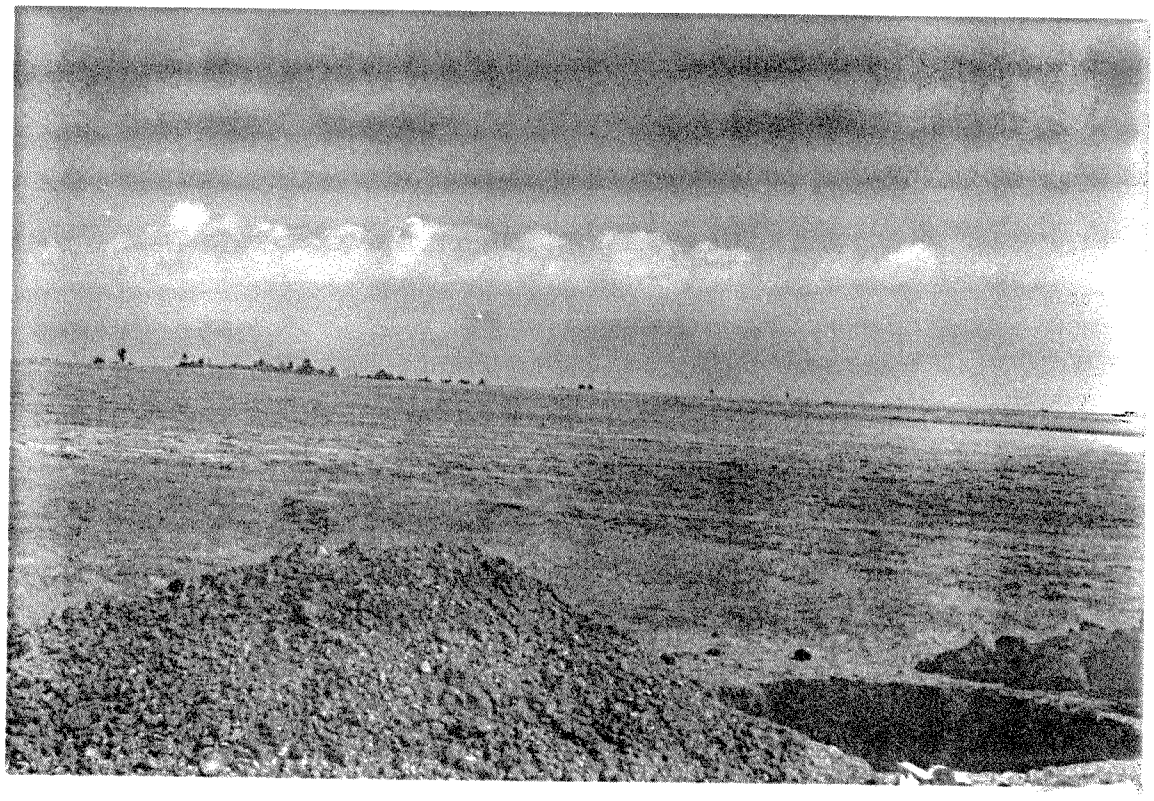
REPORT ON

SITE-PROFILE DESCRIPTION, PHYSICAL AND CHEMICAL PROPERTIES OF SOIL MONOLITHS COLLECTED FOR SOIL REFERENCE.



BY

Eylachew Zewdie
National Consultant

NATIONAL SOIL SERVICE PROJECT, FAO ETH/87/010

MINISTRY OF NATIONAL RESOURCES DEVELOPMENT AND ENVIRONMENT PROTECTION

PREFACE

According to the plan of action for the collection of soil monoliths the team has travelled to the major agro-climatic zones of the country (Shewa, Gojjam, Gonder, Wellega, Illubabur, Sidamo, Bale, Arssi, Wello, Tigray and Hararghe) and collected 27 monoliths based on the current soil map of the country. Relevant information on the sites and profiles were collected and chemical and physical properties were determined at the NSSP. The collected 27 profiles were classified using the FAO (1989) and USDA (1992) guide lines. Profiles were found to represent 20 great groups of the eight orders in the USDA classification.

The monoliths were properly impregnated to maintain the natural soil natural conditions and presently placed in one of the rooms of NSSP.

This document contains information on the collected monoliths, which will be followed by a technical paper in the near future.

Eylachew Zewdie (Dr.)
National Consultant
FAO ETH 87/010

Monolith Number : ETH-01 Country : Ethiopia - Nazerate
Date : 29/12/93

Classification FAO/UNESCO, 1989 : Haplic Andosol
USDA, 1992 : Typic Haplustand
Diagnostic horizons : Cambic, Ochric
Other diagnostic criteria : Weatherable mineral

Location : Nazerate - Dabe Altitude 1675 m.a.s.l.
Latitude 08° 36'N Longitude 39° 15'E
Author(s) : B.K.Yerima, Eylachew z. and Sahlemedhin S.

General landform : Hilly Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : 2%; ; Undulating
Position of site : Middle slope
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : Nil
Slope processes soil erosion : Slight sheet

Parent material : Volcanic Derived from : Pumice
Texture : Granular
Remarks : Partial/moderately weathered

Effective soil depth (cm) : 115cm

Water table depth (cm) : Not observed Kind : Nil
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Medium
Moisture condition of the profile : 0 - 15 cm dry; > 15cm moist

Land use : Low level arable farming, low level inputs.
Vegetation structure : Xeromorphic Status : Modified

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isothermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 01

PROFILE DESCRIPTION

Ap 0-15 cm 10YR 5/3 dry and 10YR 2/3 moist; Sandy loam; diffuse and smooth boundary; moderately strong fine to medium granular structure; slightly hard when dry and friable when moist; slightly sticky and non plastic when moist; many fine to coarse tubular pores vertically oriented which are continuous and distributed both inped and expend; highly porous; many fine roots throughout the horizon; weekly cemented massive continuous plough pan; few mycelium.

AB 15-60 cm 10YR 3/3 moist; loam; diffuse and smooth boundary; weak fine to medium sub-angular blocky structure; friable when moist; slightly sticky and non-plastic when wet; few very fine tubular pores vertically oriented which are continuous and distributed both inped and exped; moderately porous; 10 - 100 fine roots/dm^3.

Bw 60-120 cm 10YR 3/3 moist; loam; weak medium sub-angular blocky structure; friable when moist; slightly sticky and non plastic when wet; few very fine tubular pores vertically oriented which are continuous and distributed both inped and exped; slightly porous; few fine root throughout the horizon.

C 120 cm^+ 10YR 5/4 moist, sandy loam; weakly coherent coarse massive structure; slightly sticky and non-plastic.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-01

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-01	0-15	1.43	65.28	18	16.72	SL
	15-60	1.45	51.28	28	20.72	L
	60-120	2.53	45.28	34	20.72	L
	120	3.33	57.28	26	16.72	SL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	7.2	0.946	0.055	17	6.62	1.11	17.7	10.1	0.06
15-60	7.5	0.732	0.060	12	1.74	1.04	25.9	13.6	0.05
60-120	8.2	0.602	0.057	10.5	1.37	0.98	32.5	18.0	0.21
120+	9.0	0.346	0.034	10	0.64	0.90	25.7	12.7	0.28

* = oven dry

NSSP CODE : ETH-01

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	0.60	2.40	11.54	1.22				
15-60	0.89	3.45	17.60	1.50				
60-120	3.93	7.49	23.33	2.23				
120+	6.42	11.24	15.67	2.60				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	22.01	121.1	15.76	71.6	0.867	0.233	6.88	22.70
15-60	25.91	108.9	23.44	90.5	0.513	0.207	4.05	10.04
60-120	33.63	146.9	34.75	103.3	0.583	0.223	3.96	3.17
120+	27.25	155.0	35.93	131.9	0.407	0.303	4.02	2.28

Monolith Number : ETH-02 Country : Etiopia - Wonji
Date : 30/12/93

Classification FAO/UNESCO, 1989 : Eutric Vertisol
USDA, 1992 : Typic Pellustert
Diagnostic horizons : Umbric
Other diagnostic criteria : Abrupt textural change; mollic

Location : Wonji sugar estate ;field 77 Altitude 1650 masl
Latitude 08° 29'N Longitude 39° 13'E
Author(s) : B.K.Yerima; Eylachew Z. and Sahlemedhin s.

General landform : Alluvial plain Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 0.5%; ; Straight
Position of site : Closed depression
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : Nil
Slope processes soil erosion : Nil

Parent material : Alluvium Derived from : Mixed lithology
Texture : Mixed
Remarks : Materials derived from the central highland.
Cracking is not observed due to irrigation.

Effective soil depth (cm) : 200

Water table depth (cm) : 200 Kind : Perched
Drainage : Imperfectly drained
Permeability : Slow
Flooding frequency : Nil Runoff : Nil
Moisture condition of the profile : 0 - 22cm dry; 22 - 152 moist;
152 - 200cm wet.

Land use : High level arable farming and high inputs.
Vegetation structure : Nil Status : Nil

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isothermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 02

Ap 0-22 cm 10YR 4/1 dry and 10YR 3/1 moist; clay; diffuse and smooth boundary; moderately decomposed leaves; strong coarse granular structure; very hard when dry and very firm when moist; slightly sticky and very plastic when wet; meny fine to coarse interstitial pores which are continuous and located in exped; highly porous; many coarse roots distributed throughout the horizon.

AB 22-52 cm 10YR 2/2 moist; clay; diffuse and smooth boundary; strong coarse to very coarse angular block structure tilted at about 40°; very firm when moist; very sticky and plastic when wet; few interstitial micro pores which are continuous and located exped; slightly porous; many very fine to coarse roots distribute throughout the horizons.

Bw 52-75 cm 10YR 3/1 moist; clay; clear and smooth boundary; strong fine to medium prismatic structure breaking to sub-angular blocky structure; very sticky and plastic when wet; few interstitial micro pores which are continuous and located in exped; slightly porous; many fine roots throughout the horizon; few channels.

B_2 75-119 cm 10YR 3/2 moist; clay; clear and smooth boundary; weak fine platy structure that breaks into sub-angular blocky structure; very sticky and plastic when wet; many fine to coarse continuous tubular pores with oblique orientation and distributed in inped; slightly porous; few fine roots throughout the horizon; coarse size mottles upto 20% with prominent contrast and sharp boundary (2.5YR 2/10), few animal channel.

B_3 **119-154 cm** 10YR 3/1 moist; clay; clear and smooth boundary; strong coarse prismatic structure oriented at about 30°; very sticky and plastic when wet; few micro interstitial pores which are inped and continuous; slightly porous, few fine root throughout; heterogeneous sized mottles (2.5YR 2/0) with distinct contrast and clear boundary.

B_4 **154-174 cm** 10YR 3/3 moist; sandy clay loam; clear and smooth boundary; very weak very fine to fine massive structure; slightly sticky and plastic; many micro tubular pores oblique oriented and distributed in exped; highly porous, many coarse size mottles (2.5YR 2/0) with prominent contrast and sharp boundary.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-02

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-02	0-22	2.10	11.28	24	64.72	C
	22-52	1.00	7.28	24	68.72	C
	52-75	3.29	9.28	26	64.72	C
	75-119	0.76	7.28	48	44.72	SiC
	119-154	2.60	7.28	18	74.72	C
	154-174	1.18	45.28	26	28.72	SiC
	174+	1.75	9.28	36	54.72	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-22	7.6	2.104	0.124	17.0	9.58	1.12	58.0	42.9	0.27
22-52	7.9	1.299	0.083	15.7	5.95	1.01	65.0	44.7	0.34
52-75	8.0	1.090	0.087	12.5	19.58	1.20	59.7	34.6	0.73
75-119	7.7	0.711	0.045	15.8	12.01	1.24	53.9	29.5	0.43
119-154	7.7	0.543	0.048	11.3	14.71	1.21	63.5	44.1	0.35
154-174	7.7	0.503	0.046	10.9	8.01	1.09	35.2	19.7	0.25
174+	7.8	0.654	0.047	13.9	8.33	-	55.3	34.4	0.26

* = oven dry

NSSP CODE : ETH-02

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-22	4.62	2.57	40.05	6.73				
22-52	6.05	1.93	43.36	7.65				
52-75	7.57	1.65	39.09	6.84				
75-119	4.79	1.46	31.71	4.65				
119-154	4.18	2.91	46.60	6.83				
154-174	3.93	1.81	27.81	3.89				
174+	3.01	2.38	34.52	5.21				

Depth cm	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-22	62.58	87.2	53.97	86.2	1.133	1.830	14.98	30.33
22-52	65.40	91.2	58.99	90.2	1.077	2.067	12.37	13.66
52-75	57.81	86.1	55.15	95.4	1.300	1.887	12.11	12.69
75-119	42.23	92.9	42.61	100.9	1.063	1.300	10.59	14.28
119-154	56.87	74.8	60.52	106.4	1.087	1.670	8.95	14.61
154-174	37.94	120.1	37.44	98.7	1.143	1.147	7.69	34.93
174+	51.13	89.9	45.12	88.2	1.050	1.927	7.97	48.83

Monolith Number : ETH-03 Country : Ethiopia - Nazerate
Date : 31/12/93

Classification FAO/UNESCO, 1989 : Eutric Vertisol
USDA, 1992 : Typic Pellustert
Diagnostic horizons : Mollic; umbric
Other diagnostic criteria : Slickenside

Location : Wonji - EST,field 222 Altitude 1650 m.a.s.l
Latitude 08° 36'N Longitude 39° 15'E
Author(s) : Eylachew Z.

General landform : Alluvium plain Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 0.5%; ; straight
Position of site : Depression
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : Nil
Slope processes soil erosion : Nil

Parent material : alluvium Derived from : Mixed lithology
Texture : Clayey
Remarks : Materials derived from the central highland
Cracking is not observed due to irrigation.

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Imperfectly drained
Permeability : Slow
Flooding frequency : Nil Runoff : Nil
Moisture condition of the profile : 0 - 5cm dry; 5 - 200cm wet.

Land use : High level arable farming and high inputs.
Vegetation structure : Nil Status : -

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isothermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 03

Ap **0-40 cm** 10YR 4/1 dry and 10YR 3/1 moist; clay; diffuse and smooth boundary; slight decomposed unspecified organic matter; strong coarse prismatic structure breaking into granular; very hard when dry and extremely firm when moist; very sticky and plastic when wet; slightly porous; many very fine to coarse roots between peds.

Bw_1 **40-95 cm** 10YR 4/1 dry and 10YR 3/1 moist; clay; diffuse and smooth boundary; slightly decomposed unspecified organic matter; strong coarse angular blocky structure; very hard when dry and extremely firm when moist; very sticky and plastic when wet; slightly porous; few medium sized root between ped.

Bw_3 **95-200 cm** 10YR 5/2 dry and 10YR 3/1 moist; clay; diffuse and smooth boundary; slightly decomposed unspecified organic matter; strong coarse sub-angular blocky structure oriented at 45° with slickenside; very hard when dry and extremely firm when moist; very sticky and plastic when wet; slightly porous; few fine roots between ped.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-03

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-03	0-40	6.28	9.28	16	74.72	C
	40-95	2.37	9.28	10	80.72	C
	95-200	2.20	11.28	26	62.72	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-40	7.6	1.417	0.086	16.5	6.97	1.08	68.3	36.4	0.14
40-95	8.2	1.027	0.084	12.2	26.62	1.13	77.0	39.1	0.195
95-200	7.6	0.902	0.049	18.4	11.91	1.94	61.9	32.4	0.16

* = oven dry

NSSP CODE :ETH-03

Depth cm	Exch. Bases meq/100g soil Na	K	Ca	Mg	Exch. Acidity Al+H	Al	H	Sum Cations
0-40	5.03	2.60	42.24	8.62				
40-95	6.86	2.67	45.93	8.81				
95-200	4.03	2.42	39.25	6.45				

Depth cm	CEC (meq/100g) Soil	Clay	Base Sat Sum	CEC	Micronutrient (ppm) Zn	Cu	Fe	Mn
0-40	65.02	84.1	58.49	90.0	2.030	1.777	16.72	33.31
40-95	62.64	74.4	64.27	102.6	1.320	1.730	14.98	10.50
95-200	56.79	86.4	52.15	91.8	1.227	1.513	12.04	3.52

Monolith Number : ETH-04 Country : Ethiopia - Ambo
Date : 20/01/94

Classification FAO/UNESCO, 1989 : Eutric Regosol
USDA, 1992 : Typic Eutrochrept
Diagnostic horizons : Ochric
Other diagnostic criteria : Ferric properties

Location : Ambo - Sinkelle, Altitude 2090 m.a.s.l
Latitude 08° 58'N Longitude 37° 53'E
Author(s) : B.K.Yerima; Eylachew z. and Tadelle G.S.

General landform : Mountain Topography : Hilly
Physiographic unit :
Slope gradient/aspect/form : 20%; ; Undulating
Position of site : Middle slop
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : Nil
Slope processes soil erosion : Slight sheet erosion

Parent material : Colluvium Derived from : Sand-silt stone
Texture : Silty
Remarks :

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Very rapid
Moisture condition of the profile : Dry throughout

Land use : Natural grass land; grazed
Vegetation structure : Semi-deciduous Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 04

A 0-13 cm 7.5YR 5/4 dry and 7.5YR 4/4 moist; sandy clay loam; clear and smooth boundary; strongly coherent fine crumby structure; slightly hard when dry; slightly sticky and plastic when wet; many continuous microvesicular pores randomly oriented in inped and exped; highly porous; many very fine to coarse roots in mat at top of horizon; few fresh medium sized roots.

AC 13-45 cm 7.5YR 4/4 dry and 5YR 3/3 moist; sandy clay loam; diffuse and smooth boundary; moderate and medium sized columnar structure that breaks into angular block; hard when dry; slightly sticky and plastic when wet; many micro vesicular tubes which are continuous and located both inped and exped.

C_1 45-78 cm 5YR 4/6 dry and 5YR 4/4 moist; sandy clay loam; diffuse and smooth boundary; weak to moderate medium columnar structure; hard when dry ; slightly sticky and plastic when wet, many micro to very coarse continuous vesicular pores which are located in inped and exped; highly porous; few very fine to coarse roots throughout the horizon.

C_2 78-110 cm 2.5YR 4/6 dry and 2/5YR 3/6 moist, sandy clay loam; diffuse and smooth boundary; weak to moderate medium to coarse columnar structure; hard when dry; slightly sticky and plastic when wet; many micro to very coarse pores which have vesicular shape and distributed in inped; highly porous; few very fine to coarse roots throughout the horizon.

C_3 **110-153 cm** 2.5YR 4/8 dry and 2.5YR 3/6 moist; sandy clay loam; diffuse and smooth boundary; weak to moderate medium to coarse sized columnar structure; hard when dry; slightly sticky and plastic when wet; many micro to very coarse pores which have vesicular shape and distributed in inped; few fine root throughout the horizon.

C_4 **153-187 cm** 2.5YR 4/8 dry and 2.5YR 3/6 moist; sandy clay loam; diffuse and smooth boundary; weak medium porous massive structure; few fine root throughout the horizon.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-04

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-04	0-13	NIL	65.28	12	22.72	SCL
	13-45	1.94	61.28	12	26.72	SCL
	45-78	NIL	63.28	6	30.72	SCL
	78-110	NIL	59.28	8	32.72	SCL
	110-153	NIL	61.28	8	30.72	SCL
	153-187	NIL	65.28	6	28.72	SCL
	187+	NIL	67.28	6	26.72	SCL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-13	6.2	2.767	0.209	13.2	6.39	1.36	18.9	9.2	0.04
13-45	6.5	0.832	0.086	9.7	4.04	1.33	14.8	7.7	0.02
45-78	6.8	0.562	0.055	10.2	7.65	1.37	16.3	8.4	0.02
78-110	6.8	0.407	0.031	13.1	4.42	1.48	17.7	8.8	0.02
110-153	7.1	0.394	0.030	13.1	3.41	1.56	15.7	8.5	0.02
153-187	7.2	0.365	0.049	7.4	3.87	1.59	15.5	10.9	0.03
187+	7.1	0.351	0.016	21.9	3.44	1.52	13.6	9.3	0.03

* = oven dry

NSSP CODE : ETH-04

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-13	0.28	0.96	7.92	1.05				
13-45	0.29	0.97	7.02	0.94				
45-78	0.28	1.03	6.46	1.19				
78-110	0.29	1.18	5.89	1.45				
110-153	0.35	1.25	5.51	1.30				
153-187	0.39	1.48	5.29	1.22				
187+	0.34	1.47	4.64	0.99				

Depth cm	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-13	15.03	24.7	10.21	67.9	2.147	0.877	64.26	33.82
13-45	14.24	40.3	9.22	64.7	0.810	0.947	45.59	29.43
45-78	11.68	30.2	8.96	76.7	0.253	0.630	14.96	21.34
78-110	13.61	36.0	8.81	64.7	0.313	0.733	6.86	21.50
110-153	9.85	26.1	8.41	85.4	0.240	0.570	4.26	16.12
153-187	10.71	30.9	8.38	78.2	0.220	0.517	3.75	13.28
187+	12.17	39.7	7.44	61.1	0.280	0.470	3.12	5.77

Monolith Number : ETH-05 Country : Ethiopia - Ginchi
Date : 21/01/94

Classification FAO/UNESCO, 1989 : Calcic Vertisol
USDA, 1992 : Typic Pellustert
Diagnostic horizons : Calcic; cambic;
Other diagnostic criteria : Gilgai; Slickenside

Location : Ginchi IAR station, Altitude 2250 m.a.s.l
Latitude 09° 02'N Longitude 38° 05'E
Author(s) : B.K.Yerima; Eylachew z. and Tadelle G.S.

General landform : Hill Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : 2%; ; Straight
Position of site : Depression
Micro-relief rock outcrop : Nil Stoniness : -
Cracking : Large Sealing : Nil
Slope processes soil erosion : -

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks :

Effective soil depth (cm) : >150

Water table depth (cm) : Not observed Kind : -
Drainage : Imperfectly drained
Permeability : Slow
Flooding frequency : Nil Runoff : Very slow
Moisture condition of the profile : 0 - 45cm dry; 45 - 150cm moist

Land use : High level arable farming
Vegetation structure : Medium tall grass Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 05

Ap 0-20 cm 10YR 4/1 dry and 10YR 3/1 moist; clay; diffuse and wavy boundary; very strong and very coarse massive structure that breaks into granular; extremely hard when dry; very plastic and sticky when wet; few micro vesicular tubes distributed in inped; slightly porous; many fine roots in mat at the top of the horizon.

BA 20-48 cm 10YR 4/1 dry, 10YR 3/1 moist; clay; diffuse and wavy boundary; strong medium to coarse sub-angular blocky and angular blocky structure oriented between 15-45°; very hard when dry and very plastic when wet; few micro vesicular tubes distributed in inped; slightly porous; few very fine roots in mat between peds.

Bw_1 48-90 cm 10YR 4/1 dry and 10YR 3/1 moist; clay; clear and wavy boundary; moderate medium wedge shaped angular blocky structure oriented between 15-45°; very hard when dry and very plastic when wet; few micro vesicular tube distributed in inped; slightly porous; few very fine roots located between peds.

Bw_2k 90-117 cm 10YR 4/1 dry and 10YR 3/1 moist; clay; clear and wavy boundary; weak fine to medium sub-angular blocky structure; hard when dry; plastic when wet; few micro vesicular tube distributed in inped; slightly porous; few very fine roots between peds; slightly calcareous (localized); few small and hard irregular calcareous concretions;

BCk 117-148 cm 10YR 4/1 dry and 10YR 3/1 moist; clay; clear and wavy boundary; strong fine to medium wedge shaped angular blocky structure; hard when dry and slightly plastic when wet; coarse interstitial pores (50-200/dm^3) which are discontinuous and distributed both inped and exped; moderately porous; slightly calcareous throughout; 2-20% clear heterogeneous mottle (10YR 5/4) with prominent contrast; large and hard irregular shaped calcareous concretions which covered over 80% of the horizon.

C 148 cm^+ 10YR 6/4 dry and 10YR 4/4 moist; clay; structureless and weakly coherent fine to medium granular structure; slightly hard when dry slightly plastic when wet; medium interstitial pores (50..200/dm^3) which are discontinuous and located both in inped and exped; moderately porous, slightly calcareous throughout; few heterogencons mottle (10YR 2/1) with clear boundary and prominent contrast; few medium soft irregular manganiferous concretions.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-05

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-05	0-20	NIL	11.28	20	68.72	C
	20-48	NIL	11.28	20	68.72	C
	48-90	NIL	11.28	16	72.72	C
	90-117	10.81	15.28	16	68.72	C
	117-148	21.88	25.28	18	56.72	C
	148+	NIL	19.28	38	42.72	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-20	6.6	1.543	0.110	14	2.65	1.70	59.3	44.4	0.07
20-48	7.2	1.424	0.098	14.5	2.57	1.26	59.8	44.5	0.08
48-90	8.2	1.042	0.109	9.6	2.37	1.18	70.7	53.1	0.17
90-117	8.5	0.554	0.042	13.2	1.61	1.15	64.5	50.0	0.26
117-148	8.5	0.561	0.047	11.9	1.07	1.19	58.6	45.9	0.24
148+	8.0	0.276	0.027	10.2	1.57	0.96	64.4	47.4	0.15

* = oven dry

NSSP CODE : ETH-05

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-20	1.48	2.08	41.80	8.52				
20-48	2.55	2.18	46.18	8.25				
48-90	3.36	2.25	55.55	8.44				
90-117	3.01	1.88	61.59	8.18				
117-148	2.46	1.65	56.02	6.40				
148+	2.60	1.87	48.58	6.24				

Depth cm	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-20	62.44	83.7	53.88	86.3	0.443	2.100	13.06	15.35
20-48	66.52	90.3	59.16	88.9	0.537	2.207	15.06	16.99
48-90	67.22	88.9	69.60	103.5	0.490	1.860	6.70	6.03
90-117	65.29	95.7	74.66	114.4	0.440	1.793	5.13	3.07
117-148	57.15	100.5	66.53	116.4	0.473	1.563	5.79	3.10
148+	56.30	138.4	59.29	105.3	1.160	1.460	7.56	7.37

Monolith Number : ETH-06 Country : Ethiopia - Sheno
Date : 17/01/94

Classification FAO/UNESCO, 1989 : Calcic Vertisol
USDA, 1992 : Typic Pellustert
Diagnostic horizons : Cambic; calcic
Other diagnostic criteria : Abrupt textural change; Slickenside

Location : Sheno opposite IAR station, Altitude 2800 m.a.s.l
Latitude 09° 19'N Longitude 39° 17'E
Author(s) : B.K.Yerima; Eylachew z. and Shalemedhin S.

General landform : Plateau Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : < 2%; ; straight
Position of site : Flat land
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : large Sealing : Nil
Slope processes soil erosion : Nil

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks :

Effective soil depth (cm) : > 200

Water table depth (cm) : Not observed Kind : -
Drainage : Imperfectly drained
Permeability : Slow
Flooding frequency : Nil Runoff : Nil
Moisture condition of the profile : 0 - 15cm dry; 15cm+ moist

Land use : Low level arable farming
Vegetation structure : Short grass Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 06

Ap 0-18 cm 10YR 3/1 dry; clay; clear and smooth boundary; slightly decomposed grass root and leaves; strong fine angular blocky structure breaking into granular; hard to extremely hard when dry; sticky and plastic when wet; micro tubular pores (50-200/dm^3) with horizontal orientation located in inped; slightly porous; many fine roots in mat at the top, between peds and in cracks; small to large hard irregular unspecified nodules which cover over 80% of the horizon; channels very frequent.

AB 18-30 cm 10YR 3/1 dry; clay; diffuse and irregular boundary; highly decomposed organic matter; very strong coarse to very coarse wedge shaped angular blocky structure; extremely hard when dry and extremely firm when moist; sticky and plastic when wet; slightly porous; few very fine roots between peds and in cracks; few small irregular unspecified soft segregation; few termite channels.

Bw_1 30-80 cm 10YR 4/1 dry; clay; clear and smooth boundary; highly decomposed organic matter; very strong coarse to very coarse wedge shaped angular blocky structure that breaks into prismatic structure; extremely hard when dry and extremely firm when moist; very sticky and plastic when wet; slightly porous; few very fine roots between peds and in cracks; very few small hard and irregular unspecified inclusions.

Bw_2 80-120 cm 10YR 4/2 dry; clay; clear and wavy boundary; moderate fine to medium sub-angular and wedge shaped angular blocky structure; hard when dry very firm when moist; very sticky and plastic when wet; few micro tubular pores horizontally oriented in inped; slightly porous; few fine roots between peds.

BCk 120 cm^+ 10YR 4/2 dry; clay, moderate fine to medium wedge shaped angular blocky and columnar structures; hard when dry and very firm when moist; very sticky and plastic when wet; slightly porous; few fine roots between peds; strongly calcareous throughout; few fine mottles with faint contrast.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-06

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-06	0-18	2.93	19.28	28	52.72	C
	18-30	3.09	9.64	25	65.36	C
	30-80	2.52	10.64	19	70.36	C
	80-120	3.56	2.56	16	81.36	C
	120+	10.87	8.56	17	74.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-18	6.4	1.762	0.137	12.9	4.27	1.20	44.1	34.1	0.08
18-30	6.3	1.694	0.176	9.6	2.78	1.32	47.3	39.2	0.06
30-80	6.8	1.256	0.117	10.7	1.77	1.37	56.8	50.7	0.06
80-120	7.6	0.574	0.037	15.5	0.98	1.30	62.6	49.2	0.11
120+	8.4	0.397	0.029	13.7	2.08	1.25	58.6	46.5	0.27

* = oven dry

NSSP CODE : ETH-06

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-18	0.74	1.20	34.71	5.77				
18-30	0.83	1.15	37.37	6.06				
30-80	1.16	1.21	47.84	7.11				
80-120	1.49	1.39	56.26	7.16				
120+	1.16	1.15	59.89	5.80				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-18	56.77	98.9	42.42	47.7	0.587	0.743	17.02	16.48
18-30	63.13	92.9	45.41	71.9	0.280	0.627	13.26	9.81
30-80	65.85	89.6	57.32	87.0	0.547	1.663	20.40	18.01
80-120	67.88	88.2	66.30	97.7	0.517	1.300	7.29	8.88
120+	60.49	86.4	68.00	112.4	0.353	0.507	5.58	2.20

Monolith Number : ETH-07 Country : Ethiopia - Wonji
Date : 29/01/94

Classification FAO/UNESCO, 1989 : Eutric Fluvisol
USDA, 1992 : Aquic Ustifluvent
Diagnostic horizons : -
Other diagnostic criteria : Abrupt textural change, hydromorphic properties

Location : Wonji; 5m from Awash river, Altitude 1650 m.a.s.l
Latitude 08° 29'N Longitude 39° 13'E
Author(s) : B.K.Yerima and Eylachew z.

General landform : Alluvial plain Topography : Flat
Physiographic unit : Flood plain of Awash river
Slope gradient/aspect/form : <2%; ; straight
Position of site : Flat
Micro-relief rock outcrop: Nil Stoniness : Nil
Cracking : Nil Sealing : Nil
Slope processes soil erosion : Nil

Parent material : Alluvium Derived from : Mixed lithology
Texture : Mixed
Remarks : Low resistance materials

Effective soil depth (cm) : >158

Water table depth (cm) : 158 Kind : Ground water table
Drainage : Well drained
Permeability : High
Flooding frequency : Yearly Runoff : Slow
Moisture condition of the profile : 0 - 48cm moist; >48cm wet

Land use : Shrub land
Vegetation structure : Unspecified Status : -

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 07

A 0-20 cm 10YR 6/3 dry and 10YR 5/3 moist; clay loam; clear and wavy boundary; weak to moderate fine to medium sized sub-angular blocky structure that breaks into granular; firm when moist; sticky and plastic when wet; many fine to medium interstitial discontinuous pores in inpeds; slightly porous; many fine roots throughout the horizon, many fine mottles (10YR 2/4) with distinct contrast and diffuse boundary; mounds are very frequent.

AC 20-48 cm 10YR 5/4 dry and 10YR 4/4 moist;sandy clay loam; clear and wavy boundary; weak very fine granular structure; loose when dry and moist; non-sticky and plastic when wet; many fine interstitial discontinuous pores in inpeds; highly porous; many fine roots throughout; few fine mottles (10YR 2/4) with faint contrast and diffuse boundary; mounds are very frequent.

C_1 48-65 cm 10YR 3/4 moist; silty clay loam; abrupt and smooth boundary; moderate fine to medium angular blocky structure; friable when moist; sticky and plastic when wet; few micro interstitial pores which are continuous and located both in inped and exped, slightly porous; medium sized roots (10-100/dm^3) throughout the horizon; many heterogeneous mottles (7.5YR 3/4) with distinct contrast-some with sharp and some with clear boundary.

C_2 65-93 cm 10YR 5/4 dry and 10YR 4/4 moist; sand loam; clear and smooth boundary; structureless; loose when dry and moist; non-sticky and plastic when wet; many micro to very coarse interstitial pores; highly porous; few fine root throughout.

C_3 93-113 cm 10YR 3/3 moist; clay loam; clear and smooth boundary; weak fine to medium angular blocky structure that tend to break to sub-angular blocky; soft when dry and friable when moist; sticky and plastic when wet; few micro tubular pores with vertical orientation and distributed both in inped exped; slightly porous; few fine root throughout; few heterogenous mottles (7.5YR 3/4) with faint contrast and diffuse boundary.

C_4 113-158 cm 7.5YR 3/2 moist; sandy loam; clear and smooth boundary; structureless; loose when dry and moist; non-sticky and plastic when wet; many micro to very coarse interstitial pores both in inped and exped having a continuous nature; highly porous; few fine roots throughout.

C_5 158 cm$^+$ 10YR 3/4 moist; silty clay; clear and smooth boundary; moderate fine to medium angular blocky structure that tend to break to sub-angular blocky; friable when moist; sticky and plastic when wet; few micro tubular pores with vertical orientation and distributed both in inped and exped; slightly porous; medium heterogeneous sized Mn/Fe mottles (10YR 2/1) with distinct contrast and sharp boundary.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-07

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-07	30- 0	1.20	56.56	20	23.44	SCL
	0-20	2.15	24.56	42	33.44	CL
	20-48	3.37	50.56	26	23.44	SCL
	48-65	4.40	14.56	50	35.44	SiCL
	65-93	3.26	70.56	12	17.44	SL
	93-113	2.85	32.56	36	31.44	CL
	113-158	1.78	68.56	12	19.44	SL
	158+	2.57	12.56	48	40.44	SiC

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
30-0	8.4	0.287	0.017	16.9	7.64	1.20	18.1	11.4	0.16
0-20	8.1	1.195	0.079	15.1	9.86	0.84	37.1	19.4	0.22
20-48	8.3	0.538	0.039	13.8	3.63	1.05	21.5	14.8	0.14
48-65	8.0	1.071	0.083	12.9	4.10	1.06	49.2	20.8	0.19
65-93	8.2	0.365	0.035	10.4	3.68	1.04	17.4	12.8	0.11
93-113	8.1	0.498	0.049	10.2	4.42	0.97	39.8	18.5	0.196
113-158	8.3	0.517	0.053	9.8	4.17	0.97	17.8	12.9	0.16
158+	8.2	1.005	0.109	9.2	7.33	-	50.8	25.3	0.22

* = oven dry

NSSP CODE : ETH-07

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
30-0	1.08	1.94	17.53	1.94				
0-20	1.35	3.45	28.61	2.48				
20-48	1.06	2.81	23.23	1.93				
48-65	1.31	2.09	30.45	2.95				
65-93	1.16	1.88	18.35	1.61				
93-113	1.96	2.19	27.80	3.11				
113-158	2.08	2.41	20.40	2.33				
158+	3.29	5.22	30.40	3.82				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
30-0	22.48	112.7	22.49	100.0	1.037	0.667	14.16	13.90
0-20	32.97	95.9	35.89	108.9	1.427	1.333	28.16	13.71
20-48	22.45	99.3	29.03	129.3	1.080	0.730	11.42	10.96
48-65	30.94	88.7	36.72	118.7	1.300	1.090	16.00	9.64
65-93	19.49	111.2	23.00	118.0	0.983	0.487	9.25	11.00
93-113	33.27	107.3	35.06	105.4	1.263	1.033	18.19	9.89
113-158	20.39	103.0	27.22	133.5	0.843	0.520	8.89	9.59
158+	39.23	88.4	42.73	108.9	1.620	1.433	15.03	13.27

Monolith Number : ETH-08 Country : Ethiopia - Gonder
Date : 5/02/94

Classification FAO/UNESCO, 1989 : Humic Cambisol
USDA, 1992 : Typic Haplumbrept
Diagnostic horizons : Cambic; umbric
Other diagnostic criteria : High organic matter

Location : Gonder - Sayena Senbeketti, Altitude 2550 m.a.s.l
Latitude 12° 38'N Longitude 37° 28'E
Author(s) : B.K. Yerima and Eylachew Z.

General landform : Mountain Topography : Mountainous
Physiographic unit :
Slope gradient/aspect/form : 9%; ; straight.
Position of site : Middle slope
Micro-relief rock outcrop : Rocky Stoniness : Stone >10cm
Cracking : Nil Sealing : Nil
Slope processes soil erosion : Rill, sheet and gully.

Parent material : Colluvium Derived from : Mixed lithology
Texture : Mixed
Remarks : Partial/moderate weathered

Effective soil depth (cm) : >150

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Rapid
Moisture condition of the profile : Dry throughout

Land use : Low level arable farming
Vegetation structure : Unspecified Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH. 08

Ap 0-21 cm 7.5YR 3/2 dry and 7.5YR 2/2 moist; clay loam; clear and wavy boundary; strong medium granular structure; hard when dry and friable when moist; sticky and plastic when wet; fine interstitial discontinuous pores (50-200/dm^3) in inped; highly porous; many fine roots throughout; small, hard and irregular unspecified inclusions with 15-40% area coverage; few warm channels and pedotubules.

AB 21-45 cm 7.5YR 3/2 dry and 7.5YR 2/2 moist; clay loam; clear and smooth boundary; weak fine granular structure; loose when dry and friable when moist; slightly sticky and plastic; fine and randomly oriented tubular pores (50-200/dm^3) distributed both inped and exped; highly porous; very fine roots (10-100/dm^3) throughout; few medium, hard and irregular unspecified inclusions (5-15% by volume); few warm channels and pedotubules.

BA 45-75 cm 5YR 3/3 dry and 5YR 2/2 moist; clay loam; diffuse and wavy boundary; moderate fine to medium sub-angular blocky structure; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; fine and randomly oriented tubular pores (50-200/dm^3) distributed both inped and exped; highly porous; very fine roots (10-100/dm^3) throughout; very few small. hard and irregular unspecified inclusions (< 5% by volume); few warm channels and pedotubules.

Bw_1 75-105 cm 5YR 3/4, to 5YR 5/8 dry and 5YR 2/2, to 5YR 3/2 moist; clay; weak fine sub-angular blocky structure that breaks/change into granular; soft when dry and friable when moist; slightly sticky and plastic when wet; many fine and continuous

interstitial pores distributed both inped and exped; highly porous; medium heterogeneous mottles (2.5YR 3/6) with distinct contrast and diffuse boundary; very few small, hard, irregular and unspecified inclusions.

Bw_2 105-132 cm 5YR 4/2 dry and 5YR 2/2 moist; clay; clear and wavy boundary; weak fine sub-angular blocky structure that break into granular; soft when dry and friable when moist; slightly sticky and plastic when wet; many fine and continuous interstitial pores distributed both in inped and exped; highly porous; very few and very fine root throughout; heterogeneous mottles (5YR 4/8) having 2-20% coverage by volume with faint contrast and diffuse boundary; very few small, hard and irregular stone/gravel; few mounds and unspecified pedotubules.

B_2 132 cm^+ 5YR 3/2 dry and 5YR 2/2 moist; clay loam; weak very fine sub-angular blocky structure that break into granular; soft when dry and friable when moist; slightly sticky and plastic when wet; many fine and continuous interstitial pores distributed both inpeds and exped; highly porous; very few and very fine roots throughout; very few small, hard and irregular gravel/stone; few mounds and unspecified perdotubules.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-08

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-08	0-21	4.49	28.56	38	33.44	CL
	21-45	5.65	32.56	34	33.44	CL
	45-72	6.64	28.56	36	35.44	CL
	72-105	7.80	22.56	37	40.44	C
	105-132	5.49	24.56	34	41.44	C
	132+	5.70	42.92	28	29.08	CL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-21	6.8	2.364	0.171	13.8	7.71	1.31	32.4	22.8	0.05
21-45	6.9	1.546	0.150	10.3	6.18	1.31	29.8	21.4	0.03
45-72	7.0	1.311	0.132	9.9	5.30		32.3	24.0	0.03
72-105	6.8	1.162	0.110	10.6	12.09		34.0	24.5	0.02
105-132	7.1	0.890	0.107	8.3	11.49	1.08	33.9	24.6	0.02
132+	7.2	0.866	0.100	8.7	10.00	1.19	28.1	18.5	0.02

* = oven dry

NSSP CODE : ETH-08

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-21	0.62	0.57	31.94	10.09				
21-45	0.56	0.46	30.18	9.77				
45-72	0.66	0.35	35.83	10.83				
72-105	0.67	0.27	37.04	10.86				
105-132	0.70	0.30	38.84	10.61				
132+	0.77	0.27	33.16	7.92				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-21	54.67	146.6	43.22	79.1	0.817	3.141	40.35	25.55
21-45	51.00	141.0	40.97	80.3	0.727	2.997	34.88	21.38
45-72	56.63	167.7	47.67	84.2	0.590	3.403	35.43	18.12
72-105	54.36	131.1	48.84	89.8	0.613	3.873	35.17	10.22
105-132	62.76	155.4	50.45	80.4	0.607	3.893	33.57	5.51
132+	50.07	161.5	42.12	84.1	0.663	3.477	34.11	5.42

Monolith Number : ETH-09 Country : Ethiopia - Gojjam
Date : 7/02/94

Classification FAO/UNESCO, 1989 : Ferric Luvisol
USDA, 1992 : Typic Rhodustalf
Diagnostic horizons : -
Other diagnostic criteria : High OM in B; Durinodes; ferralic properties.

Location : Gojjam - Bahrdar Altitude 2100 m.a.s.l
Latitude 11° 36'N Longitude 37° 22'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Hilly
Physiographic unit :
Slope gradient/aspect/form : 8%; ; crest.
Position of site : Middle slope.
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : Nil
Slope processes soil erosion : Moderate sheet erosion

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks : Low resistant parent material

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Medium
Moisture condition of the profile : Dry throughout

Land use : Low level arable farming
Vegetation structure : Deciduous Status : Degraded

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 09

Ap 0-21 cm 2.5YR 3/4 dry and 2.5YR 2/4 moist; clay; clear and smooth boundary; strong medium sub-angular blocky structure that breaks in to granular; hard when dry and friable when moist; sticky and plastic when wet; fine continuous tubular pores (50-200/dm^3) randomly oriented and distributed both in inpeds and expeds; moderately porous; many fine roots throughout the horizon; few coprogenic elements.

BA 21-45 cm 2.5YR 3/4 dry and moist; clay; diffuse and smooth boundary; strong and coarse wedge shaped angular blocky structure; hard when dry and friable when moist; sticky and plastic when wet; fine micro continuous tubular pores randomly oriented and distributed both inpeds and expeds; slightly porous; few fine roots throughout; few coprogenic elements.

B_{t1} 45-94 cm 2.5YR 3/6 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; strong and coarse wedge shaped angular blocky structure; hard when dry and friable when moist; few microtubular pores randomly oriented, continuous and distributed both in inpeds and expeds; slightly porous; few fine roots throughout; abundant distinct clay cutans both on hor/vert. ped faces; medium size, hard and irregular manganiferous concretions (2.5YR 0/0) with a coverage of > 80% by volume.

Bt_2 94-140 cm 2.5YR 3/6 dry and 2.5YR 3/5 moist; clay; diffuse and smooth boundary; strong and medium angular blocky structure that breaks into sub-angular blocky; few micro tubular pores randomly oriented, continuous and distributed both in inpeds and expeds; slightly porous; few and very fine roots throughout; abundant distinct clay cutants both on hor/vert. ped faces; medium, hard and irregular manganiferous concretions and nodules (2.5YR 0/0) with a coverage of 15-40% by volume.

Bt_3 140-180cm 2.5YR 3/6 moist; clay; diffuse and smooth boundary; weak fine to medium angular blocky structure that breaks into sub-angular blocky; hard when dry and friable when moist; sticky and plastic when wet; few micro tubular pores randomly oriented, continuous and distributed in inpeds; slightly porous; few and very fine roots throughout; patchy thin clay cutans both on hor/ver ped faces; medium to large, hard and irregular manganiferous concretions and nodules (2.5YR 0/0) with a coverage of 15-40% by volume.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-09

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-09	0-21	NIL	8.92	26	65.08	C
	21-45	NIL	6.92	22	71.08	C
	45-94	NIL	6.92	20	73.08	C
	94-140	3.11	6.92	20	73.08	C
	140-180	2.51	4.92	18	77.08	C
	180-220	2.78	2.92	14	83.08	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-21	6.2	1.781	0.114	15.6	27.24		34.2	23.3	0.03
21-45	6.4	0.799	0.075	10.6	19.53		37.1	25.9	0.02
45-94	6.4	0.765	0.078	9.8	9.00		48.0	28.6	0.03
94-140	6.7	1.000	0.095	10.5	4.95		39.1	27.2	0.01
140-180	6.7	0.595	0.101	6.0	6.23		39.1	27.6	0.02
180-220	6.7	0.719	0.167	4.3	3.60		44.0	30.1	0.02

* = oven dry

NSSP CODE : ETH-09

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-21	0.41	0.72	16.84	6.34				
21-45	0.38	0.65	16.65	6.25				
45-94	0.45	0.70	16.47	6.77				
94-140	0.41	0.72	17.15	7.10				
140-180	0.40	0.59	14.45	6.15				
180-220	0.42	0.60	12.03	5.17				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-21	37.06	49.2	24.31	65.5	0.617	1.487	18.12	14.33
21-45	38.83	51.8	23.93	61.6	0.643	1.620	14.16	16.88
45-94	38.02	48.6	24.39	64.2	0.520	1.230	11.17	18.44
94-140	35.18	43.1	25.38	72.1	0.493	1.053	10.14	15.83
140-180	32.15	38.7	21.59	67.2	0.427	0.557	5.72	17.92
180-220	27.82	30.3	18.22	65.5	0.270	0.327	2.15	10.70

Monolith Number : ETH-10 Country : Ethiopia - Gojjam
Date : 9/02/94

Classification FAO/UNESCO, 1989 : Rodic Nitisol
USDA, 1992 : Typic Rhodustult
Diagnostic horizons : Argillic horizon; umbric
Other diagnostic criteria : -

Location : Gojjam - Debre Markos,Wonka.Altitude 2375 m.a.s.l
Latitude 10° 20'N Longitude 37° 43'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 2%; ; straight.
Position of site : Lower slope.
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Slight sheet & rill erosion.

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks : Low resistant parent material

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Medium
Moisture condition of the profile : 0 - 60cm dry; 60 - 200cm moist.

Land use : Low level arable farming
Vegetation structure : Unspecified Status : Modified

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 10

Ap 0-25 cm 5YR 4/8 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak and medium sub-angular blocky structure that breaks into granular,; slightly hard when dry and friable when moist; sticky and plastic when wet; many fine tubular pores randomly oriented, continuous and distributed in inpeds; highly porous; fine roots (10-100/dm^3) throughout; few worm channels.

BA 23-55 cm 5YR 4/8 dry and 2.5YR 3/2 moist; clay; diffuse and smooth boundary; moderate and medium sub-angular blocky structure; slightly hard when dry and firm when moist; sticky and plastic when wet; fine interstitial continuous pores (50-200/dm^3) in inpeds; highly porous; few fine roots throughout; few warm channels.

Bt_1 55-112 cm 5YR 4/8 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; moderate and medium angular blocky structure that breaks into sub-angular blocky structure; hard when dry and firm when moist; sticky and plastic when wet; very fine tubular pores randomly oriented, continuous and distributed in inpeds; highly porous; few fine roots throughout; patchy and thin clay cutans both on vert/hor ped faces; few termite channels.

Bt_2 112-151 cm 5YR 4/8 dry and 2.5YR 3/4 moist; clay; clear and smooth boundary; moderate and medium prismatic structure that breaks into angular blocky; few fine tubular pores randomly oriented, continuous and distributed in inpeds; moderately porous; few very fine roots throughout; patchy and thin clay cutans on hor/vert. ped faces; few termite channels.

Bt_3 151-200 cm 2.5YR 3/6 dry and 2.5YR 3/4 moist; clay; strong and medium prismatic structures that breaks into angular blocky; hard when dry and firm when moist; sticky and plastic when wet; few fine tubular pores randomly oriented, continuous and distributed in inpeds; slightly porous; abundant faint to distinct clay cutants both on hor/vert ped faces; medium, hard and irregular manganiferous concretions (2.5YR 2/0) with a coverage of 15-40% by volume; few termite channels.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-10

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-10	0-23	-	12.92	36	51.08	C
	23-55	-	12.92	32	55.08	C
	55-112	-	12.92	18	69.08	C
	112-151	-	2.92	20	77.08	C
	151-200	-	2.92	16	81.08	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-23	6.7	2.117	0.196	10.8	22.05		35.5	22.7	0.06
23-55	5.5	1.721	0.151	11.4	4.51		37.2	23.4	0.07
55-112	5.4	1.244	0.126	9.9	7.10		35.6	24.0	0.03
112-151	5.8	0.883	0.086	10.3	12.00		38.5	25.0	0.02
151-200	5.9	0.571	0.099	5.8	18.69		40.1	25.7	0.02

* = oven dry

NSSP CODE : ETH-10

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-23	0.82	3.94	12.25	5.17				
23-55	0.99	5.66	4.64	2.37				
55-112	0.51	0.72	6.52	1.46				
112-151	0.73	0.62	8.21	2.39				
151-200	0.71	0.55	9.39	2.48				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-23	25.86	44.0	19.38	74.9	1.470	2.700	18.89	39.24
23-55	24.90	32.2	12.75	51.2	0.280	1.117	10.98	14.18
55-112	24.03	30.5	9.78	40.7	0.317	0.930	8.24	11.53
112-151	25.58	29.8	11.95	46.7	0.303	0.957	7.10	6.81
151-200	24.10	27.8	13.13	54.5	0.353	0.677	5.90	7.68

Monolith Number : ETH-11 Country : Ethiopia - Wollega
Date : 26/02/94

Classification FAO/UNESCO, 1989 : Rhodic Nitisol
USDA, 1992 : Typic Rhodustult
Diagnostic horizons : Argillic,umbric
Other diagnostic criteria : -

Location : Wollega- Nekemte, Guto Geda.Altitude 2150 m.a.s.l
Latitude 09° 05'N Longitude 36° 22'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 2%; ; straight.
Position of site : Flat
Micro-relief rock outcrop : Little rock Stoniness : Very few
Cracking : Nil Sealing : -
Slope processes soil erosion : Slight sheet & rill erosion.

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks : Parent material appeared at 200cm

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Rapid
Moisture condition of the profile : 0 - 30cm dry;60 - 200cm moist.

Land use : Low level arable farming
Vegetation structure : Unspecified Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 11

Ap 0-10 cm 5YR 4/4 dry and 5YR 4/3 moist; clay; clear and smooth boundary; strong and coarse granular structure; hard when dry and firm when moist; sticky and plastic when wet; many fine interstitial pores, which are continuous and distributed in inpeds; highly porous; many fine roots throughout; few termite channels.

BA 10-41 cm 5YR 4/4 dry and 5YR 3/3 moist; clay; diffuse and smooth boundary; moderate fine to medium sub-angular blocky structure that breaks into granular; hard when dry and firm to friable when moist; sticky and plastic when wet; very fine vesicular and tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; moderately porous; few fine roots throughout;few termite channels.

Bt_1 41-86 cm 5YR 4/4 dry and 5YR 3/3 moist, clay; diffuse and smooth boundary; moderate medium to coarse angular blocky structure; hard when dry and firm to friable when moist; sticky and plastic when wet; micro tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; moderately porous; few very fine root throughout; patchy and thin clay cutans both on hor/vert. ped faces; termite channels are frequent.

Bt_2 86-131 cm 2.5YR 4/4 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak and fine angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; micro tubular pores randomly oriented, continuous and distributed in inpeds; moderately porous; few very fine roots throughout; patchy and thin clay catans both on hor/vert ped faces; few termite channels.

Bt_3 131-168 cm 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak and fine angular blocky structure; friable when moist; few micro tubular pores randomly oriented, continuous and distributed in inpeds; moderately porous; few very fine roots throughout; broken and thin clay catans both on hor/vert. ped faces; few termite channels.

Bt_4 168-200 cm 5YR 3/4 moist; clay; weak and fine angular blocky structure; friable when moist; few micro tubular pores randomly oriented, continuous and distributed in inpeds; moderately porous; few very fine root throughout; broken and thin clay cutans both on vert/hor. ped faces; small to medium soft and irregular manganiferous concretions with 40-80% coverage by volume; few termite channels.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-11

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-11	0-10	-	11.64	37	51.36	C
	10-41	-	9.64	26	64.36	C
	41-86	-	3.64	18	78.36	C
	86-131	-	1.64	14	84.36	C
	131-168	-	1.64	14	84.36	C
	168-200	-	9.64	16	74.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-10	5.2	3.607	0.207	17.4	2.74	1.28	45.0	27.2	0.04
10-41	4.9	1.873	0.130	14.4	2.49	1.05	40.3	27.6	0.02
41-86	5.1	0.990	0.116	8.5	3.95	1.09	38.2	28.1	0.01
86-131	5.2	0.728	0.111	6.6	6.07	1.15	43.7	29.9	0.01
131-168	5.3	0.739	0.092	8.0	7.88	1.12	41.8	30.1	0.00
168-200	5.2	0.617	0.118	5.2	7.56	1.11	38.4	28.8	0.00

* = oven dry

NSSP CODE : ETH-11

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-10	0.29	0.64	5.49	1.82	4.0	1.6	2.4	12.24
10-41	0.27	0.32	3.60	1.20	4.1	2.7	1.4	9.47
41-86	0.23	0.26	3.93	1.44	3.5	3.2	0.3	9.36
86-131	0.25	0.24	3.94	1.43	2.1	1.5	0.6	7.96
131-168	0.27	0.21	3.67	1.88	1.4	0.75	0.65	7.43
168-200	0.25	0.15	3.39	1.61	1.2	0.55	0.95	6.60

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-10	29.93	36.7	8.24	27.5	0.255	0.820	10.06	38.18
10-41	25.74	32.4	5.37	20.9	0.190	0.300	4.83	22.66
41-86	23.56	26.9	5.86	24.9	0.080	0.230	3.75	8.62
86-131	21.69	22.9	5.86	27.0	0.130	0.163	3.02	1.42
131-168	17.76	18.2	6.03	34.0	0.135	0.145	2.85	1.04
168-200	16.28	19.4	5.40	33.2	0.110	0.145	2.13	1.06

Monolith Number : ETH-12 Country : Ethiopia - Wollega
Date : 28/02/94

Classification FAO/UNESCO, 1989 : Rhodic Nitisol
USDA, 1992 : Typic Rhodustult
Diagnostic horizons : Argillic,umbric
Other diagnostic criteria : -

Location : Gembie - Cholli Mariame. Altitude 2050 m.a.s.l
Latitude 09° 40'N Longitude 37° 54'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 3%, ; straight.
Position of site : Middle slope
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : -
Slope processes soil erosion : Slight sheet

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks : Deeply weathered soil.

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Medium
Moisture condition of the profile : 0 - 80cm dry; 80 - 200cm moist.

Land use : Low level arable farming
Vegetation structure : Unspecified Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

Bt_2 123-176 cm 2.5YR 2/4 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak very fine angular blocky; structure that breaks into sub-angular blocky; hard when dry and friable when moist; sticky and plastic when wet; few fine tubular pores randomly oriented, continuous and distributed in inpeds; slightly porous; few fine roots throughout; abundant and thin clay cutants both on hor/vert ped faces; very few coarse fresh roots.

Bt_3 176-205 cm 2.5YR 2/4 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak very fine angular blocky structure that breaks into sub-angular blocky; hard when dry and friable when moist; sticky and plastic when wet; few fine tubular pores randomly oriented, continuous and distributed in inpeds; slightly porous; abundant and thin clay cutants both on hor/vert ped faces.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-12

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-12	0-15	-	23.64	32	44.36	C
	15-49	-	25.64	31	43.36	C
	49-86	-	19.64	22	58.36	C
	86-123	-	9.64	14	76.36	C
	123-176	-	3.64	9	87.36	C
	176-205	-	1.64	8	90.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	4.9	2.664	0.238	11.2	3.51	1.12	33.6	26.7	0.02
15-49	4.8	1.838	0.176	10.4	1.80	1.07	40.1	26.5	0.01
49-86	5.0	1.257	0.157	8.0	1.77	1.03	39.1	27.8	0.00
86-123	5.3	0.871	0.110	7.9	0.90	1.09	37.4	28.9	0.00
123-176	5.3	0.588	0.073	8.1	3.00	1.18	37.7	30.1	0.00
176-205	4.9	0.628	0.073	8.6	3.81	1.25	38.8	31.0	0.05

* = oven dry

NSSP CODE : ETH-12

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	0.33	1.16	3.52	1.31	5.5	4.8	0.7	11.83
15-49	0.23	0.63	1.95	0.39	6.4	5.65	0.85	8.60
49-86	0.23	0.28	2.05	0.53	6.9	4.9	2.0	9.99
86-123	0.13	0.15	2.20	0.48	6.0	5.5	0.5	8.96
123-176	0.14	0.10	2.22	0.30	3.3	2.85	0.45	6.06
176-205	0.18	0.13	2.71	0.47	3.0	2.45	0.55	6.49

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	28.03	45.2	6.32	22.5	0.180	0.327	5.55	15.66
15-49	24.47	46.1	2.20	9.0	0.100	0.080	1.36	15.99
49-86	23.38	30.3	3.09	13.2	0.125	NIL	0.84	7.92
86-123	20.19	24.2	2.96	14.7	0.150	NIL	0.45	1.93
123-176	16.03	17.3	2.76	17.2	0.155	NIL	0.52	0.22
176-205	14.39	14.8	3.49	24.3	0.135	0.08	0.42	0.15

Monolith Number : ETH-13 Country : Ethiopia - Wollega
Date : 01/03/94

Classification FAO/UNESCO, 1989 : Humic Ferralsol
USDA, 1992 : Humic Rhodic Haplustox
Diagnostic horizons : Umbric, oxic
Other diagnostic criteria : -

Location : Wollega - Bako IAR station. Altitude 1850 m.a.s.l
Latitude 09° 07'N Longitude 37° 03'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : <2%; ; straight.
Position of site : Middle slope
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : -
Slope processes soil erosion : Nil

Parent material : Volcanic ejecta Derived from : Basalt
Texture : Clayey
Remarks : Deeply weathered soil.

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 25cm dry; >25cm moist.

Land use : Natural vegetation
Vegetation structure : Semi-deciduous Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 13

A 0-25 cm 5YR 3/2 dry and 5YR 2/2 moist; clay; clear and smooth boundary; moderate and medium granular structure; slightly hard when dry and friable when moist; many fine to medium tubular pores randomly oriented, continuous and distributed in inpeds; highly porous; many fine roots throughout; few termite channels.

AB 25-50 cm 2.5YR 3/4 moist; clay; diffuse and smooth boundary; moderate and medium sub-angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; sticky and plastic when wet; fine tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; highly porous; few fine roots throughout; few sclerotium and termite channels.

B_1 50-80 cm 2.5YR 3/4 moist; clay; diffuse and smooth boundary moderate and medium sub-angular blocky structure that breaks easily into granular; slightly hard when dry and friable when moist; sticky and plastic when wet; fine tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; highly porous; few fine roots throughout; few termite channels.

B_2 80-120 cm 2.5YR 4/4 moist; clay; diffuse and smooth boundary; moderate and fine sub-angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; sticky and plastic when wet; very fine tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; highly porous; few fine roots throughout; few termite channels.

B_3 120-158 cm 2.5YR 4/4 moist; clay; diffuse and smooth boundary; moderate fine to medium sub-angular blocky structure that breaks into granular; friable when moist; sticky and plastic when wet; very fine tubular pores (50-200/dm^3) randomly oriented, continuous and distributed in inpeds; highly porous; few fine roots throughout; few termite channels.

B_4 158-200 cm 2.5YR 4/4 moist; clay; strong fine to medium sub-angular blocky structure that breaks into granular; friable when moist; sticky and plastic when wet; few very fine tubular pores randomly oriented, continuous and distributed in inpeds; moderately porous.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-13

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-13	0-25	-	17.64	24	58.36	C
	25-50	-	5.64	20	74.36	C
	50-80	2.77	3.64	18	78.36	C
	80-120	2.45	30	20	50	C
	120-158	2.66	4	14	82	C
	158-200	3.05	2	14	84	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-25	5.8	4.22	0.387	10.9	2.14	1.13	39.3	27.4	0.04
25-50	5.9	1.41	0.128	11.0	2.75	1.17	36.7	29.8	0.01
50-80	6.2	1.34	0.097	13.8	1.82	1.03	41.4	31.3	0.01
80-120	6.4	0.91	0.083	10.9	1.34	1.13	44.5	33.8	0.01
120-158	6.4	0.80	0.063	12.7	2.05	1.18	41.7	33.0	0.01
158-200	6.7	0.76	0.073	10.4	2.09	1.21	41.3	32.7	0.01

* = oven dry

NSSP CODE : ETH-13

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-25	0.29	0.77	16.61	2.97				
25-50	0.18	0.25	10.68	1.91				
50-80	0.20	0.26	8.18	1.48				
80-120	0.24	0.44	7.18	1.59				
120-158	4.95	0.60	6.58	1.77				
158-200	0.57	0.77	7.44	1.91				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-25	35.02	34.7	20.64	58.9	0.58	1.71	15.11	36.51
25-50	22.79	27.6	13.02	57.1	0.25	0.78	5.52	7.77
50-80	17.96	17.6	10.12	56.3	0.20	0.30	2.61	3.73
80-120	17.65	18.1	9.45	53.5	0.19	0.19	1.31	1.52
120-158	18.97	19.7	13.90	73.3	0.17	0.15	1.21	1.41
158-200	19.96	20.4	10.69	53.6	0.09	0.10	0.46	1.02

Monolith Number : ETH-14 Country : Ethiopia - Tigray
Date : 26/03/94

Classification FAO/UNESCO, 1989 : Calcic Cambisol
USDA, 1992 : Typic Eutrochrept
Diagnostic horizons : calcic; argillic; ochric
Other diagnostic criteria : Abrupt textural change

Location : Tigray - Mekele IAR center. Altitude 2050 m.a.s.l
Latitude 13° 30'N Longitude 39° 29'E
Author(s) : Eylachew Zewdie

General landform : Mountain Topography : Mountainous
Physiographic unit :
Slope gradient/aspect/form : 3%; ; undulating
Position of site : open depression
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : -
Slope processes soil erosion : Slight sheet

Parent material : Colluvium Derived from : Lime-sand stone
Texture : Mixed
Remarks : Dominately lime and sand stone

Effective soil depth (cm) : 190

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Yearly Runoff : Rapid
Moisture condition of the profile : 0 - 30cm dry; 30 - 190cm moist.

Land use : Fallow land
Vegetation structure : Grass Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 14

A 0-30 cm 10YR 5/3 dry and 10YR 4/2 moist; loam; clear and smooth boundary; weak and fine crumby structure; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous tubular pores which are horizontally oriented and distributed both in inpeds and expeds; highly porous; many fine roots throughout the horizon; strongly calcareous throughout; very few fresh medium sized rocks.

AB 30-65 10YR 5/2 dry and 10YR 3/2 moist; clay loam; diffuse and smooth boundary; moderate and fine to medium sub-angular blocky structure; hard when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous tubular pores which are horizontally oriented and distributed both in inpeds and expeds; fine roots (50-200/dm^3) throughout; strongly calcareous; few fresh medium sized rocks; few unspecified channels.

Bw_1 65-90 cm 10YR 4/2 dry and 10YR 3/2 moist; clay loam; diffuse and smooth boundary; strong medium to coarse angular blocky structure; hard when dry and firm when moist; sticky and plastic when wet; many medium continuous tubular pores which are oriented vertical and horizontal directions and distributed both in inpeds and expeds; highly porous; few very fine roots between peds; highly calcareous.

Bw_2 90-133 cm 10YR 4/2 dry and 10YR 3/2 moist; clay loam; diffuse and smooth boundary; strong medium to coarse angular blocky structure; hard when dry and firm when moist; very sticky and plastic when wet; few fine continuous tubular pore which are vertically and horizontally oriented and

distributed in inpeds; moderately porous; few very fine roots between peds; strongly calcareous throughout.

BC 133-161 cm 10YR 5/2 dry and 10YR 3/2 moist; clay loam; diffuse and smooth boundary; weak fine to medium sub-angular blocky structure that tends to break into small sub-angular peds; loose when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous pores which are vertically and horizontally oriented and distributed in inpeds; highly porous; highly calcareous throughout.

C_1 161-185 cm 10YR 5/3 dry and 10YR 3/2 moist;sand clay loam; clear and smooth boundary; weakly coherent fine to medium porous massive structure; loose when dry and friable when moist; non-sticky and plastic when wet; many fine continuous interstitial pores distributed both inpeds and expeds; highly porous; strongly calcareous throughout.

C_2 185 cm$^+$ 10YR 3/1 dry and 10YR 2/1 moist; clay loam; moderately strong fine to medium wedge shaped angular blocky structure; hard when dry and firm when moist; sticky and plastic when wet; few fine continuous interstitial pores which are vertically and horizontally oriented and distributed both inpeds and expeds; slightly porous; slightly calcareous on ped faces.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-14

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-14	0-30	5.49	40	36	24	L
	30-65	4.87	40	30	30	CL
	65-90	4.45	34	34	32	CL
	90-133	7.61	26	34	40	CL
	133-161	10.60	36	32	32	CL
	161-185	11.68	62	18	20	SCL
	185+	4.49	34	28	38	CL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-30	7.6	1.26	0.087	14.5	2.77	1.18	23.8	14.7	0.11
30-65	8.1	0.92	0.071	12.9	2.75	1.61	26.0	17.9	0.16
65-90	8.2	1.17	0.078	15.0	2.41	1.39	30.2	20.6	0.24
90-133	8.0	1.26	0.110	11.4	1.26	1.47	32.2	22.8	1.23
133-161	7.9	0.92	0.067	13.7	2.00	1.65	28.6	19.4	1.50
161-185	8.2	0.73	0.058	12.6	1.69	1.76	19.6	12.2	0.51
185+	8.1	0.94	0.082	11.5	1.42	1.75	32.3	22.2	1.72

* = oven dry

NSSP CODE : ETH-14

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-30	0.53	0.53	30.78	1.55				
30-65	0.68	0.72	33.78	1.77				
65-90	1.68	0.86	34.86	2.82				
90-133	3.07	0.74	38.21	5.57				
133-161	3.11	0.47	33.60	5.42				
161-185	2.16	0.28	24.54	4.09				
185+	3.14	0.45	33.34	9.11				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-30	27.81	97.3	33.39	120.1	0.35	1.153	6.26	10.37
30-65	31.63	92.5	36.95	116.8	0.98	1.740	7.74	6.22
65-90	34.20	88.4	40.22	117.6	0.353	1.947	7.83	5.69
90-133	35.95	80.1	47.59	132.4	0.493	2.223	8.46	5.95
133-161	30.14	85.5	42.60	141.3	0.350	1.800	8.53	5.61
161-185	20.58	79.0	31.07	151.0	0.253	0.561	9.57	4.12
185+	37.77	93.7	46.04	121.9	0.275	1.637	7.92	5.32

Monolith Number : ETH-15 Country : Ethiopia - Wello
Date : 28/03/94

Classification FAO/UNESCO, 1989 : Eutric Regosol
USDA, 1992 : Lithic Ustipsamment
Diagnostic horizons : -
Other diagnostic criteria : -

Location : Wello - Dessie, Tita. Altitude 2500 m.a.s.l
Latitude 11° 07'N Longitude 39° 37'E
Author(s) : Eylachew Zewdie

General landform : Mountain Topography : Mountainous
Physiographic unit :
Slope gradient/aspect/form : 30%; ; Undulating
Position of site : Lower slope
Micro-relief rock outcrop : Rocky Stoniness : Very stony
Cracking : - Sealing : -
Slope processes soil erosion : Moderate sheet

Parent material : Volcanic ejecta Derived from : Diorite
Texture : Coarse
Remarks : Deep weathered parent material.

Effective soil depth (cm) : 32

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Yearly Runoff : Very rapid
Moisture condition of the profile : Dry throughout.

Land use : Grazing
Vegetation structure : Evergreen wood land Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 15

A 0-32 cm 5YR 4/2 dry and 5YR 3/2 moist; loam; clear and smooth boundary; weak fine to medium crumby structure; soft when dry and friable when moist; slightly sticky and plastic when wet; fine continuous tubular pores (50-200/dm^3) which are vertically and horizontally oriented and distributed both inpeds and expeds; highly porous; few extremely coarse fresh rocks.

AC 32-40 cm 5YR 4/2 dry and 5YR 3/2 moist; diffuse and smooth boundary; Coarse sand; moderate to strong massive structure; hard when dry and very firm when moist; non-sticky and plastic when wet.

C 40 cm^+

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-15

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-15	0-32		40	34	26	L
	32+	UNCONSOLIDATED PARENT MATERIAL				

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-32	7.4	1.58	0.117	13.5	12.54				
32+		UNCONSOLIDATED PARENT MATERIAL							

* = oven dry

NSSP CODE : ETH-15

Depth cm	Exch. Bases meq/100g soil Na	K	Ca	Mg	Exch. Acidity meq/100g soil Al+H	Al	H	Sum Cations
0-32	0.58	0.97	25.45	7.13				
32+		UNCONSOLIDATED PARENT MATERIAL						

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-32	43.94	150.8	34.13	77.7	0.597	0.717	16.79	19.31
32+		UNCONSOLIDATED ARENT MATERIAL						

Monolith Number : ETH-16 Country : Ethiopia - Wello
Date : 31/03/94

Classification FAO/UNESCO, 1989 : Luvic Phaeozem
USDA, 1992 : Typic Haplustoll
Diagnostic horizons : Mollic
Other diagnostic criteria : High organic matter

Location : Wello - Harbu (Kemessie). Altitude 1510 m.a.s.l
Latitude 10° 43'N Longitude 39° 50'E
Author(s) : Eylachew Zewdie

General landform : Mountain Topography : Hilly
Physiographic unit :
Slope gradient/aspect/form : 3%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : - Sealing : -
Slope processes soil erosion : slight sheet

Parent material : Colluvium Derived from : Mixed lithology
Texture : Clayey
Remarks : Contain unwathered round rock

Effective soil depth (cm) : 110

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Yearly Runoff : Rapid
Moisture condition of the profile : 0 - 20cm dry; >20cm moist.

Land use : Fallow land
Vegetation structure : Grass Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH-16

Ah 0-20 cm 5YR 3/1 dry and 5YR 2.5/1 moist; clay; diffuse and smooth boundary; strong fine to medium crumby structure; hard when dry and firm when moist; sticky and plastic when wet; continuous tubular pores (950-200/dm^3) which are horizontally and vertically oriented and distributed both in inpeds and expeds; highly porous; many very fine to coarse roots throughout; very few medium sized fresh rocks.

Bh 20-52 cm 2.5YR 2.5/0 moist; clay; diffuse and smooth boundary; weak moderately coherent sub-angular blocky structure; soft when dry and friable when moist; sticky and plastic when wet; many fine continuous tubular pores which are randomly oriented and distributed both in inpeds and on expeds; highly porous; fine to medium roots throughout.

B_{t1} 52-108 cm 5YR 3/1 moist; clay; diffuse and smooth boundary; strong and moderately coherent angular blocky structure; very hard when dry and firm when moist; very sticky and plastic when wet; few fine continuous tubular pores which are horizontally oriented and distributed in inpeds; moderately porous; few fine roots throughout; thin continuous clay/humus cutants on hor/vert ped faces; on the low side of the horizon 15-40% coverage of fine to very coarse sized fresh rocks.

C_1 108-135 cm 5YR 4/4 moist; sand clay loam; abrupt and smooth boundary; weakly coherent massive structure; loose when dry and friable when moist; non-sticky and plastic when wet; few micro interstitial continuous pores both inpeds/expeds; moderately porous; few very fine

roots throughout; grater than 80% by volume fresh and slightly weathered fine to very coarse rock.

C_2 135-160 cm 5YR 5/4 dry and 5YR 4/3 moist; clay loam; diffuse and smooth boundary; strong medium angular blocky structure; very hard when dry and firm when moist; sticky and plastic when wet; slightly porous; few very fine roots throughout; very few medium sized fresh and weathered rock.

C_3 16-182 cm 5YR 4/2 dry and 5YR 4/3 moist; sand clay loam; diffuse and smooth boundary; weakly coherent fine to medium size massive structure that break into single grain; hard when dry and friable when moist; non-sticky and plastic when wet; highly porous; few very fine roots throughout; fresh and weathered very fine to extremely coarse sized rocks with greater than 80% coverage by volume.

C_4 182 cm$^+$ 5YR 5/3 dry and 5YR 5/4 moist; sand clay loam; weakly coherent medium size massive structure; hard when dry and friable when moist; non-sticky and plastic when wet; many continuous micro tubular pores which are vertically and horizontally oriented and distributed both inpeds/expeds; highly porous.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-16

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-16	0-20		23.64	31	45.36	C
	20-52		22.64	27	50.36	C
	52-108	1.97	23.64	26	50.36	C
	108-135	1.05	51.64	18	30.36	SCL
	135-160	3.40	40.92	26.18	32.90	CL
	160-182	1.46	58.92	17.18	23.90	SCL
	182+	2.27	48.92	24.18	26.90	SCL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-20	7.1	2.51	0.228	11.0	97.20	1.28	36.0	19.9	0.06
20-52	7.0	2.22	0.209	10.6	86.66	1.31	38.2	24.9	0.05
52-108	7.5	1.35	0.117	11.5	69.72	1.43	37.9	21.5	0.05
108-135	7.8	0.45	0.047	9.6	56.54	-	29.5	17.1	0.08
135-160	7.9	0.52	0.053	9.8	43.29	-	33.1	18.2	0.07
160-182	7.8	0.52	0.044	11.8	42.25	-	26.0	14.4	0.02
182+	7.9	0.38	0.037	10.3	43.13	-	29.6	15.8	0.08

* = oven dry

NSSP CODE : ETH-16

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-20	1.09	5.51	26.91	3.96				
20-52	0.97	4.29	31.27	4.13				
52-108	1.02	4.52	31.21	4.14				
108-135	1.85	9.81	21.65	3.33				
135-160	1.89	9.71	23.42	3.80				
160-182	2.73	15.80	19.19	3.01				
182+	2.78	16.39	20.90	3.34				

Depth cm	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-20	42.04	75.7	37.47	89.1	2.485	2.09	29.13	47.14
20-52	39.83	67.4	40.66	102.1	2.02	1.91	23.06	39.81
52-108	43.16	79.5	40.69	94.3	0.41	1.74	12.45	14.52
108-135	30.40	101.4	36.64	120.5	0.247	0.23	3.12	5.13
135-160	36.18	107.0	38.82	107.3	0.470	0.41	3.99	5.42
160-182	36.92	143.6	40.73	110.3	13.07	0.38	4.64	6.62
182+	38.54	144.3	43.41	120.6	0.426	0.487	5.31	4.69

Monolith Number : ETH-17 Country : Ethiopia - Bale
Date : 15/04/94

Classification FAO/UNESCO, 1989 : Eutric Vertisol
USDA, 1992 : Typic Chromustert
Diagnostic horizons : -
Other diagnostic criteria : Slickenside

Location : Bale - Robi,Roboka. Altitude 2600 m.a.s.l
Latitude 07° 08'N Longitude 40° 60'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Flat Topography : Hilly
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Large Sealing : -
Slope processes soil erosion : slight sheet

Parent material : Colluvium Derived from : Mixed lithology
Texture : Clayey
Remarks : Contain unwathered round rock

Effective soil depth (cm) : >225

Water table depth (cm) : 300 Kind : -
Drainage : Moderately drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 24cm dry; 24cm - 202cm moist; 202 - 255cm wet.

Land use : Low level arable farming
Vegetation structure : Semi-deciduous Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 17

A 0-24 cm 10YR 3/4 moist; clay; diffuse and smooth boundary; strong coarse granular structure; very hard when dry and friable when moist; very sticky and plastic when wet; many continuous medium interstitial pores with random orientation and distributed both in inpeds and expeds; highly porous; many fine roots throughout.

AB 24-58 cm 10YR 4/2 moist; clay; clear and wavy boundary; weak fine to medium angular blocky structure that breaks into granular; very sticky and plastic when wet; many continuous micro interstitial pores with random orientation and distributed both in inpeds and expeds; moderately porous; many fine roots throughout.

BA 58-100 cm 10YR 3/1 moist; clay; diffuse and smooth boundary; very strong and coarse prismatic structure that breaks into angular blocky; few continuous micro tubular pores with random orientation and distributed both in inpeds and expeds; slightly porous; common (12-115/dm^3 different sized) roots throughout.

Bw_1 100-120 cm 10YR 3/1 moist; clay; clear and wavy boundary; strong coarse prismatic structure (few oriented at about 20° from the horizontal line) with abundant slickenside that tends to break into angular blocky; extremely hard when dry and extremely friable when moist; very sticky and plastic when wet; many continuous micro tubular pores with random orientation and distributed both in inpeds and expeds; moderately porous; few fine roots throughout.

Bw_2 120-159 cm 10YR 4/2 moist; clay; diffuse and smooth boundary; strong coarse prismatic structure (with slickenside) oriented > 60° from the horizontal line; extremely hard when dry and extremely friable when moist; very sticky and plastic when wet; very few fine continuous interstitial pores with random orientation and distributed both in inpeds and expeds; slightly porous; few fine roots between peds and along the parapaypates.

Bw_3 159-202 cm 10YR 4/2 moist; clay; diffuse and smooth boundary; strong coarse prismatic; structure oriented at about 800 from horizontal and has with high organic matter (10YR 3/1) fusion in between; extremely hard when dry and extremely friable when moist; very sticky and plastic when wet; very few fine continuous interstitial pores with random orientation and distributed both in inpeds and expeds; slightly porous; very few fine roots between peds and along the parapypates.

Bw_4 202-255 cm 10YR 4/2 moist; clay; strong coarse prismatic structure; extremely hard when dry and extremely friable when moist; very sticky and plastic when wet; very few fine continuous interstitial pores with random orientation and distributed both in inpeds; and expeds; slightly porous and no roots throughout.

Remark : starting 70 cm there is inclusion of the upper materials through cracks and sampling was done on the micro low. In the micro high depth of cracking was upto 140 cm and maximum slickenside and parapaypates were between 75-255 cm.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-17

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-17	0-24		30.92	24.18	44.90	C
	24-58	1.68	16.92	20.18	62.90	C
	58-100	1.96	20.92	16.18	62.90	C
	100-120	3.42	16.92	14.18	68.90	C
	120-159	1.65	12.92	20.18	66.90	C
	159-202	2.64	12.92	18.18	68.90	C
	202-255	26.24	12.92	18.18	68.90	C
	255+	16.79	13.92	19.18	66.90	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-24	6.7	2.96	0.274	10.8	3.30	0.97	44.6	36.8	0.13
24-58	7.3	1.00	0.113	8.9	1.00	1.65	51.1	41.3	0.55
58-100	7.8	0.96	0.113	8.5	1.03	1.76	53.2	43.9	0.73
100-120	7.6	0.72	0.057	12.6	0.67	1.60	60.6	46.4	0.09
120-159	6.7	0.50	0.044	11.4	0.33	1.72	59.6	43.8	0.02
159-202	7.0	0.42	0.060	7.0	0.46	1.76	65.6	49.3	0.00
202-255	7.2	0.46	0.035	13.1	0.81	1.67	65.1	47.5	0.09
255+	7.7	0.55	0.035	16.7	1.00		63.5	44.4	0.06

* = oven dry

NSSP CODE : ETH-17

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-24	1.28	5.79	23.47	5.54				
24-58	1.35	2.36	30.21	7.95				
58-100	1.55	2.44	34.42	8.83				
100-120	2.09	2.08	40.47	9.41				
120-159	2.08	1.99	40.35	9.65				
159-202	2.31	2.12	40.02	9.11				
202-255	2.40	2.01	40.09	8.64				
255+	2.26	2.03	39.21	8.36				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-24	42.73	72.7	36.08	84.4	0.687	2.41	13.6	44.24
24-58	51.69	79.3	41.87	81.0	0.440	2.12	18.81	28.93
58-100	58.62	90.0	47.24	80.6	0.543	2.11	19.34	28.47
100-120	60.07	89.3	54.05	90.0	0.667	1.83	12.39	18.97
120-159	59.92	94.2	54.07	90.2	0.767	1.77	11.37	10.98
159-202	56.62	85.1	53.56	94.6	0.817	1.56	11.90	8.98
202-255	53.87	80.7	53.14	98.6	0.80	1.48	12.18	10.25
255+	53.63	77.1	51.86	96.7	0.77	1.55	7.74	8.92

Monolith Number : ETH-18 Country : Ethiopia - Bale
Date : 16/04/94

Classification FAO/UNESCO, 1989 : Humic Cambisol
USDA, 1992 : Aquic Cryumbrept ? Trejona isohyperthermic
Diagnostic horizons : Mollic; umbric; cambic
Other diagnostic criteria : -

Location : Bale - Dinesho Zallo. Altitude 3100 m.a.s.l
Latitude 07° 06'N Longitude 39° 46'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Mountain Topography : Mountainous
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Fairly rocky Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : -

Parent material : Volcanic ejecta Derived from : Rhyolite
Texture : Fine
Remarks : Partical/moderately weathered

Effective soil depth (cm) : 117

Water table depth (cm) : Not observed Kind : -
Drainage : Moderately well drained
Permeability : Moderate
Flooding frequency : Yearly Runoff : Slow
Moisture condition of the profile : 0 - 70cm moist; >70cm wet

Land use : Low level arable farming
Vegetation structure : Evergreen semi-deciduous Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic ?

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 18

A 0-22 cm 7.5YR 3/2 moist; loam; diffuse and smooth boundary; very weak fine granular structure; very friable when moist; non-sticky and non-plastic when wet; many fine continuous interstitial pores with random orientation and distributed both in inped and expeds; highly porous; many fine roots throughout.

AB 22-38 cm 7.5YR 3/4 moist; clay; clear and wavy boundary; weak fine sub-angular blocky structure that breaks into granular; friable when moist; very sticky and plastic when wet; fine continuous tubular pores (50-200/dm^3 coverage by volume) with random orientation and distributed both in inpeds and expeds; moderately porous; few fine roots throughout; few medium to coarse fresh gravels.

Bw_1 38-72 cm 5YR 5/3 dry and 5YR 3/4 moist; clay; clear and smooth boundary; moderate medium massive structure that breaks into angular blocky; hard when dry and friable when moist; very sticky and plastic when wet; few continuous micro interstitial pores with random orientation and distributed both in inpeds and expeds; slightly porous; no roots; few medium to large weathered (exfoliated) rocks; few animal channels.

Bw_2 72-110 cm 5YR 3/4 moist; clay; clear and wavy boundary; weak medium massive structure that breaks into angular blocky and then to granular; friable when moist; very sticky and plastic when wet; common (50-200/dm^3 coverage by volume) continuous micro interstitial pores with random orientation and distributed both in inpeds and expeds; moderately porous; no roots throughout; many fine distinct shapes mottles (7.5YR 2/0); many

very coarse and big weathered (exfoliation) rocks.

Bw_3 110-170 cm 7.5YR 3/4 moist; clay; weak fine to medium massive structure that breaks into angular blocky and then to granular; friable when moist; very sticky and plastic when wet; few continuous micro interstitial pores with random orientation and distributed both inpeds and expeds; slightly porous; few fine distinct mottles with two different colours (7.5YR 6/6 and 7.5YR 2/10); many very coare and very big weathered (exfoliation) rocks.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-18

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution %			Texture Class
			Sand	Silt	Clay	
ETH-18	0-22	-	38.92	34.18	26.90	C
	22-38	-	20.92	34.18	44.90	C
	38-72	-	19.92	28.18	51.90	C
	72-110	-	22.92	21.18	55.90	C
	110-170	-	38.92	20.18	40.90	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-22	8.1	8.05	0.557	14.4	5.72	0.83	37.8	30.2	0.17
22-38	5.3	2.47	0.167	14.8	1.38	1.18	27.5	18.4	0.12
38-72	6.0	0.91	0.053	17.2	1.93	1.54	27.8	13.5	0.12
72-110	6.5	0.33	0.042	7.9	20.82		28.6	17.9	0.01
110-170	6.1	0.61	0.050	12.2	34.55		30.3	16.7	0.02

* = oven dry

NSSP CODE :ETH-18

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-22	0.42	1.13	9.87	1.84				
22-38	0.24	0.56	5.59	1.39				
38-72	0.21	0.47	5.86	1.60				
72-110	0.51	0.67	8.26	2.21				
110-170	0.74	0.79	8.84	2.17				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-22	32.69	21.0	13.26	40.6	1.51	0.75	42.58	57.22
22-38	25.89	44.8	7.78	30.1	0.153	0.78	49.55	11.62
38-72	19.13	32.5	8.14	42.6	0.263	0.437	20.07	9.32
72-110	20.73	35.5	11.65	56.2	0.267	0.293	9.56	18.05
110-170	24.98	59.0	12.54	50.2	0.290	0.230	10.39	10.33

Monolith Number : ETH-19 Country : Ethiopia - Arussi
Date : 18/04/94

Classification FAO/UNESCO, 1989 : Vertic Cambisol
USDA, 1992 : Andic Haplumbrept
Diagnostic horizons : Umbric; calcic
Other diagnostic criteria : Abrupt textural changes

Location : Arussi - Gonde,ESE. Altitude 2300 m.a.s.l
Latitude 08° 02'N Longitude 39° 11'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Mountain Topography : Mountainous
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Small Sealing : -
Slope processes soil erosion : -

Parent material : Volcanic ejecta Derived from : Ash(Unspecified)
Texture : Clayey
Remarks : Partial/moderately weathered

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Moderately well drained
Permeability : Moderate
Flooding frequency : Yearly Runoff : Slow
Moisture condition of the profile : Dry throughout the profile

Land use : High level arable farming
Vegetation structure : Semi-deciduous Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 19

Ap 0-25 cm 7.5YR 3/0 moist; clay loam; clear and smooth boundary; moderate and fine to medium granular structure; friable when moist and very sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed both in inpeds and expeds; highly porous; many fine roots throughout the horizon.

Bw_1 25-68 cm 7.5YR 3/0 moist; clay; clear and wavy boundary; strong medium to coarse columnar structure that breaks into angular blocky; hard when dry and friable when moist; very sticky and plastic when wet; fine to medium continuous interstitial pores with random orientation and 50-200/dm^3 coverage by volume and distributed both inpeds and expeds; moderately porously; very fine to coarse roots throughout the horizon.

Bw_2 68-105 cm 10YR 3/2 moist; clay; clear and wavy boundry; very strong coarse and well developed columnar structure with slickenside that breaks into angular blocky; hard when dry and friable when moist; very sticky and plastic when wet; few continuous micro tubular pores randomly oriented and distributed both inped and expeds; slightly porous; few fine roots throughout.

BC 105-128 cm 5YR 3/3 moist; clay; clear and wavy boundary; weak fine massive structure that breaks into fine granular; slightly hard when dry and very friable when moist; very sticky and plastic when wet; many fine continuous tubular pores randomly oriented and distributed both inpeds and expeds; highly porous; few fine roots throughout and few unspecified channels.

$2C_1$ 128-153 cm 5YR 5/6 moist containing white material in the matrix; clay; clear and wavy boundary; weak fine to medium massive structure that breaks into granular; slightly hard when dry and friable when moist; sticky and plastic when wet; medium continuous tubular pores with random orientation and 50-200/dm^3 coverage by volume; highly porous; few fine roots throughout; few fine to coarse fresh volcanic material (pumice); and few unspecified channels.

$2C_2$ 152-200 cm 7.5YR 5/6 moist; sandy clay loam; weak fine to medium massive structure that breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous tubular pores with random orientation and distributed in inpeds; highly porous; few fine roots throughout; coarse fresh volcanic material (pumice) with 80% coverage by volume.

Remark : Cracks are observed between 25-105 cm

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-19

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-19	0-25	1.65	23.64	40	36.36	CL
	25-68	2.64	21.64	28	50.36	C
	68-105	-	17.64	26	56.36	C
	105-128	-	15.64	28	56.36	C
	128-153	26.24	23.64	32	44.36	C
	153-200	16.79	47.64	26	26.36	SCL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-25	7.7	3.182	0.196	15.3	9.62	1.45			0.16
25-68	8.6	2.65	0.137	19.3	2.64	1.39			0.12
68-105	7.2	1.15	0.108	10.6	0.87	1.66			0.17
105-128	7.6	0.92	0.072	12.8	0.45				0.08
128-153	7.8	0.77	0.025	30.8	0.61				0.06
153-200	8.3	0.78	0.050	15.6	0.86				0.06

* = oven dry

NSSP CODE :ETH-19

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-25	0.79	2.65	28.95	2.92				
25-68	1.20	2.58	33.97	3.68				
68-105	1.84	2.93	38.40	4.40				
105-128	1.86	2.88	43.29	4.69				
128-153	2.12	1.93	40.05	3.85				
153-200	3.35	1.65	40.47	4.56				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-25	40.25	82.6	35.31	87.7	1.187	1.33	8.81	90.14
25-68	45.64	77.5	41.43	90.8	0.297	1.14	10.18	41.64
68-105	52.32	86.7	47.57	90.9	0.290	1.39	6.83	21.50
105-128	50.08	87.9	52.72	105.3	0.417	1.37	3.87	3.82
128-153	36.17	82.6	47.95	132.6	0.367	0.76	2.45	2.45
153-200	31.68	115.5	50.03	157.9	0.510	0.60	2.10	2.10

Monolith Number : ETH-20 Country : Ethiopia - Sidamo
Date : 21/04/94

Classification FAO/UNESCO, 1989 : Rhodic Ferralsol
USDA, 1992 : Rhodic Eutrustox
Diagnostic horizons : -
Other diagnostic criteria :

Location : Sidamo - Agere Mariam Altitude 2100 m.a.s.l
Latitude 05° 39'N Longitude 39° 14'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hilly Topography : Rolling
Physiographic unit :
Slope gradient/aspect/form : 6%; ; Straight
Position of site : Upper slope
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Slight sheet

Parent material : Derived from :
Texture :
Remarks : Not able to see the parent material, too deep soil.

Effective soil depth (cm) : >205

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Very rapid
Moisture condition of the profile : Dry throughout the profile

Land use : Low level arable farming
Vegetation structure : Wood land (unspecified). Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 20

Ap 0-15 cm 5YR 3/3 moist; clay loam; clear and wavy boundary; weak fine granular structure; friable when moist; sticky and slightly plastic when wet; many fine continuous tubular pores with random orientation and distributed both inpeds and expeds; highly porous; many fine roots throughout and few ant channels.

BA 15-41 cm 5YR 3/4 dry and 5YR 3/3 moist; clay; diffuse and smooth boundary; weak fine to medium angular blocky structure, which is massive in place and breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; few to common fine continuous tubular pores with random orientation and distributed both inpeds and expeds; moderately porous; very fine to coase roots throughout and few ant channels.

B_1 41-73 cm 5YR 3/4 dry and 5YR 3/3 moist; clay; diffuse and smooth boundary; moderate medium to coarse angular blocky structure with few shining skin on the surface and breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; fine continuous vesicular pores with random orientation (50-200/dm^3 coverage by volume) and distributed both inpeds and expeds; moderately porous; few fine roots throughout; ant and warm channels are frequent.

B_2 73-122 cm 2.5YR 3/6 dry and 2.5YR 3/4 moist; clay; diffuse and smooth boundary; weak to moderate fine to medium angular blocky structure with few shiny skin, but massive in place and breaks into granular; slightly hard when dry and friable when moist; slightly sticky and

plastic when wet; fine continuous tubular pores with 50-200/dm^3 coverage by volume, random orientation and distributed both inpeds and expeds moderately porous; very few fine roots throughout and few unspecified channels.

B_3 122-161 cm 2.5YR 3/4 moist; clay; diffuse and wavy boundary; weak fine to medium angular blocky structure (slightly massive in place) that breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; fine continuous tubular pores with 50-200/dm^3 coverage by volume, random orientation and inpeds and expeds distribution; moderately porous; very few fine roots throughout.

BC 161-205 cm 2.5YR 3/4, moist; clay ; weak fine to medium angular blocky structure (very few shiny skin) that breaks into granular; friable when moist; slightly sticky and plastic when wet; few fine continuous tubular pores with random orientation and both inpes and expeds distribution; moderately porous; very few fine roots throughout; few unspecified channels.

Remark : B_2 and B_3 are very weak in place.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-20

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-20	0-15	-	41.64	24	34.36	CL
	15-41	-	39.64	14	46.36	C
	41-73	-	35.64	16	48.36	C
	73-122	-	39.64	20	40.36	C
	122-161		33.64	16	50.36	C
	161-205	0.77	33.64	14	52.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	6.7	1.42	0.163	8.7	1.94	1.22			0.07
15-41	5.6	2.18	0.118	18.4	0.26	1.25			0.13
41-73	6.6	1.20	0.236	5.1	0.33	1.19			0.01
73-122	7.0	0.642	0.078	8.2	0.23	1.15			0.24
122-161	7.1	1.016	0.064	15.9	6.19	1.13			0.05
161-205	7.5	0.750	0.059	12.7	9.88	1.11			0.16

* = oven dry

NSSP CODE :ETH-20

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	0.19	0.50	4.47	1.47				
15-41	0.20	0.20	7.50	1.78				
41-73	0.12	0.18	5.71	2.04				
73-122	0.15	0.17	4.69	1.85				
122-161	0.09	0.14	3.76	1.98				
161-205	0.095	0.13	2.84	1.43				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	16.74	35.9	6.63	39.6	0.41	0.623	3.75	60.45
15-41	15.42	17.9	9.68	62.8	0.16	0.630	4.12	18.34
41-73	16.20	25.8	8.05	49.7	0.09	0.280	1.52	2.71
73-122	15.21	26.7	6.86	45.1	0.135	0.510	1.09	0.86
122-161	14.36	22.5	5.97	41.6	0.125	0.095	1.26	0.47
161-205	15.52	24.5	4.50	29.0	0.140	0.115	0.63	0.34

Monolith Number : ETH-21 Country : Ethiopia - Shewa
Date : 24/04/94

Classification FAO/UNESCO, 1989 : Mollic Andosol
USDA, 1992 : Mollic Haplustand
Diagnostic horizons : mollic; umbric
Other diagnostic criteria : Abrupt textural change

Location : Shashemene (road to Awassa).Altitude 2000 m.a.s.l
Latitude 07° 11'N Longitude 38° 35'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Plain Topography : Flat
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : -

Parent material : Volcanic ejecta Derived from : Pyroclasts
Texture : Gravelly
Remarks : Slightly weathered volcanic ash.

Effective soil depth (cm) : 70

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 14cm moist; 14cm+ dry.

Land use : Low level arable farming
Vegetation structure : Wood land Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 21

Ap 0-14 cm 10YR 3/2 moist; sandy loam; clear and wavy boundary; weak fine granular structure; friable when moist; non sticky and plastic when wet; many fine to coarse continuous interstitial pores randomly orientation and distributed both inpeds and expeds; highly porous; many fine roots throughout; few weathered gravel sized volcanic ash materials; few unspecified channels.

AC_1 14-45 cm 10YR 5/2 dry and 7.5YR 2/0 moist; sandy loam; diffuse and smooth boundary; weak fine granular structure; loose when dry and friable when moist; non-sticky and plastic when wet; many fine to coarse continuous interstitial pores with random orientation and both inped and expeds distribution; highly porous; many fine roots throughout; few unspecified channels.

AC_2 45-71 cm 7.5YR 4/2 dry and 7.5YR 2/0 moist; sandy loam; clear and wavy boundary; weak fine granular structure; loose when dry and friable when moist; non-sticky and plastic when wet; many fine to coarse continuous interstitial pores with random orientation; highly porous; very fine to coarse roots throughout; very few unspecified channels.

C_1 71-104 cm 7.5YR 7/6 dry and 7.5YR 6/4 moist; sandy loam; clear and wavy boundary; weakly coherent fine massive structure; loose when dry and moist; non-sticky and plastic when wet; many fine to coarse continuous interstitial pores with random orientation and distributed both inpeds and expeds; highly porous, common fine roots throughout; few unspecified channels.

C_2 **104-170 cm** 7.5YR 8/2 dry and 7.5YR 7/2 moist; sandy loam; weakly coherent medium massive structure; loose when dry and moist; non-sticky and plastic when wet; many coarse continuous interstitial porous with random orientation and both inpeds and expeds distribution; highly porous; few fine roots throughout.

Remark : 70-170 cm volcanic ash deposition.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-21

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution %			Texture Class
			Sand	Silt	Clay	
ETH-21	0-14	0.73	75.64	18	6.36	SL
	14-45	-	63.64	26	10.36	SL
	45-71	-	63.64	24	12.36	SL
	71-104	-	75.64	14	10.36	SL
	104-170	-	73.64	22	4.36	SL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-14	7.5	2.58	0.225	11.4	10.90	1.08			0.17
14-45	6.5	3.55	0.226	15.7	9.50	0.97			0.00
45-71	6.7	*5.34	0.223	23.9	4.37	0.81			0.01
71-104	6.9	3.01	0.269	11.2	3.93	0.69			0.11
104-170	7.9	0.71	0.018	39.4	2.22	0.61			0.06

* = oven dry

NSSP CODE :ETH-21

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-14	0.16	1.93	6.44	0.89				
14-45	1.12	2.33	10.50	1.36				
45-71	1.38	2.15	12.46	1.59				
71-104	2.58	1.03	15.27	1.14				
104-170	1.81	0.90	7.33	0.87				

Depth cm	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-14	11.83	36.8	9.87	83.4	9.85	0.227	25.78	10.32
14-45	14.40	18.0	15.31	106.3	10.51	0.230	21.34	12.35
45-71	12.78	**	17.58	137.6	8.78	0.263	10.94	10.94
71-104	13.36	29.9	20.02	149.9	2.58	0.240	5.04	5.04
104-170	4.07	31.7	10.91	268.1	0.73	0.160	2.19	2.19

Monolith Number : ETH-22 Country : Ethiopia - Shewa
Date : 26/04/94

Classification FAO/UNESCO, 1989 : Umbric Andosol
USDA, 1992 : Umbric Haplustand
Diagnostic horizons : mollic; umbric
Other diagnostic criteria : Abrupt textural change tonging.

Location : Shashemene (Truffe Kechema).Altitude 2050 m.a.s.l
Latitude 07° 11'N Longitude 38° 35'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Plain Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Slightly sheet

Parent material : Volcanic ejecta Derived from : Pyroclasts
Texture : Silty
Remarks : Slightly weathered .

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Moderately well drained
Permeability : Moderate
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 105cm dry;105 - 200cm moist

Land use : Low level arable farming + wood land
Vegetation structure : Man made wood land Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 22

Ap 0-15 cm 10YR 2/1 moist; loam; diffuse and smooth boundary; weak and fine granular structure; loose when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; highly porous; many fine roots throughout.

AC 15-30 cm 5YR 3/1 dry and 10YR 2/1 moist; loam; clear and irregular boundary; weak fine to medium granular structure; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; highly porous; many fine roots throughout; few unspecified pores.

C 30-49 cm 5YR 6/4 dry and 5YR 5/4 moist; sandy loam; clear and smooth boundary; weak fine massive structure that breaks to granular; loose when dry and moist; non-sticky and plastic when wet; many fine to coarse continuous interstitial pores with random orientation and distributed in the matrix; highly porous; few unspecified channels.

II AB 49-65 cm 10YR 3/3 dry and 10YR 2/1 moist; clay loam; diffuse and smooth boundary; mixture of moderate coarse granules and fine angular blocky structures; slightly hard when dry and friable when moist; sticky and plastic when wet; many fine continuous tubular tubes with random orientation and distributed both inpeds and expeds; moderately porous; common fine roots throughout; vouch channel are frequent.

II BA 65-85 cm 10YR 2/2 dry and 10YR 2/1 moist; clay loam; diffuse and smooth boundary; strong medium angular blocky structure that breaks into granular; hard when dry and very firm when moist; sticky and plastic when wet; common fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; moderately porous; few fine roots throughout; few vouch and meta-vouch channels.

II BC 85-105 cm 10YR 6/3 dry and 10YR 3/2 moist; clay loam; clear and wavy boundary; moderates medium to coarse sub-angular blocky structure that breaks into granular; slightly hard when dry and slightly hard when dry and slightly friable when moist; sticky and plastic when wet; many fine continuous tabular pores with random orientation and distributed both in inpeds and expeds; highly porous; few fine roots throughout; unspecified channels are frequent.

IIIB 105-123 cm 10YR 2/1 moist; clay; diffuse and smooth boundary; strong coarse columnar structure that breaks into sub-angular and angular blocky; extremely hard when dry and extremely firm when moist; sticky and plastic when wet; few continuous micro interstitial pores with random orientation and distributed inpeds; slightly porous; few fine roots between peds.

IIBC$_1$ 123-146 cm 10YR2/1 moist; clay; diffuse and smooth boundary; strong coarse to very coarse columnar structure that breaks into angular blocky; extremely hard when dry and

extremely firm when moist; sticky and plastic when wet; very few continuous fine interstitial pores with random orientation and distributed in inpeds; slightly porous; few fine roots between peds.

IIIBC$_2$ 146-170 cm 7.5YR 4/6 moist; clay loam; clear and wavy boundary; mixture of strong coarse angular blocky and columnar structure; extremely hard when dry and extremely firm when moist; sticky and plastic when wet; very few continuous micro tubular pores with random orientation and distributed in inpeds; slightly porous; few fine roots in cracks; continuous thick slickensides and/or pressure face on ped faces.

IV BC$_3$ 170-200cm 7.5YR 3/2 moist; clay ; mixture of strong coarse sub-angular blocky (dominant) and columnar structure; extremely hard when dry and extremely firm when moist; sticky and plastic when wet; few fine continuous tubular pores with random orientation and distributed in inpeds; slightly porous; few fine roots between peds; continuous thick slickensides or pressure face on ped faces.

Remarks : Color of AC is tonging into the C horizon 105-123 was the former. A horizon (A_b), but transformed into B horizon as a result of pressure exerted on it due to accumulation of volcanic ash at different period of the time. Line of weakness is strongly expressed between structural peds, which is considered as pores. Moreover, structural aggregates are separated by wide crack through which roots are conducted. Lining the cracks of III BC_1 there is BC materials. The peds faces of III BC_2 and BC_3 have different color (10YR 2/2) as compared with the inner part.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-22

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-22	0-15	3.43	46.64	30.82	22.54	L
	15-30	-	45.64	29.82	24.54	L
	30-49	-	75.64	11.82	12.54	SL
	49-65	-	29.64	33.82	36.54	CL
	65-85	-	30.64	30.82	38.54	CL
	85-105	-	33.64	29.82	36.54	CL
	105-123	-	21.64	27.82	50.54	C
	123-146	-	21.64	31.82	46.54	C
	146-170	-	29.64	37.82	32.54	CL
	170-200	1.75	27.64	23.82	48.54	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	7.7	5.555	0.357	15.5	28.64	0.95			0.48
15-30	7.1	3.459	0.236	14.6	1.90	0.97			0.12
30-49	6.9	1.723	0.127	13.5	3.56	0.74			0.26
49-65	6.7	1.666	0.084	19.8	0.59	1.74			0.14
65-85	6.8	1.523	0.105	14.5	0.46	1.22			0.04
85-105	6.7	1.052	0.055	19.1	0.21	1.20			0.04
105-123	6.8	0.893	0.078	11.4	0.29	1.59			0.06
123-146	7.1	0.737	0.055	13.4	0.11	1.32			0.08
146-170	7.5	0.575	0.058	9.9	0.39	1.76			0.11
170-200	7.7	0.668	0.045	14.8	87.68	1.77			0.097

* = oven dry

NSSP CODE :ETH-22

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	1.35	5.32	13.11	1.87				
15-30	1.80	2.20	14.99	1.80				
30-49	2.21	2.81	7.09	1.10				
49-65	2.29	2.14	13.55	1.93				
65-85	2.33	2.05	12.35	1.99				
85-105	1.95	2.17	11.40	1.79				
105-123	3.08	4.64	20.75	3.28				
123-146	3.52	5.68	21.31	3.45				
146-170	4.12	6.63	20.74	3.20				
170-200	3.53	5.55	22.20	3.32				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	21.28	10.5	21.65	101.7	8.257	0.443	32.41	43.16
15-30	22.50	46.2	20.79	92.4	4.537	0.313	22.88	30.63
30-49	14.00	61.7	13.21	94.4	3.047	0.187	17.91	9.40
49-65	16.99	30.8	19.91	117.2	1.497	0.330	8.55	33.30
65-85	21.65	40.9	18.72	86.5	0.523	0.313	3.89	15.36
85-105	15.64	32.4	17.31	110.7	0.520	0.313	5.21	16.54
105-123	28.88	50.5	31.75	109.9	0.567	0.253	1.73	6.19
123-146	37.33	69.5	33.96	91.0	0.817	0.15	3.23	20.06
146-170	30.34	88.0	34.69	114.3	0.193	0.167	3.31	11.92
170-200	30.38	55.0	34.60	113.9	1.05	0.42	1.37	1.42

Monolith Number : ETH-23 Country : Ethiopia - Shewa
Date : 28/04/94

Classification FAO/UNESCO, 1989 : Haplic Solonchak
USDA, 1992 : Andic Xerochrept
Diagnostic horizons : Ochric
Other diagnostic criteria : -

Location : Zeway town . Altitude 2300 m.a.s.l
Latitude 07° 55'N Longitude 38° 41'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Plain Topography : Flat
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Partly slaked Sealing : -
Slope processes soil erosion : Slightly sheet

Parent material : Volcanic ejecta Derived from : Pumic
Texture : Silty
Remarks : Slightly weathered .

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Medium
Moisture condition of the profile : Dry throughout the profile.

Land use : High level arable farming + afforestation
Vegetation structure : Wood land (Unspecified) Status : Primary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 23

Ap_1 0-4 cm 10YR 8/2 dry and 10YR 5/3 moist; silty clay; clean and smooth boundary; weak fine platy structure (laminic layer); slightly hard when dry and friable when moist; slightly sticky and plastic when wet; common fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; moderately porous; many fine roots throughout.

Ap_2 4-31 cm 10YR 6/2 dry and 10YR 4/4 moist; loam ; diffuse and smooth boundary; weak fine angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; few fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; moderately porous; common fine roots throughout; few very coarse fresh pumice.

BC 31-75 cm 10YR 6/3 dry and 10YR 5/4 moist; loam ; diffuse and smooth boundary; weak fine to medium angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; slightly sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed in inpeds; highly porous; common fine roots throughout, few coarse fresh pumice.

CB 75-145 cm 10YR 6/3 dry and 10YR 4/3 moist; silty loam; clear and smooth boundary; weak fine angular blocky structure that breaks into granular; slightly hard when dry and friable when moist; slightly plastic and sticky when wet; many fine continuous interstitial pores with random orientation and distributed in inpeds; highly

porous; few fine roots throughout; extremely coarse fresh pumice are very frequent (40-80%), few bettles channels.

C_1 145-175 cm 5YR 5/1 moist; silty loam; diffuse and smooth boundary; very weak fine massive structure that breaks into single grain; loose and smeary when moist; non-sticky and plastic when wet; many continuous micro interstitial pores with random orientation and distributed in the matrix; highly porous; few fine roots throughout; few very coarse fresh pumice.

C_2 175-200 cm 5YR 5/1 moist; silty loam ; very weak fine massive structure; loose and smeary when moist; non-sticky and plastic when wet; many micro interstitial pores with random orientation and distributed in the matrix; highly porous; very few fine roots throughout; very few (< 5% by volume) coarse unweathered pumice.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-23

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-23	0-4	8.69	25.64	52.82	21.54	SiL
	4-31	7.53	27.64	46.82	25.54	L
	31-75	-	27.64	49.82	22.54	L
	75-145	-	23.64	51.82	24.54	SiL
	145-175	2.08	41.64	52.82	5.54	SiL
	175-200	1.01	49.64	49.82	0.54	SiL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-4	8.0	3.162	0.219	14.4	30.80				0.22
4-31	8.3	2.031	0.216	9.4	43.01	1.14			0.20
31-75	8.5	1.507	0.134	11.2	55.61	0.86			
75-145	9.2	1.497	0.155	9.6	6.36	0.78			
145-175	9.8	0.554	0.031	17.8	6.20	0.60			
175-200	9.7	0.650	0.040	16.2	1.20	0.63			

* = oven dry

NSSP CODE : ETH-23

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-4	1.87	5.00	24.78	3.54				
4-31	2.15	3.29	27.57	3.71				
31-75	2.40	2.95	24.33	4.81				
75-145	6.98	4.91	19.74	4.25				
145-175								
175-200								

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-4	21.53	44.5	35.19	163.4	4.393	0.370	2.80	42.46
4-31	21.83	58.8	36.72	167.8	3.627	0.343	2.76	9.70
31-75	21.51	67.3	34.49	160.3	2.290	0.340	2.21	7.89
75-145	12.20	28.7	35.88	294.1	2.447	0.420	3.46	13.14
145-175	7.92	91.6			1.163	0.147	4.88	3.05
175-200	5.04	57.1			0.660	0.113	6.42	3.45

Monolith Number : ETH-24 Country : Ethiopia - Hararghie
Date : 3/06/94

Classification FAO/UNESCO, 1989 : Eutric Vertisol
USDA, 1992 : Typic Pellustert
Diagnostic horizons : Umbric; cambic
Other diagnostic criteria : Slickenside

Location : Alemaya - AUA main campus. Altitude 1950 m.a.s.l
Latitude 07° 23'N Longitude 42° 01'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : <2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Large Sealing : -
Slope processes soil erosion : Nil

Parent material : Volcanic ejecta Derived from : Granite
Texture : Sandy
Remarks : Highly weathered .

Effective soil depth (cm) : 200

Water table depth (cm) : Not observed Kind : -
Drainage : Imperfectly drained
Permeability : Low
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 20cm dry; 20cm+ moist.

Land use : High level arable farming
Vegetation structure : Mixed man made Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 24

Ap 0-20 cm 10R 4/2 when dry and 10R 3/2 when wet; clay diffuse and smooth boundary; weak moderate sub-angular blocky structure that breaks into coarse granules; loose to hard when dry and friable when moist; sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; many fine roots throughout; few ants.

AB 20-50 cm 2.5YR 3/2 when dry and 2.5YR 5/2 when moist; Clay;diffuse and smooth boundary; strong coarse to moderate sub-angular blocky structure; hard when dry and very firm when moist; very sticky and plastic when wet; fine to medium continuous vasicular pores (coverage of 50-200/dm^3 by volume) with random orientation and distributed both inpeds and expeds; moderately porous; many fine roots dominately within ped but also along ped faces; few irregular small and hard calcareous nodules; few fungal activities.

Bw_1 50-95 cm 5YR 3/1 when dry and 5YR 2.5/1 when moist; clay;diffuse and smooth boundary; strong coarse angular blocky structure that breaks into sub-angular blocky; parapaypates are common and slickensides are developed at about 50° from horizontally; very hard when dry and very firm when moist; very sticky and plastic when wet; very few and fine continuous vascular pores with random orientation and distributed inpeds; low porosity; few fine roots along the slickenside surface; very few irregular small and hard calcareous nodules.

Bw_2 95-146 cm 2.5YR 2.5/0 when wet;clay; clear and wavy

boundary; strong coarse prismatic structure that breaks into angular blocky; many parapaypates and slikensides oriented 45° - 60° from horizontal; very hard when dry and firm when moist; sticky and plastic when wet; few fine discontinuous tubular pores with random orientation and distributed inpeds; low porosity; very few fine roots along the slicken side faces; very few small irregular and hard calcareous nodules.

Bk_1 146-196 cm 10YR 4/3 when moist; clay;diffuse and smooth boundary; moderate coarse prismatic structure that breaks into angular blocky; many parapaypates and slickenside oriented at about 60° from the horizontal line; friable to firm when moist; sticky and plastic when wet; few fine continuous tubular pores with random orientation and distributed inpeds; low porosity; very few fine roots along the slickenside faces; many small irregular and hard calcareous nodules.

Bk_2 196^+ cm

ETH - 24

Ap 0-18 cm 10R 4/2 when dry and 10R 3/2 when moist; clay diffuse and smooth boundary; weak fine to moderate sub-angular blocky structure that breaks into coarse granular; loose to firm when dry and friable when moist; sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; many fine roots throughout; few ants.

BA 18-39 cm 10YR 4/3 when wet; clay;clear and wavy boundary; strong coarse angular blocky structure that breaks

into sub-angular blocky; very hard when dry and firm when moist; sticky and plastic when wet; fine discontinuous interstitial pores (50-200/dm^3 coverage) with random orientation and distributed inpeds; low total porosity; few fine roots throughout; few small, irregular and hard calcareous modules in matrix.

Bk_1 39-78 cm 5YR 4/3 when wet; clay;diffuse and smooth boundary; strong moderate to coarse angular blocky and few prismatic structures that break into sub-angular blocky structure; few parapaypates and weakly developed slickenside oriented at about 45° from horizontal; very hard when dry and extremely firm when moist; sticky and plastic when wet; few fine discontinuous interstitial pores with random orientation and distributed inpeds; low total porosity; few fine roots both inpeds and along the slickenside faces; small and hard irregular calcareous nodules with 15-45% coverage by volume; few medium and distinct mottles (2.5YR 2.5/0) with clear boundary.

Bk_2 78-115 cm 5YR 3/3 when moist; clay;diffuse and smooth boundary; strong coarse prismatic structure that breaks into angular blocky; common parapaypates and slickenside oriented at about 70° from horizontal; hard when dry and friable to firm when moist; sticky and plastic when wet; few fine discontinuous interstitial pores with random orientation and distributed inpeds; low porosity; few fine roots some inpeds and some along slickenside faces; few medium and distinct mottles (2.5YR 2.5/0) with clear boundary; small and hard irregular calcarious nodules.

Bk_3 115-155 cm 5YR 3/3 when moist; clay;diffuse and smooth boundary; strong coarse prismatic structure that breaks into angular blocky, many

parapaypates with slickensides that are oriented at about 65-80° from horizontal; firm when moist; sticky and plastic when wet; few fine discontinuous interstitial pores with random orientation and distributed inpeds; low porosity; few fine roots along the slickenside faces; few medium and distinct mottles (2.5YR 2.5/0) with clear boundary; small and hard irregular calcareous nodules.

Bk_4 155-190 cm 5YR 4/3 when wet; clay; diffuse and smooth boundary; weak fine to coarse prismatic structure that breaks to angular blocky; common parapaypates and few slickenside with orientation at about 65-80° from horizontal; friable when moist; sticky and plastic when wet; few fine discontinuous interstitial pores with random orientation and distributed inpeds; low porosity; very few fine roots along the slickenside faces; few small and hard irregular cacarous nodules.

Remarkes : The carbonate matrial and dark surface are demarked by the slickenside in the sub-surface soil.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-24A

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-24			MICRO LOW			
	0-20	3.30	19.64	30	50.36	C
	20-50	4.33	25.64	25	49.36	C
	50-95	3.40	19.64	24	56.36	C
	95-146	4.91	21.64	26	52.36	C
	146-196	12.84	21.64	20	58.36	C
	196+	6.89	19.64	20	60.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-20	8.0	2.833	0.310	9.1	43.0				0.17
20-50	8.2	1.312	0.255	5.1	2.16				0.13
50-95	8.5	0.734	0.073	10.0	1.21				0.25
95-146	8.5	0.650	0.144	5.0	0.21				0.27
146-196	8.5	0.452	0.059	7.7	0.46				0.25
196+	8.7	0.252	0.020	12.6	0.80				0.27

* = oven dry

NSSP CODE :ETH-24A

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-20	1.26	2.88	50.09	5.91				
20-50	1.19	0.80	51.16	5.77				
50-95	1.46	0.67	49.54	8.83				
95-146	1.81	0.66	50.50	8.80				
146-196	1.90	0.57	54.63	7.35				
196+	2.09	0.59	47.00	7.27				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-20	62.48	106.8	60.14	96.3	1.068	1.545	5.14	10.99
20-50	63.93	119.1	58.92	92.2	0.900	1.466	5.06	4.79
50-95	63.31	107.8	60.50	95.6	0.772	1.128	4.23	2.42
95-146	59.16	102.8	61.77	104.4	1.005	1.234	4.59	1.72
146-196	51.35	85.3	64.45	125.5	0.498	0.815	3.50	1.05
196+	50.97	83.0	56.95	111.7	0.540	0.655	3.47	0.94

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-24B

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-24			MICRO HIGH			
	0-18	3.57	21.64	28	50.36	C
	18-39	3.31	25.64	24	50.36	C
	39-78	13.33	17.64	22	60.36	C
	78-115	15.57	19.64	22	58.36	C
	115-155	14.19	17.64	22	60.36	C
	155-190	12.38	23.64	20	56.36	C
	190+	8.59	21.64	18	60.36	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-18	8.8	1.570	0.174	9.0	10.87				0.23
18-39	8.5	1.071	0.152	7.0	1.36				0.20
39-78	8.7	0.407	0.028	14.5	0.77				0.25
78-115	8.7	0.316	0.032	9.9	0.74				0.28
115-155	8.8	0.317	0.032	9.9	0.62				0.28
155-190	8.9	0.124	0.047	2.6	0.43				0.26
190+	8.8	0.102	0.008	12.8	0.50				0.26

* = oven dry

NSSP CODE :ETH-24B

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-18	0.99	1.79	50.50	5.61				
18-39	0.90	0.72	48.07	5.25				
39-78	1.26	0.66	62.78	7.24				
78-115	1.78	0.70	50.88	7.71				
115-155	2.02	0.69	50.26	7.47				
155-190	2.07	0.58	45.73	7.08				
190+	2.24	0.68	49.68	7.16				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-18	57.73	108.2	58.89	102.0	0.793	1.415	4.63	6.45
18-39	55.78	105.5	54.94	98.5	0.476	1.250	4.06	3.82
39-78	52.89	88.2	71.94	136.0	0.636	1.045	4.46	1.97
78-115	51.44	80.7	61.07	118.7	0.959	0.993	3.89	1.81
115-155	44.49	73.1	60.44	135.9	0.489	0.818	3.51	1.37
155-190	42.75	73.8	55.46	129.7	0.338	0.597	3.82	1.06
190+	41.13	67.6	59.76	145.3	0.475	0.588	3.82	0.98

Monolith Number : ETH-25 Country : Ethiopia - Hararghie
Date : 06/06/94

Classification FAO/UNESCO, 1989 : Ferric Luvisol
USDA, 1992 : Udic Rhodoxeralf
Diagnostic horizons : Argillic; ochric
Other diagnostic criteria : -

Location : Hararghie - Amaressa Altitude 1950 m.a.s.l
Latitude 09° 19'N Longitude 42° 06'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : 3%; ; Straight
Position of site : Flat or almost flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Slight sheet

Parent material : Volcanic ejecta Derived from : Granite
Texture : Sandy
Remarks : Highly weathered .

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 19cm dry; 19cm+ moist.

Land use : Low level arable farming with intercropping
Vegetation structure : Mixed man made Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 25

Ap 0-19 cm 2.5YR 3/4 dry and 2.5YR 2.5/4 moist; clay loam; diffuse and smooth boundary; weak fine granular structure; loose when dry and friable when moist; sticky and plastic when wet; many continuous micro tubular pores with random orientation and distributed inpeds; highly porous; many fine roots throughout; very few fresh quartz grains; few ants.

BA 19-45 cm 10R 3/3 moist; clay; diffuse and smooth boundary; weak fine angular blocky structure that breaks to coarse granular structure; friable when moist; sticky and plastic when wet; many fine continuous and discontinuous tubular pores with random orientation and distributed inpeds; moderately porous; few fine roots throughout; thin continuous clay cutans with shiny pad faces; few unspecified channels.

Bt_1 45-70 cm 10R 3/3 moist; clay; diffuse and smooth boundary; weak fine angular blocky structure that breaks to fine sub-angular blocky and then to granular; friable when moist; sticky and plastic when wet; few fine discontinuous tubular pores with random orientation and distributed inpeds; low porosity; very few fine roots throughout; thin and continuous clay cutans with shiny surface.

Bt_2 70-100 cm 10R 3/3 moist; clay; diffuse and smooth boundary; moderate medium to coarse columnar structure that breaks first to angular blocky and then to granular; friable when moist; sticky and plastic when wet; few discontinuous fine tubular pores with random orientation and distributed in inpeds; low porosity; very few fine roots throughout; thick and continuous well developed clay cutans on ped faces.

Bt_3 100-134 cm 10R 3/4 moist; clay; diffuse and smooth boundary; strong coarse columnar structure that breaks first to angular blocky and then to granular; friable when moist; sticky and plastic when wet; few discontinuous fine tubular pores with random orientation and distributed inpeds; low porosity; few fine faint diffuse Fe-Mn mottles (10R 2.5/1); thick continuous well developed clay cutans on ped faces.

Bt_4 134-171 cm 10R 3/4 moist; clay; diffuse and smooth boundary;strong coarse columnar structure; friable when moist; sticky and plastic when wet; few discontinuous tubular pores with random orientation and distributed in inpeds; low porosity; fine faint and diffuse Fe-Mn mottles (10R 2.5/1) with a coverage of 2-20% by volume; thick continuous well developed clay cutants on ped faces.

Bt_5 171 cm$^+$ 10R 3/4 moist; clay; strong coarse columnar structure; friable when moist; sticky and plastic when wet; few discontinuous tubular pores with random orientation and distributed in inpeds; low porosity; fine faint and diffuse Fe-Mn mottles (10R 2.5/1) with a coverage of 2-20% by volume; very thick continuous well developed clay cutants on ped faces.

Remarks :
- At the subsurface soil pore size is not evidenced; porosity is low, but inflectration is high as a result of sand like and size particles.
- Water movement is associated along the pad faces.
- After 20 cm clay distribution is uniform.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-25

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-25	0-19	1.48	35.64	32	32.36	CL
	19-45	0.57	23.64	20	56.36	C
	45-70	1.03	21.64	14	64.36	C
	70-100	1.13	21.64	12	66.36	C
	100-134	1.26	21.64	10	68.36	C
	134-171	1.54	23.28	10	66.72	C
	171+	0.97	23.28	10	66.72	C

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-19	8.5	1.202	0.176	6.8	4.22	1.05			1.11
19-45	7.8	0.597	0.091	6.6	1.34	1.14			0.07
45-70	7.7	0.900	0.056	16.0	0.71	1.19			0.03
70-100	7.2	0.169	0.056	3.0	1.03	1.06			0.08
100-134	7.3	0.990	0.073	13.6	1.29	1.18			0.07
134-171	7.7	0.077	0.043	1.8	1.03	1.36			0.03
171+	7.5	0.226	0.189		1.07				0.04

* = oven dry

NSSP CODE : ETH-25

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-19	0.64	0.90	25.05	3.11				
19-45	0.70	0.53	15.69	3.96				
45-70	0.86	0.62	15.19	4.66				
70-100	0.76	0.63	13.91	4.27				
100-134	0.61	0.55	12.26	3.70				
134-171	0.66	0.55	11.58	3.62				
171+	0.65	0.55	11.01	3.42				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-19	26.96	63.6	29.70	110.2	1.074	1.611	1.97	3.88
19-45	29.90	49.4	20.88	69.8	0.062	1.073	3.66	2.84
45-70	30.83	43.1	21.33	69.2	0.069	0.754	4.29	5.01
70-100	21.84	-	19.57	89.6	0.124	0.439	2.21	5.28
100-134	49.54	67.5	17.12	34.6	0.121	0.186	1.13	1.37
134-171	24.62	-	16.41	66.7	0.132	0.121	0.72	1.00
171+	22.66	-	15.36	69.0	0.129	0.097	0.67	0.69

Monolith Number : ETH-26 Country : Ethiopia - Hararghie
Date : 08/06/94

Classification FAO/UNESCO, 1989 : Eutric Regosol
USDA, 1992 : Typic Ustorthent
Diagnostic horizons : -
Other diagnostic criteria : -

Location : Hararghie - Alemaya (AUA).Altitude 1950 m.a.s.l
Latitude 09° 23'N Longitude 42° 01'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Hill Topography : Undulating
Physiographic unit :
Slope gradient/aspect/form : 8%; ; Straight
Position of site : Lower slope
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Slight sheet

Parent material : Volcanic ejecta Derived from : Granite
Texture : Sandy
Remarks : Starting 40cm unconsolidated parent material.

Effective soil depth (cm) : 40

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Nil Runoff : Slow
Moisture condition of the profile : 0 - 40cm dry.

Land use : Low level arable farming.
Vegetation structure : Mixed man made Status : Secondary

Climate
Station :
Soil moisture regime : Ustic
Soil temperature regime : Isohyperthermic

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 26

Ap 0-15 cm 10R 3/2 dry and 10R 2.5/2 moist; clay;clear and wavy boundary; weak fine to moderate massive structure that breaks to coarse granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous interstitial pores with random orientation and distributed both inped and exped; highly porous; many fine roots throughout; many medium sized and irregular shaped quartz grains; few termite channels.

AC 15-40 cm 10R 3/3 dry and moist; clay; diffuse and smooth boundary; weak fine medium massive structure that breaks to granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous fine interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; very few fine roots throughout; few ant channels.

CR_1 40-85 cm 10R 3/4 when dry and moist; clay;diffuse and smooth boundary; weak coarse massive structure that breaks to granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous fine interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; very few fine roots throughout; few ant channels.

CR_2 85-135 cm 10R 3/6 when dry and moist; clay ;diffuse and smooth boundary; strong coarse massive structure that breaks to coarse granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous fine interstitial pores oriented randomly and

distributed both inpeds and expeds; highly porous; few unspecified channels.

CR_3 135-173 cm 5YR 5/8 dry and 5YR 5/6 moist; sandy clay loam;diffuse and smooth boundary; weak coarse massive structure that breaks first to sub-angular blocky and then to granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous fine interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; few ants channels.

CR_4 173-215 cm 5YR 6/6 dry and 5YR 5/6 moist; sandy clay loam; weak coarse massive structure that breaks first to sub-angular blocky and then to granular; hard when dry and friable when moist; slightly sticky and plastic when wet; many continuous fine interstitial pores randomly oriented and distributed both inpeds and expeds; high total porosity; few ant channels.

Remarks :
- CR_1 has a zone of high alteration.
- CR_2 has a high amount of un-altered granite.
- CR_3 has high amount of saprolyte.
- CR_4 dominated by saprolitic material.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH-ETH-26

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-26	0-15	0.43	37.28	20	42.72	C
	15-40	0.94	43.28	10	46.72	C
	40-85	0.95	41.28	13	45.72	C
	85-135	0.79	41.28	12	46.72	C
	135-173	0.26	49.28	16	34.72	SCL
	173-215	0.88	51.28	16	32.72	SCL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	7.4	1.280	0.114	11.2	6.92	1.35			0.06
15-40	7.5	0.963	0.128	7.5	2.70	1.397			0.04
40-85	7.6	0.388	0.044	8.8	1.41	1.55			0.03
85-135	7.7	0.157	0.062	2.5	1.08	1.54			0.03
135-173	8.0	0.331	0.040	8.3	1.19	1.58			0.03
173-215	8.2	0.308	0.022	14.0	1.32	1.44			0.07

* = oven dry

NSSP CODE : ETH-26

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	0.75	1.60	13.15	3.25				
15-40	0.65	0.70	11.93	3.18				
40-85	0.64	0.44	8.77	2.49				
85-135	0.63	0.33	7.94	2.35				
135-173	0.59	0.21	5.63	1.73				
173-215	0.63	0.21	6.74	1.94				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	23.35	44.3	18.76	80.3	1.021	1.463	12.28	19.32
15-40	23.58	43.4	16.46	69.8	0.247	1.062	11.22	7.50
40-85	18.25	37.4	12.34	67.6	0.242	0.818	6.47	6.06
85-135	20.23	42.1	11.25	55.6	0.229	0.605	3.27	5.36
135-173	4.77	10.5	8.16	171.1	0.405	0.353	2.43	3.20
173-215	13.80	38.3	9.52	69.0	0.350	0.371	3.13	3.25

Monolith Number : ETH-27 Country : Ethiopia - Hararghie
Date : 11/06/94

Classification FAO/UNESCO, 1989 : Salic Fluvisol
USDA, 1992 : Xeric Terrifluvent
Diagnostic horizons : Ochric
Other diagnostic criteria : -

Location : Melka Sedi (near main canal).Altitude 1100 m.a.s.l
Latitude 09° 16'N Longitude 40° 08'E
Author(s) : B.K.Yerima and Eylachew Z.

General landform : Alluvial plain Topography : Flat
Physiographic unit :
Slope gradient/aspect/form : 2%; ; Straight
Position of site : Flat
Micro-relief rock outcrop : Nil Stoniness : Nil
Cracking : Nil Sealing : -
Slope processes soil erosion : Nil

Parent material : Alluvium Derived from : Mixed lithology
Texture : Mixed
Remarks : Deposits transported from central highland.

Effective soil depth (cm) : >200

Water table depth (cm) : Not observed Kind : -
Drainage : Well drained
Permeability : High
Flooding frequency : Yearly Runoff : Slow
Moisture condition of the profile : 0 - 87cm dry; 87cm wet

Land use : High level arable farming.
Vegetation structure : Mixed Status : Secondary

Climate
Station :
Soil moisture regime :
Soil temperature regime :

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rel.Hum. %												
Sun s.hrs/day												
ppt (mm)												
T. mean (c°)												
max. (c°)												
min. (c°)												

ETH - 27

Ap 0-15 cm 7.5YR 4/3 dry and 7.5YR 3/2 moist; clay; diffuse and smooth boundary; strong coarse granular structure; hard when dry and firm when moist; sticky and plastic when wet; many continuous micro interstitial pores with random orientation and distributed both inpeds and expeds; high total porosity; many fine roots throughout; few ant channels.

AB 15-35 cm 7.5YR 5/2 dry and 7.5YR 4/2 moist; silty clay; clear and smooth boundary; strong coarse sub-angular blocky structures which is granular in place; hard when dry and firm when moist; sticky and plastic when wet; many discontinuous and continuous fine to medium interstitial pores with random orientation and distributed both inpeds and expeds; moderately porous; few fine roots throughout; ant channels are frequent.

C 35-51 cm 7.5YR 6/2 dry and 7.5YR 4/2 moist; silty loam;clear and smooth boundary; weak fine to medium massive structure that breaks to granular; slightly hard when dry and friable when moist; sticky and plastic when wet; fine continuous tubular pores with coverage of 50-200/dm^3 by volume and distributed both inpeds and expeds with random orientation; high total porosity; few fine roots throughout; ant channels are frequent.

II BA 51-62 cm 10YR 3/1 both dry and moist; silty clay loam;clear and smooth boundary; weak fine granular structure; slightly hard when dry and friable when moist; sticky and plastic when wet; fine continuous tubular pores (50-200/dm^3) with random orientation and

distributed both inpeds and expeds; high total porosity; very few fine roots throughout; ant channels are frequent.

II C 62-87 cm 7.5YR 5/2 dry and 7.5YR 4/2 moist; silty clay;clear and smooth boundary; weak fine massive structure that breaks to granular; slightly hard when dry and friable when moist; sticky and plastic when wet; fine continuous tubular pores (50-200/dm^3) with random orientation and distributed in inpeds; high total porosity; very few fine roots throughout; ant channels are frequent.

IIIBA 87-106 cm 7.5YR 3/4 moist; clay; clear and wavy boundary; strong coarse sub-angular blocky structure; hard when dry and friable when moist; sticky and plastic when wet; few fine continuous tubular pores with random orientation and distributed in inpeds; moderately porous.

IIIC 106-123 cm 7.5YR 4/2 moist; silty clay;clear and smooth boundary; weak fine massive structure that breaks to granular, has thin laminar in place and whitish materials in the matrix; slightly hard when dry and friable when moist; few fine continuous tubular pores with random orientation and distributed in inpeds; high total porosity.

IV BA 123-134 cm 7.5YR 3/2 moist; clay; clear and smooth boundary; weak fine massive structure that breaks to granular and has whitish materials in the matrix; slightly hard when dry and friable when moist; sticky and plastic when wet; few fine continuous interstitial pores with random orientation and distributed inpeds; moderately porous.

IV BC 134-155 cm 7.5YR 4/2 moist; clay; clear and wavy boundary; weak fine massive structure that breaks to granular and has thin laminar in place; slightly hard when dry and friable when moist; sticky and plastic when wet; few fine continuous tubular pores with random orientation and distributed inpeds; moderately porous.

IV C 155-167 cm 7.5YR 3/2 moist; silty clay loam;clear and wavy boundary; weak fine massive structure that breaks to granular, has thin laminar in place and whitish materials in the matrix; slightly hard when dry and friable when moist; sticky and plastic when wet; many fine and continuous tubular pores with random orientation and distributed inpeds; moderately porous.

V C_1 167-195 cm 7.5YR 4/2 moist; clay loam; clear and wavy boundary; weak fine massive structure that breaks to granular; slightly hard when dry and friable when moist; sticky and plastics when wet; many fine and continuous tubular pores with random orientation and distributed inpeds; high total porosity.

V C_2 195-209 cm 7.5YR 5/2 moist; clay loam; clear and smooth boundary; weak fine massive structure that breaks to granular; loose when dry and moist; non-sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distributed inpeds; high total porosity.

VI BA 209 cm+ 7.5YR 3/0 moist; sandy clay loam; weak fine massive structure; friable when moist; sticky and plastic when wet; many fine continuous interstitial pores with random orientation and distribution inpeds; high total porosity.

Remarks : Between 155 and 167 cm the three faces of the profile have different texture as compared with the sampled face. Therefore, bulk sample was taken separately as sub-sample.

National Soil Service Project ETH/87/010
Soil Chemical and Physical Data

NSSP CODE : ETH- 27

Field No	Depth cm	$CaCO_3$ %	Particle Size Distribution % Sand	Silt	Clay	Texture Class
ETH-27	0-15	6.36	19.28	36	44.72	C
	15-35	7.28	19.28	40	40.72	SiC
	35-51	5.29	15.28	58	26.72	SiC
	51-62	6.35	14.28	49	36.72	SiCL
	62-87	4.50	13.28	48	38.72	SiC
	87-106	5.70	11.28	34	54.72	C
	106-123	5.51	9.28	46	44.72	SiC
	123-134	7.69	15.28	30	54.72	C
	134-155	9.61	29.28	26	44.72	C
	155-167	7.22	55.28	16	28.72	SCL
	167-195	8.76	29.28	30	40.72	CL
	195-209	6.72	41.28	28	30.72	CL
	209+	6.51	57.28	22	20.72	SCL

Depth cm	pH	O.C %	T.N %	C/N %	Av.P ppm	B.D* gm cm^{-3}	F.C %	P.W.P %	E.C mmhos/cm
0-15	8.7	1.593	0.144	11.1	9.28	1.16			0.28
15-35	8.8	0.950	0.104	9.1	4.65	1.14			0.25
35-51	8.7	0.643	0.039	16.4	3.78	1.07			0.25
51-62	8.8	0.779	0.078	10.0	4.66	1.07			0.25
62-87	8.8	0.878	0.102	8.6	4.90	1.17			0.26
87-106	8.7	0.648	0.052	12.4	4.68	1.25			
106-123	8.6	0.556	0.047	11.8	7.02	1.21			
123-134	8.8	0.556	0.023	24.1	5.99	1.30			
134-155	9.0	0.599	0.038	15.8	5.02				
155-167	8.8	0.248	0.029	8.6	5.41				
167-195	8.9	0.561	0.050	11.2	5.53				
195-209	9.1	0.343	0.030	11.4	4.73				
209+	9.3	0.343	0.087	3.9	2.92				

* = oven dry

NSSP CODE :ETH-27

Depth cm	Exch. Bases meq/100g soil				Exch. Acidity meq/100g soil			Sum Cations
	Na	K	Ca	Mg	Al+H	Al	H	
0-15	2.81	5.31	43.14	4.11				
15-35	3.08	3.76	39.61	3.92				
35-51	3.94	2.58	34.87	3.05				
51-62	3.75	3.38	43.42	3.30				
62-87	3.53	3.21	43.47	3.62				
87-106	4.06	3.54	47.03	4.61				
106-123	3.62	2.87	43.72	4.15				
123-134	3.73	2.95	44.47	5.24				
134-155	3.07	1.92	38.36	5.27				
155-167	1.52	2.11	24.89	2.25				
167-195	3.04	1.73	36.55	5.14				
195-209	3.23	1.50	31.67	4.57				
209+	2.96	1.06	21.09	3.39				

Depth	CEC (meq/100g)		Base Sat		Micronutrient (ppm)			
cm	Soil	Clay	Sum	CEC	Zn	Cu	Fe	Mn
0-15	43.25	48.7	55.37	127.7	0.932	1.631	2.45	5.97
15-35	45.07	102.6	50.37	111.8	0.602	1.477	3.35	3.06
35-51	42.33	150.1	44.44	105.0	0.513	1.320	3.56	2.84
51-62	45.90	121.0	53.85	117.3	0.446	1.293	2.91	2.64
62-87	46.79	110.2	53.83	115.0	0.446	1.270	2.85	2.63
87-106	49.66	88.3	59.24	119.3	0.558	1.481	2.84	2.49
106-123	44.11	92.3	54.86	124.4	0.424	1.348	2.59	2.23
123-134	45.01	80.2	56.39	125.3	0.401	1.348	2.21	2.03
134-155	34.04	71.5	48.62	142.8	0.327	1.047	1.63	1.51
155-167	19.72	68.1	30.77	156.0	0.281	0.696	1.99	1.53
167-195	33.51	80.5	46.46	138.6	0.281	0.844	1.33	1.41
195-209	33.94	104.9	40.97	120.7	0.333	0.677	1.22	1.21
209+	21.86	99.8	28.50	130.4	0.344	0.479	1.30	1.16