B	vfSCL	rY	vfSCL	
D6/35785962	C72	Nz	S1	>210	0	Py	dkB	mSL	rY	fSCL	stB	CL	
D6/35805975	C73	Nz	S1	>260	0	F	B	mSL	stB	mSCL	rY	CL	
D6/35995970	C74	No(s)	N2r	95	2 cx	Py	dkyB	mSL	rY	CL	-	-	55
D7/35326019	C115	Mk(d)	S2m	185	5 cx	Py	dkgB	mSCL	rY	fSCL	-	-	135
D7/35536000	C66	Mk(s)	S3m	>185	3 cx	Py	dkB	mSL	B	fSCL	rY	C	85
D7/35696061	R77	No(s)	N2r	58	2 str	Py	dkgB	mSCL	stB	cSCL	-	-	58
D7/35736007	C65	Mk(d)	S2m	280	0	Py	dkgB	fSL	stB	fSCL	rY	CL	200
D7/35856083	R78	No(d)	N1r	120	2 str	Py	B	CL	rY	CL	-	-	70
D7/35866023	C64	Lg(s)	S3r	60	1 cx	Py	dkB	mSCL	stB	CL	-	-	35
D7/35866048	R76	Mk(d)	S2m	>190	1 str	Py	dkgB	mSL	B	mSCL	stB	mSC	120
E3/36085659	C55	Nz	S1	>300	<1	Py	dkgB	mSL	yB	mSL	rY	CL	
E3/36235675	C56	Nz	S1	>200	<1 str	Py	dkgB	mSL	B	mSCL	rY	fSCL	
E3/36245649	C104	Nz	S1	>305	2 str	Py	dkgB	mSL	stB	CL	rY	fSCL	
E3/36395689	C57	Nz	S1	>300	-	Py	vdkgB	mSL	yB	mSCL	rY	fSCL	
E3/36405636	C103	Nz	S1	>300	3 str	Py	dkB	mSL	yB	mSCL	rY	fSCL	
E3/36535634	C102	Nz	S1	>300	3 str	Py	B	mSL	stB	mSCL	rY	CL	
E3/36545628	C101	No(s)	N2r	90	3 cx	Py	dkgB	mSL	yB	mSCL	rY	CL	
E3/36595625	C100	Kg	S2d	>305	6 cx	Py	dkgB	cSL	lyB	mSCL	rY	CL	55
E3/36655623	C99	Bc	N1d	110	0	G	dkgB	cSL	lyB	fSCL	Wh	vfSCL	
E4/36455709	C58	Nz	S1	>300	1 str	Py	vdkgB	mSL	yB	mSL	rY	CL	
E4/36575726	C59	Nz	S1	>210	2 str	Py	dkgB	mSL	B	mSCL	rY	CL	
E4/36635735	C60	Nz	S1	>300	1 str	Py	dkgB	mSL	yB	mSCL	rY	CL	
E4/36685786	C119	Bc	N1d	170	2 cv	Py	dkgB	fSCL	yB	CL	-	-	
E4/36715759	C61	Nz	S1	>210	2 str	Py	vdkgB	mSL	stB	fSCL	rY	CL	
E4/36835773	C62	Nz	S1	>310	2 str	Py	dkgB	mSL	stB	mSCL	rY	CL	
E4/36875779	C116	Nz	S1	>300	3 cx	Py	dkB	mSL	yB	fSCL	rY	CL	
E4/36915788	C117	Kg(d)	S2d	255	2 cx	Py	dkgB	mSL	B	fSCL	rY	fSCL	
E4/36935791	C118	Bc	N1d	70	0	S	Bk	P	vdkgB	ISC	-	-	
E5/36165878	C93	Lg(s)	S3r	125	0	Py	vdkgB	hcSL	rY	CL	-	-	15
E5/36235834	R131	Nz	S1	>250	4 cx	G	vdkg	mSL	stB	mSCL	rY	fSCL	
E5/36255831	R132	Ng	S2d	>150	6 cx	G	vdkg	hmSL	B	mSCL	-	-	
E5/36355887	C92	Mk(s)	S3m	>220	2 cx	Py	dkB	mSL	rB	mSCL	rY	CL	25

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE & SHAPE	LAND USE	TOPSOIL (0 - 10 cm)			UPPER SUBSOIL (65 - 65 cm)			LOWER SUBSOIL (180 - 200 cm)			Fe NODULE DEPTH cm
							COLOUR	TEXTURE	pH	COLOUR	TEXTURE	pH	COLOUR	TEXTURE	pH	
F5/37745861	R69	He(d)	S2en	>210	9 str	W	dkB	CL	5.30	rB	C	4.60	R	C		
F5/37745872	R68	He(d)	S2en	>210	4 cx	W	B	CL	4.14	YR	CL	4.03	R	CL		
F5/37775884	R67	He(d)	S2en	>300	4 cx	G	vdkgB	CL	5.07	stB	CL	5.07	rY	SC		
F5/37825896	R66	He(g)	S2en	295	3 cx	W	dkgB	CL	4.88	stB	CL	5.11	R	mSCL		130
F6/37045990	R95	Kg(d)	S2d	175	2 str	C	dkG	mSL	5.70	B	mSL	5.09	-	-		
F6/37135981	R96	Kg(d)	S2d	>220	2 str	C	dkG	mSL	6.40	B	mSCL	5.23	Y	mSCL		
F6/37145938	R104	Kg(d)	S2d	>210	3 cx	C	dkG	mSL	6.63	gB	mSCL	5.02	IG	mSCL		
F6/37205957	R105	No(s)	N2r	35	2 cx	C	vdkgB	mSCL	5.20	-	-	-	-	-		30
F6/37265937	R103	Nz(g)	S1	>300	3 str	G	vdkgB	mSL	5.02	B	mSCL	4.82	rY	fSCL		240
F6/37315913	R102	Nz(g)	S1	276	1 str	Co	vdkgB	mSCL	4.94	stB	mSCL	3.97	rY	fSCL		276
F6/37365949	R100	Nz	S1	>270	4 cx	G	dkgB	mSCL	5.12	B	mSCL	5.50	stB	fSCL		
F6/37375998	R92	Mk(d)	S2m	205	0	C	dkG	mSL	6.24	B	cSCL	5.62	YB	mSCL		170
F6/37395976	R99	Mk(s)	S3m	>210	4 str	G	dkgB	mSCL	5.61	stB	mSCL	5.38	stB	mSCL		100
F6/37485994	R98	Nz	S1	>300	4 str	G	vdkgB	L	5.60	B	CL	5.71	rY	fSCL		
F6/37535960	R106	Mk(d)	S2m	>210	3 str	G	vdkgB	fSCL	5.25	stB	fSCL	5.16	stB	fSCL		165
F6/37635923	R109	Nz(m)	S1	>300	1 str	G	vdkgB	mSL	4.94	stB	mSCL	5.54	rY	fSCL		170
F6/37645939	R108	Nz	S1	>300	1 str	G	vdkgB	mSCL	5.26	B	CL	5.61	YR	fSCL		
F6/37715959	R107	Nz	S1	>300	2 str	G	dkB	CL	4.65	stB	fSCL	4.66	YR	fSCL		
F6/37875904	R65	No(s)	N2r	30	2 str	W	dkgB	mSCL	4.81	-	-	-	-	-		20
F6/37945916	R64	Mk(d)	S2m	240	0	G	dkgB	mSL	5.06	stB	mSCL	5.05	stB	CL		105
F7/37056043	C89	Ng	S2d	>240	4 cx	F	dkgB	LcS	5.73	B	cSL	5.22	Wh	cSL		
F7/37056079	C87	Ng	S2d	>300	2 str	G	dkgB	cSL	5.38	YB	mSCL	5.07	pY	mSCL		
F7/37096003	R93	No(d)	N1r	110	2 cx	C	dkgB	mSL	5.71	YR	mSCL	5.32	-	-		38
F7/37296067	C3	Nz(g)	S1	>280	2 str	F	dkB	mSL	5.16	rB	CL	5.29	YR	vISC		210
F7/37296078	C86	Nz(g)	S1	>240	2 str	F	dkgB	fSL	5.92	B	CL	5.74	YR	CL		220
F7/37336046	C90	Nz(m)	S1	>150	2 str	F	dkyB	mSL	4.65	stB	mSCL	4.80	-	-		
F7/37346093	C84	Kg(s)	S2d	>210	4 str	F	dkgB	cSL	5.72	dkyB	mSCL	5.20	IG	mSCL		170
F7/37446063	C85	Lg(d)	S3r	170	2 str	F	dkgB	fSL	5.63	stB	fSCL	5.28	rY	mSC		
F7/37486099	C80	Kg(d)	S2d	>210	3 str	F	vdkgB	hLcS	6.34	B	cSL	5.91	pY	cSCL		
F7/37546019	R97	Lg(d)	S2r	>310	2 str	G	vdkgB	mSCL	5.20	YR	CL	5.40	YR	C		160
F7/37556013	R91	Mk(d)	S2m	188	0	G	dkgB	mSL	6.32	stB	mSCL	5.77	YR	mSCL		135
F7/37556023	R90	Mk(d)	S2m	180	1 str	G	dkgB	mSCL	5.85	B	mSCL	5.59	rY	fSCL		180
F7/37586057	C76	Mk(s)	S3m	>220	2 str	F	vdkgB	mSL	6.00	stB	fSCL	5.42	rY	CL		50
F7/37606035	R89	Mk(d)	S2m	>200	2 cx	G	dkgB	mSCL	5.35	B	mSL	5.21	bY	mSCL		135
F7/37616045	R88	Nz(g)	S1	>305	2 str	G	dkgB	mSL	4.99	stB	fSCL	5.41	rY	fSCL		295
F7/37676085	C79	Nz(g)	S1	250	3 str	G	vdkgB	fSL	6.19	B	fSCL	5.79	YR	fSC		220

Summary Database of Soil Auger Descriptions

GRID SQUARE /REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE ° & SHAPE	LAND USE	TOPSOIL (0 - 10 cm) COLOUR TEXTURE	PH	UPPER SUBSOIL (55 - 65 cm) COLOUR TEXTURE	PH	LOWER SUBSOIL (180 - 200 cm) COLOUR TEXTURE	Fe NODULE DEPTH cm
F7/37696066	C77	No(s)	N2r	45	3 str	F	dkGB	6.02	-	-	-	30
F7/37776076	C78	Mk(s)	S3m	>300	4 str	G	rB	5.15	YR	5.50	CL	95
F7/37916065	R3	No(s)	N2r	25	3 cx	G	vdkgB	6.59	stB	5.71	-	25
F8/37146147	C83	Bc	N1d	>80	0	S	vdkg	4.82	vdkg	5.53	-	
F8/37286131	C82	Bc	N1d	60	0	S	vdkg	5.41	vdkg	5.83	-	
F8/37416118	C81	Bc	N1d	70	0	S	vdkg	4.84	dkG	4.86	-	
G1/38185493	C139	Nz	S1	>200	5 cx	C	dkB	4.95	yB	4.60	CL	
G1/38345477	C140	Nz(m)	S1	>200	4 cx	G	dkGB	4.80	yB	5.44	fSCL	
G1/38535492	R30	Mk(s)	S3m	150	2 cx	F	vdkg	5.64	lyB	6.01	-	57
G1/38805486	R31	Bc	N1d	>310	1 cv	F	vdKB	5.76	dkG	5.35	mSCL	
G1/38975466	R51	Bc	N1d	>310	2 cv	G	Bk	5.91	Bk	5.90	Wh	
G2/38025518	C120	Nz(m)	S1	>210	3 str	C	vdkgB	5.93	B	5.48	cSCL	
G2/38095587	R58	Nz	S1	>310	3 cx	Co	dkGB	5.00	B	4.96	fSCL	
G2/38145530	C123	Nz(m)	S1	>210	2 str	C	dkGB	3.36	dkyB	4.90	mSCL	
G2/38285578	R57	Nz	S1	>310	1 str	G	dkGB	4.92	B	4.40	fSCL	
G2/38425548	C125	Nz	S1	>210	3 str	G	vdkgB	6.15	B	6.11	fSCL	
G2/38545507	C133	Nz(m)	S1	>210	2 str	Gu	dkB	4.94	yB	5.54	fSCL	
G2/38555535	R5	Nz	S1	>300	0	C	dkGB	5.33	B	5.19	fSCL	
G2/38565586	R56	Nz	S1	>210	0	G	vdkg	5.07	vdkgB	5.34	CL	
G2/38595515	C132	Nz	S1	>300	1 str	W	vdkgB	5.27	B	5.14	fSCL	
G2/38655526	C131	Nz	S1	>210	1 str	W	vdkgB	4.64	B	5.28	CL	
G2/38725539	C130	Nz	S1	>200	1 str	G	dkGB	5.12	yB	4.96	fSCL	
G2/38795549	C129	Nz	S1	>300	1 str	W	dkB	3.99	yB	4.67	CL	
G2/38865563	C128	Nz	S1	>200	1 str	G	dkB	4.86	stB	4.71	CL	
G2/38945576	C127	Nz	S1	>300	1 str	G	dkGB	4.18	yB	4.57	fSCL	
G2/58285539	C124	Nz	S1	>210	3 str	G	dkGB	5.01	yB	5.01	fSCL	
G3/38555698	R39	Ng	S2d	>450	4 cx	Tm	dkGB	4.45	yB	3.91	vfSCL	
G3/38565626	R42	Nz	S1	>310	2 str	C	dkG	5.03	B	4.24	fSCL	
G3/38665694	R38	Kg(d)	S2d	>240	2 cx	Tm	dkG	5.20	yB	4.58	fSCL	
G3/38765611	R43	Nz	S1	>210	2 str	G	dkGB	4.73	B	4.18	fSCL	
G3/38775691	R37	Nz	S1	>300	2 str	Ty	dkGB	4.68	B	4.94	fSCL	
G3/38885686	R36	Nz	S1	>210	2 str	Ty	dkGB	5.45	B	5.08	fSCL	
G3/38925601	R44	Nz	S1	>450	0	G	dkGB	4.50	yB	4.45	fSCL	
G4/38505701	R41	Bc	N1d	>210	1 cv	Ty	dkGB	4.44	B	4.50	fSCL	
G4/38525700	R40	Ng	S2d	>210	4 cx	Ty	dkGB	4.42	yB	4.01	fSCL	
G4/38785744	R70	Ng	S2d	>220	2 cx	Ty	vdkg	5.28	dkG	4.61	mSCL	

Summary Database of Soil Auger Descriptions

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE ° & SHAPE	LAND USE	TOPSOIL COLOUR	TOPSOIL TEXTURE (0 - 10 cm)	PH	UPPER SUBSOIL COLOUR	UPPER SUBSOIL TEXTURE (55 - 65 cm)	PH	LOWER SUBSOIL COLOUR	LOWER SUBSOIL TEXTURE (180 - 200 cm)	Fe NODULE DEPTH cm
G4/38855713	R48	Nz	S1	>310	2 cx	Ty	dkgB	mSCL	4.19	B	mSCL	3.61	rY	fSCL	
G4/38895738	R49	Nz	S1	>305	2 cx	Ty	dkG	mSCL	4.61	dkgB	mSCL	4.14	rY	fSCL	
G5/38775891	R164	Lg(d)	S2r	175	2 cx	M	rY	CL	5.16	rY	C	5.65	R	cSCL	175
G5/38955884	R163	Lg(d)	S2r	160	1 str	M	B	CL	5.16	rY	CL	5.39	R	cSCL	160
G6/38045933	R63	Nz	S1	>210	<1 str	G	dkgB	mSL	4.96	B	mSCL	4.64	rY	fSCL	
G6/38135951	R62	Mk(d)	S2m	>305	0	G	dkgB	mSL	5.14	B	mSL	4.82	rY	CL	180
G6/38235968	R61	Mk(d)	S2m	>210	0	G	dkgB	mSL	4.67	B	mSL	4.62	rY	CL	160
G6/38345986	R60	Mk(d)	S2m	250	0	G	dkgB	mSL	5.06	B	mSCL	4.95	rY	CL	160
G6/38555933	R165	Mk(d)	S2m	>170	2 str	W	B	CL	5.01	stB	CL	5.14	rY	CL	130
G7/38026049	C2	Mk(s)	S3m	>170	2 str	G	dkgB	hSL	5.70	stB	mSCL	5.67	-	-	70
G7/38266035	R2	No(s)	N2r	55	3 str	G	vdkgB	(h)SL	5.59	B	mSCL	5.40	rY	mSCL	55
G7/38306019	C1	Mk(s)	S3m	>300	3 str	G	dkgB	mSL	5.65	stB	mSCL	5.60	rY	cSCL	90
G7/38346004	R1	Nz(g)	S1	>300	1 cx	G	vdkgB	mSL	5.25	B	mSCL	4.89	rY	CL	260
H1/39055478	R52	Ng	S2d	>210	4 cx	G	vdkg	mSCL	4.37	dkG	mSCL	4.93	Wh	fSCL	
H1/39125491	R53	Nz	S1	>210	2 cx	G	vdkgB	mSCL	5.43	B	mSCL	5.40	rY	fSCL	
H1/39585475	C54	Nz	S1	>60	<1	Gu	vdkgB	mSL	5.05	yB	fSL	5.26	-	-	
H2/38855537	C47	Nz	S1	>300	2 str	W	dkgB	mSL	4.52	dkyB	fSCL	4.64	rY	fSCL	
H2/39015586	C126	Nz	S1	>300	1 str	G	dkB	fSCL	4.55	B	fSCL	4.77	rY	CL	
H2/39235507	R54	Nz	S1	>210	1 cx	G	dkG	mSCL	4.20	B	mSCL	4.30	rY	fSCL	
H2/39315522	R55	Nz	S1	>310	<1	G	dkgB	mSL	4.04	B	mSCL	4.30	rY	fSCL	
H2/39445547	R16	Nz	S1	>310	0	F	vdkgB	mSCL	5.59	B	mSCL	5.60	rY	fSCL	
H2/39555535	C44	Nz	S1	>300	0	W	dkB	mSL	5.72	yB	mSL	5.19	rY	CL	
H2/39605571	C43	Nz	S1	>220	<1	F	dkgB	mSL	5.76	yB	mSL	5.30	rY	fSCL	
H2/39705587	C42	Nz	S1	>280	2 str	F	dkgB	mSL	5.44	yB	fSCL	5.41	yB	fSCL	
H2/39725511	C45	Nz	S1	>200	1 str	F	vdkgB	mSL	5.37	yB	fSCL	5.31	rY	CL	
H2/39865520	C46	Nz(g)	S1	>300	2 cx	W	dkB	mSL	4.21	yB	fSCL	4.88	rY	CL	
H3/39005679	R35	Nz	S1	>210	2 str	Ty	dkgB	mSCL	4.92	B	mSCL	4.28	stB	fSCL	240
H3/39055622	R45	Nz	S1	>210	2 cx	G	dkgB	mSL	4.72	yB	mSL	3.61	stB	fSCL	
H3/39115674	R34	Nz	S1	>310	2 cx	Ty	dkG	mSL	5.27	B	mSCL	4.47	rY	fSCL	
H3/39215667	R33	Nz	S1	>210	1 str	Ty	dkgB	mSCL	5.06	yB	mSCL	4.40	rY	fSCL	
H3/39305664	R32	Nz	S1	>300	0	Ty	dkG	mSL	5.96	B	mSCL	5.06	rY	fSCL	
H3/39345602	R50	Nz	S1	>210	0	G	dkG	mSCL	4.52	B	mSCL	4.54	stB	fSCL	
H3/39485696	R47	Nz	S1	>310	1 str	Ty	dkG	mSCL	4.44	yB	mSCL	3.83	stB	fSCL	
H3/39835609	C41	Nz	S1	>240	1 str	F	dkB	hmSL	5.59	stB	fSCL	5.41	rY	CL	
H3/39935627	C40	Nz	S1	>300	1 str	F	dkB	mSL	4.36	yB	mSCL	5.05	rY	CL	
H4/39055798	C29	Kg	S2d	>300	3 cx	Ty	dkB	mSL	4.43	yB	mSCL	4.91	Y	fSCL	

ANNEX 1

Summary Database of Soil Auger Descriptions

Annex 1.9

GRID SQUARE REFERENCE	BORE NO.	SOIL TYPE	SUITABILITY CLASS for TEA	ROOTING DEPTH cm	SLOPE ° & SHAPE	LAND USE	TOPSOIL (0 - 10 cm) COLOUR	TEXTURE	pH	UPPER SUBSOIL (55 - 65 cm) COLOUR	TEXTURE	pH	LOWER SUBSOIL (180 - 200 cm) COLOUR	TEXTURE	Fe NODULE DEPTH cm
H4/39175780	C30	Nz	S1	>300	1 str	Ty	dkGB	mSL	5.06	yB	mSL	4.87	rY	fSC	
H4/39315771	C31	Nz	S1	>300	1 str	Ty	dkGB	mSL	5.24	yB	fSCL	5.04	rY	fSC	
H4/39505762	C32	Nz	S1	>310	<1	Ty	dkGB	mSL	4.43	yB	mSL	4.81	rY	fSCL	
H4/39615717	R46	Nz	S1	>210	<1	Ty	vdkg	mSCL	5.93	B	mSCL	5.13	rY	fSCL	
H4/39715758	C33	Nz	S1	>300	1 str	G	dkGB	mSL	5.73	yB	mSL	5.15	rY	CL	
H4/39815748	C34	Nz	S1	>220	1 str	Gu	vdkgB	hcSL	5.74	yB	mSCL	5.36	rY	fSC	
H4/39945728	C135	Nz	S1	>200	2 str	G	dkB	mSL	5.49	stB	mSCL	5.22	stB	mSCL	
H4/39985702	C136	Nz	S1	>200	<1 str	F	dkB	hmSCL	5.03	dkyB	mSCL	5.23	rY	fSCL	
H5/39035807	C28	Bc	N1d	160	2 str	Ty	vdkgB	mSL	4.92	B	mSCL	4.88	Wh	fSC	
H5/39035847	R161	He(g)	S2en	>210	4 cx	W	dkB	mSCL	4.94	rB	CL	5.26	R	CL	45
H5/39125868	R162	Lg(s)	S3r	115	0	G	dkB	mSCL	5.12	yR	CL	5.40	-	-	38
H5/39415823	R160	Nz(m)	S1	>210	0	Ty	vdkg	mSL	5.71	B	mSL	5.30	bY	mSCL	
H5/39435838	R86	Nz	S1	>300	2 str	Ty	dkGB	mSCL	4.67	yB	mSCL	4.64	stB	fSCL	
H5/39505827	R87	Nz	S1	>200	1 cv	Ty	dkGB	mSL	4.24	B	mSL	4.63	yB	mSCL	
H5/39565818	R159	Nz	S1	>200	<1	Ty	dkGB	mSL	4.31	B	mSCL	4.76	rY	fSCL	
J2/40075555	C48	Nz(m)	S1	>290	2 str	W	dkB	mSL	4.48	yB	mSCL	5.05	rY	CL	
J2/40155573	C49	Nz	S1	>220	1 str	F	dkGB	mSL	5.94	yB	mSCL	5.51	rY	fSCL	
J3/40015642	C39	No(d)	N1r	130	1	F	dkGB	mSL	4.97	yB	fSL	5.12	-	-	90
J3/40035684	C137	Nz(g)	S1	>280	2 str	F	dkGB	mSCL	4.65	yB	mSCL	4.91	rY	mSCL	270
J3/40125662	C38	No(d)	N1r	130	2 cx	F	dkGB	mSL	4.66	yB	mSCL	4.68	-	-	70
J3/40235679	C37	Kg(d)	S2d	>220	4 cv	F	vdkg	hmSL	5.33	dkGB	mSL	5.03	yB	mSCL	
J3/40265602	C53	Nz	S1	>190	2 str	Gu	dkGB	mSL	5.54	B	mSL	5.66	yB	fSCL	
J3/40405616	C52	Nz	S1	>210	2 str	Gu	vdkgB	mSL	4.89	yB	mSCL	4.41	rY	CL	
J3/40515635	C51	Nz	S1	>200	2 str	W	dkGB	mSL	4.21	dkB	mSL	4.98	yB	mSCL	
J3/40625654	C50	Nz	S1	>280	3 str	W	dkGB	mSL	5.79	yB	mSL	5.41	rY	fSC	
J4/40025732	C35	Nz	S1	>300	1 str	G	dkB	mSL	5.41	yB	fSL	5.31	rY	CL	
J4/40325701	C36	Nz(m)	S1	>275	0	Gu	dkGB	hmSL	5.19	vdkgB	hmSCL	5.07	rY	mSCL	

GRID SQUARE is according to the scheme indicated in Figure 2.2; the **REFERENCE** no. is that of the map coordinates.

BORE NO. was ascribed consecutively to each surveyor's investigations by auger, and locations are shown on the 1:10,000-scale Field Map.

SOIL TYPE symbol follows the classification explained in Table 3.1.

SUITABILITY CLASS FOR TEA is as explained in section 4.

ROOTING DEPTH in cm is that estimated for the tea plant; the > sign indicates that rooting should be able to extend beyond the augered depth.

SLOPE is given to the nearest degree, and slope **SHAPE** is allocated to straight or rectilinear (str), convex (cx) or concave (cv).

LAND USE: abbreviations used are:

W	Wattle	S	Swamp
G	Grassland	Co	Coffee (formerly)
Pm	Mature pine	Tm	Mature tea
Py	Young pine	Ty	Young tea
F	Fallow	Gu	Gums
C	Cultivated	M	Miombo woodland

SOIL COLOUR follows the Munsell notation; where alternative colour names are possible, only one is given. Abbreviations used are:

v	very	b	brownish	B	brown
dk	dark	g	greyish	G	grey
l	light	y	yellowish	Y	yellow
p	pale	r	reddish	R	red
st	strong			Bk	black
				Wh	white
				PK	pink

SOIL TEXTURE: abbreviations are as given in Appendix 2. Where a texture falls near a class boundary (e.g. mSL - mSCL), only the first texture class from the field notes is given (e.g. mSL).

pH was measured on a 10 g sample collected in a field-moist state and mixed with 10 ml distilled water. For Bore nos. prefixed with 'R' the value was obtained in the field; for those prefixed with 'C' the samples were taken to the U.K. and measured in the SSLRC laboratory.

Fe NODULE DEPTH gives the depth at which common or more frequently occurring iron nodules were first encountered in the soil.

ANNEX 2

**LABORATORY
ANALYTICAL METHODS**

ANNEX 2

LABORATORY ANALYTICAL METHODS

An2.1 INTRODUCTION

A proportion of the soil physical and chemical analyses were carried out at Silsoe and Shardlow in the U.K. by SSLRC following the methods described by Avery and Bascomb (1982), except where stated below. The bulk of the samples were analysed at Kericho in Kenya, the physical determinations by the Tea Research Foundation of Kenya and the chemical ones by Brooke Bond Kenya Ltd. Table An2.1 shows the source of the analytical data quoted in this report.

It is important to know which analytical method is used to understand the implications of any results. Analytical results can vary with field sampling procedures, but also with analytical procedures. Reasons for variability can be summarised (Landon 1991) under five headings:

1. *Pretreatment effects*, particularly time and temperature of drying, changes in microbiological conditions, and clay dispersion;
2. *Intrinsic errors in methods* – random errors of ± 2 to 15% can occur depending on the property being analysed;
3. *Operator errors*, such as incorrect preparation of standard solutions or incorrect calculations;
4. *Contamination effects*, most commonly by dust;
5. *Variation between laboratories*.

An2.2 ANALYTICAL METHODS

An2.2.1 Soil Physical Analyses

Particle-size distribution was determined on <2 mm peroxide-treated soil using buffered (pH9.5) sodium hexametaphosphate as a dispersing reagent. The suspension passing through a 63 μ m

sieve was sampled by pipette to determine the $<63\mu\text{m}$ (silt+clay) and $<2\mu\text{m}$ (clay) fractions. Sand fractions were collected on a nest of sieves, 600, 212, 106 and $63\mu\text{m}$ at Silsoe and 500, 250, 106 and $63\mu\text{m}$ at Kericho respectively.

Moisture retention

Undisturbed samples for bulk density and water-release measurements were taken using a special coring device (Dagg and Hosegood 1962) constructed to fit sampling tins 76 mm in diameter and 51 mm high. Three replicate cores were taken from each horizon sampled.

Bulk density of soil was calculated from the mass of oven-dry soil and its field volume.

Available water

The **total available water** of a soil has been calculated for horizons and for profiles according to procedures given by Hall *et al.* (1977). It is the difference between the retained water capacity at 0.1 bar suction, taken as equivalent to **field capacity**, and the water retained at 15 bar (1500 kPa or pF 4.2) suction, called the **permanent wilting point**, expressed as a volumetric percentage. It represents the amount of water in a soil available for plant uptake after excess moisture has drained away under the influence of gravity. A proportion of this water is considered to be more easily available to plants and a value for **easily available water** has been calculated using the water retained at 2 bar (200 kPa) as the lower limit.

Total porosity is calculated from the water content of the soil at saturation.

Air capacity can be calculated for each suction by subtracting the moisture retained from the total porosity value. It is given here for the field capacity state (0.1 bar).

Table An2.1 Guide to the samples and analytical laboratories used.

Soil Type (phase)	Symbol	Profile Code	Sample Code											
			1/A	2/B	3/C	4/D	5/E	6/F	7/G	8/H	9/J	10/K		
Nzivi	Nz	PR3	S	S	S	S	S	S	S	S/K				
Nzivi	Nz	PC1	K	K	K	K	K	K	K	K				
Nzivi	Nz	PC2	K	K	K	K	K	K	K	K				
Nzivi (mottled)	Nz (m)	PR4	K	K	K	K	K	K	K	K				
Nzivi (gravelly)	Nz (g)	PC4	K	K	K	K	K	K	K					
Makabila (deep)	Mk (d)	PC3	K	K	K	K	K	K	K	K	K	K		
Ngongwa (shallow)	No (s)	PC7	K	K/S										
Longstaff (deep)	Lg (d)	PC5	K	K	K	K	K	K	K					
Longstaff (shallow)	Lg (s)	PC6	K/S	K/S	K/S	K	K	K						
Hehe (deep)	He (d)	PR1	K	K	K	K	K							
Kihanga (deep)	Kg (d)	PR2	K	K	K	K	K	K	K	K	K	K	K	K
Ngwazi	Ng	RWP1990	S	S	S	S	S	S						
Ngwazi	Ng	PC8	K	K	K	K	K	K	K					

KEY	S	analysed by SSLRC, U.K.
	K	analysed in Kenya by BBK (chemical) and TRFK (physical)
	S/K or K/S	duplicate samples analysed by both labs; the first letter refers to the lab data presented below

An2.2.2 Soil Chemical Analyses

All soil chemical analyses were carried out on <2 mm air dried soil.

Soil pH was measured with a combined glass electrode in a 1:2.5 suspension of soil and deionised water. The suspension was stirred initially, allowed to equilibrate for one hour, stirred again, and the pH measured just above the sediment-water interface.

Organic carbon was determined by the Walkley Black wet combustion method using potassium dichromate in the presence of concentrated sulphuric acid at 120°C and titration of residual dichromate with ferrous sulphate (Hesse 1971) at Kericho. At Silsoe the acid dichromate method of Kalembasa and Jenkinson (1973) was used. This involved heating the mixture to its constant

boiling point of 165°C for 20 minutes. It is preferred to the Walkley-Black procedure because of its more precise control of the digestion temperature and, according to Kalembasa and Jenkinson, its more efficient digestion of carbon as evidenced by small coefficients of variation and near quantitative recovery of sucrose-carbon. Figures for organic carbon % can be converted to **organic matter %** by multiplying by 1.724.

Cation exchange capacity (CEC) was measured by leaching the soil with ammonium acetate buffered at pH 7.0, the excess ammonium ions being removed with ethanol, and the residual ammonium ions determined by steam distillation (USDA 1984) to give the cation exchange capacity.

Exchangeable cations (Ca Mg K Na) were extracted by 1M ammonium nitrate solution (MAFF 1986), and measured in the extract by atomic absorption spectrometry.

Aluminium was determined as that extractable to 1M potassium chloride solution (Hesse 1971) and was measured in the extract by atomic absorption spectrometry. It is reported as mg/kg. This can be converted to me/100g by dividing by 90.

Available phosphorus was extracted from soil by the Olsen method with a sodium bicarbonate solution of pH8.5 (Olsen *et al.* 1954) and determined in the extract colorimetrically as the blue phosphomolybdate complex.

ANNEX 3

SOIL PROFILES

**DETAILED DESCRIPTIONS
AND ANALYSES**

**WATER RELEASE
CHARACTERISTICS**

ANNEX 3

SOIL PROFILES

DETAILED DESCRIPTIONS AND ANALYSES

Twelve profiles were described and sampled in 1993. In addition R. W. Payton of SSLRC described and analysed the soil of the deep pit close to experiment N9 in 1990. The profiles are coded by surveyor and chronological order, but they are here grouped by soil type, in the sequence:

Soil Type (phase)	Symbol	Profile Code
Nzivi	Nz	PR3
Nzivi	Nz	PC1
Nzivi	Nz	PC2
Nzivi (mottled)	Nz (m)	PR4
Nzivi (gravelly)	Nz (g)	PC4
Makabila (deep)	Mk (d)	PC3
Ngongwa (shallow)	No (s)	PC7
Longstaff (deep)	Lg (d)	PC5
Longstaff (shallow)	Lg (s)	PC6
Hehe (deep)	He (d)	PR1
Kihanga (deep)	Kg (d)	PR2
Ngwazi	Ng	R W Payton 1990
Ngwazi	Ng	PC8

Note: The texture given for each horizon is that allocated by hand texturing in the field, and reflects the mechanical characteristics of the soil.

PROFILE PR3

Soil Type:	Nzivi Nz
F.A.O.:	Haplic Ferralsol
Described:	8 - 12 Feb 1993, R.G.O. Burton.
Location:	Ngwazi Block (Auger bore R45, Square H3, Grid ref 39055622), Ngwazi Estate, Mufindi, Tanzania.
Topography:	Flat, edge of broad interfluvium, falling to the NW towards Lake Ngwazi with average slope of 2°. Altitude 1880 m a.s.l.
Parent material:	Deeply and strongly weathered Basement Complex.
Land use and vegetation:	Fallow, being cultivated for tea planting.
Site drainage:	Good.
Surface:	Flattened.
Summary of profile:	Deep, friable, porous sandy clay loam, dominantly brown with medium grade sand passing to reddish with fine grade sand with depth.

PROFILE DESCRIPTION

Horizons:

cm	
0 - 20	Dark greyish brown (10YR 4/2.5 moist); stoneless medium sandy loam (p.s.c. sandy clay); moist; weak fine and medium subangular blocky structure, easily breaking to fine and medium granular; medium packing density; very porous; very weak ped strength; semi-deformable; slightly sticky; moderately plastic; many very fine fibrous roots; moderately acid; abrupt smooth boundary to:
20 - 40	Brown (7.5YR 5/3 moist); stoneless medium sandy clay loam (p.s.c. sandy clay); moist; very weak medium and coarse subangular blocky to massive structure; medium packing density; very to moderately porous; 5% very fine macropores and fissures; moderately weak; semi-deformable; non-sticky; moderately plastic; common very fine fibrous roots; moderately acid; clear smooth boundary to:
40 - 74	Brown (7.5YR 5/4 moist); stoneless medium sandy clay loam (p.s.c. clay); moist; weak coarse and medium subangular blocky structure, easily breaking to fine subangular blocky; medium packing density; very porous; moderately weak; semi-deformable; non-sticky; non-plastic; few very fine fibrous roots; infilling of root channels with material from above; moderately acid; clear smooth boundary to:
74 - 122	Brown to strong brown (8.5YR 5/5 moist); stoneless medium sandy clay loam (p.s.c. clay); moist; weak very coarse and coarse subangular blocky structure; medium to low packing density; very porous; 4% very fine and fine macropores; very weak ped strength; semi-deformable; non-sticky; moderately plastic; few very fine fibrous and medium woody roots; moderately acid; few very firm brittle concentrations of soil material, especially concentrated along base of horizon; abrupt smooth boundary to:

- 122 - 210 Reddish yellow (7.5YR 6/6 moist); stoneless medium to fine sandy clay loam (p.s.c. clay); moist; weak coarse and medium, easily breaking to fine granular structure; medium to low packing density; extremely porous; 5% very fine macropores; very weak ped strength; semi-deformable; non-sticky; non-plastic; few fine and medium woody roots; moderately acid; diffuse smooth boundary to:
- 210 - 249 Reddish yellow (6.5YR 6/6 moist); stoneless fine sandy clay loam (p.s.c. clay); moist; weak coarse and very coarse subangular blocky structure easily breaking to fine subangular blocky; medium packing density; moderately porous; 1% fine macropores; moderately weak; semi-deformable; non-sticky; moderately plastic; few very fine fibrous and fine woody roots; slightly acid; diffuse smooth boundary to:
- 249 - 302 Yellowish red to reddish yellow (5YR 5.5/6 moist); stoneless fine sandy clay loam (p.s.c. clay); moist; apedal massive, easily breaking down to fine granular structure; medium packing density; moderately porous; 1% very fine macropores and occasional medium vertical channel; moderately weak; semi-deformable; slightly sticky; very plastic; few fine woody roots; slightly acid; common amorphous nodules 5-10 mm diameter.

ANALYSES

Sample depth (cm)	PR3/1 0-20	PR3/2 20-40	PR3/3 40-74	PR3/4 74-122	PR3/5 122-210	PR3/6 210-249	PR3/7 249-302
Physical analyses:							
Sand coarse 600µm - 2mm %	7.5	5.4	5.6	4.8	4.8	4.7	6.9
medium 212µm - 600µm %	26.8	26.3	17.5	10.4	8.3	6.5	9.5
fine 106µm - 212µm %	10.0	11.1	8.0	6.1	6.4	6.1	10.5
v. fine 63µm - 106µm %	2.2	2.2	2.4	3.0	3.1	4.6	7.0
Silt 2µm - 63µm %	2.7	2.6	3.7	7.1	10.8	14.7	15.2
Clay < 2µm %	50.7	52.5	62.9	68.6	66.5	63.4	50.9
Chemical analyses:							
pH (1:2.5) in water	4.8	4.7	5.0	4.8	5.0	5.4	5.6
Organic Carbon %	1.5	1.1	0.9	0.9	0.5	0.2	0.3
P _{available} mg/kg	5.6	1.2	<0.05	<0.05	1.5	<0.05	<0.05
Al _{KCl extractable} mg/kg	60.1	59.5	46.9	33.7	8.4	5.5	6.6
Ca _{exchangeable} me/100g	0.5	0.1	0.1	0.2	0.2	<0.05	<0.05
Mg _{exchangeable} me/100g	0.1	<0.05	<0.05	<0.05	0.1	<0.05	<0.05
Na _{exchangeable} me/100g	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<0.05
K _{exchangeable} me/100g	0.3	0.1	0.1	0.1	<0.05	0.4	0.1
CEC me/100g	11.7	8.8	9.5	9.1	9.2	6.4	6.1

PROFILE PC1

Soil Type:	Nzivi Nz
F.A.O:	Haplic Ferralsol
Described and sampled:	6 and 8 Feb 1993, I.C. Baillie.
Location:	SW corner of Nzivi block (Auger bore C4, Square C2, Grid ref 34175532), Ngwazi Estate, Mufindi, Tanzania.
Topography:	Flat crest of broad, low interfluvium.
Parent material:	Deeply weathered Basement Complex, possibly colluvial.
Land use and vegetation:	Plantation forestry. Young <i>Pinus patula</i> , ca 3-5 m in height. Moderately dense grass cover (40-50 cm high).
Site drainage:	Good.
Surface:	Continuous grass litter; slight microrelief.
Summary of profile:	Deep, uniform, very brightly coloured reddish yellow sandy clay loam to clay loam.

PROFILE DESCRIPTION

Horizons:

- | cm | |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 - 0 | Grass and twig litter, no needles. |
| 0 - 7 | Very dark greyish brown (10YR 3/2 moist); humose loamy medium sand to sandy loam, moderate to weak fine crumb structure; many medium interpedal pores; moist and extremely friable, almost loose; non-sticky and non-plastic when wet; abundant fine and medium roots; gradual smooth lower boundary to: |
| 7 - 22 | Faintly contrasting mixed dark brown (10YR 3/3 moist) and brown to dark brown (10YR 4/3 to 7.5YR 4/3); medium sandy loam to loamy sand; moderate medium to fine crumb structure; many medium interpedal pores; moist and friable; non-sticky and non-plastic when wet; many fine and medium roots; clear smooth lower boundary to: |
| 22 - 44 | Brown to dark yellowish brown (9YR 4/4 moist), with common fine very faint yellowish brown mottles; medium sandy loam; common medium and coarse faunal and many fine pores; moist and firm, slightly compact; sticky and plastic when wet; common medium and fine roots; rare fine angular quartz grit; diffuse boundary to: |
| 44 - 82 | Yellowish brown (10YR 5/6 moist), with common medium distinct blotches of greyish brown (10YR 5/2) and dark greyish brown (10YR 4/2) in old faunal voids and channels, and few medium distinct strong brown (7.5YR 5/7) mottles; medium sandy loam to sandy clay loam; weak medium subangular blocky structure breaking to moderate fine to medium crumb; moist and slightly firm <i>en masse</i> , slightly compact, but friable when disturbed; slightly sticky and slightly plastic when wet; common fine and few medium roots; common angular quartz coarse sand to grit; common very fine rounded black ferrimanganiferous sand; diffuse boundary to: |

82 - 150 Reddish yellow (7.5YR 6/6 moist, strong brown 7.5YR 5/6 wet), with common medium faint dark greyish brown organic stains, and common very fine and very faint yellowish red mottles; medium sandy clay loam; extremely weak fine to medium subangular blocky structure breaking readily to moderate fine to medium crumb; many fine and medium pores; moist and friable *in situ*, very friable when disturbed; moderately sticky and moderately plastic when wet; common to many fine (more than horizon above) and few medium roots; rare medium to fine slightly harder nodules of very porous amorphous soil, colour very slightly browner than matrix; very rare fragments of yellow and yellowish red slightly hard weathering rock (up to 3 cm diameter); very diffuse lower boundary to:

150 - 290+ Reddish yellow (6YR 6/8 moist and wet), with common very fine very faint yellowish red mottles; clay loam; extremely weak medium subangular blocky structure breaking to weak fine to medium crumb, very patchy weak films (possibly moisture) especially against occasional quartz grit; many to abundant fine and medium pores; moist and very friable but with few nodules only slightly friable; sticky and plastic when wet; common fine and few medium roots (no decline with depth); few medium round nodules of slightly harder and browner (10YR 5/6, 7.5YR 5/6) soil, mostly amorphous but some with very weak laminations; few angular quartz coarse sand and grit, common fine black ferrimanganiferous sand.

Comment:

Prominent features include the contrast in the firm and slightly compact consistence at 22-82 cm (especially 22-44 cm) compared with the friable horizons above and beneath.

ANALYSES

Sample depth (cm)	PC1/A 0-7	PC1/B 10-20	PC1/C 25-35	PC1/D 58-68	PC1/E 110-120	PC1/F 175-199	PC1/G 255-275
Physical analyses:							
Sand							
500µm - 2mm %	25.1	25.4	18.0	12.0	9.8	8.4	11.3
250µm - 500µm %	18.4	19.9	19.0	12.2	11.0	7.0	7.7
106µm - 250µm %	9.2	9.7	10.3	8.2	8.1	8.8	9.4
63µm - 106µm %	1.1	1.0	1.1	1.3	2.2	4.6	3.8
Silt							
2µm - 63µm %	38.2	31.1	36.8	49.4	44.1	30.0	25.4
Clay							
< 2µm %	7.9	13.0	14.8	16.8	24.9	40.6	42.3
Chemical analyses:							
pH (1:2.5) in water	5.09	5.14	4.32	4.23	4.45	5.05	5.47
Organic Carbon %	1.94	1.16	0.96	0.64	0.28	0.19	0.20
P _{available} mg/kg	35	16	26	27	30	16	17
Al _{KCl extractable} mg/kg	4	26	77	40	3	2	2
Ca _{exchangeable} me/100g	2.45	1.01	0.39	0.32	0.05	0.01	0.02
Mg _{exchangeable} me/100g	1.07	0.62	0.33	0.31	0.18	0.01	0.01
Na _{exchangeable} me/100g	0.04	0.04	0.03	0.04	0.04	0.04	0.04
K _{exchangeable} me/100g	0.61	0.27	0.11	0.14	0.14	0.19	0.08
CEC me/100g	17.60	12.32	8.32	6.80	5.40	4.80	5.00

PROFILE PC2

Soil Type:	Nzivi Nz
F.A.O:	Haplic Ferralsol
Described:	9 Feb 1993, I.C. Baillie.
Location:	Nzivi Block peninsula (Auger bore C6, Square E4, Grid ref 36635735), Ngwazi Estate, Mufindi, Tanzania.
Topography:	Crest of very low broad spur, straight 2° slope to 340° (NNW).
Parent material:	Deeply weathered granite, possibly colluvial.
Land use and vegetation:	Plantation forestry; area of very patchy and poor growth of young <i>Pinus patula</i> . Air photograph shows similar patchiness and poor growth in previous rotation. Possibly due to soil-borne parasite, possibly to trace element deficiency. Pit site has dense growth of shrubs and grass, with few volunteer wattle (<i>Acacia sp.</i>).
Site drainage:	Good.
Surface:	Slight microrelief (<25 cm, at <1 m intervals), probably from forestry operations. Discontinuous grass litter 1-2 cm thick. Discontinuous patches of charcoal.
Summary of profile:	Deep, uniform, reddish yellow to strong brown sandy clay loam.

PROFILE DESCRIPTION

Horizons

cm	
2 - 0	Discontinuous grass litter
0 - 11	Dark greyish brown (10YR 4/2 moist and wet); medium and fine sandy loam; weak fine subangular blocky structure, breaking to weak fine crumb; common medium and fine pores; moist and friable, non-sticky and very slightly plastic when wet; many medium and fine roots; clear smooth boundary to:
11 - 23	Brown to dark brown (9YR 4/3 moist and wet), with common medium faint patches of dark greyish brown (10YR 4/2); medium sandy clay loam (to sandy loam); weak to moderate fine subangular blocky structure, breaking to moderate fine crumb; common medium and fine pores; moist and friable; very slightly sticky and slightly plastic when wet; common medium and many fine roots; discontinuous thin charcoal layer at base of horizon; many ants; clear, slightly wavy boundary to:
23 - 61	Brown to dark brown (7.5YR 4/4 moist); medium sandy clay loam; moderate medium subangular blocky structure, plus few rounded faunal nodules, breaking to moderate fine crumb; common medium and fine pores; moist and moderately firm and slightly compact; slightly sticky and slightly plastic when wet; few medium and common fine roots; nodules up to 10 mm diameter slightly firmer than matrix; diffuse boundary to:

- 61 - 86 Faintly contrasting mixed brown to dark brown (7.5YR 4/4) and brown to strong brown (7.5YR 5/5) with common very fine very faint reddish brown and pale yellow mottles; medium sandy clay loam; moderate medium subangular blocky structure; with slight tendency to break to weak fine crumb; abundant medium tubular ant and termite channel pores; moist and slightly firm, with slight tendency to fragile to crisp; slightly plastic and very slightly sticky when wet; few fine roots; few slightly hard fragments of yellowish and brownish weathering granite (up to 1 cm diameter), many rounded nodules 1-10 mm diameter the same colour but slightly harder than matrix; diffuse boundary to:
- 86 - 131 Strong brown (7.5YR 5/6 moist), with many very fine very faint mottles; medium sandy clay loam (much of sand is fine, rounded black and ferruginous); weak medium to fine subangular blocky structure breaking to weak fine crumb; patchy organic dark coatings on walls of few coarse (termite and ant) pores; moist and moderately friable but common nodules are slightly firm; very slightly sticky and slightly plastic when wet; few medium and fine roots; weak discontinuous stone line of yellow, brown and orange, fairly soft, highly weathered granite fragments, up to 8 cm diameter at base (125-131 cm); gradual smooth boundary to:
- 131 - 195 Strong brown (7.5YR 5/8 moist); fine sandy clay loam; very weak medium and fine subangular blocky structure breaking to weak fine crumb; many medium and fine pores; moist and very friable matrix with few slightly hard and hard nodules (fewer in number than above but hardness contrast is greater); rare coarse and medium roots; rare yellowish fragment (up to 3 cm diameter) of slightly hard weathering granite; diffuse boundary to:
- 195 - 290 Reddish yellow (5YR 6/8 moist), with few nodules of reddish yellow (7.5YR 7/8); fine sandy clay; weak medium subangular blocky structure breaking to moderate fine crumb; common medium and fine faunal pores, with weak clay and organic coatings on walls of coarser, matrix moist and friable, yellower nodules slightly harder; few fine angular quartz grit, rare fragments of yellow and brown slightly hard weathering granite (up to 3 cm diameter)
- continued by auger below 290 cm
- 290-350 As 195-290 cm
- 350-580 Similar to 195-290 but nodules and fragments of yellowish and reddish weathering granite increase to common.

Comments:

1. As in PC1 and PR3, there is a distinctly harder consistence just below the friable surface, and above the deep friable subsoils. This may be a cultivation effect from forestry operations.
2. The weak stone line at 125-131 cm may mark a discontinuity between colluvia of different ages. The material below appears to be more weathered, being brighter coloured, more friable, and with fine rather than medium sand.

ANALYSES

Sample depth (cm)	PC2/A 0-10	PC2/B 11-20	PC2/C 35-45	PC2/D 70-80	PC2/E 100-120	PC2/F 150-170	PC2/G 270-290
Physical analyses:							
Sand 500µm - 2mm %	18.8	16.2	10.5	10.8	8.6	18.8	17.4
250µm - 500µm %	17.3	16.0	11.8	7.3	12.9	20.6	16.8
106µm - 250µm %	15.0	10.5	10.0	11.4	24.5	1.6	11.3
63µm - 106µm %	2.5	2.2	2.5	3.1	3.6	4.8	6.6
Silt 2µm - 63µm %	20.1	20.7	26.4	18.0	27.8	35.9	30.7
Clay <2µm %	26.2	34.4	38.8	49.35	22.4	18.3	17.3
Chemical analyses:							
pH (1:2.5) in water	5.36	4.79	4.26	5.26	4.87	4.87	5.30
Organic Carbon %	2.67	1.30	1.97	0.78	0.33	0.35	0.14
P _{available} mg/kg	40	19	30	13	8	2	33
Al _{KCl extractable} mg/kg	3	23	87	12	13	1	2
Ca _{exchangeable} me/100g	2.30	1.40	0.46	0.50	0.10	0.17	0.06
Mg _{exchangeable} me/100g	1.81	0.68	0.41	0.51	0.11	0.19	0.20
Na _{exchangeable} me/100g	0.05	0.06	0.06	0.04	0.02	0.03	0.02
K _{exchangeable} me/100g	0.79	0.73	0.23	0.18	0.08	0.09	0.15
CEC me/100g	12.20	10.60	9.80	9.20	19.00	17.12	14.60

PROFILE PR4

Soil Type:	Nzivi (mottled subsoil phase) Nz(m)
F.A.O.:	Haplic Ferralsol
Described:	11 Feb 1993, R.G.O. Burton.
Location:	Nzivi Block (Auger bore C6, Square D4, Grid ref 35765711), 40 m S of cross-roads, Ngwazi Estate, Mufindi, Tanzania.
Topography:	Gentle straight mid-slope of broad, flat interfluvium, 1° down to N. Altitude about 1850 m a.s.l.
Parent material:	Deeply and strongly weathered Basement Complex.
Land use and vegetation:	Second rotation plantation of fast-growing exotic timber, young <i>Pinus patula</i> . Dense grass ground vegetation.
Site drainage:	Good.
Surface:	Grass and pine needle litter.
Summary of profile:	Deep, friable, porous sandy loam and sandy clay loam, dominantly brown becoming more yellow with depth, with reddish mottles and ferruginous nodules.

PROFILE DESCRIPTION

Horizons:

cm	
0 - 10	Dark brown (7.5YR 3/1 moist); stoneless medium sandy loam; moist; fine granular structure; extremely porous; very weak soil strength; non-sticky; non-plastic; abundant very fine to medium roots; moderately acid; sharp smooth boundary to:
10 - 21	Very dark grey to very dark greyish brown (2.5Y 3/1 moist); stoneless medium sandy loam; moist; weak fine and medium subangular blocky easily breaking to fine and medium granular structure; low packing density; very porous; very weak ped strength; semi-deformable; non-sticky; slightly plastic; abundant very fine fibrous and medium woody roots; strongly acid; abrupt smooth boundary to:
21 - 36	Brown (10YR to 2.5Y 5/3 moist) with diffuse patches of light yellowish brown (10YR 6/4); stoneless medium sandy clay loam; moist; weak fine subangular blocky easily breaking to fine and medium granular structure; medium packing density; moderately porous; 1% medium ant channels and very fine macropores; very weak ped strength; slightly sticky; moderately plastic; many very fine fibrous roots, and many medium woody roots; strongly acid; abrupt smooth boundary to:
36 - 66	As Bw1 above, but compact, apedal massive structure; moderately firm soil strength; common very fine fibrous roots, and many medium woody roots; clear smooth boundary to:
66 - 101	Yellowish brown (10YR 5/4 moist); stoneless medium sandy loam; moist; weak coarse and medium subangular blocky structure; medium packing density; very porous; 2% very fine and medium pores with coatings of soil material from above; moderately weak ped strength; slightly sticky; moderately plastic; few very fine fibrous and medium woody roots; strongly acid; clear smooth boundary to:

- 101 - 134 Yellowish brown (10YR 5/5 moist); stoneless medium sandy loam; moist; weak coarse and medium subangular blocky structure; medium packing density; very porous; 1% very fine and medium macropores and vertical channels; moderately weak ped strength; semi-deformable; non-sticky; moderately plastic; few very fine fibrous and common woody roots; strongly acid; clear smooth boundary to:
- 134 - 228 Brownish yellow (10YR 6/6 moist) with few sharp distinct medium red (3YR 5/6) mottles and nodules; stoneless medium sandy clay loam; moist; weak coarse and very coarse subangular blocky structure (adherent); medium packing density; very porous; 1% very fine macropores and medium vertical channels; moderately weak ped strength; semi-deformable; slightly sticky; moderately plastic; common fine and medium woody roots; moderately acid; few, passing to common with depth, rounded and irregular ferruginous nodules 3 to 7 mm diameter; gradual smooth boundary to:
- 228 - 305 Yellow (10YR 7/6 moist) with common sharp distinct medium red (2.5YR 5/6) nodules; stoneless medium sandy clay loam; moist; weak very coarse breaking to medium and fine subangular blocky structure; medium packing density; very porous; moderately weak ped strength; semi-deformable; slightly sticky; moderately plastic; few medium woody roots; moderately acid; common rounded and irregular ferruginous nodules 3 to 7 mm diameter.

ANALYSES

Sample depth (cm)	PR4/1 0-10	PR4/2 10-21	PR4/3 21-66	PR4/4 66-101	PR4/5 101-134	PR4/6 134-228	PR4/7 228-305
Physical analyses:							
Sand							
500µm - 2mm %	53.5	47.3	36.5	24.5	19.9	23.0	27.4
250µm - 500µm %	18.5	22.5	20.0	16.1	15.6	13.4	12.2
106µm - 250µm %	5.6	7.7	9.0	9.6	10.2	8.2	7.6
63µm - 106µm %	0.7	0.7	0.8	1.5	1.8	1.4	1.5
Silt							
2µm - 63µm %	7.9	9.6	18.7	13.7	8.2	13.6	14.6
Clay							
< 2µm %	13.7	11.4	14.9	31.7	44.4	40.3	36.4
Chemical analyses:							
pH (1:2.5) in water	4.25	4.19	4.14	4.64	4.43	4.94	5.02
Organic Carbon %	3.55	0.65	0.41	0.37	0.44	0.14	0.21
P_{available} mg/kg	28	12	26	22	19	2	4
Al_{KCl extractable} mg/kg	40	40	26	30	111	100	65
Ca_{exchangeable} me/100g	0.96	0.25	0.01	0.02	0.02	0.02	0.04
Mg_{exchangeable} me/100g	52.08	20.83	0.02	0.04	0.01	0.05	0.03
Na_{exchangeable} me/100g	0.01	0.02	0.01	0.03	0.07	0.03	0.03
K_{exchangeable} me/100g	0.22	0.06	0.05	0.13	0.10	0.03	0.01
CEC me/100g	68.20	66.30	63.40	57.90	7.00	7.00	7.00

Note the high CEC values for the upper metre of the profile as reported by BBTK; these may be in error.

PROFILE PC4

Soil Type:	Nzivi (gravel subsoil phase) Nz(g)
F.A.O:	Haplic Ferralsol
Described	10 Feb 1993, I.C. Baillie.
Location:	80 m northeast of cross-roads on northeastern boundary (Auger bore R1, Square G7, Grid ref 38346004), Ngwazi Estate, Mufindi, Tanzania.
Parent material:	Deeply weathered Basement Complex, possibly colluvial.
Topography:	Crest of broad flat ridge.
Land use and vegetation:	Fallow with mixed low (>3 m) shrubs and moderately tall grass (50-100 cm).
Site drainage:	Good.
Surface:	2 cm grass litter; irregular microrelief of about 10 cm amplitude at about 2 m intervals, possible from old termitaria.
Summary of profile:	Very deep, uniform, yellowish red sandy clay, with ferricrete-derived ferruginous gravel only at almost 3 m depth.

PROFILE DESCRIPTION**Horizons:**

cm	
2 - 0	Grass litter.
0 - 10/14	Dark brown (10YR 3/3 moist and wet); medium sandy loam; moderate fine crumb structure; many medium intercrumb pores; moist and friable; non-sticky and non-plastic when wet; abundant medium and fine roots; clear wavy boundary to:
10/14 - 20/25	Brown to dark brown (9YR 4/3 moist, brown to dark brown 7.5YR 4/3 wet); medium sandy clay loam to sandy loam; moderate to weak fine subangular blocky structure breaking to moderate medium and fine crumb; many medium interped and common fine intraped pores; moist and slightly firm; very slightly sticky and slightly plastic when wet; many fine and common medium roots; gradual slightly wavy boundary to:
20/25 - 56	Brown to strong brown (7.5YR 5/5 moist, brown 7.5YR 5/4 wet); medium sandy loam to sandy clay loam; weak fine subangular blocky structure breaking to moderate medium crumb; few coarse pores with dark greyish brown infill, and common medium and fine pores; moist and friable; slightly sticky and slightly plastic when wet; common fine and medium roots; gradual to diffuse smooth boundary to:

56 - 135 Yellowish red to strong brown (6YR 5/8 moist and wet); medium to fine sandy clay loam; weak fine to medium subangular blocky structure breaking to weak fine crumb; common coarse (up to 10 mm) infilled termite channel with very dark greyish brown (10YR 3/2) and brown to dark brown (7.5YR 4/4) colours; common medium and fine pores; moist and very friable with few harder, rounded nodules of yellowish brown (10YR 5/6 and 10YR 5/4) soil, sometimes coarser (sandy loam), also some cored by very highly weathered rock; slightly sticky and plastic when wet; few fine and medium roots; rare soft to slightly hard fragments (to 3 cm) yellowish weathered rock; diffuse boundary to:

135 - 270 Yellowish red (5YR 5/8 moist and wet), with few fine very faint reddish yellow (5YR 6/8) mottles and dark streaks in old termite channels; clay loam to fine to medium sandy clay loam; moderate to weak medium angular to subangular blocky structure breaking to moderate medium to fine crumb; weak clay coatings on walls of fresh termite channels; common medium and fine pores and coarse termite channels; moist and slightly to moderately firm; slightly sticky and moderately plastic when wet; rare fine roots; clear smooth boundary to:

270 - 300 Yellowish red (5YR 5/8 moist and wet); very gravelly clay loam; structure affected by gravel but matrix weak medium subangular blocky breaking to weak fine crumb; weak shiny coatings against some gravel; common fine and few medium pores, few dark-infilled coarse voids, probably on termite channels; matrix moist and friable; few to rare hard subangular stones (to 5 cm) dark purplish hard ferricrete with embedded quartz grains; many gravel (5-10 mm) round, red coated, soil cored moderately hard concretions, also few angular fragments of very hard purplish ferricrete with embedded quartz grains.

Continued by auger

300 - 320 As 270 - 300 cm

320 - 400 Yellowish red (5YR 5/8 moist and wet); soft, highly weathered rock (texturing as clay loam), with many medium fragments of slightly harder reddish and yellowish weathered rock, with many fine distinct pinkish and whitish flecks; common angular quartz grit.

400 - 440+ Reddish yellow (7.5YR 6/8 moist); soft, highly weathered rock (texturing as gritty clay), with many coarse reddish, yellowish and orange patches.

ANALYSES

Sample depth (cm)		PC4/A 0-10	PC4/B 14-20	PC4/C 30-40	PC4/D 90-100	PC4/E 195-205	PC4/F 270-290	
Physical analyses:								
Sand	coarse	500µm - 2mm %	7.5	6.8	4.8	4.1	5.6	7.4
	medium	250µm - 500µm %	16.0	12.6	11.0	6.3	5.3	9.6
	fine	106µm - 250µm %	13.3	17.7	17.7	9.1	10.6	12.1
	v. fine	63µm - 106µm %	15.5	16.6	9.9	7.3	4.8	4.8
Silt		2µm - 63µm %	28.9	23.8	29.4	36.6	38.8	37.0
Clay		< 2µm %	18.3	22.0	26.9	36.6	34.8	29.0

Sample depth (cm)	PC4/A 0-10	PC4/B 14-20	PC4/C 30-40	PC4/D 90-100	PC4/E 195-205	PC4/F 270-290
Chemical analyses:						
pH (1:2.5) in water	4.24	4.29	4.32	4.53	5.48	5.34
Organic Carbon %	2.07	1.24	1.06	0.51	0.35	0.23
P _{available} mg/kg	22	26	26	32	13	30
Al _{KCl extractable} mg/kg	292	242	322	68	48	42
Ca _{exchangeable} me/100g	0.28	0.11	0.03	0.03	0.01	0.02
Mg _{exchangeable} me/100g	0.23	0.09	0.04	0.03	0.01	0.02
Na _{exchangeable} me/100g	0.03	0.02	0.03	0.03	0.03	0.04
K _{exchangeable} me/100g	0.23	0.08	0.08	0.05	0.08	0.08
CEC me/100g	8.72	6.20	3.80	6.60	5.00	5.40

PROFILE PC3

Soil Type:	Makabila (deep subsoil phase) Mk(d)
F.A.O:	Plinthic Ferralsol
Described:	9 Feb 1993, I C. Baillie.
Location:	Makabila Hill (Auger bore R64, Square F6, Grid ref 37945916), Ngwazi Estate, Mufindi, Tanzania.
Topography:	Straight 3° mid-slope, down to 165° (SSE) on ferricrete-fringed hill.
Parent material:	Highly weathered Basement Complex, possibly colluvial.
Land use and vegetation:	Grassland fallow near wattle belt.
Site drainage:	Good.
Surface:	3 cm continuous grass litter. No microrelief.
Summary of profile:	Reddish yellow sandy clay to about one metre depth over gravel derived from ferricrete, over strongly weathered rock.

PROFILE DESCRIPTION**Horizons:**

cm	
3 - 0	Grass litter.
0 - 11	Brown to dark brown (7.5YR 4/4 moist); medium sandy loam; moderate fine crumb structure; abundant medium interped pores; moist and friable; non-sticky and non-plastic when wet; abundant fine and medium roots; rare red rounded iron-coated nodules (<2 cm diameter); clear smooth boundary to:
11 - 20	Brown (7.5YR 4.5/4 moist); medium sandy loam; very weak fine subangular blocky structure breaking to moderate fine crumb; abundant medium interped pores and common coarse faunal channels with weak organic coatings; moist and friable; non-sticky and non-plastic when wet; many medium and fine roots; clear smooth boundary to:
20 - 33	Brown (7.5YR 5/4 moist); medium sandy loam; moderate to weak medium subangular blocky structure breaking to medium fine crumb; many medium and fine pores, and common faunal channels with weak organic coatings; moist and slightly firm; non-sticky and slightly plastic when wet; common medium and fine roots; common very fine quartz grit and fine black iron concretions; clear smooth boundary to:
33 - 51	Faintly contrasting mixed brown and strong brown (7.5YR 5/4 and 5/8 moist); medium sandy loam; moderate medium subangular blocky structure with slight tendency to break to moderate fine crumb; few coarse faunal channels with weak organic and few clay linings, and many fine and medium pores; moist and slightly firm; slightly sticky and slightly plastic when wet; few coarse and medium and common fine roots; clear smooth boundary to:

- 51 - 78 Reddish yellow (7.5YR 6/8 moist); fine and medium sandy clay loam; weak fine and medium subangular blocky structure breaking to moderate to weak fine crumb; common coarse faunal pores with some organic linings, and many medium and fine pores; moist and friable; slightly plastic and slightly sticky when wet; many fine and few medium roots; common slightly harder and browner rounded nodules of soil up to 2 cm diameter; diffuse boundary to:
- 78 - Yellowish red to strong brown (6YR 5/8) moist; fine and medium sandy clay loam; 106/109 weak fine and medium subangular blocky breaking to moderate to weak fine crumb; many medium and fine pores, some with dark organic linings; moist and friable; slightly sticky and slightly plastic when wet; few round brownish and yellowish ferruginous gravel at >90 cm; clear slightly wavy boundary to:
- 106/109 - Yellowish red to strong brown (6YR 5/8 moist); gravelly sandy clay loam; structure 138 mainly determined by gravel, but some interstitial weak very fine subangular blocky to crumb; common coarse and medium pores, with dark organic linings on walls; weak, discontinuous shiny films against some gravel; moist and moderately firm; non-sticky and slightly plastic when wet; few fine roots; many to abundant moderately hard rounded red and dark red ferruginous nodular gravel (up to 4 cm) with amorphous yellowish interiors, also few to common angular and subangular quartz grit and gravel and rare stones; diffuse boundary to:
- 138 - 177 Mixed distinct coarse blotches yellowish red and reddish yellow (5YR 5/8 and 7.5YR 6/6 moist); slightly gravelly sandy clay loam (possibly very highly weathered rock); structure affected by gravel but mainly moderate coarse subangular blocky; many fine and medium pores some with dark organic linings; weak discontinuous shiny films against some gravel; moist and slightly firm; non-sticky and non-plastic when wet; few fine roots; common gravel, some as in above horizon but increasing proportion of hard to slightly hard angular and subangular fragments of yellowish highly weathered rock with reddish coatings; also many quartz grit; diffuse boundary to:
- 177 - 250 Mixed very distinct coarse blotches of yellowish red and yellow (5YR 5/8 and 10YR 7/8 moist) with many patches of intermediate reds and yellows; highly weathered rock (yellowish patches texture as sandy loam to sandy clay loam, reddish as clay loam, but mass is gravelly due to harder fragments); gravel affects structure, but overall massive breaking to weak fine to medium subangular blocky, with weak discontinuous shiny films against some gravel; common fine pores; moist and moderately firm; rare fine roots; common harder fragments of weathered rock and many quartz grit.

Continued by auger

- 250 - 330 As 177-250 cm
- 330 - 430 Red (2.5YR and 5YR 5/8 moist) with common coarse distinct yellow patches; gritty clay loam to weathered rock.
- 430 - 450+ Mixed reddish and yellowish weathered rock (gritty sandy clay loam).

ANALYSES

Sample depth (cm)		PC3/A 0-10	PC3/B 11-20	PC3/C 20-30	PC3/D 35-45	PC3/E 60-70	PC3/F 85-95	PC3/G 115-125	PC3/H 150-160	PC3/J 220-240	
Physical analyses:											
Sand	coarse	500µm - 2mm %	12.2	14.1	10.5	9.5	8.0	9.6	33.3	46.0	41.9
	medium	250µm - 500µm %	16.1	13.7	13.2	12.0	7.9	7.4	8.7	8.8	10.4
	fine	106µm - 250µm %	17.5	11.1	18.4	17.7	16.6	15.8	11.6	9.1	11.2
	v. fine	63µm - 106µm %	3.9	2.2	4.2	4.5	6.4	7.1	4.9	4.2	4.9
Silt		2µm - 63µm %	16.8	22.3	18.9	18.4	17.1	20.4	20.1	13.9	16.1
Clay		< 2µm %	33.2	36.3	34.7	37.8	44.1	39.3	21.3	17.8	15.5
Chemical analyses:											
pH (1:2.5) in water			4.57	4.01	4.27	4.50	4.59	4.96	5.00	4.94	5.19
Organic Carbon %			1.32	1.38	1.09	0.82	0.56	0.78	0.69	0.08	0.91
P_{available} mg/kg			16	7	12	6	13	12	6	6	22
Al_{KCl extractable} mg/kg			28	171	72	40	20	2	6	14	14
Ca_{exchangeable} me/100g			0.37	0.41	0.11	0.06	0.06	0.02	0.01	0.01	<0.01
Mg_{exchangeable} me/100g			0.37	0.29	0.11	0.06	0.60	0.05	<0.01	<0.01	<0.01
Na_{exchangeable} me/100g			0.03	0.07	0.02	0.02	0.02	0.03	0.03	0.03	0.03
K_{exchangeable} me/100g			0.25	0.58	0.10	0.05	0.05	0.07	0.10	0.13	0.11
CEC me/100g			16.00	18.80	10.40	14.60	6.80	5.40	5.00	12.80	6.80

PROFILE PC7

Soil Type:	Ngongwa (shallow subsoil phase)	No(s)
F.A.O:	Petroferric Dystric Ferralsol	
Described	12 Feb 1992, I. C. Baillie.	
Location:	Murrum pit on northwestern boundary (Square D7, Grid ref 35636067), Ngwazi Estate, Mufindi, Tanzania.	
Parent material:	Highly weathered Basement Complex, possibly colluvial.	
Topography:	Mid- to upper slope of ferricrete-capped hill, 2° rectilinear down to 25°, tending to convex downslope. Altitude about 1855 m a.s.l.	
Land use and vegetation:	Second generation plantation of fast-growing <i>Pinus patula</i> , but growth very poor and area mostly used as borrow pit for road murrum. Vegetation above profile is moderately thick grasses, herbs and low shrubs with occasional volunteer wattle (<i>Acacia sp.</i>).	
Site drainage:	Good.	
Surface:	Variable 2-5 cm litter of grass, twigs and few cones; few ferricrete rounded gravel (up to 1 cm); irregular interval micro-relief up to 25 cm amplitude, possibly from forestry operations.	
Summary of profile:	Shallow brown loam abruptly overlying indurated, deep and impenetrable continuous layer of ferricrete.	

PROFILE DESCRIPTION**Horizons:**

cm

- 4 - 0 Litter, mostly grass.
- 0 - 9 Brown to dark yellowish brown ((9YR 4/4) moist, light brown to light yellowish brown (9YR 6/4) dry, brown to dark brown (10YR 4/3) wet); fine sandy clay loam; moderate to weak fine to medium subangular blocky structure, breaking to weak fine crumb; common medium and fine pores; moist slightly friable; moderately sticky and moderately plastic when wet; abundant fine and medium and few coarse roots; common fine to medium (<10 mm) subrounded and round red and reddish brown hard ferruginous gravel, common angular quartz grit (up to 1 cm), few angular to subangular quartz stones (up to 8 cm); gradual smooth to slightly wavy boundary to:
- 9 - 44/52 Brown to yellowish brown ((9YR 4/4) moist, brown (7.5YR 5/4) dry, brown to yellowish brown (9YR 4/4) wet); medium to fine sandy clay loam; weak fine subangular blocky structure, breaking to moderate fine and medium crumb; many medium and fine pores; moist and friable; slightly sticky and slightly plastic when wet; rare coarse and common medium and fine roots; moderately acid; common rounded hard ferruginous gravel (up to 20 mm) in lower 5 cm; abrupt wavy boundary to:

44/52 - 80 Hard ferricrete of rounded to subrounded hard ferruginous gravel (up to 1 cm) with many red coatings and amorphous yellow to orange interiors and few coarser (up to 3 cm) angular red and yellow fragments of an earlier ferricrete, and few quartz gravel and stones (3 mm to 3 cm) in a hard to moderately hard reddish yellow (7.5YR 6/8) matrix; common fine and few medium and coarse roots; very diffuse boundary to:

80 - 210+ As above, but proportion of round red gravel decreases and that of dark red, purplish, dark brown and black angular ferricrete fragments increases. The matrix tends to yellower colours, yellow (9YR and 10YR 7/8). There are fine roots down the face of this section but few appear to penetrate the ferricrete mass.

Comments:

This is a fairly extreme example of Ngongwa soil type. Elsewhere in the borrow pit it can be seen that:-

1. The depth of solum above the ferricrete is generally greater than in PC7, reaching 2 m in places.
2. In the deeper soils, the subsoil is more clearly distinguished, usually reddish yellow (7YR 6/8), fine sandy clay.
3. Under the deeper sola the ferricrete matrix tends to be softer, so that it may texture as a very gravelly sandy clay.
4. The matrix is laterally quite variable, and is reddish clay in places.
5. The pattern of clasts in the ferricrete in Profile PC7 is general, with more rounded reddish ferruginous gravel in the upper levels.
6. However, the clasts in the lower levels are variable with clusters of angular ferricrete fragments (up to 15 cm) in some places, and nests of rounded and subrounded quartz stones (up to 10 cm) in others.

ANALYSES

Sample depth (cm)		PC7/A 0-9	PC7/B 20-35	
Physical analyses:				
Sand	coarse	500µm - 2mm %	14.6	19.5
	medium	250µm - 500µm %	12.1	12.9
	fine	106µm - 250µm %	18.6	19.4
	v. fine	63µm - 106µm %	4.6	5.2
Silt		2µm - 63µm %	19.0	12.0
Clay		< 2µm %	30.4	30.1

Sample depth (cm)	PC7/A 0-9	PC7/B 20-35
Chemical analyses:		
pH (1:2.5) in water	4.51	4.35
Organic Carbon %	1.96	1.06
P _{available} mg/kg	20	13
Al _{KCl extractable} mg/kg	71	105
Ca _{exchangeable} me/100g	0.87	0.09
Mg _{exchangeable} me/100g	0.89	0.13
Na _{exchangeable} me/100g	0.03	0.03
K _{exchangeable} me/100g	0.16	0.07
CEC me/100g	11.08	7.40

PROFILE PC5

Soil Type:	Longstaff (deep subsoil phase) Lg(d)
F.A.O:	Haplic Ferralsol (to Ferrallic Cambisol)
Described	11 Feb 1993, I.C. Baillie.
Location:	Adjacent to experiment N10 (Square G3, Grid ref 38635699), Ngwazi Tea Research Unit, Mufindi, Tanzania.
Parent material:	Strongly weathered Basement Complex, possibly colluvial.
Topography:	Lower, 4° convex slope down to Lake Ngwazi; aspect 280° (W). Altitude about 1845 m a.s.l.
Land use and vegetation:	Experimental plot (N10) in mature tea.
Site drainage:	Good.
Surface:	Discontinuous layer of single dry leaves; microtopography due to paths and slight hummocks of tea cultivation.
Summary of profile:	Brown sandy clay loam topsoil over yellowish red subsoil over very heterogeneous weathered rock at just over one metre depth. Continues soft and rootable to 3 m+.

PROFILE DESCRIPTION**Horizons:**

cm	
0 - 13	Dark brown to dark reddish brown (6YR 3/3 moist, 6YR 4/2 wet); coarse and medium sandy clay loam; weak to moderate fine subangular blocky to very fine subangular blocky structure breaking to very fine subangular blocky, further breaking to moderate fine crumb; common fine pores; moist and friable; slightly sticky and plastic when wet; many fine and medium roots, abundant in pockets; clear smooth boundary to:
13 - 29	Yellowish red (5YR 4/8 moist and wet), with common fine very faint darker (reddish brown) patches; coarse and medium sand clay loam; moderate to weak fine subangular blocky structure tending to break to weak medium crumb; few medium and many fine pores; moist and firm to slightly compact (possibly cultivation pan); slightly sticky and plastic to very plastic when wet; common fine and few medium roots; rare fine (<5 mm) subangular to subrounded fragments of reddish and yellowish highly weathered rock; gradual smooth boundary to:
29 - 66	Yellowish red (5YR 4/8 moist and wet); coarse and medium sandy clay loam; moderate to weak medium subangular blocky structure breaking to medium fine crumb; many medium and fine pores, and few coarse pores with slight to moderate dark organic coatings on walls; moist and friable to slightly firm; slightly sticky and plastic when wet; common fine and few medium roots; gradual slightly wavy boundary to:
66 - 104/132	Strong brown (7YR 5/8 moist, 5/6 wet); medium sandy clay loam; weak fine subangular blocky structure breaking to moderate fine crumb; many medium and fine pores; moist and friable; slightly sticky and plastic when wet; many medium and fine roots; few increasing to common fine and medium (<5 mm) subrounded and subangular fragments of soft yellow, red and pale yellow strongly weathered rock; gradual wavy boundary to:

- 104/132 - Red (2.5YR 4/8 moist and wet); with many medium faint linear yellow patches (10YR 7/8) up to 10 mm long and 3 mm wide, also some irregular fine to medium blotches; soft strongly weathered rock (textures as gravelly medium and fine sandy clay loam); massive breaking to weak medium subangular blocky structure, further breaking to moderate fine crumb; few fine and medium pores; moist and slightly crisp in mass but crumbles to friable in the hand; non-sticky and slightly plastic when wet; common medium and fine roots; gravel is mostly slightly hard to hard fragments of less weathered rock, also some with soft white, mauve and pale yellow colours; gradual wavy boundary to:
- 180/220 - Faintly contrasting fine and medium sized patches of yellow and pink (10YR 7/6 and 5YR 7/4) with many fine faint to distinct flecks of mauve, pale yellow and reddish yellow; strongly weathered rock (textures as gravelly very fine sandy clay loam); massive; rare very coarse void filled with strong brown (7.5YR 5/6) fine sandy clay loam, probably old termite chamber; moist and firm, friable in patches; non-sticky and slightly plastic when wet; common medium and fine roots.

Comment:

This profile shows that the solum can be quite shallow on convex lower slopes with saprolite at about 1 m depth. The saprolite is quite variable, and the red horizon at 104/132 to 180/220 does not extend across the whole face and had a roundish shape, rather as if it resulted from the weathering of a lithologically distinct boulder in the colluvial matrix.

In other parts of the pit the sequence of horizons in the saprolite is:

- 100 - 150 Reddish yellow (7.5YR 7/6 moist), with moderate medium distinct yellow, white, yellowish red and red patches; strongly weathered rock (textures as fine sandy clay loam); weak medium subangular blocky structure breaking to moderate fine crumb; common fine and medium pores; moist and firm; non-sticky and non-plastic when wet; common medium and fine roots; many slightly hard white, pale yellow, light grey fragments of slightly hard weathering rock (without quartz grit or coarse sand - not granitic); diffuse boundary to:
- 150 - 230 Reddish yellow (5YR 6/8 moist), with many medium distinct yellowish and reddish patches; weathered rock; massive; common fine and medium pores; moist and firm to slightly hard; common decreasing to few fine roots; many patches of harder material; diffuse boundary to:
- 230 270+ White (2.5Y 8/2) with many coarse distinct patches of pink (5YR 7/4) and some pale brown and pale yellow; weathered rock (textures as very fine sandy clay loam); massive; common medium pores; moist to slightly wet and firm to slightly hard; rare fine roots, common harder fragments.

Comments:

The pit was dug adjacent to Experiment N10 to monitor rooting in tea. The zone of moderate compaction at 13–66 cm is less friable and less rooted, but does not prevent root penetration. The rooting is also not inhibited by the relatively shallow solum, and roots were found down to the base of the pit at 2.7 m.

ANALYSES

Sample depth (cm)		PC5/A 0-10	PC5/B 15-25	PC5/C 35-45	PC5/D 80-90	PC5/E 140-160	PC5/F 220-240	
Physical analyses:								
Sand	coarse	500µm - 2mm %	16.6	10.3	9.8	10.0	6.2	6.2
	medium	250µm - 500µm %	17.4	18.9	13.1	12.0	5.5	5.2
	fine	106µm - 250µm %	12.5	22.4	11.9	11.3	8.5	7.8
	v. fine	63µm - 106µm %	2.5	3.8	2.0	2.8	4.3	3.3
Silt		2µm - 63µm %	15.7	7.5	32.4	38.0	34.9	19.8
Clay		< 2µm %	35.4	36.2	28.4	25.9	40.5	57.6
Chemical analyses:								
	pH (1:2.5) in water		4.93	4.69	4.32	4.71	5.45	5.84
	Organic Carbon %		1.93	1.17	1.15	0.78	0.25	0.25
	P _{available} mg/kg		22	22	30	22	25	13
	Al _{KCl extractable} mg/kg		28	46	82	53	43	41
	Ca _{exchangeable} me/100g		2.06	0.16	0.25	0.10	0.30	0.10
	Mg _{exchangeable} me/100g		0.66	0.13	0.20	0.06	0.40	0.17
	Na _{exchangeable} me/100g		0.09	0.02	0.08	0.09	0.03	0.12
	K _{exchangeable} me/100g		0.80	0.16	0.24	0.07	0.09	0.09
	CEC me/100g		13.00	6.80	13.60	7.12	3.80	3.40

PROFILE PC6

Soil Type:	Longstaff (shallow subsoil phase)	Lg(s)
F.A.O:	Ferralic Cambisol	
Described	12 Feb 1993, I. C. Baillie.	
Location:	Northwestern boundary road (Auger bore C113, Square C6, Grid ref 34955968), Ngwazi Estate, Mufindi, Tanzania.	
Parent material:	Deeply weathered Basement Complex, probably colluvial.	
Topography:	Straight mid-slope, 4° down to bearing 295° (WNW), in undulating-rolling plateau.	
Land use and vegetation:	Mature fast growing plantation, second generation, of <i>Pinus elliottii</i> . Sparse undergrowth of grasses, broadleaf shrubs, herbs and bracken (<i>Pteridium aquilinum</i>).	
Site drainage:	Good.	
Surface:	2-6 cm needle litter; regular cross-slope furrows of 15 cm amplitude at 2 m spacing, probably from forestry cultivations.	
Summary of profile:	Shallow brown sandy loam to sandy clay solum over strongly weathered rock, with moderate quartz stone layer at junction. Weathered rock penetrable and rootable to 2.5 m+.	

PROFILE DESCRIPTION

Horizons:

- cm
- 3 - 0 Needle litter.
- 0 - 6/10 Brown to dark brown (10YR 4/3 moist), with common fine very faint dark greyish brown and brown (10YR 4/2 and 5/3) patches; medium sandy loam; weak medium subangular blocky structure, breaking to weak fine crumb; many fine and medium intercrumb pores; moist and very friable; non-sticky and slightly plastic when wet; common coarse and many fine and medium roots; moderately acid; gradual wavy boundary to:
- 6/10 - 20 Weakly contrasting fine patches of brown to yellowish brown to strong brown (9YR and 10YR 5/4 and 9YR 5/6 moist); medium sandy loam to sandy clay loam; moderate to weak fine subangular blocky structure breaking to moderate medium crumb; many to common medium and fine pores; moist and slightly firm *in situ* but friable in the hand; slightly sticky and moderately plastic when wet; common coarse and many medium and fine roots; moderately acid; diffuse boundary to:
- 20 - 47/55 Strong brown (7.5YR 5/6 moist), with common faint fine to medium darker linear streaks down old channels; medium sandy clay loam; weak medium angular blocky structure, breaking to fine subangular blocky, further breaking to moderate medium crumb; few coarse pores with weak and discontinuous shiny films on walls, and common medium and fine pores, tending to be grouped in clusters; moist and friable; moderately to slightly sticky and plastic when wet; few coarse and medium and common fine roots; moderately acid; clear slightly wavy boundary to:

- 47/55 - 56/65 Weak stone layer of rounded (possibly rolled) moderately hard reddish coated gravel (up to 1 cm) with reddish and yellowish amorphous interiors, with few subangular fragments of hard ferricrete up to 2 cm, and common subrounded and angular hard quartz gravel, set in a strong brown matrix (7.5YR 5/6); gravelly coarse sandy clay loam; structure determined by gravel interstices; weak shiny films against some gravel; common medium and fine pores; consistence *en masse* determined by gravel, with interstitial matrix moist and friable; slightly sticky and plastic when wet; few coarse, medium and fine roots; clear wavy boundary to:
- 56/65 - 106 Distinctly contrasting mixture of yellow and reddish yellow (10YR 7/8, 7.5YR and 5YR 6/8 moist, reddish yellow 6YR 7/6 wet and rubbed) with common medium prominent patches of red (2.5YR 5/8); strongly weathered rock (textures as gritty fine sandy clay loam); massive breaking to weak fine angular blocky structure; discontinuous weak films against some grit; common coarse and medium pores; moist and firm to hard; slightly sticky and slightly plastic when wet; rare coarse and few medium and fine roots; much angular quartz grit (up to 5 mm) and few patches of harder weakened rock; common coarse (up to 6 cm wide) vertical and subvertical voids filled with strong to yellowish brown (9YR 5/6 moist), fine sandy clay loam to sandy clay; moderate to weak fine subangular blocky structure breaking to moderate coarse crumb; many medium and fine pores; moist and friable; sticky and plastic when wet; common medium and fine roots; very diffuse boundary to:
- 106 - 240 Similar to above but includes redder roundish coarse patches, possibly highly weathered corestones of mixed distinct red (10R 4/8) and white (10YR 8/1); weathered rock (textures as very gritty clay loam); few coarse and many fine roots; coarse yellowish brown voids continue but decrease in frequency to rare at base.
- continued by auger
- 240 - 330 As 106 - 240 cm.
- 330 - 360+ Yellow, orange and white fairly hard weathered rock (textures at gritty coarse sandy clay loam); hard and compact on auger but dry and crumbly in hand.

ANALYSES

Sample depth (cm)		PC6/a 0-6	PC6/b 10-20	PC6/c 25-35	PC6/D 75-85	PC6/E 150-160	PC6/F 330-360	
Physical analyses:								
Sand	coarse	500µm - 2mm %	16.49	11.15	17.15	18.73	23.04	27.38
	medium	250µm - 500µm %	19.06	17.59	14.36	8.88	6.35	7.27
	fine	106µm - 250µm %	27.49	27.26	24.79	15.03	9.34	9.30
	v. fine	63µm - 106µm %	5.21	3.38	4.88	6.27	4.36	4.87
Silt		2µm - 63µm %	19.11	15.74	17.23	19.95	23.45	36.99
Clay		< 2µm %	12.63	22.50	20.87	30.72	33.47	13.65
Chemical analyses:								
pH (1:2.5) in water			4.6	5.1	5.0	4.55	4.88	4.53
Organic Carbon %			1.5	0.8	0.6	0.45	0.11	0.09
P _{available} mg/kg			3.9	7.3	30.9	15	13	8
Al _{KCl extractable} mg/kg			64.8	49.6	36.8	67	33	30
Ca _{exchangeable} me/100g			0.5	0.1	<0.05	<0.01	0.03	0.03
Mg _{exchangeable} me/100g			0.4	0.1	<0.05	0.03	0.04	0.20
Na _{exchangeable} me/100g			<0.05	<0.05	<0.05	0.04	0.03	0.03
K _{exchangeable} me/100g			0.1	0.1	0.2	0.22	0.05	0.10
CEC me/100g			9.0	8.2	6.4	7.32	6.12	5.80

PROFILE PR1

Soil Type:	Hehe (deep subsoil phase)	He(d)
F.A.O:	Haplic Ferralsol	
Described:	28 Jan 1993, R.G.O. Burton and I.C. Baillie.	
Location:	Borrow pit 100 m NE of main dam (Square G6, Grid ref 38535901), Ngwazi Estate, Mufindi, Tanzania.	
Parent material:	Granitic colluvium, with few erratics of bluish-green grey argillite.	
Topography:	6° straight lower slope (aspect 120°) down from undulating plateau/broad spur.	
Land use and vegetation:	Abandoned maize land between contour belts of wattle. Now borrow pit for inert rooting material for Ngwazi Tea Nursery. Fallow with bracken (<i>Pteridium aquilinum</i>), mixed low grasses, herbs and shrub sprouts.	
Site drainage:	Good.	
Surface:	Slightly disturbed by mechanical scraping. No cracks. Rare fine angular quartz gravel.	
Summary of profile:	Deep, exceptionally uniform red clay loam.	

PROFILE DESCRIPTION

Horizons:

- cm
- 0 - 8 Brown to dark brown (7.5YR 4/2 moist), with common medium faint dark brown to black patches; (medium sandy) clay loam; weak fine subangular blocky to granular structure; common medium pores; moist, friable; many medium and fine roots; dark patches appear to be infilled termite channels; clear smooth boundary to:
- 8 - 22 Reddish brown (5YR 4/3); medium to coarse sandy clay loam; weak fine to medium subangular blocky structure, breaking to moderate medium granular with very weak discontinuous shiny coatings against quartz grains; common medium pores; moist and friable; common medium and fine roots; few very fine rounded slightly hard black ferrimanganiferous gravel; gradual smooth boundary to:
- 22 - 65 Reddish brown to yellowish red (4YR 4/5 moist); medium to fine sandy clay loam; very weak medium subangular blocky structure, breaking to moderate medium granular; many medium and fine pores, often with brown to dark brown lining; moist and friable; common fine and medium and few coarse roots; rare fine black ferrimanganiferous concretions; diffuse boundary to:
- 65 - 125 Red (2.5YR 5/8 moist); (medium and fine sandy) clay loam; massive to weak coarse subangular blocky to prismatic structure, breaking to moderate medium and fine granular; common to many medium and fine pores; moist and friable to firm; common medium and fine roots decreasing to few; rare fine to medium fragments of soft yellowish brown weathered granite; few faint and slightly darker and brown vertical infilled termite/root channels; very diffuse boundary to:

- 125 - 230 Red (2.5YR 4/7 moist); clay loam; massive to weak coarse subangular blocky to prismatic structure, breaking to moderate medium granular; common fine and few medium vertical pores; moist and slightly firm; rare medium and few fine roots; rare fragments of soft yellowish brown weathered granite; rare faint darker and browner relict termite channels; very diffuse boundary to;
Continued by auger below 230 cm.
- 230 - 320 Red (2.5YR 5.5/6 moist), with many fine to medium distinct yellowish brown (10YR 5/7) mottles; clay loam; moderate medium to fine subangular blocky structure breaking to moderate medium granular; common fine and few medium vertical pores; moist and slightly firm.
- 320 - 380 Red (2.5YR 4/6 moist), with common fine to medium distinct pale yellow to yellow (2.5Y 8/5) mottles; sandy clay loam; moist and slightly firm:
- 380 - 440 Red (10R 4/6 moist), with common coarse distinct bright yellow mottles; fine sandy clay loam; moist and firm:
- 440 - 480+ Brownish yellow weathered granite with many distinct red, white and pale yellow patches

Comments:

1. Material from this pit is currently used as an inert rooting medium in the Ngwazi tea nursery.
2. About 10 m away there is a floater of bluish-green grey weathered metargillite – poorly laminated. Indicates great depth of colluvium on these lower slopes.

ANALYSES

Sample depth (cm)		PR1/A 0-8	PR1/B 8-22	PR1/C 22-65	PR1/D 65-125	PR1/E 125-230	
Physical analyses:							
Sand	coarse	500µm - 2mm %	14.6	16.9	9.8	14.8	12.5
	medium	250µm - 500µm %	10.8	8.1	7.3	5.7	4.8
	fine	106µm - 250µm %	12.5	10.2	11.4	10.5	8.6
	v. fine	63µm - 106µm %	3.3	3.0	4.7	4.3	4.0
Silt		2µm - 63µm %	9.4	11.1	20.9	19.1	23.4
Clay		< 2µm %	49.4	50.7	45.9	45.4	46.6

Sample depth (cm)	PR1/A 0-8	PR1/B 8-22	PR1/C 22-65	PR1/D 65-125	PR1/E 125-230
Chemical analyses:					
pH (1:2.5) in water	4.73	4.39	4.63	4.97	5.15
Organic Carbon %	2.22	1.43	0.61	0.42	0.44
P _{available} mg/kg	2	4	1	7	2
Al _{KCl extractable} mg/kg	6	49	11	7	8
Ca _{exchangeable} me/100g	1.79	0.35	0.33	0.28	0.31
Mg _{exchangeable} me/100g	1.25	0.34	0.20	0.29	0.25
Na _{exchangeable} me/100g	0.04	0.09	0.08	0.04	0.04
K _{exchangeable} me/100g	0.44	0.42	0.16	0.05	0.04
CEC me/100g	13.52	28.00	57.60	65.50	19.52

Note the high CEC values as reported by BBTK; these may be in error.

PROFILE PR2

Soil Type:	Kihanga (deep subsoil phase) Kg(d)
F.A.O.:	Haplic Ferralsol
Described:	6 - 11 Feb 1993, R.G.O. Burton.
Location:	Nzivi Block (Auger bore R6, Square D4, Grid ref 35545753), Ngwazi Estate, Mufindi, Tanzania.
Topography:	Very gentle straight lower slope of broad, flat interfluvium, <1° down to E-SE. Altitude about 1850 m a.s.l.
Parent material:	Deeply and strongly weathered Basement Complex, possibly colluvial.
Land use and vegetation:	Second rotation plantation of fast-growing exotic timber. Young <i>Pinus patula</i> about 5-8 m tall. Moderately thick grass ground vegetation.
Site drainage:	Good, possibly seasonal waterlogging below 1 m depth occurred formerly.
Surface:	Very thin grass litter.
Summary of profile:	Dark sandy clay loam friable topsoil grades through mottled brown intermediate horizons to deep, very pale mottled sandy clay loam subsoil, with some bands of brown and reddish ferruginous nodules.

PROFILE DESCRIPTION

Horizons:

cm	
0 - 3	Very dark grey (10YR 3/1 moist, 2.5Y 5/1 dry); stoneless humose medium sandy loam; moist; weak fine and medium granular structure; low packing density; extremely porous; loose; non-sticky; non-plastic; many fine fibrous roots; dead grass stems and semi-decomposed plant remains; moderately acid; sharp smooth boundary to:
3 - 19	Very dark grey (10YR 3/1 moist, 10YR 4/2 dry); stoneless medium sandy clay loam; moist; weak medium and coarse subangular blocky structure breaking to fine granular; medium packing density; very porous; very fine fissures and macropores; very weak ped strength, moderately weak soil strength; semi-deformable; slightly sticky; moderately plastic; many medium and coarse woody roots and very fine fibrous roots; moderately acid; clear smooth boundary to:
19 - 35	Dark greyish brown (10YR 4/2 moist); stoneless medium sandy clay loam; moist; weak coarse subangular blocky structure; medium packing density; very porous; 1% very fine macropores and fissures; moderately firm ped and soil strength; brittle; slightly sticky; moderately plastic; many very fine fibrous roots; strongly acid; clear smooth boundary to:

- 35 -69 Dark brown (8YR 4/2 moist) with slight variegations; stoneless medium sandy clay loam; moist; very weakly developed very coarse subangular blocky to massive structure; medium to high packing density; moderately porous; 1% very fine macropores; moderately firm soil strength; brittle; slightly sticky; moderately plastic; common very fine fibrous roots; strongly acid; clear smooth boundary to:
- 69 - 102 Slightly variegated brown, yellowish brown and pale brown (10YR 5/3, 5/4, 6/3 moist); stoneless medium sandy clay loam; moist; weak medium and coarse subangular blocky structure; medium packing density; very porous; 2% very fine macropores and fissures; moderately weak ped strength; semi-deformable; non-sticky; moderately plastic; many very fine fibrous roots; moderately acid; few rounded 5-10 mm nodules; clear smooth boundary to:
- 102 - 121 Variegated brownish yellow (10YR 6/5 moist) with 5 mm patches of yellow and yellowish brown (10YR 7/6 and 5/6), rubbed colour light yellowish brown (10YR 6/4); stoneless medium sandy clay loam; moist; weak medium and coarse subangular blocky structure; very porous; 3% very fine macropores; moderately weak ped strength; semi-deformable; non-sticky; moderately plastic; few very fine fibrous roots; moderately acid; common (5%) 7 mm vertically aligned strong brown (7.5YR 5/8) ferruginous nodules; clear smooth boundary to:
- 121 - 150 Light yellowish brown (10YR 6/4 moist) with fine 5 mm patches of very pale brown (10YR 7/4), rubbed colour pale brown (10YR 6/3); stoneless medium sandy loam; moist; weak medium subangular blocky structure; very porous; 5% very fine and medium macropores; moderately weak ped strength; semi-deformable; non-sticky; slightly plastic; few very fine fibrous roots; moderately acid; common (10%) nodules to 30 mm long and 15 mm wide, with red (2.5YR 5/8) centres and strong brown (7.5YR 5/8) edges, often vertically aligned; clear smooth boundary to:
- 150 - 166 Very pale brown to yellow (10YR 7/5 moist) with common medium and coarse prominent sharp yellowish brown (10YR 5/8) nodules with dark red (2.5YR 4/8 and 10R 3/6) centres, and a few fine patches of very pale brown (10YR 7/3), rubbed colour light yellowish brown (10YR 6/4); stoneless medium sandy clay loam; moist; weak medium and coarse subangular blocky structure easily breaking to fine granular; very porous; 7% very fine macropores; moderately weak ped strength; semi-deformable; slightly sticky; moderately plastic; few very fine fibrous roots; moderately acid; common (15%) vertically aligned nodules to 30 mm long by 20 mm wide; clear smooth boundary to:
- 166 -199 Pale yellow (2.5Y - 10YR 7/4 moist) with many coarse prominent sharp strong brown (7.5YR 5/8) nodules with red (10R 4/8) centres, rubbed colour very pale brown (10YR 7/4); stoneless medium sandy clay loam; moist; medium packing density; weak coarse and very coarse subangular blocky structure, strongly adherent; moderately porous; 4% very fine macropores; moderately firm soil strength; semi-deformable; slightly sticky; moderately plastic; few very fine fibrous roots; moderately acid; many (20%) vertically aligned irregular very firm nodules to 50 mm long by 20 mm wide
- 199 - 230 Pale yellow (2.5Y 8/4 moist) with medium streaks of white (5Y 8/2) and many coarse prominent sharp strong brown (7.5YR 5/8) and red to light red (10R 4/6 to 6/6) nodules, rubbed colour white to pale yellow (2.5Y 8/3); stoneless medium sandy clay loam; moist medium packing density; apedal massive with structure dominated by nodules, breaking to fine and medium granular; moderately porous; moderately strong soil strength, brittle (nodules); moderately weak ped strength, semi-deformable (soil matrix); slightly sticky; moderately plastic; few very fine fibrous roots; moderately acid; many (25%) irregular vertically aligned ferruginous nodules to 50 mm long by 20 mm wide.

Two vertical woody (pine) roots 30 mm diameter extend the full depth of the pit.

ANALYSES

Sample depth (cm)	PR2/1 0-3	PR2/2 3-19	PR2/3 19-35	PR2/4 35-69	PR2/5 69-102	PR2/6 102-121	PR2/7 121-150	PR2/8 150-166	PR2/9 166-199	PR2/10 199-230
Physical analyses:										
Sand 500µm - 2mm %	28.6	29.0	24.7	16.8	18.3	19.8	18.4	14.1	23.2	24.4
250µm - 500µm %	20.0	20.5	21.3	14.1	16.8	13.8	12.1	9.7	10.0	9.0
106µm - 250µm %	13.8	13.5	14.7	12.0	14.0	11.8	11.8	10.0	10.5	10.3
63µm - 106µm %	2.3	2.4	2.1	2.4	2.2	2.7	3.2	3.6	3.7	4.1
Silt 2µm - 63µm %	20.2	29.0	5.4	14.5	21.8	22.8	17.9	14.2	12.2	13.0
Clay < 2µm %	14.5	5.3	31.7	40.2	26.9	29.1	36.6	48.5	39.8	39.1
Chemical analyses:										
pH (1:2.5) in water	5.53	4.56	4.31	4.45	4.54	4.74	4.65	5.33	4.90	5.10
Organic Carbon %	2.04	1.26	0.69	0.74	0.43	0.24	0.20	0.27	0.22	0.14
P _{available} mg/kg	4	28	17	22	22	1	22	17	7	22
Al _{KCl extractable} mg/kg	9	13	22	15	4	4	5	4	3	4
Ca _{exchangeable} me/100g	2.90	1.34	0.66	0.86	0.53	0.40	0.37	0.24	0.17	0.10
Mg _{exchangeable} me/100g	2.08	52.08	33.33	41.67	39.58	35.42	39.58	41.67	49.99	52.08
Na _{exchangeable} me/100g	0.07	0.04	0.04	0.04	0.04	0.02	0.03	0.03	0.02	0.03
K _{exchangeable} me/100g	0.40	0.22	0.20	0.20	0.10	0.12	0.10	0.12	0.09	0.04
CEC me/100g	24.40	54.40	62.40	67.20	69.20	64.00	71.40	66.90	66.60	62.90

Note the high CEC and exchangeable Mg values reported by BBTK.

PROFILE RWP 1990

Soil Type:	Ngwazi Ng
F.A.O:	Xanthic Ferralsol
Described	16 Jun 1990, R W Payton.
Location:	Adjacent to experiment N9, (Square G3, Grid ref 38505671), Ngwazi Tea Research Unit, Ngwazi, Mufindi, Tanzania.
Parent material:	Deeply weathered Basement Complex, possibly colluvial.
Topography:	NW-facing slightly convex lower slope (<3%) about 200 m from shore of Lake Ngwazi. Altitude about 1845 m a.s.l.
Land use and vegetation:	Mature tea planted in 1971.
Site drainage:	Well drained.
Surface:	
Summary of profile:	Brown medium to fine textured topsoil over deep, very light coloured, unmottled, clay subsoil, moist but not wet, over mixed brightly coloured red and yellow weathered rock at 3 m+.

PROFILE DESCRIPTION**Horizons:**

- cm**
- 0 - 15 Dark greyish brown (10YR 4/2) slightly moist, stoneless sandy clay (p.s.c.); very weakly developed fine granular structure; very friable; very porous; low packing density; slightly sticky and moderately plastic when wet; abundant fine fibrous roots; gradual wavy boundary to:
- 15 - 70 Brown (10YR 5/3) moist stoneless clay (p.s.c.); massive breaking easily to a very fine granular structure; very porous; low packing density; moderately weak soil strength; very friable; slightly sticky and moderately plastic when wet; many fine fibrous roots, common fine and coarse woody roots; diffuse smooth boundary to:
- 70 - 160 Pale brown (10YR 6/3) moist clay (p.s.c.); massive breaking easily to very fine granular structure; extremely porous; low packing density; very weak soil strength; very friable; slightly sticky and slightly plastic when wet; many fine fibrous roots, common fine and coarse woody roots.
- 160 - 200 Pale olive (5Y 6/3) with many prominent white (5Y 7/1) mottles: moist stoneless clay (p.s.c.); moderately developed medium blocky structure; very porous; medium packing density; firm when moist; slightly sticky and moderately plastic when wet; common fine fibrous roots, few coarse woody roots; gradual smooth boundary to:
- 200 - 260 Light grey (7.5GY 7/1) with common pale olive mottles; slightly moist stoneless clay (p.s.c.); weakly developed coarse angular blocky structure; moderately porous; medium packing density; very firm when moist; common fine fibrous roots; clear smooth boundary to:

320 - 500 Plinthite horizon consisting of reddish yellow (7.5YR 6/6) slightly moist friable clay (p.s.c.) with a cellular network of very firm, brittle red (2.5YR 4/8) weakly cemented by iron oxides.

Comments:

The soil is a friable clay classified as a Xanthic Ferralsol, i.e. dominated by low activity clays with low effective cation exchange capacity (ECEC) ($<16 \text{ mmol } 100 \text{ g}^{-1}$ of clay). The profile has been affected in the past by a fluctuating watertable at 160 cm depth, but is now freely drained.

ANALYSES

Sample depth (cm)	Ah 0-15	AB 15-70	Bw 70-160	Bg1 160-200	Bg2 200-260	BC(g) 260-400
Physical analyses:						
Sand coarse 600 μm - 2mm %	11	8	2	6	5	5
medium 212 μm - 600 μm %	34	26	12	6	8	7
fine 106 μm - 212 μm %	13	9	10	4	8	5
v. fine 63 μm - 106 μm %	2	3	2	5	3	6
Silt 2 μm - 63 μm %	2	2	4	10	10	23
Clay < 2 μm %	38	52	70	69	66	54
Chemical analyses:						
pH (H ₂ O)	4.55	4.18	4.90	5.82	5.45	6.04
pH (KCl)	3.83	3.90	4.18	4.76	4.84	4.72
Organic carbon %	1.46	0.76				
Exchangeable cations mmol 100 g ⁻¹						
Ca	1.17	0.82	1.09	0.79	0.77	0.81
Mg	0.30	0.21	0.40	0.21	0.19	0.20
K	0.55	0.15	0.01	0.02	0.06	0.01
Al (1M KCl)	1.66	1.31	0.71	0.15	0.10	0.15
Exchangeable acidity mmol 100 g ⁻¹	0.30	0.21	0.40	0.21	0.19	0.20
CEC mmol 100 g ⁻¹						
ECEC (0.1M BaCl ₂)	4.08	2.79	2.41	1.27	1.17	1.32
CEC (NH ₄ OAc)	12.46		3.98			
Avail P mg kg ⁻¹ (Bray 1)	6.51	3.52	1.44	1.26	1.09	0.56
Dithionite ext. Fe %	0.20	0.26	0.21	0.12	0.10	1.69
Base saturation at soil pH %	49.5	42.3	62.2	80.3	87.2	77.3

PROFILE PC8

Soil Type:	Ngwazi Ng
F.A.O:	Xanthic Ferralsol
Described	13 Feb 1993, I.C. Baillie.
Location:	North western boundary (Bore C112, Square C6, Grid ref 34965947), Ngwazi Estate, Mufindi, Tanzania.
Parent material:	Strongly weathered Basement Complex, probably colluvial.
Topography:	Mid-slope of ferricrete-capped hill on undulating plateau, 4° straight, bearing 260°.
Land use and vegetation:	Second rotation of plantation of fast-growing <i>Pinus elliottii</i> . Moderately thick ground vegetation of grasses, broad-leaved shrubs and bracken (<i>Pteridium aquilinum</i>).
Site drainage:	Good, (possibly formerly impeded).
Surface:	5 cm needle litter; 20 cm amplitude microrelief at regular 3 m intervals, probably from forestry operations.
Summary of profile:	Brown loamy topsoil and upper subsoil over grey to white lower subsoil, with no evidence of current wetness, over brightly coloured red and yellow, well drained highly weathered rock.

PROFILE DESCRIPTION

Horizons:

- | cm | |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 - 0 | Litter of little decomposed pine needles. |
| 0 - 6/8 | Very dark greyish brown (10YR 3/2 moist and wet), with common medium faint dark greyish brown (10YR 4/2) and common fine very faint dark brown and dark reddish brown mottles; slightly humose medium and fine sandy clay loam; moderate fine subangular blocky structure, breaking to moderate fine crumb; common medium and fine pores; moist and slightly friable; very slightly sticky and slightly plastic when wet; common medium and coarse and many fine roots; clear slightly wavy boundary to: |
| 6/8 - 27 | Brown to dark brown (10YR 4/3 moist and wet) with common medium faint dark greyish brown (10YR 4/2) mottles; medium sandy loam to sandy clay loam; moderate fine subangular blocky structure breaking to moderate fine crumb; common medium pores; moist and slightly firm; very slightly sticky and slightly plastic when wet; few medium and common fine roots; gradual slightly wavy boundary to: |
| 27 - 57 | Faintly contrasting coarse patches yellowish brown (10YR 5/6) and dark brown to dark yellowish brown (9YR 4/4 moist); medium sandy loam to sandy clay loam; moderate medium subangular blocky structure breaking to moderate to weak fine subangular blocky; many medium and fine, and few coarse dark-filled pores; moist and very slightly firm; very slightly sticky and slightly plastic when wet; few coarse and medium and common fine roots; gradual wavy boundary to: |

- 57 - 102 Yellowish brown (9–10YR 5/8 moist), with common fine faint reddish yellow (7.5YR 6/8) mottles; fine sandy clay loam; weak medium subangular blocky structure; many medium and fine, and few dark-filled coarse pores; moist and friable to firm; slightly sticky and slightly plastic when wet; common medium and fine and few coarse pores; clusters of slightly hard fragments (up to 3 cm) white and very pale brown (10YR 8/2 and 8/3) weathered non-quartzose rock (possibly metargillite); gradual smooth boundary to:
- 102 - 142 Reddish to brownish yellow (9YR 6/6 moist); medium and fine sandy clay loam; weak medium subangular blocky structure, breaking to weak to moderate fine crumb; many medium and fine, and few dark-filled coarse pores; moist and friable; slightly sticky and moderately plastic when wet; few coarse, medium and fine roots; white and very pale brown fragments of weathered rock increase to common, but still clustered, also slightly larger (up to 5 cm) and harder than in 57 - 102 cm; diffuse boundary to:
- 142 - 150 Discontinuous stone layer of subrounded to subangular hard quartz (up to 5 cm).
- 150 - 170/180 White (10YR 8/2 moist), with common coarse to medium faint light grey to pale yellow (2.5Y 7/3) and many fine distinct linear yellowish brown (10YR 5/6) mottles; slightly hard weathered rock with interstitial reddish yellow and brown (7.5YR 6/6 and 5/4) softer patches; mainly rock structure but interstitial pockets are weak fine crumb; coarse dark voids and common medium and fine pores in weathered rock; moist and moderately hard; few coarse and medium roots, mainly in dark-filled vertical coarse voids; clear cusped boundary with appearance of relict columnar caps to:
- 170/180 - 210 Reddish cores of red (10R 5/8 and 2.5YR 5/8) with many distinct flecks of pink and white, harder coatings of yellow (10YR 7/6 and 7/8) and reddish yellow (7.5YR 7/8) with orange and yellowish brown patches, in a matrix of reddish yellow (7.5YR 6/8); plinthitic cores of slightly hard weathered rock in matrix of stony to gritty very fine sandy clay loam; structure dominated by stones, matrix weak to moderate fine angular blocky; weak shiny films against some stones; common medium and fine pores and coarse pores filled with light yellowish brown and brown (10YR 6/4 and 7.5YR 3/4); moist and firm and compact; moderately sticky and plastic when wet; few coarse and medium vertical pine roots;
- continued by auger:
- 210 - 250 Reddish yellow (6YR 7/6), with many fine distinct yellow, pink and orange patches; dry crumbly, weathered rock.
- 250 - 270+ Reddish yellow to yellow (7.5YR to 9YR 7/6) weathered rock, varicoloured as above, also with patches of distinct red and white flecking; harder and more compact than above.

ANALYSES

Sample depth (cm)	PC8/A 0-6	PC8/B 12-22	PC8/C 37-47	PC8/D 75-85	PC8/E 120-130	PC8/F 155-165	PC8/G 190-200
Physical analyses:							
Sand 500µm - 2mm %	9.5	10.6	7.7	5.4	5.8	10.2	14.8
250µm - 500µm %	16.3	17.5	9.4	5.9	6.1	7.5	5.5
106µm - 250µm %	23.1	23.1	17.9	15.1	15.6	16.4	11.1
63µm - 106µm %	5.4	4.5	6.1	7.3	7.2	9.3	6.5
Silt 2µm - 63µm %	17.2	12.6	10.9	13.2	15.1	14.6	60.8
Clay < 2µm %	27.4	30.8	48.0	52.6	49.9	41.3	45.4
Chemical analyses:							
pH (1:2.5) in water	4.48	4.56	5.16	5.33	5.47	5.00	5.52
Organic Carbon %	1.63	0.66	0.45	0.51	0.20	0.18	0.16
P_{available} mg/kg	13	22	16	12	20	25	22
Al_{KCl extractable} mg/kg	59	43	32	18	13	11	6
Ca_{exchangeable} me/100g	0.16	0.23	0.31	0.31	0.37	0.32	0.44
Mg_{exchangeable} me/100g	0.92	0.38	0.33	0.41	0.48	0.42	0.41
Na_{exchangeable} me/100g	0.05	0.04	0.04	0.04	0.04	0.04	0.07
K_{exchangeable} me/100g	0.23	0.14	0.14	0.14	0.17	0.18	0.18
CEC me/100g	8.00	5.00	10.46	8.60	10.00	8.52	4.60

WATER RELEASE CHARACTERISTICS

Water release characteristics were obtained by sampling at selected depths in the main soil types. Additionally, data obtained by R.W. Payton of SSLRC from the pit close to experiment N9 in 1990 are available.

Soil Type (phase)	Profile Code	Location (square)
Nzivi	PR3	H3
Nzivi	PC1	C2
Nzivi (mottled)	PR4	D4
Nzivi (gravelly)	PC4	G7
Makabila (deep)	PC3	F6
Kihanga (deep)	PR2	D4
Ngwazi	RWP 1990	G3

As explained in Annex 2, water retained by undisturbed triplicate core samples was measured in the laboratory at suctions of 0.05, 0.1 and 0.4 bar on sand and kaolin tension tables, and at 2 and 15 bar in pressure membrane cells. Mean values for the water content at each suction are expressed as a volumetric water content (per cent) on the basis of total soil volume. Calculations can be made of available and easily available water, total pore space, air capacity and bulk density.

DATA INTERPRETATION

The data for each of the six pits sampled in 1993 are presented in full to allow users to make their own interpretations if required.

The analysis of profile PR3 was performed at the SSLRC laboratory at Shardlow, U.K.; the remainder by the Tea Research Foundation of Kenya at Kericho. The latter received their undisturbed core samples in mid-May 1993, 2½ months after collection and without refrigeration in the intervening period.

The raw data are accompanied by a calculation for the water holding capacity for each soil, both for Total Available Water (TAW) and Easily Available Water (EAW). The figures are summed for each horizon over its total thickness (Hor), and an accumulated total (Acc) is given down the soil profile to full sampling depth. A projected set of figures is given to a depth of 500 cm using the water release data for the lowest sampled horizon. This aids the calculation of water holding capacities for any crop, at whatever growth stage and rooting depth.

Nzivi soil type and its mottled and gravelly subsoil phases appear to have a wide range of available water capacities, as projected to 500 cm depth, from 472 mm TAW (SSLRC) to 185 mm TAW (TRFK) for the mottled subsoil phase.

Makabila soil type, with restrictions due to soil nodules, has a projected TAW calculated at only 129 mm.

Kihanga and Ngwazi soil types, both on lower slopes, have unexplained contrasting TAW projected values of 217 mm (TRFK) and 523 mm (SSLRC) respectively

Profile PR3 – Nzivi soil type, cultivated land

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar TAW	0.1-2 bar EAW	
		0.05	0.1	0.4	2.0	15.0					
5-10	PR3 W/1 a	30.51	27.70	22.83	-	15.96	1.18	53.72			
5-10	PR3 W/1 b	30.15	27.38	22.59	18.88	18.87	1.13	55.66			
5-10	PR3 W/1 c	31.14	28.19	23.35	19.97	15.94	1.18	53.79			
	Mean	30.60	27.76	22.92	19.42	16.92	1.16	54.39	10.84	8.34	26.63
50-55	PR3 W/2 a	35.07	29.98	22.99	20.21	18.07	1.14	55.36			
50-55	PR3 W/2 b	34.43	30.91	26.48	19.95	19.45	1.14	55.26			
50-55	PR3 W/2 c	33.91	28.72	23.37	19.95	19.40	1.12	55.97			
	Mean	34.47	29.87	24.28	20.03	18.97	1.13	55.53	10.90	9.84	25.66
115-120	PR3 W/3 a	36.09	31.79	27.07	22.71	20.67	1.06	58.54			
115-120	PR3 W/3 b	33.73	29.50	23.55	21.03	19.97	0.98	61.62			
115-120	PR3 W/3 c	35.90	29.43	24.08	22.09	19.34	1.01	60.49			
	Mean	35.24	30.24	24.90	21.94	19.99	1.01	60.21	10.25	8.30	29.97
165-170	PR3 W/4 a	37.33	32.32	25.75	22.96	21.53	1.00	60.76			
165-170	PR3 W/4 b	38.15	31.38	25.65	23.13	20.18	0.99	61.17			
165-170	PR3 W/4 c	38.99	32.30	26.38	22.46	21.57	1.01	60.21			
	Mean	38.16	32.00	25.93	22.85	21.09	1.00	60.71	10.91	9.15	28.71
252-257	PR3 W/5 a	38.20	35.12	31.49	28.88	25.06	1.11	56.54			
252-257	PR3 W/5 b	39.76	35.50	31.46	27.63	27.29	1.16	54.41			
252-257	PR3 W/5 c	37.61	33.27	28.97	26.48	25.85	1.10	56.77			
	Mean	38.52	34.63	30.64	27.67	26.07	1.12	55.91	8.56	6.96	21.28

**Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc)
by horizon down the soil profile - Nzivi soil type, Profile PR3**

Depth cm	Thickness cm	TAW		EAW	
		mm Hor	mm Acc	mm Hor	mm Acc
0-20	20	20.50	20.50	16.68	16.68
20-40	20	21.80	42.30	19.68	36.36
40-74	34	37.06	79.36	33.46	69.82
74-122	48	49.20	128.56	39.84	109.66
122-210	88	96.01	224.57	80.52	190.18
210-249	39	33.38	257.95	27.14	217.32
249-302	53	45.37	303.32	36.89	254.21
[302-500	198	169.49	472.81	137.81	392.02] projected

Profile PC1 – Nzivi soil type, forested land

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar	0.1-2 bar	
		0.05	0.1	0.4	2.0	15.0			TAW	EAW	
5-10	PC1a	28.97	27.53	26.72	24.57	24.08	1.33	46.15		9.45	
5-10	PC1b	30.29	24.20	23.09	21.70	21.28	1.33	45.93		13.78	
5-10	PC1c	25.12	23.01	22.20	21.70	21.45	1.31	46.96		17.11	
	Mean	28.13	24.91	24.00	22.66	22.27	1.32	46.35	2.64	2.25	13.45
60-65	PC1a	32.99	24.39	21.49	20.55	20.05	1.31	47.18		15.03	
60-65	PC1b	35.85	26.16	23.79	22.19	21.28	1.26	50.00		17.01	
60-65	PC1c	40.94	28.05	25.57	23.15	22.16	1.19	53.33		19.71	
	Mean	36.59	26.20	23.62	21.96	21.16	1.25	50.17	5.04	4.24	17.25
110-115	PC1a	42.33	31.29	29.71	29.02	28.43	1.16	53.97		17.89	
110-115	PC1b	42.03	31.00	30.46	29.71	29.15	1.18	52.80		16.16	
110-115	PC1c	40.25	31.92	29.16	28.01	26.93	1.19	52.02		14.29	
	Mean	41.54	31.40	29.78	28.91	28.17	1.18	52.93	3.23	2.49	16.11
210-215	PC1a	41.91	36.15	32.77	30.79	29.82	1.13	54.62		13.39	
210-215	PC1b	43.70	35.67	33.05	31.47	30.59	1.20	51.61		8.69	
210-215	PC1c	28.23	25.49	22.32	21.04	20.31	1.27	49.00		16.63	
	Mean	37.95	32.44	29.38	27.77	26.91	1.20	51.74	5.53	4.67	12.90

Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc) by horizon down the soil profile - Nzivi soil type, Profile PC1

Depth cm	Thickness cm	TAW mm Hor	TAW mm Acc	EAW mm Hor	EAW mm Acc
0-7	7	1.85	1.85	1.58	1.58
7-22	15	3.96	5.81	6.36	7.94
22-44	22	11.09	16.90	9.33	17.27
44-82	38	19.15	36.05	16.11	33.38
82-150	68	21.96	58.01	16.93	50.31
150-290	140	77.42	135.43	65.38	115.69
1290-500	210	116.13	251.56	98.07	213.76] projected

Profile PR4 – Nzivi (mottled subsoil phase) soil type, forested land

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar	0.1-2 bar	
		0.05	0.1	0.4	2.0	15.0			TAW	EAW	
10-15	PR4 W/1a	23.73	14.30	12.33	11.57	11.14	1.40	44.88			25.07
10-15	PR4 W/1b	24.73	14.88	12.75	11.97	11.46	1.37	44.53			24.25
10-15	PR4 W/1c	23.55	14.44	12.85	12.81	12.31	1.43	43.70			22.84
	Mean	24.00	14.54	12.64	12.12	11.64	1.40	44.37	2.90	2.42	24.05
50-55	PR4 W/2a	26.53	18.02	13.68	13.45	13.02	1.42	41.80			16.40
50-55	PR4 W/2b	25.53	17.68	15.47	13.21	12.42	1.44	43.08			17.41
50-55	PR4 W/2c	27.91	16.32	15.18	14.11	13.46	1.41	44.71			21.81
	Mean	26.66	17.34	14.78	13.59	12.97	1.42	43.20	4.37	3.75	18.54
135-140	PR4 W/3a	43.72	21.79	19.16	18.01	17.22	1.07	57.71			34.43
135-140	PR4 W/3b	47.41	22.45	18.36	17.60	16.81	1.00	60.00			37.43
135-140	PR4 W/3c	45.97	22.45	19.88	18.93	15.96	1.05	58.82			35.43
	Mean	45.70	22.23	19.13	18.18	16.66	1.04	58.84	5.57	4.05	35.76
230-235	PR4 W/4a	33.66	24.85	22.90	21.96	21.09	1.20	49.01			16.73
230-235	PR4 W/4b	31.91	23.36	22.51	21.71	21.44	1.32	47.83			17.04
230-235	PR4 W/4c	31.95	23.93	22.76	21.89	20.96	1.31	48.22			16.57
	Mean	32.51	24.05	22.72	21.85	21.16	1.28	48.35	2.89	2.20	16.78

**Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc)
by horizon down the soil profile - Nzivi (mottled phase) soil type, Profile PR4**

Depth cm	Thickness cm	TAW		EAW	
		mm	mm	mm	mm
		Hor	Acc	Hor	Acc
0-10	10	2.90	2.90	2.42	2.42
10-21	11	3.19	6.09	2.66	5.08
21-36	15	6.56	12.65	5.63	10.71
36-66	30	13.11	25.76	11.25	21.96
66-101	35	15.30	41.06	13.13	35.09
101-134	24	13.37	54.43	9.72	44.81
134-228	94	52.36	106.79	38.07	82.88
228-305	77	22.25	129.04	16.94	99.82
[305-500	195	56.36	185.40	42.90	142.72] projected

Profile PC4 – Nzivi (gravelly subsoil phase) soil type, fallow land with shrubs

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar	0.1-2 bar	
		0.05	0.1	0.4	2.0	15.0			TAW	EAW	
0-5	PC4a	36.25	27.43	25.18	24.16	23.22	1.24	49.39			15.20
0-5	PC4b	39.45	30.74	28.27	27.47	26.67	1.14	53.09			18.11
	Mean	37.85	29.09	26.73	25.82	24.95	1.19	51.24	4.14	3.27	16.66
35-40	PC4a	39.99	30.13	27.33	26.35	25.75	1.17	52.44			16.93
35-40	PC4b	34.49	27.23	24.34	22.74	19.95	1.36	45.38			8.25
35-40	PC4c	36.74	26.99	23.51	21.97	20.25	1.27	49.40			15.07
	Mean	37.07	28.12	25.06	23.69	21.98	1.27	49.07	6.14	4.43	13.42
90-95	PC4a	44.42	36.09	27.24	25.97	24.95	1.11	55.24			15.28
90-95	PC4b	46.06	37.96	30.25	28.61	27.57	1.10	55.10			13.71
	Mean	45.24	37.03	28.75	27.29	26.26	1.11	55.17	10.77	9.74	14.50
195-200	PC4a	38.75	32.51	30.01	29.45	28.38	1.26	48.78			8.10
195-200	PC4b	44.78	35.72	32.48	31.21	30.11	1.17	52.63			10.69
195-200	PC4c	41.26	33.26	30.08	29.01	28.26	1.11	54.88			17.68
	Mean	41.60	33.83	30.86	29.89	28.92	1.18	52.10	4.91	3.94	12.16

Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc) by horizon down the soil profile – Nzivi (gravelly phase) soil type, Profile PC4

Depth cm	Thickness cm	TAW mm Hor	TAW mm Acc	EAW mm Hor	EAW mm Acc
0-12	12	4.97	4.97	3.92	3.92
12-22	10	4.14	9.11	3.27	7.19
22-56	34	20.88	29.99	15.06	22.25
56-135	79	85.08	115.07	76.95	99.20
135-270	135	66.29	181.36	53.19	152.39
270-300	30	14.73	196.09	11.82	164.21
[300-500	200	98.20	294.29	78.80	243.01] projected

Profile PC3 – Makabila (deep subsoil phase) soil type, grassland fallow

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar TAW	0.1-2 bar EAW	
		0.05	0.1	0.4	2.0	15.0					
0-5	PC3a	31.46	23.01	22.08	21.40	20.46	1.35	46.00			15.05
0-5	PC3b	34.20	24.30	23.62	22.84	22.32	1.31	46.96			15.22
0-5	PC3c	29.38	26.53	25.83	25.04	24.68	1.26	48.99			15.43
	Mean	31.68	24.61	23.84	23.09	22.49	1.31	47.32	2.12	1.52	15.23
65-70	PC3a	43.58	33.49	28.81	26.78	25.29	1.21	51.79			11.57
65-70	PC3b	42.05	31.44	29.02	27.80	25.37	1.15	54.00			17.89
65-70	PC3c	44.04	30.07	27.12	25.94	23.33	1.11	55.06			21.82
	Mean	43.22	31.67	28.32	26.84	24.66	1.16	53.62	7.01	4.83	17.09
110-115	PC3a	27.55	21.61	21.16	20.83	20.36	1.46	42.06			10.54
110-115	PC3b	28.91	21.45	21.02	20.53	19.73	1.42	44.09			13.43
110-115	PC3c	29.33	22.25	22.07	21.60	21.34	1.38	45.67			14.65
	Mean	28.60	21.77	21.42	20.99	20.48	1.42	43.94	1.29	0.78	12.87
220-240	PC3a	24.90	19.89	19.36	19.03	18.67	1.55	39.22			8.22
220-240	PC3b	24.79	19.07	18.02	17.46	16.76	1.58	37.55			7.60
220-240	PC3c	26.76	20.72	19.99	19.35	18.57	1.46	42.06			12.08
	Mean	25.48	19.89	19.12	18.61	18.00	1.53	39.61	1.89	1.28	9.3

**Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc)
by horizon down the soil profile – Makabila (deep phase) soil type, Profile PC3**

Depth cm	Thickness cm	TAW mm Hor	TAW mm Acc	EAW mm Hor	EAW mm Acc
0-11	11	2.33	2.33	1.67	1.67
11-20	9	1.91	4.24	1.37	3.04
20-33	13	2.76	7.00	1.98	5.02
33-51	18	12.62	19.62	8.69	13.71
51-78	27	18.93	38.55	13.04	26.75
78-108	30	21.03	59.58	14.49	41.24
108-138	30	3.87	63.45	2.34	43.58
138-177	39	5.03	68.48	3.04	46.62
177-250	73	13.80	82.28	9.34	55.96
1250-500	250	47.25	129.53	32.00	87.96] projected

Profile PR2 – Kihanga (deep subsoil phase) soil type, forested land

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar TAW	0.1-2 bar EAW	
		0.05	0.1	0.4	2.0	15.0					
4-9	PR2 W/1a	37.21	28.90	25.44	24.24	23.26	1.18	51.44			17.19
4-9	PR2 W/1b	30.13	23.03	19.43	18.27	17.25	1.27	48.16			18.95
4-9	PR2 W/1c	31.80	23.11	19.40	18.31	17.58	1.23	49.38			20.96
	Mean	33.05	25.01	21.42	20.27	19.36	1.23	49.66	5.65	4.74	19.03
50-55	PR2 W/2a	39.07	28.80	23.41	22.49	21.53	1.17	51.25			17.83
50-55	PR2 W/2b	34.23	25.14	20.68	19.98	19.27	1.25	48.15			17.14
50-55	PR2 W/2c	38.10	29.50	25.11	23.98	22.98	1.15	52.48			18.58
	Mean	37.13	27.81	23.07	22.15	21.26	1.19	50.63	6.55	5.66	17.85
110-115	PR2 W/3a	36.25	26.03	22.39	21.75	21.05	1.23	49.17			17.31
110-115	PR2 W/3b	34.49	24.04	21.14	20.72	19.96	1.33	46.15			14.25
110-115	PR2 W/3c	37.06	26.43	22.90	21.66	20.35	1.23	50.40			18.20
	Mean	35.93	25.50	22.14	21.38	20.45	1.26	48.57	5.05	4.12	16.59
200-205	PR2 W/4a	32.06	26.88	25.62	24.89	24.19	1.37	44.76			7.71
200-205	PR2 W/4b	33.98	26.55	24.44	23.95	23.53	1.29	47.35			13.10
200-205	PR2 W/4c	34.06	27.52	24.21	23.45	22.46	1.30	47.37			11.27
	Mean	33.37	26.98	24.76	24.10	23.39	1.32	46.49	3.59	2.88	10.69

**Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc)
by horizon down the soil profile – Kihanga (deep phase) soil type, Profile PR2**

Depth cm	Thickness cm	TAW mm Hor	TAW mm Acc	EAW mm Hor	EAW mm Acc
0-3	3	1.70	1.70	1.42	1.42
3-19	16	9.04	10.74	7.58	9.00
19-35	16	10.48	21.22	9.06	18.06
35-69	34	22.27	43.49	19.24	37.30
69-102	33	21.62	65.11	18.68	55.98
102-121	19	9.60	74.71	7.83	63.81
121-150	29	14.65	89.36	11.95	75.76
150-166	16	8.08	97.44	6.59	82.35
166-199	33	11.85	109.29	9.50	91.85
199-230	31	11.13	120.42	8.93	100.78
[230-500	270	96.93	217.35	77.76	178.54] projected

Profile RWP1990 – Ngwazi soil type, tea plantation

Depth cm	Sample No.	Soil moisture release data (0.05 to 15 bar)					Bulk density g/cm ³	Total Porosity % vol	Available water %		Air capacity % 0.1bar
		% moisture retention at (bar)							0.1-15 bar TAW	0.1-2 bar EAW	
		0.05	0.1	0.4	2.0	15.0					
15-20	1	26.00	24.71	22.37	12.67	12.93	1.24	51	11.78	12.04 [#]	26
55-60	2	29.52	26.83	23.89	16.48	14.65	1.21	53	12.12	10.35	26
180-185	3	35.88	32.54	28.64	23.02	22.03	1.01	61	10.51	9.52	29
270-275	4	36.53	34.88	32.67	27.36	25.59	1.17	55	9.29	7.52	20

**Total and Easily available water calculations by Horizon (Hor) and Accumulated (Acc)
by horizon down the soil profile – Ngwazi soil type, Profile RWP1990**

Depth cm	Thickness cm	TAW mm Hor	TAW mm Acc	EAW mm Hor	EAW mm Acc
0-15	15	17.67	17.67	18.06 [#]	18.06
15-70	55	64.79	82.46	66.22	84.28
70-160	90	109.62	192.08	93.15	177.43
160-200	40	42.04	234.12	38.08	215.51
200-260	60	66.48	300.60	68.76	284.27
260-320	60	55.74	356.34	45.12	329.39
320-500	180	167.22	523.56	135.36	464.24

[#] Possible error, as EAW>TAW